MADRID 2018
iROS

TOWARDS A ROBOTIC SOCIETY

2018 IEEE/RSJ International Conference on Intelligent Robots and Systems

October, 1-5, 2018
Madrid, Spain, Madrid Municipal Conference Centre

Digest

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1. Program at a Glance

Monday Oct 1, 2018	Tuesday Oct 2, 2018		Wednesday Oct 3, 2018		Thursday Oct 4, 2018		Friday Oct 5, 2018
WS / TUT	**CONFERENCE**		**CONFERENCE**		**CONFERENCE**		**WS / TUT**
Workshops / Tutorials 9:00-11:00	Technical sessions 9:00-11:00		Technical sessions 9:00-10:00		Technical sessions 9:00-10:00		Workshops / Tutorials 9:00-11:00
			Plenary session II 10:00-11:00		Plenary session III 10:00-11:00		
Coffee break 11:00-11:30	Coffee break 11:00-11:30		Coffee break 11:00-11:30		Coffee break 11:00-11:30		Coffee break 11:00-11:30
Workshops / Tutorials 11:30-13:30	Exhibition opening 11:30-12:00	Forums/ Robot Competitions /Exhibition/ Technical tour	Technical sessions 11:30-13:30	Forums/ Robot Competitions /Exhibition/ Technical tour	Technical sessions 11:30-13:30	Forums/ Robot Competitions /Exhibition/ Technical tour	Workshops / Tutorials 11:30-13:30
	Opening ceremony 12:00-12:30						
	Plenary session I 12:30-13:30						
Lunch 13:30-14:30	Lunch 13:30-14:30		Lunch 13:30-14:30		Awards Luncheon 13:30-15:30		Lunch 13:30-14:30
Workshops / Tutorials 14:30-16:30	Technical sessions 14:30-15:30		Technical sessions 14:30-15:30				Workshops / Tutorials 14:30-16:30
	Keynotes 15:30-16:00		Keynotes 15:30-16:00		Technical sessions 15:30-16:30		
	Coffee break 16:00-16:30		Coffee break 16:00-16:30				
Coffee break 16:30-17:00	Keynotes 16:30-17:00		Keynotes 16:30-17:00		Keynotes 16:30-17:00		Coffee break 16:30-17:00
Workshops / Tutorials 17:00-19:00	Technical sessions 17:00-19:00		Technical sessions 17:00-19:00		Technical sessions 17:00-19:00		Workshops / Tutorials 17:00-19:00
Welcome reception - Town Hall	OC/iCPRB Dinner (by invitation)		Banquet - WiZink Centre		Farewell party - Madrid MCC		

2. Registration

The registration desk, located in the Madrid Municipal Conference Centre, at the main hall on the ground floor, will be open for general information, picking up your registration materials, and onsite registrations.

Registration hours are as follows:

Day	Time
Monday, October 1	7:00 – 19:00
Tuesday, October 2	7:00 – 19:00
Wednesday, October 3	8:00 – 19:00
Thursday, October 4	8:00 – 19:00
Friday, October 5	8:00 – 14:30

Registration fees, in euros (€)

	Category	Onsite
CONFERENCE (2-4 October)	IEEE/RSJ members	910
	Nonmembers	1120
	IEEE/RSJ students members	465
	Nonmember students	570
	IEEE Life member	Free
WORKSHOPS / TUTORIALS (1 and 5 October)	IEEE/RSJ members	205
	Nonmembers	370
	IEEE/RSJ students members	125
	Nonmember students	200
	IEEE Life member	Free

IROS 2018 Exhibition is located at the Madrid Municipal Conference Centre, on the third floor. Conference registration allows you to visit the Exhibition freely, any time within the opening hours.

Exhibition hours are as follows:

| Day	Time
Tuesday, October 2	9:00 – 18:00
Wednesday, October 3	9:00 – 18:00
Thursday, October 4	9:00 – 16:00

3. Conference application

IROS 2018 Proceedings will be given in electronic iProceeding or eProceeding format, based on availability, to every full-registered person in the conference.

- iProceedings format: IROS has partnered with InfoVaya to provide the conference interactive App which accesses and views the Proceedings (PDFs and videos).

- eProceedings format: an external viewer is required to access the contents which is provided as a web-browsable interface with the Proceedings (PDFs and videos).

- Cloud access format: an additional password set link has been emailed to you to be able to access the InfoVaya cloud with the Proceedings from any device.

InfoVaya-related formats (iProceedings and InfoVaya cloud) additionally allow you:

- View your events

- Explore the program in full detail

- Plan your time at the event

- Set up your profile

- Browse other profiles

- Access conference documents

- View venue maps / floor plans

- Like your favourites

4. Conference Venue
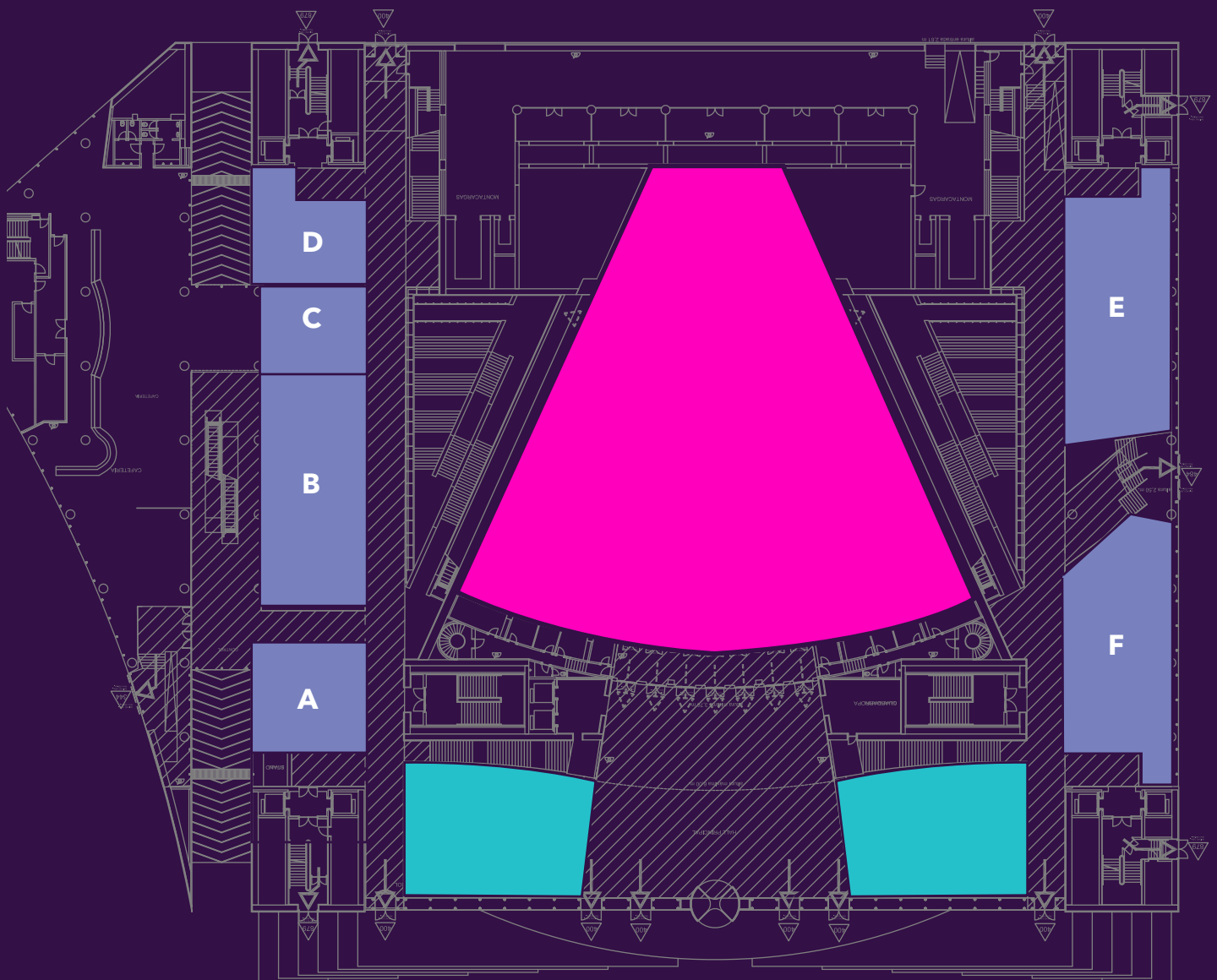
Ground Floor

- Registration desk, Madrid info desk
- Indoor competitions areas
- Auditorium

4. Conference Venue
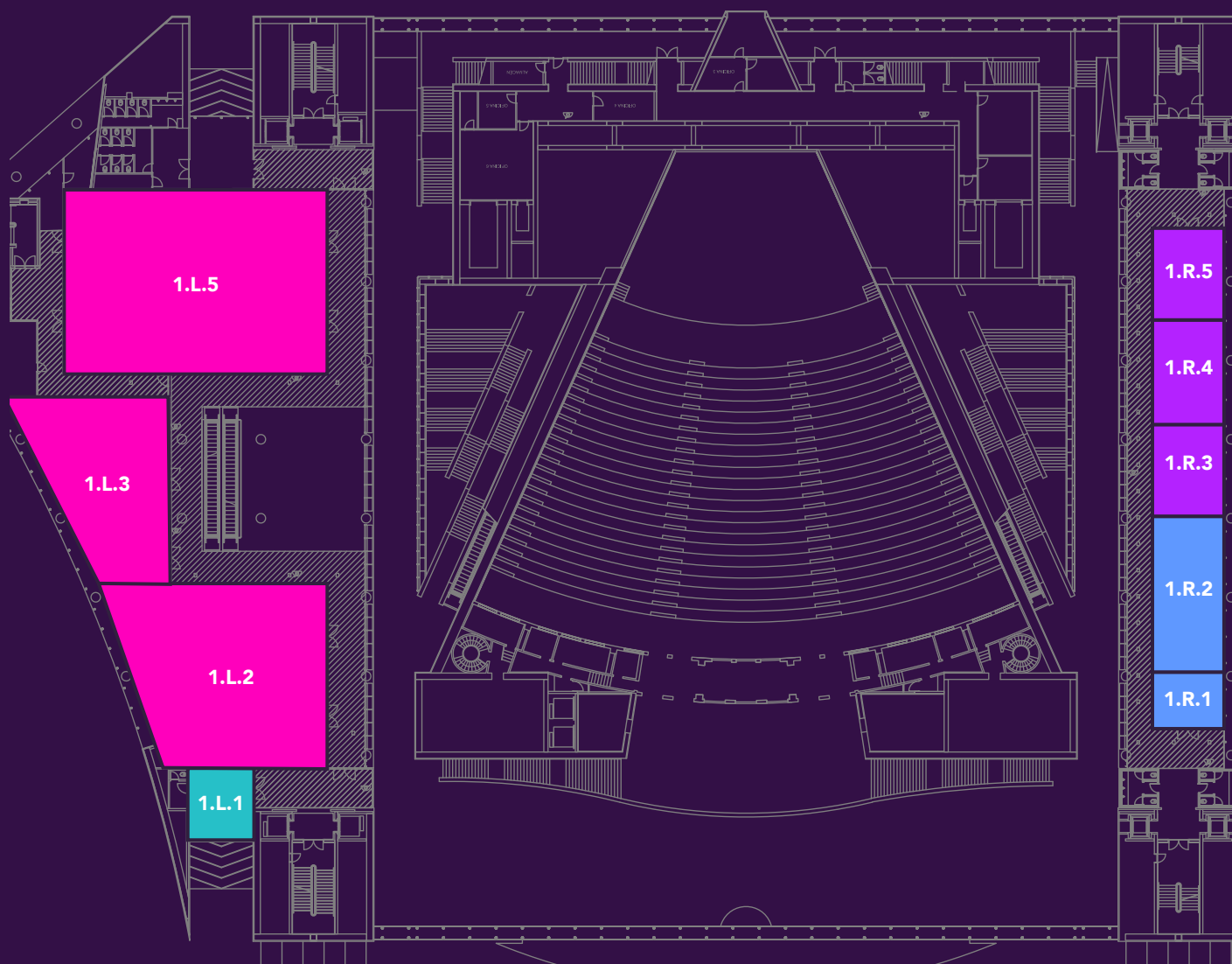
1ˢᵗ Floor

■ Technical sessions   ■ Speakers' room   ■ Press room   ■ Other events

Conference events 1ˢᵗ floor:
Technical Sessions (left wing)
Press room, and special meetings and sessions (right wing)

1.L.1 MÓNACO
1.L.2 PARÍS
1.L.3 BERLÍN
1.L.5 MADRID

1.R.1 PRESS ROOM I
1.R.2 PRESS ROOM II
1.R.3 LA HABANA
1.R.4 BUENOS AIRES
1.R.5 MÉXICO D.F.

4. Conference Venue
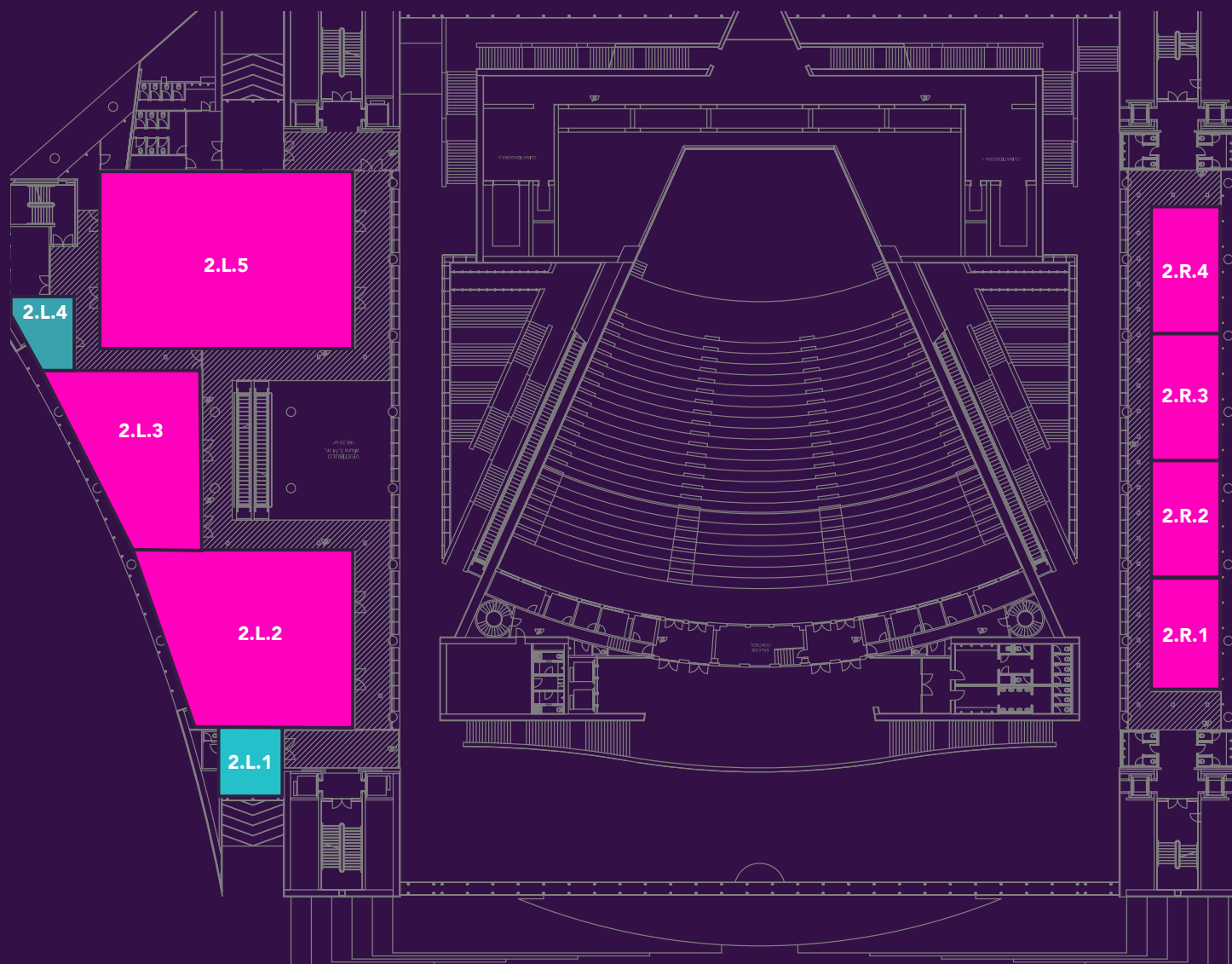
2ⁿᵈ Floor

Technical sessions   Speakers' room

Conference events 2ⁿᵈ floor:
Technical sessions (right and left wings)

2.L.1	REYKIAVIK	2.R.1	CARACAS
2.L.2	LONDRES	2.R.2	BOGOTÁ
2.L.3	ÁMSTERDAM	2.R.3	LA PAZ
2.L.4	DUBLIN	2.R.4	MONTEVIDEO
2.L.5	KUKA (sponsored by)		
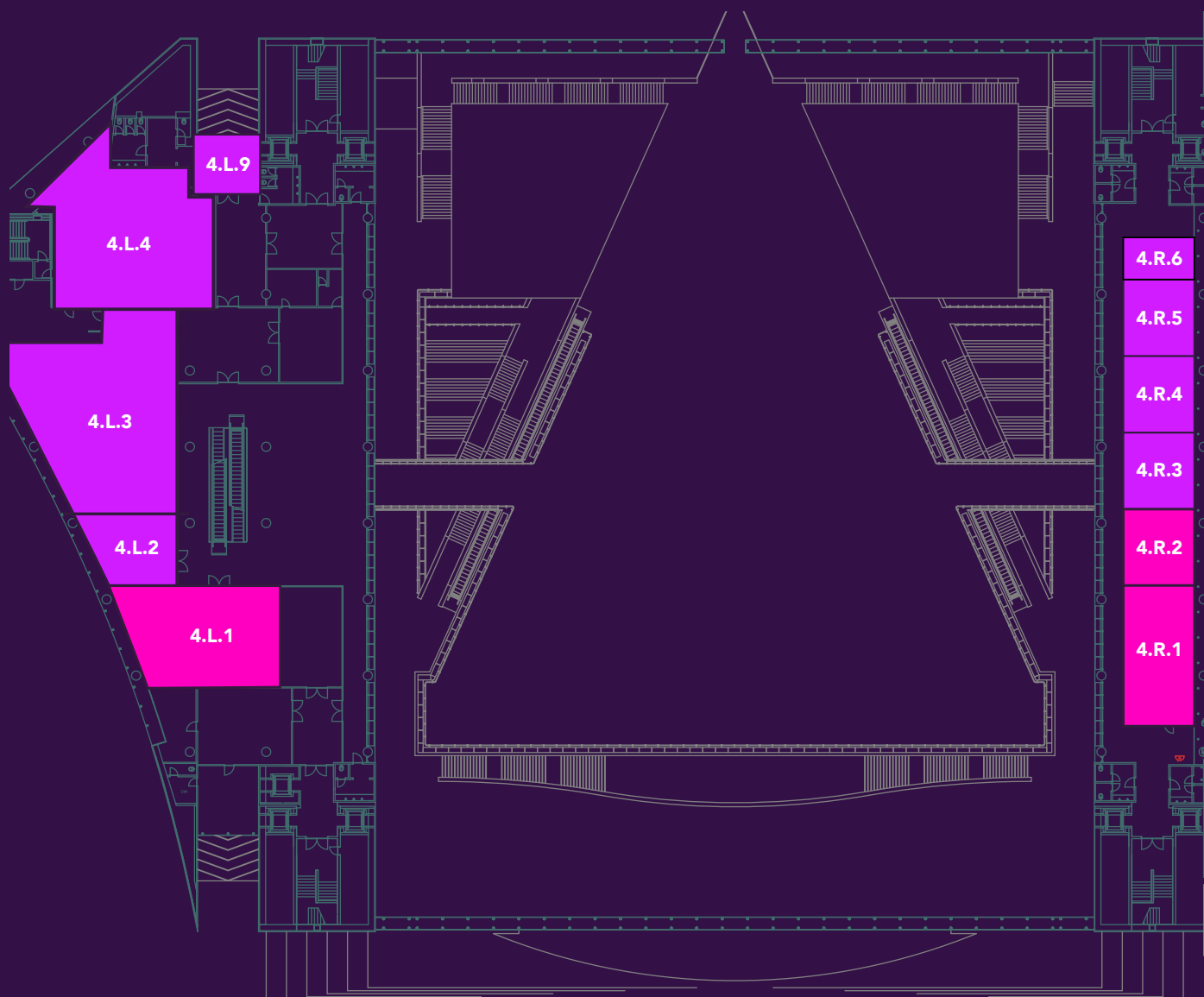
4. Conference Venue

4ᵗʰ Floor

■ Technical sessions   ■ Society/board meetings and luncheons

Conference events 4ᵗʰ floor:
Technical sessions
Society and board meetings and luncheons.

4.L.1	BRUSELAS
4.L.2	COMEDOR PRIVADO
4.L.3	RESTAURANTE VIP
4.L.4	SALA DEL CONSEJO
4.L.9	SALA MIRADOR

4.R.1	BRATISLAVA
4.R.2	ESTOCOLMO
4.R.3	OSLO
4.R.4	PRAGA
4.R.5	VARSOVIA
4.R.6	BUDAPEST

5. Welcome message

Dear Attendees,

Welcome to IROS 2018! Welcome to Madrid! We are honored to host you at the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2018), held for the first time in Spain, in the lively capital city of Madrid. Nowadays Madrid is a cosmopolitan open city that combines the most modern infrastructures and the status as an economic, financial and administrative center of Southern Europe, with a large cultural and artistic heritage, a legacy of centuries of exciting history. Art, traditions, gastronomy and multicultural openness play a key role in Madrid's life.

This year IROS has broken all records, becoming the biggest scientific robotic conference ever. We received a total of 2,700 paper submissions from 62 countries, including 2,197 regular paper submissions and 503 submissions to Robotics and Automation Letters (RA-L) with IROS option. After more than 20,000 reviews (IROS and RA-L), a total of 1,254 papers were accepted into the IROS program, representing an acceptance rate of 46%.

A total of 84 workshop and 15 tutorial proposals were submitted, and 48 workshops and 8 tutorials were accepted, which will take place on the two days before and after the main conference. More than 3,300 researchers and industrial partners have registered for the full conference and more than 2,200 have registered for workshops and tutorials. This tremendous growth confirms the IROS 2018 motto - "Towards a robotic society".

Looking at these record numbers, it is also interesting to notice that the distribution of accepted papers among world regions is: 25% from Asia and Australia/Oceania, 29% from America and 46% from Europe. The European Union (EU) countries contribute with a 41%, being a leading robotic community as a direct result of the individual countries and EU investments in robotics. The EU's Horizon2020 research program emphasizes in robotics, AI and cognitive systems. Besides, the euRobotics association plays a crucial role in this leadership.

The IROS 2018 technical program is anchored by three plenary speakers and twenty keynote presentations from leading researchers in our field, on a wide range of topics representing the latest in robotics and intelligent systems. The Senior Program Committee meeting held in Toledo in June 2018 selected these talks looking at diversity of topics and considering balance between senior researchers and young and promising ones, as well as gender distribution. IROS 2018 pushes for new faces, new topics and frontier research.

In parallel with the technical talks, the program also includes plenty of exciting activities such as five general forums, the industrial forum, governmental forum and the entrepreneurship forum and startup contest with 10 companies. There are also 10 robot competitions, including IROS2018 Fan Challenge (manipulates the Spanish fan), and two outdoor competitions for autonomous vehicles and humanitarian robotic demining. This year's conference sees a strong industrial participation with over 150 exhibits booths, becoming one of the biggest IROS exhibition.

We would like you to enjoy not only the scientific side of the conference, but also the hospitality of Madrid and its citizens, its cultural heritage. Several social events have been planned, such as the Welcome Reception in "modernistic" Crystal Ballroom of Madrid's Town Hall; the Conference Banquet at the WiZink Centre (main sporting arena), organized as an entertaining cultural and artistic performance with excellent Spanish food and wines; and the Farewell Party, in the venue, to meet colleagues again. We also offer the visits to the unique art district of Prado, Reina Sofia and Thyssen-Bornemisza museums and invite to taste Madrid's fabulous gastronomy from typical tapas bar to world's best restaurants and to enjoy an endless nightlife offer.

5. Welcome message

IROS has enjoyed this year an important growth, and the management and the organization of the conference has become a major undertaking, requiring the collective efforts of many people. Firstly, thanks to all the members of the Organizing Committee, without their support and experience this conference would not be successful. We would like to thank also all the Editors and reviewers under the leadership of Tony Maciejewski, he has done an outstanding job keeping IROS high quality and a fair review process. In addition, we want to thank Antonio Bicchi and Allison Okamura for their important partnership with RA-L. We would also like to express our gratitude to the members of the National Advisory Committee with representatives of the huge Spanish robotic community. But what was amazing is the job of the Local Organizing Committee, whose tireless work managed the workflow and the many threads in organizing IROS 2018. Thanks also to the conference managers for their self-denying work during long months of conference preparation.

Last but not least, we thank all our sponsors, exhibitors, supporting partners, volunteers, and of course the authors and registrants for their contributions to IROS 2018. It is truly an amazing collective achievement, and we would like to congratulate everyone involved for a job well done.

Once again, enjoy IROS 2018! Enjoy Madrid!

Carlos Balaguer
University Carlos III of Madrid
IROS 2018 General Chair

Cecilia Laschi
Sant'Anna School of Advanced Studies, Pisa
IROS 2018 Program Chair

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Nishide, Shun
Nuechter, Andreas
Oddo, Calogero Maria
Ohara, Kenichi
Ohno, Kazunori
Okamoto, Shogo
O'Kane, Jason
Ortiz, Alberto
Owaki, Dai
Padois, Vincent
Paik, Jamie
Pallottino, Lucia
Park, Jaeheung
Paull, Liam
Perdereau, Véronique
Pierson, Alyssa
Pinciroli, Carlo
Pitti, Alexandre
Platt, Robert
Poignet, Philippe
Polygerinos, Panagiotis
Popov, Dmitry
Poulakakis, Ioannis
Prorok, Amanda
Quan, Qiquan
Quattrini Li, Alberto
Ranzani, Tommaso
Reina, Andreagiovanni
Rekleitis, Georgios
Renaud, Pierre
Rickert, Markus
Roa, Maximo A.
Rojas, Juan
Rozo, Leonel
Russo, Sheila
Sabattini, Lorenzo
Sakagami, Norimitsu
Sakuma, Shinya
Sanjurjo Rivo, Manuel
Sartori, Massimo
Saska, Martin
Sattar, Junaed
Schmiedeler, James
Secco, Emanuele Lindo
Sekimoto, Masahiro
Seo, TaeWon
Shafti, Ali

Shaheed, M Hasan
Shankar, Krishna
Shen, Yajing
Shen, Yantao
Shi, Qing
Shimoda, Shingo
Silvestre, Carlos
Simaan, Nabil
Solà, Joan
Soler Arnedo, Manuel Fernando
Song, Sang-Eun
Stefanini, Cesare
Stegagno, Paolo
Steinbauer, Gerald
Stiffler, Nicholas
Stopforth, Riaan
Sugihara, Tomomichi
Sugimoto, Yasuhiro
Sun, Yi
Sung, Cynthia
Suzuki, Yosuke
Taffoni, Fabrizio
Taghvaei, Sajjad
Takaiwa, Masahiro
Takayama, Toshio
Takei, Toshinobu
Takesue, Naoyuki
Takeuchi, Masaru
Tamosiunaite, Minija
Tan, Jindong
Tan, U-Xuan
Tanaka, Yoshihiro
Tang, Chaoquan
Tang, Hui
Tavakoli, Mahdi
Trianni, Vito
Triebel, Rudolph
Tsuji, Tokuo
Tsuji, Toshiaki
Ueda, Jun
Umedachi, Takuya
Vahrenkamp, Nikolaus
Vidal-Calleja, Teresa A.
Vitzilaios, Nikolaos
Wang, Hesheng
Wang, Hongbo
Wang, Kundong
Wang, Wei
Wang, Zhongkui
Watanabe, Tetsuyou
Williams, Mary-Anne
Woo, Jinseok
Wurdemann, Helge Arne
Xia, Zeyang
Xiao, Jizhong
Xie, Biyun
Xu, Weiliang
Yamaguchi, Akihiko
Yamaguchi, Tomoyuki
Yamamoto, Ko
Yamawaki, Tasuku
Yamazaki, Kimitoshi
Yano, Hiroaki
Yi, Byung-Ju
Yi, Jingang
Yim, Sehyuk
Yu, Hui
Yu, Yong
Yuan, Jianjun
Zhang, Guoteng
Zhang, Li
Zhang, Wenlong
Zhang, Yu
Zhao, Jianguo
Zhao, Jing
Zhao, Shiyu
Zhao, Ye
Zhu, Chi

13. Transportation

From Madrid-Barajas airport (MAD) to the Palacio Municipal de Congresos de Madrid (Madrid Municipal Conference Centre):

Metro

From Airport T4
Travel time: 12 min
Cost: 4,5 €

From Airport T1, T2, T3
Travel time: 8 min
Cost: 4,5 €

From the Madrid-Barajas airport, board the line 9 towards Nuevos Ministerios, and stop at Feria de Madrid. The "Palacio de Congresos" (Municipal Convention Centre) is 220 m away from the metro station. Metro is open from 6:00am to 1:30am every day, and tickets can be purchased from vending machines at any station.

Taxi

Travel time: 10 min
Cost: 20 €

Airport taxis are available at Taxi stands at the exit of the arrival area of each terminal.

From Madrid-Barajas airport (MAD) to the town centre:

Taxi

Travel time: 25 min
Cost: 30 € - flat rate

Bus Express Airport

Travel time: 30/35 min
Cost: 5 €

The Airport Express shuttle completes the journey to T4 in approximately 40 minutes (it takes 30 min to reach T1 and 35 mins to get to T2). It runs every 15 minutes during the day and every 35 minutes at night. Single tickets cost 5 euros and are purchased on the coach.
Stops: Cibeles square and Atocha station.

13. Transportation

Within Madrid:

We highly recommend you to use the public transport. The metro is the fastest, cheapest mean of transport in the city centre. A single trip from the conference venue to town centre (Feria de Madrid – Sol) takes 25 min and costs 2€.

*If you are full-registered for the conference, you will receive a Metro card valid for three days for you to use.

There is a free IROS 2018 shuttle (morning and afternoon) from Meliá & NH Eurobuilding hotels to the Conference Venue. At the time of printing this digest, the schedule was not yet determined

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RED DE METRO Y METRO LIGERO *Metro and Light Rail Network*

SIMBOLOGÍA *Key*

- Estación accesible / ascensor — *Step-free access / lift*
- Transbordo corto — *Metro interchange*
- Transbordo largo — *Metro interchange with long walking distance*
- Cambio de tren — *Change of trains*
- Horario restringido — *Restricted opening times*
- Metro Ligero — *Light Rail*
- Cercanías — *Suburban railway*
- Autobuses interurbanos — *Suburban buses*
- Autobuses largo recorrido — *Interregional bus station*
- Terminal autobuses nocturnos — *Night bus line terminal*
- Autobús exprés aeropuerto — *Airport express bus*
- Estación de tren — *Railway station*

- Aeropuerto / Airport — Adolfo Suárez Madrid-Barajas
- ZONA A / ZONA B1 — Zonas tarifarias — *Fare zones*
- ATENCIÓN A LA TARIFA — Validación a la SALIDA — *PAY THE RIGHT FARE / Ticket checked at the EXIT*
- Atención al cliente — *Customer Service*
- Oficina de gestión — tarjeta transporte público — *Public Transport Card Office*
- Bibliometro — *Metro Library*
- Productos oficiales Metro — *Official Metro merchandising*
- Espacio histórico de Metro — *Metro historic space*

- Aparcamiento disuasorio gratuito — *Free park and ride*
- Aparcamiento disuasorio de pago — *Paid park and ride*
- Estacionamiento de bicicletas — *Bicycle parking*

1. Airport/Conference Venue
2. City Center

HORARIO *Opening times*

Todos los días de 06:00 a 01:30 h.
Every day from 6:00 a.m. to 1:30 a.m.

Metro líneas:

1 — Pinar de Chamartín / Valdecarros
2 — Las Rosas / Cuatro Caminos
3 — Villaverde Alto / Moncloa
4 — Argüelles / Pinar de Chamartín
5 — Alameda de Osuna / Casa de Campo
6 — Circular
7 — Hospital del Henares / Pitis
8 — Nuevos Ministerios / Aeropuerto
9 — Paco de Lucía / Arganda del Rey
10 — Hospital Infanta Sofía / Puerta del Sur
11 — Plaza Elíptica / La Fortuna
12 — MetroSur
R — Ópera / Príncipe Pío

Metro Ligero:

1 — Pinar de Chamartín / Las Tablas
2 — Colonia Jardín / Estación de Aravaca
3 — Colonia Jardín / Puerta de Boadilla

14. Nearby dining

1 **Food House**
2 **Capital – D**
3 **Tabernas La Canica**
4 **Dehesa**
5 **Green**
6 **Nostrum**
7 **Madame Salade**
8 **Club Sandwich Cafe**
9 **El Living Food**

10 **La Cozina**
11 **El Urogallo**
12 **La Tagliatella**
13 **La Canica**
14 **Burguer King**
15 **Lan Lan**
16 **Peggy Sue's**
17 **VIPS**
18 **Ginos**

19 **Taramara**
20 **Orgaz**
21 **Mallorca**
22 **Rodilla**
23 **El Tinglao**
24 **Tao 3.6.9**
25 **Foster's Hollywood**
26 **McDonald's**
27 **La Piemontesa**

28 **Hamburguesa Nostra**
29 **El Corte Inglés**
30 **Rodilla**
31 **Como en casa**
32 **El Patio Andaluz**
33 **Claravia**
34 **Deliquo**

14. Nearby dining

#	Title	Cost	Style	Street Address	Phone	Distance from MMCC
1	Food House	€€ - €€€	International	Av. Capital de España, 10	910669941	100 M
2	Capital – D	€€ - €€€	Spanish, sandwiches, salads	Av. Capital de España, 10	917211220	100 M
3	Tabernas La Canica	€€ - €€€	Mediterranean, Modern	Av. Partenón, 10	917210192	180 M
4	La Dehesa	€€ - €€€	Spanish	Av. Partenón, 10	917210306	180 M
5	Green	€€ - €€€	Mediterranean	Av. Partenón, 10	917211800	180 M
6	Nostrum	€ - €€	Mediterranean, salads, take-away	Amberes, 8	902150950	220 M
7	Madame Salade	€ - €€	Mediterranean, salads, soups	Av. Partenón, 10	911546507	220 M
8	Club Sandwich Cafe	€ - €€	Sandwiches, salads, soups, take-away	Estrasburgo, 4	NC	160 M
9	El Living Food	€€ - €€€	Mediterranean, International	Paseo Doce Estrellas, 3	NC	110 M
10	La CoZina	€€ - €€€	Mediterranean, International	Paseo Doce Estrellas, 2	914558654	110 M
11	El Urogallo	€€ - €€€	Spanish	Av. de los Andes, 33	910579638	700 M
12	La Tagliatella	€€ - €€€	Italian	Mahonia, 3	917416321	850 M
13	La Canica	€€ - €€€	Mediterranean, Spanish	Av. de los Andes, 25	913201503	850 M
14	Burger King	€ - €€	Fast food	Mahonia, 3	NC	850 M
15	Lan Lan	€€ - €€€	Asian	Av. de los Andes, 25	913202515	850 M
16	Peggy Sue's	€ - €€	American	Av. de los Andes, 25	913616449	850 M
17	VIPS	€ - €€	Mediterranean, International	Glorieta Mar Caribe, 1	912759561	1.2 KM
18	Ginos	€€ - €€€	Italian	Glorieta Mar Caribe, 1	912759571	1.2 KM
19	Taramara	€€ - €€€	International	Av. de los Arces, 11	910581121	1.2 KM
20	Orgaz Madrid	€€ - €€€	Spanish, Mediterranean	Av. de los Arces, 11	913200822	1.2 KM
21	Mallorca	€€ - €€€	Café, International, sandwiches, salads	Av. de los Andes, 22	917418484	1 KM
22	Rodilla	€ - €€	Sandwiches	Av. de los Andes, 22	913717695	1 KM
23	El Tinglao	€€ - €€€	Mediterranean	Av. de los Andes, 26	913931045	950 M
24	Tao 3.6.9	€€ - €€€	Asian	Av. de los Andes, 26	917527605	950 M
25	Foster's Hollywood	€€ - €€€	American	Av. de los Arces, 17	917412647	1 KM
26	McDonald's	€ - €€	Fast Food	Av. de los Andes, 46	913209196	900 M
27	La Piemontesa	€€ - €€€	Italian	Av. de los Andes, 48	913932900	850 M
28	Hamburguesa Nostra	€€ - €€€	Hamburgers	Boj, 5	916926693	850 M
29	El Corte Inglés	€€ - €€€	Mediterranean, sandwiches	Av. de los Andes, 50 (2nd floor)	913248800	750 M
30	Rodilla	€ - €€	Sandwiches	Av. de los Andes, 50 (2nd floor)	917418922	750 M
31	Como en casa	€ - €€	Spanish, sandwiches	Av. Consejo de Europa, 2	NC	600 M
32	El Patio Andaluz	€€ - €€€	Mediterranean	Av. Capital de España, 10 (Pullman Hotel)	917210070	95 M
33	Claravia	€€ - €€€	Mediterranean, buffet	Amsterdam, 3 (Novotel Hotel)	917211818	100 M
34	Deliquo	€€ - €€€	Mediterranean, Spanish, buffet	Av. Partenon 16,	917210576	350 M

15. About Madrid

The first historical record of Madrid dates to the year 865, when Emir Muhammad I commissioned the construction of a fortress in the village of Mayrit, on the banks of the river Manzanares. 'Mayrit' means 'plenty of waterways', which is why the city's first records mentioned ´build in the water´. Madrid belonged to the Islamic world until 1083, when Alfonso VI of Castile took over the city.

Nowadays Madrid, capital of Spain, is a cosmopolitan open city that combines the most modern infrastructures and the status as an economic, financial, administrative and service centre of Southern Europe, with a large cultural and artistic heritage, a legacy of centuries of exciting history. Art, traditions, gastronomy and multicultural openness play a key role in Madrid's cultural life.

The capital has over 60 museums including the Prado Museum, a flagship art gallery with Goya, Velázquez, El Greco paintings, among others; the Thyssen-Bornemisza Museum, with paintings ranging from Flemish artists to the avant-garde movements; and the Reina Sofía National Art Centre, dedicated to contemporary art containing works by Picasso, Joan Miró, Salvador Dalí, etc.

But if there is one thing that sets Madrid apart, it must be its deep and infectious passion for life that finds its outlet in the friendly and open character of its inhabitants. You will have the opportunity to enjoy a wide range of the best Spanish and international gastronomy, to savour the charms of its tapas bars and taverns. The lively nightlife is another key attraction of Madrid, due to its variety and the exciting atmosphere to be found in its bars, clubs and flamenco halls.

16. Sight seeing and useful info

General information area:

- International calling code for Spain: 0034
- Local currency: euros (EUR, €)
- Language: Spanish
- Weather in October: average high temperature 19,4°C / average low temperature 10,7°C.
- Timezone: Central European Time (CET)
- Emergencies number: 112
- Foreign Tourist Assistance Service (SATE): 0034 91 548 85 37

Top ten landmarks & museums:

1. Royal Palace
2. Puerta del Sol
3. Plaza Mayor
4. Puerta de Alcala
5. Cibeles fountain
6. Prado Museum
7. Reina Sofía Museum
8. Temple of Debod

9. Thyssen-Bornemisza Museum
10. Almudena Basilic
11. Gran Via
12. Royal Opera House.
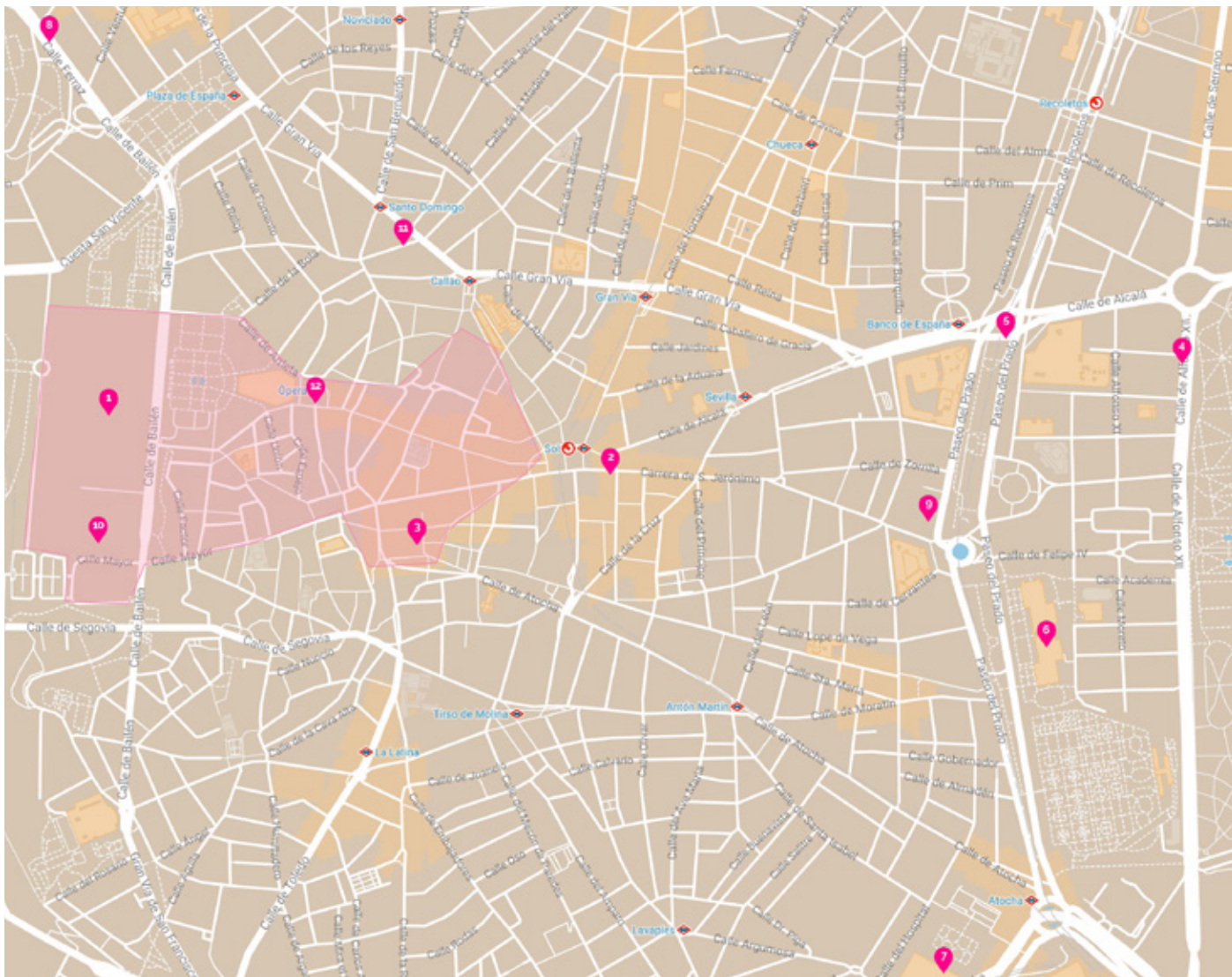
More info in the Madrid Official Tourism Website: https://www.esmadrid.com/en

17. Social events at the Conference

MADRID 2018 iROS

*Availability is limited to the capacity of each event. We shall follow the order of registration.

Welcome Reception*

Monday, October 1, 20:00 – 21:00
Galeria de Cristal, Madrid Town Hall.
C/ Montalban 1. Madrid.
Metro: Banco de Espana (line 2)

IROS 2018 will welcome its participants with a one-hour reception in the beautiful glass gallery of the Town Hall, at the heart of the city. Entrance will be at 19:30h and is strictly limited to maximum capacity of the gallery. The admission limit is done by order of registration. The standing reception will serve a variety of food choices as well as alcoholic and non-alcoholic beverages to fully registered IROS delegates.

Conference Banquet*

Wednesday, October 3, 20:30 – 23:30
Wizink Center
Av. Felipe II, S/N, Madrid
Metro: Goya

We have prepared a very special night, with delicious food and outstanding performances for you to enjoy and have fun. Entrance is strictly limited to maximum capacity of the venue, and the admission limit is done by order of registration.

Farewell Reception

Thursday, October 4, 13:30 – 15:30
MMCC, Main hall.

An informal cocktail will be provided as farewell for IROS 2018. Join us to share your impressions on the conference, make last minute contacts, and say to your colleagues -see you in Macau, 2019!

Coffee breaks

Coffee Breaks will be provided throughout the five days of the conference, twice a day. Serving stations will be located conveniently on the Exhibition floor (3rd floor).

NEDO-RSJ Workshop on Robot Benchmarking for Commercial Use: What and How?

Monday, Oct 1, 14:30-18:30
Hotel Novotel Campo de las Naciones, room: Madrid C
St. Amsterdam, 3. 28042 Madrid

In collaboration with Robotics Society of Japan, we are pleased to organize a meeting as a NEDO-RSJ workshop at IROS 2018 site. There will be short talks and discussions about robot benchmarking. IROS participants who are interested in following activities are welcome. Giving short talks (10min TBC) are encouraged.
This is not an official workshop and privately held in conjunction with IROS 2018. Programs, and information will be posted to RoboPedia. http://robopedia.sakura.tv/
To register, send your name, institution, e-mail address and short talk title (if applicable) to: yamamototmy@nedo.go.jp

RSJ Luncheon for Industry and Academia Collaboration

Tuesday, October 2, 13:30-14:30
MMCC, Room 4.L.3

This event provides a collaboration opportunity for industries and academia at lunchtime for anyone who attends IROS 2018. Each participant of this event will enjoy an introduction of products/prototypes available by exhibitors and opportunities for recruitment, as well as a lunch box (max 120).

17. Social events at the Conference

IEEE/RAS Young professional/TC networking Event

Tuesday, October 2, 17:00-18:30
MMCC, Room 4.L.3

This event is open to attendees in the early stages of their career – young professionals and researchers. Chairs and Co-Chairs of the RAS Technical Committees will be available for informal conversation centered on new technologies in robotics and automation, future growth in the field, and how to get involved and contribute to RAS Technical Committee work. Refreshments will be served! Come enjoy a snack and beverage, and meet some new colleagues! Space is limited, so please register for this FREE networking event on-line: https://app.smartsheet.com/b/form/3a3a2c0493b64f81bbf3c7e11241275d

IEEE/RAS Women in Engineering Breakfast

Wednesday, October 3, 8:00-10:00
MMCC, Room 4.L.3

This breakfast provides the opportunity to foster discussion on the role of women in robotics and automation, inspire girls, and promote collaborations and initiatives to advance women in leadership. As the goal for this event is to be more than a breakfast for women, but a breakfast with women, men are more than welcome to participate and enjoy the discussion.
Space is limited, so please register in advance!
https://app.smartsheet.com/b/form/17e1c2c3940947919382b0cb185ce6ae

IEEE/RAS Lunch with leaders for Students

Wednesday, October 3, 13:30-15:00
MMCC, Room 4.L.3

This luncheon is open to student and young professional attendees offering the chance to meet and interact with Leaders from RAS and industry. Informal discussion over lunch will take place round table style. Join us for career advice, insights into where the field is headed, or general conversation to get to know Leaders in the field of robotics and automation.
Confirmed RAS Leaders to include: Wolfram Burgard, Torsten Kroeger, Venkat Krovi, Yasushi Nakauchi, Zhidong Wang, Tony Maciejewski, Raja Chatila, Nancy Amato, Hong Zhang, Jaydev Desai. And more...
Space is limited, so please register in advance!
https://app.smartsheet.com/b/form/048cd55eb7314057a3aad7e6e143df6f

SICE Luncheon Seminar

Wednesday, October 3, 13:30-14:30
MMCC, Room 4.R.5

In this event, several researchers give us their activity for anyone who attends the IROS2018. Each participant would enjoy their talks with a lunch box (max. 45).
Please visit the following HP to know the detail of seminar https://sice-si.org/iros2018-lunch-seminar_eng/

Awards Luncheon

Thursday, October 4, 13:30 – 15:30
MMCC, Auditorium.

A pic-nic luncheon will be offered, first come first served, followed by a ceremony, where the main awards, together with competitions awards will be announced. This year, we count with the IEEE president, who will hand out the IEEE Technical Field Award in Robotics and Automation, and the IEEE/RAS George Saridis Leadership Award in Robotics and Automation. Coffees will be offered at the end of the ceremony.

17. Social events at the Conference

Student Scavenger Hunt – IROS 2018

Are you a student planning to attend IROS 2018 Madrid, Spain? Join the IEEE RAS Student Activities Committee for a fun photo scavenger hunt! Teams of 2-3 students will be emailed a super top secret list of objectives on the morning of 1 October. Throughout the conference, teams will then take pictures demonstrating they achieved each objective – ranging from shaking hands with RAS leadership, visiting local sights near the conference venue, to doing funny poses. Awards will be presented to teams which found the most items and teams with the most creative photos!

Who: Students attending IROS 2018
What: A fun picture scavenger hunt
When: 1-5 October 2018
Where: IROS in Madrid, Spain
Why: Because everyone needs a little fun!

If you already know a few other students attending, you can form a Team and register as a group. If not, please register yourself, and we will team you up with other enthusiastic roboticists. See you in Brisbane!

Register here: https://app.smartsheet.com/b/form/0cb766c0756a4684a0b03d719e45f32e

Calling All Students: Tapas Tour of Madrid

Many of you may have heard about the exciting night life in Madrid. It's one of the best in the world, and the Robotics and Automation Society has organized an event on Tuesday, 2 October, for those of you who would like to experience it!

In keeping with usual Spanish tradition, we will be exploring various tapas bars throughout the night - and they're open very late! Food will be covered by RAS, although you'll have to purchase your own drinks.

Availability is limited, so please be sure to sign up to reserve a spot. The event starts at 20:00. Further details will be provided later via email to those who have registered in advance.

Register here: https://app.smartsheet.com/b/home?lx=zmxehuoDlGUK1-VLb5g_ng

Robotic Online Short Film Festival Awards Ceremony
Thursday, October 4, 17:00 – 19:00
MMCC, Auditorium

ROS Film Festival is the first international festival of science fiction short films starring robots. The Ceremony will be conducted by the magician Miguel Angel Gea, also known for his incursions into neuroscience. Come to enjoy the winning short films and other live shows.

iCPRB & OC Appreciation Dinner (by invitation only)
Tuesday, October 2, 20:30 – 23:30
Restaurante Casa Patas
C/ Canizares, 10. Madrid

Metro: Tirso de Molina
Located in the heart of the town centre, this dinner will take place in an emblematic "tablao", where a flamenco show will be offered after the dinner.

In addition, IROS 2018 offered one free social activity in the town centre of Madrid per full conference attendee, as an effort to get you to know and enjoy our vibrant city. These are the activities that the ones who signed for it (deadline was September 22nd) will enjoy, upon availability.

1. Prado Museum - guided tour
2. Reina Sofía Museum - guided tour
3. Thyssen-Bornemisza Museum - guided tour
4. National Archeological Museum - guided tour
5. Las Ventas Bullring Tour
6. Madrid of Austrias – guided walk
7. Madrid of Carlos III – guided walk
8. Shopping at Castellana Mall
9. Real Madrid - Santiago Bernabéu Stadium Tour
10. Tapas at San Miguel market
11. Spanish party

18. Technical Tours

Three technical tours are held in IROS 2018. Registration is needed for each of them, and has to be done onsite at the Technical Tours registration desk. Tours are limited to 50 people each, and are for free for delegates. Admission is done upon registration, first come first served. The bus for each tour departs punctually, in front of the main door of the venue.

	Date	Time	Company	Location
Tour 1	October 2	9:00 – 11:30	**AIRBUS**	Getafe
Tour 2	October 3	11:00 – 13:30	**ESAC**	Villanueva de la Cañada
Tour 3	October 4	11:00 – 13:30	**CAR-CSIC**	Arganda del Rey

Tour 1: AIRBUS

Date: October 2, 09:00-11:30.
Departure: 9:00, from main door of Municipal Conference Centre. Tour starts at 9:30
Location: Paseo John Lennon, s/n, 28906 Getafe, Madrid
url: https://www.airbus.com/
Tour coordinator: Dr. Silvia Lazcano, Head of R&T program at Airbus Operations S.L.

Airbus is a global pioneer in the aerospace industry, operating in the commercial aircraft, helicopters, defence and space sectors. The Company is a leader in designing, manufacturing and delivering aerospace products, services and solutions to customers on a worldwide scale.
As the largest aeronautics and space company in Europe and a worldwide leader, Airbus is at the forefront of the aviation industry, building the most innovative commercial aircraft and consistently capturing about half of all commercial airliner orders. Thanks to its deep understanding of changing market needs, customer focus and technological innovation, Airbus helps airlines grow and people connect. 7.500 people works directly for the three Airbus Divisions inMadrid area. During the visit, you will see the assembly of structures of different commercial aircrafts.

Tour 2: ESAC (European Space Agency centre)

Date: October 3, 11:00-13:30
Departure: 11:00, from main door of Municipal Conference Centre. Tour starts at 11:30.
Location: Camino Bajo del Castillo, s/n, urb. Villafranca del Castillo, 28692 Villanueva de la Cañada, Madrid
url: http://www.esa.int/About_Us/ESAC
Tour coordinator: Dr. Javier Ventura-Traveset, ESAC Director's Office & Head of Galileo navigation Science office and Dr Michel Breitfellner, CESAR ESA Education programme & Mars Express Science Operations

The European Space Agency (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world.ESA is an international organisation with 22 Member States. By coordinating the financial and intellectual resources of its members, it can undertake programmes and activities far beyond the scope of any single European country.
ESAC, the European Space Astronomy Centre, is a hub for science operations and a centre of excellence for space science. ESAC is where the science operations of all ESA astronomy and planetary missions are conducted, and where all the scientific data obtained by them are archived and made accessible to the world.

18. Technical Tours

Tour 3: **CAR-CSIC**

Date: October 4, 11:00-13:30;
Departure: 11:00, from main door of Municipal Conference Centre. Tour starts at 11:30
Location: Ctra. M300 Campo Real, Km 0,200, Arganda del Rey, 28500 Madrid
url: https://www.car.upm-csic.es
Tour coordinator: Prof. Manuel Ferre, Director CAR UPM-CSIC

The Centre for Automation and Robotics (CAR) is a joint research centre of the Spanish Council for Scientific Research (CSIC) and the Universidad Politécnica de Madrid (UPM). The main objective of CAR is to develop applied research which aims at offering useful results for the society in the field of Robotics and Automation. Around one hundred researchers work at CAR and their activities are focused on the following scientific-technological areas: Control Engineering, Artificial Perception, Intelligent Robots and Applied Robotics.

19. Sponsors

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20. Exhibition

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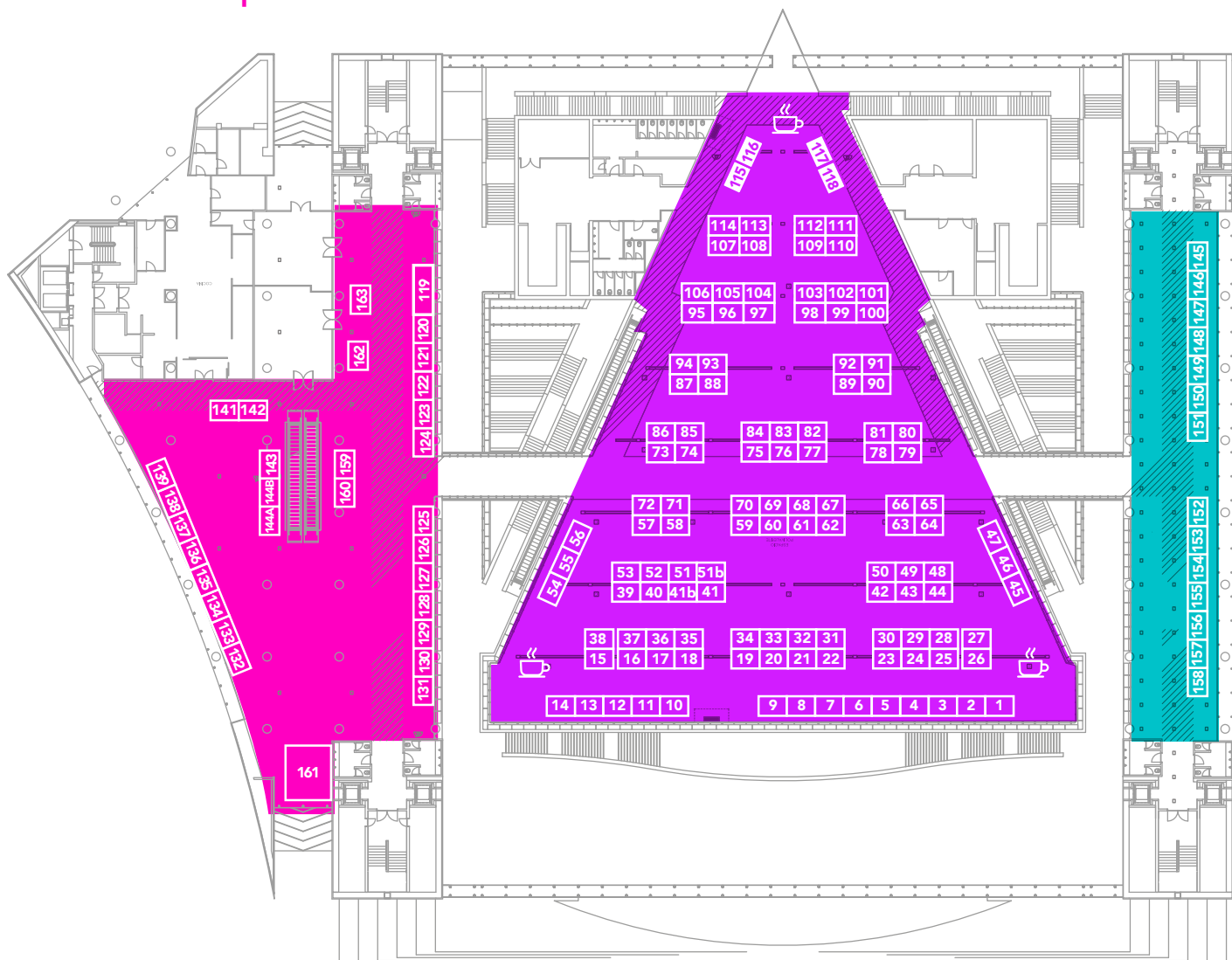
3rd Floor

■ EU projects (selected by EU)   ■ Companies, Start-ups, and Spin-offs   ■ Research Centres and Universities

20. Exhibition

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20. Exhibition

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Building Dynamic Robots	Marc Raibert, Boston Dynamics	Oct. 2	12:30-13:30
ImPACT Bionic Humanoids; platform for Medicine-Engineering collaboration	Kanako Harada, University of Tokyo	Oct. 3	10:00-11:00
True AI For Learning Robots	Juergen Schmidhuber, NNAISENSE, Lugano	Oct. 4	10:00-11:00

Marc Raibert
Boston Dynamics

Building Dynamic Robots

Dynamics opens a world of opportunity for robotics. Robots that move dynamically can go where other robots can't go, handle larger payloads with smaller footprint and smaller robot mass, and move faster to get work done more quickly. This talk will give a status report on Boston Dynamics' work in this area, both its long-term effort to develop robots of the future and shorter-term efforts to build products that capitalize on existing robot capability.

Biography

Marc Raibert is CEO and founder of Boston Dynamics, a company that creates some of the world's most advanced dynamic robots, such as BigDog, Atlas, Spot and Handle. These robots are inspired by the remarkable ability of animals to move with agility, dexterity, perception and intelligence. A key ingredient of these robots is their dynamic behavior, which contributes to their life-like qualities and their effectiveness in the real-world. Before starting Boston Dynamics, Raibert was professor of EE&CS at MIT from 1987-1995 and of Computer Science & Robotics at Carnegie Mellon University from 1981-1986. There he founded the Leg Laboratory, a lab that helped establish the scientific basis for highly dynamic robots and that set the stage for the work done at Boston Dynamics. Raibert is a member of the National Academy of Engineering.

21. Plenary sessions

Plenary II

Kanako Harada
University of Tokyo

ImPACT Bionic Humanoids; platform for Medicine-Engineering collaboration

Medicine-Engineering collaboration often requires trial-and-error processes; surgeons describe surgical procedures using qualitative sensory expressions such "very softly" or "relatively large", while engineers need to understand constraints, requirements, and targets in a quantitative manner to develop new medical devices. The Japan Cabinet Office's ImPACT program "Bionic Humanoids Propelling New Industrial Revolution" (https://www.jst.go.jp/impact/bionichumanoids/en/index.html) started in February 2016 and proposes to develop the Bionic Humanoids, which are elaborate human dummies equipped with sensors, as a platform to quantify such sensory expressions and eventually facilitate Medicine-Engineering collaboration. We are currently developing Bionic Humanoid models for neurosurgical and eye surgical applications to show a proof of concept. A surgical robotic system, which can be used for several applications, are also being developed to demonstrate accelerated medicine-engineering collaboration. Our latest achievements will be presented in the talk.

Biography

Kanako Harada, is Program Manager of the ImPACT program "Bionic Humanoids Propelling New Industrial Revolution" of the Cabinet Office, Japan. She is also Associate Professor of the departments of Bioengineering and Mechanical Engineering, School of Engineering, The University of Tokyo, Japan. She obtained her M.Sc. in Engineering from The University of Tokyo in 2001, and her Ph.D. in Engineering from Waseda University in 2007. She worked for Hitachi Ltd., Japan Association for the Advancement of Medical Equipment, and Scuola Superiore Sant'Anna, Italy, before joining The University of Tokyo. Her research interests include surgical robots and surgical skill assessment.

21. Plenary sessions

Plenary III

Juergen Schmidhuber
NNAISENSE, Lugano.

True AI for Learning Robots

Our deep learning artificial neural networks have won numerous contests in pattern recognition and machine learning by imitating human teachers. They are now used billions of times per day by the world's most valuable public companies, whose main profits are in marketing. True AI, however, goes far beyond this – that's why for over 3 decades we have also been working on unsupervised AIs & robots that invent their own experiments and goals, to figure out how the world works, and to become increasingly general problem solvers. I will discuss recent state-of-the-art examples. What will be the next wave of AI? In the not too distant future (not yet!) we will have "show-and-tell robotics" or "watch-and-learn robotics" or "see-and-do robotics:" quickly and economically teach a recurrent neural network to control a complex robot with many degrees of freedom to execute complex tasks, such as assembling a smartphone, solely by visual demonstration, and by talking to it, without touching or otherwise directly guiding the robot - a bit like we'd teach a kid. Finally, I'll speculate how learning robots will transform every aspect of our civilisation, and eventually colonise the universe, and make it intelligent.

Biography

Jürgen Schmidhuber is president of the company NNAISENSE, which aims at building the first practical general purpose AI, and robots that learn like kids. He also is scientific director of the Swiss AI Lab IDSIA (USI & SUPSI) and former head of Cognitive Robotics at TU Munich. The deep learning neural networks of his lab (such as LSTM) have revolutionized AI and machine learning. As of 2017, they are on 3 billion smartphones, and used billions of times per day, for Google's & Facebook's automatic translation, Google's speech recognition, Apple's Siri & QuickType, Amazon's Alexa, etc. LSTM also is the core of OpenAI's Dota 2 video game player and its controller of dextrous robot hands. He is (co-)author of over 350 peer-reviewed papers and recipient of numerous awards including the 2016 IEEE Neural Networks Pioneer Award "for pioneering contributions to deep learning and neural networks."

22. Keynote sessions

Oct. 2	**15:30-16:00**	1.L.5	Personalisation in Assistive Robotics	Yiannis Demiris
		2.L.5 KUKA	Models of our Interactions	Reid Simmons
		1.L.2	Soft Robots with Physically Embodied Intelligence	Kyujin Cho
		2.L.2	Manipulation Skills that I Wish My Robots Had	Alberto Rodriguez
	16:30-17:00	1.L.5	Electronic skins for robotics and wearables	Takao Someya
		2.L.5 KUKA	Life's Intelligent Devices: Scientific Research with Bioinspired Robots	John Long
		1.L.2	Semantics for Robotics	Amy Loutfi
		2.L.2	Humanoid Motion and Human Movement at LAAS-CNRS	Philippe Souères

Oct. 3	**15:30-16:00**	1.L.5	A Future with Affordable Self-driving Vehicles	Raquel Urtasun
		2.L.5 KUKA	Realistic models of human motions for better wearable robots	Katja Mombaur
		1.L.2	Hard Challenges in Soft Robotics	Jaimie Paik
		2.L.2	Psychology to Coexist with Robots	Hiroko Kamide
	16:30-17:00	1.L.5	Challenges in Aerial Robotic Manipulation	Anibal Ollero
		2.L.5 KUKA	Elastic Actuators: From mastering vibrations towards utilization of intrinsic dynamics	Christian Ott
		1.L.2	Robust Decision Making in Partially Observable World	Hanna Kurniawati
		2.L.2	Gait Exoskeletons: A New Horizon in the Therapy of Neuromuscular Diseases in Childhood and Adolescence	Elena García Armada

Oct. 4	**16:30-17:00**	1.L.5	Computer Vision and AI for Robot Visual Intelligence	Rita Cucchiara
		2.L.5 KUKA	Optimal Robot Action for and around People	Anca Dragan
		1.L.2	Underwater 3D Mapping and Intervention	Pere Ridao
		2.L.2	Plant-like robots are growing up	Barbara Mazzolai

22. Keynote sessions

Speakers and talks, in alphabetical order:

Alberto Rodríguez
MIT

Electronic skins for robotics and wearables

Manipulation is the process by which we rearrange the world around us, most often using our hands. It is a very wide and unstructured problem, from throwing a rock to unbuttoning your shirt, with high impact potential applications, from manufacturing to home assistance, from food production to waste management. Like many other human skills, however, its apparent simplicity is largely deceiving. It sits right between art and science, and replicating it by an artificial agent has proven a very challenging endeavor. My main goal in this talk is to describe some capabilities that I believe are essential to develop autonomous robotic manipulation systems, and to discuss research directions that I think need more attention for manipulation research to move forward: planning reaching motions instead of grasps; manipulation within, rather than despite, the environment; co-design of morphology and control; and reactive control strategies.

Biography

Alberto Rodríguez is the Walter-Henry-Gale Career Development Professor in Mechanical Engineering at MIT. Alberto graduated in Mathematics ('05) and Telecommunication Engineering ('06) from Universitat Politecnica Catalunya and did his PhD ('13) at the Robotics Institute at Carnegie Mellon University. Alberto has received the Best Student Paper Awards at conferences RSS'11, ICRA'13 and RSS'18, and Best Paper Award finalist at IROS'16. He led Team MIT-Princeton in the Amazon Robotics Challenge 2015-2017, finishing in first place in the stowing task, and has received the Amazon Research Award. He leads the Manipulation and Mechanisms Lab at MIT researching autonomous dexterous manipulation, robot automation, and end-effector design.

Amy Loutfi
Örebro University

Semantics for Robotics

As humans and robots start to cohabit the same environment and interact deeper with each other, the need for robots and other artificial agents to truly understand human instruction increases. This understanding not only involves the ability for robots to decode human speech, but also the ability to ground words that refer to physical objects, actions, and concepts - to the perceptual information coming from the sensors embedded on the agent. This challenge in part deals with the symbol grounding problem, that is, how to ground symbols into something other than symbols. Further with the advent of advances within representation learning, due to many of the advances within sub-symbolic architectures there has been an opportunity to examine how the grounding can be learned using large (and simulated) datasets. This talk will highlight the research at Örebro University where semantics are learned, integrated and used for robotic systems.

Biography

Amy Loutfi is head of the Center for Applied Autonomous Sensor Systems (www.aass.oru.se) at Örebro University. She is also a professor in Information Technology at Örebro University. She received her Ph.d in Computer Science with a focus on the integration of artificial olfaction on robotic and intelligent systems. She currently leads one of the labs at the Center, the machine perception and interaction lab (www.mpi.aass.oru.se). Her general interests are in the area of integration of artificial intelligence with autonomous systems, and over the years has looked into applications where robots closely interact with humans in both industry and domestic environments.

Anca Dragan
UC Berkeley

Optimal Robot Action for and around People

Estimation, planning, control, and learning are giving us robots that can generate good behavior given a specified objective and set of constraints. What I care about is how humans enter this behavior generation picture, and study two complementary challenges: 1) how to optimize behavior when the robot is not acting in isolation, but needs to coordinate or collaborate with people; and 2) what to optimize in order to get the behavior we want. My work has traditionally focused on the former, but more recently I have been casting the latter as a human-robot collaboration problem as well (where the human is the end-user, or even the robotics engineer building the system). Treating it as such has enabled us to use robot actions to gain information; to account for human pedagogic behavior; and to exchange information between the human and the robot via a plethora of communication channels, from external forces that the person physically applies to the robot, to comparison queries, to defining a proxy objective function.

Biography

Anca Dragan is an Assistant Professor in EECS at UC Berkeley, where she runs the InterACT lab. Her goal is to enable robots to work with, around, and in support of people. Anca did her PhD in the Robotics Institute at Carnegie Mellon University on legible motion planning. At Berkeley, she helped found the Berkeley AI Research Lab, is a co-PI for the Center for Human-Compatible AI, and has been honored by the Sloan fellowship, the NSF CAREER award, the Okawa award, MIT's TR35, and an IJCAI Early Career Spotlight.

Aníbal Ollero
University of Seville

Challenges in Aerial Robotic Manipulation

The key-note will start by introducing the challenges posed by industrial applications of aerial manipulation, and particularly by the contact inspection in oil and gas industries and in bridges, and by the logistic applications that involve accuracy and interactions with humans. Then, methods and technologies in aerial robotic manipulation will be introduced. Systems with different aerial platforms and robotic arms, including dual arms and long reach manipulators, will be presented. Different centralized and decentralized control methods of the flying manipulators will be described. The talk will include perception methods for localization and mapping, and visual servoing in aerial manipulation. Moreover, planning and reactivity for general manipulation tasks while flying will be considered. Implementations and industrial applications, including recent results in the AEROARMS H2020 project, will be also presented. Finally, the existing limitations will be pointed out and the trends and new challenges to increase flight endurance and the safety in the interaction with humans will be analysed in the framework of the GRIFFIN ERC Advanced Grant.

Biography

Head of GRVC at University Seville and Scientific Advisor of the Center for Aerospace Technologies (CATEC). He has been full professor at Universities of Santiago and Malaga (Spain), researcher at the Robotics Institute of Carnegie Mellon University (Pittsburgh, USA) and LAAS-CNRS (Toulouse, France). He authored more than 670 publications, supervised 38 PhD Thesis and led 160 projects, including 7 European projects. He is currently the coordinator of the H2020-AEROARMS and is launching the GRIFFIN ERC-Advanced Grant. He has 20 years expertise in aerial robotics, has developed the aerial robotic manipulation and transferred technologies to many companies. He is recipient of 19 Research and Innovation awards, including the recent Overall ICT Innovation Radar Prize 2017 of the European Commission.

22. Keynote sessions

Elena Garcia
CAR-CSIC, Madrid

Gait Exoskeletons: A New Horizon in the Therapy of Neuromuscular Diseases in Childhood and Adolescence

A large variety of neuromuscular diseases are the cause of progressive muscle weakness and wasting in children. It is hypothesized that maintaining walking would significantly reduce or delay the onset of related complications. The ATLAS2020 project has been a unique, successful initiative carried out jointly by the Centre for Automation and Robotics (CSIC-UPM) and Marsi Bionics company, that first investigated and developed a wearable gait exoskeleton for children affected by Spinal Muscular Atrophy (SMA). The pediatric gait exoskeleton is indicated for SMA children thanks to the inclusion of variable stiffness joints that mimic the versatile operation of the human muscle providing safe mobility. The resulting prototype was tested in Sant Joan de Déu Children Hospital involving 7 patients, demonstrating usability and absence of adverse events. The ATLAS2020 project jumped out from the lab towards market by Marsi Bionics. Meanwhile, the commercial exoskeleton initiated a series of clinical trials to study the psychological impact if its use at home, aiding SMA kids to perform daily life activities. The impact on life quality was quickly noticed from the first day at each home. However, the most impressive results arise after analyzing the evolution of muscle strength and functional abilities of the kids.

Biography

She is PhD in Robotics Engineering and Tenured Scientist at the Spanish National Research Council (CSIC). She is leading research on the development of wearable gait exoskeletons for the therapy of neuromuscular diseases in childhood focused on pediatric gait exoskeletons for Spinal Muscular Atrophy, Duchenne Muscular Dystrophy and Cerebral Palsy. Her research is aimed at improving the performance of legged locomotion, including dynamic stability, active compliance in the foot-ground interaction, and variable stiffness actuators for lower-limb exoskeletons. She has published more than 100 international papers, owns 7 patents and founded Marsi Bionics company.

22. Keynote sessions

Barbara Mazzolai
IIT, Pontedera

Plant-like robots are growing up

A rich literature exists in bioinspired robotics and recently the use of soft materials and variable stiffness technologies represents an emerging way to build new classes of robotic systems that are expected to interact more safely with natural unstructured environments and with humans, and that better deal with un-certain and dynamic tasks. Despite the big achievements in this field, robotic technologies are still inadequate to mimic the biological system capabilities in changing their morphology and adapting their body and functionality during their lifetime. Growth is a very interesting feature of living beings that can inspire a generation of robots with new and unpredictable abilities of movement. Noteworthy, plants represent an alternative model of movement in robotics based on growing.

We propose a new generation of self-creating plant-like robots that are able to move adding new material to their bodies while adapting to external conditions. The potential impact on society of plant-like self-creating robots could be huge and wide, e.g., in rescue, medical applications, space, or environmental monitoring. Since the design of these robotic solutions is deeply based on a few selected plant features, a new view of robots for biology can be envisaged, with the goal to give insights on the organisms themselves and open new exciting opportunities both in science and engineering.

Biography

Barbara Mazzolai is Director of the Center for Micro-BioRobotics at the Istituto Italiano di Tecnologia (IIT) since 2011, and she was Deputy Director for the Supervision and Organization of the IIT Centers Network from 2012 to 2017. She holds an MSc cum laude in biology at the University of Pisa and PhD in microsystems engineering from the University of Rome Tor Vergata.

From January to July 2017 she was Visiting Faculty at Aerial Robotics Lab, Department of Aeronautics, of Imperial College of London. She is member of the Scientific Advisory Board of the Max Planck Institute for Intelligent Systems, Tübingen and Stuttgart, Germany.

22. Keynote sessions

Christian Ott
DLR, Munich

Elastic Actuators: From mastering vibrations towards utilization of intrinsic dynamics

Compliant actuation is both a traditional and a timely topic in robotics. While early works on elastic robots focused on mastering the vibration damping and torque control problems, the topic has regained attention by a new generation of intrinsically compliant robots driven by variable impedance actuators. In these systems elasticity is deliberately introduced in the mechanical design in order to protect the robot against external shocks and to utilize energy storage in highly dynamic motion generation. More recently, variable dampers and soft material components are used in some compliant actuator designs. While considerable progress has been made in the basic motion and interaction control for these systems, there still exist some fundamental questions that prevented a widespread application of this technology. How to take best use of variable impedance for specific tasks such as manipulation or locomotion? How to preserve energetic efficiency from open loop trajectory planning during closed loop control? In this keynote I will highlight the state of the art in the control of elastic robots and discuss some open challenges in intrinsically compliant robots.

Biography

Dr. Christian Ott received the Dipl.-Ing. degree in mechatronics from the Johannes Kepler University in Linz, Austria, in 2001, and the Dr.-Ing. degree in control engineering from Saarland University, Germany, in 2005. From 2001 to 2007, he was working as a researcher at the German Aerospace Center (DLR). From 2007 to 2009, he was a Project Assistant Professor in the Department of Mechano-Informatics at the University of Tokyo. He has led a Helmholtz Young Investigators Group on Legged Locomotion at DLR. Since 2014, he is head of the Department for Analysis and Control of Advanced Robotic Systems at DLR. His research interests include nonlinear robot control, elastic robots, interaction control, and humanoid robots.

Hanna Kurniawati
University of Queensland

Robust Decision Making in Partially Observable World

A critical question robust robot operation must answer is: What to do now, so as to receive good long-term returns, despite not knowing the exact effect of its actions, despite various errors in sensors and sensing, and despite limited information about the environment and itself. This problem itself is not new. In fact, mathematically principled concepts --called Partially Observable Markov Decision Processes (POMDPs)-- have been developed more than five decades ago exactly to address the problem mentioned above. However, such concepts are notorious for its computational complexity, that they have often been considered impractical. I will present some of our effort in addressing the computational complexity issues of solving POMDPs, along with the software toolkit we have developed to ease their application in physical robots, including in 6-7 DOFs manipulators.

Biography

Hanna Kurniawati is a Senior Lecturer of Information Technology and Electrical Engineering at the University of Queensland. She earned her PhD from National University of Singapore for work in motion planning. Her research focuses on algorithms to enable robust decision theory to become practical software tools in robotics. She received a Gold Award for ICT Researcher of the year (2015) from the Australian Computing Society. Along with colleagues and students, her work was nominated for the best paper award at ICRA'15 and won a best paper award at the International Conference on Automated Planning and Scheduling 2015.

22. Keynote sessions

Hiroko Kamide
Nagoya University

Psychology to Coexist with Robots

Advanced technological development has enabled robots that are guaranteed safety and it is also necessary to carefully examine whether general users feel "psychological" safety for such robots. Our studies found general users sees a sense of psychological safety with specific viewpoints. In addition, as more and more anthropomorphized robots are being developed, it has become clearer that a cultural background of users influence the relationship between anthropomorphic factors of robots and psychological safety. These findings may provide useful suggestions on how advanced robotic technologies will be acceptable to general users. Finally, as an important point, we would like to discuss not only how the users just accepts robot technology but also how to proactively find values for technology. External existence such as physical safety technology and social legal system is inevitable for the socialization of robot technology without any doubt. On the other hand, the possibility of extracting the inherent unlimited values of a physical robot depends on the attitude of the humans of not only engineering developers but also the users. We call this "Manners for things". We will discuss that to acquire manners to things plays an important role in coexistence of humans and robots.

Biography

Hiroko Kamide received PhD. Degree in Human Science from Osaka University, Japan, in 2008. Since 2009, she had been a Specially Appointed Assistant Professor in Graduate School of Engineering Science, Osaka University and was engaged in research of human-robot interaction. She stayed at Tohoku University in 2015 as an assistant professor and moved to Institute of Innovation for Future Society in Nagoya University in 2016 as a designated associate professor. Her current research topics are harmonious relationships between robotic technology and humans from psychological perspectives. She is a member of IEEE, and Society for Personality and Social Psychology (SPSP).

22. Keynote sessions

Jamie Paik
EPFL, Lausanne

Hard Challenges in Soft Robotics

The ultimate goal of any soft robotics system is to have a cohesive solution to improve the human – machine interface. For such an interface, it is critical to realize a versatile and adaptable multi-degrees of freedom robotic design. While the findings in soft robotics have broadened the application of robotics, they are still limited to specific scenarios. The next challenge is in pushing the boundaries of multi-disciplinary science interceptions simultaneously: materials, mechatronics, energy, control, and design. Such efforts will lead to robust solutions in design methodology, novel actuators, and a comprehensive fabrication and integration method of the core robotic components. This talk will highlight on the recent progresses in soft- material robots and origami robots that aim at achieving comprehensive solutions toward diverse soft human – robot applications.

Biography

Prof. Jamie Paik is director and founder of Reconfigurable Robotics Lab (RRL) of Swiss Federal Institute of Technology (EPFL) and a core member of Swiss National Centers of Competence in Research (NCCR) Robotics consortium. RRL's research leverages expertise in multi-material fabrication and smart material actuation. She received her Ph.D. in Seoul National University on designing humanoid arm and a hand. During her Postdoctoral positions in ISIR (Institut des Systems Intelligents et de Robotic) in Universitat Pierre Marie Curie, Paris VI, she developed laparoscopic tools that are internationally patented and commercialized. At Harvard University's Microrobotics Laboratory, she started developing unconventional robots that push the physical limits of material and mechanisms. Her latest research effort is in soft robotics and self-morphing Robogami (robotic origami) that transforms its planar shape to 2D or 3D by folding in predefined patterns and sequences, just like the paper art, origami.

John Long
Vassar College, New York

Life's Intelligent Devices: Scientific Research with Bioinspired Robots

From flying fish to swimming birds, the surprisingly diverse movements of lifeforms inspire robotics. Morphological and biomechanical principles, instantiated in physical systems, solve practical problems in aquatic, terrestrial, and aerial propulsion. But movement means more than just motion: we learn from biology and cognitive science that it is foundational to embodied intelligence. Movement structures dynamical interactions with the world, enacting perception, and feeding back to create opportunities for new behaviours. New behaviours, in turn, drive novel developmental and evolutionary patterns; robust intelligence increases as agents learn or evolve to integrate their physical and cognitive systems. As scientists, we use robots as models to test theory governing the actions, the behaviours, and the evolution of lifeforms.

Biography

John Long is Director of the Interdisciplinary Robotics Research Laboratory at Vassar College (Poughkeepsie, New York, USA), where he also is Chair of the Cognitive Science Department and Professor of Cognitive Science and Biology on the John G. Vassar Chair of Natural History. He is professor on "The Great Courses: Robotics," and author of Darwin's Devices: What Evolving Robots Can Teach Us About the History of Life and the Future of Technology. His research is currently supported by the US National Science Foundation (INSPIRE, Special Projects, grant no. 1344227).

22. Keynote sessions

Katja Mombaur
Heidelberg University

Realistic models of human motions for better wearable robots

Wearable robots such as exoskeletons, orthoses and prostheses, are important examples of human-centered robots that ideally have to work in perfect synergy with the human. For the design and control of wearable robots it is therefore important to understand and to be able to predict how humans behave in different situations, how they move under different loads, and how they interact with the wearable robot.   In my research group, we have been developing experimentally validated, realistic models of human movement for this purpose, as well as different optimization approaches for motion prediction and design and control optimization of wearable robots. These models capture essential subject-specific mechanical properties, also including the influence of passive elements and the muscular effort of motion generation, as well as motion stability. We also investigate ergonomic models for human-robot interaction and models of pain for specific pathologies. I will present recent results from my group obtained within the SPEXOR project on the development of passive and active spinal exoskeletons to prevent back pain in challenging working conditions. In addition, I will show results on the use of prostheses in sports, analyzing running motions of amputee and non-amputee athletes.

Biography

Katja Mombaur is a full professor at the Institute of Computer Engineering of Heidelberg University and head of the Optimization, Robotics & Biomechanics Chair, as well as coordinator of the newly founded Heidelberg Center for Motion Research. She holds a diploma degree in Aerospace Engineering from the University of Stuttgart and a Ph.D. degree in Mathematics from Heidelberg University and has worked as a researcher at Seoul National University, and in LAAS-CNRS in Toulouse. Her research focuses on understanding human movement by a combined approach of model-based optimization and experiments and using this knowledge to improve motions of humanoid robots and the interactions of humans with exoskeletons, prostheses and external physical devices.

22. Keynote sessions

Kyujin Cho
Seoul National Univeristy

Soft Robots with Physically Embodied Intelligence

Soft robotics deals with interaction with environments that are uncertain and vulnerable to change, by easily adapting to the environment with soft materials. However, softness requires controlling large degrees of freedom. Many soft robots use pneumatics which can easily distribute the actuation. If tendons are used for actuating a soft body, the large degrees of freedom of the material either requires large number of tendons or limits the controllability. Tendon drive soft robots can benefit from using the concept of physically embodied intelligence, first proposed by Prof. Rolf Pfeifer. By embodying intelligence into the design, better performance can be achieved with a simpler actuation. In nature, there are few example that exhibit this property. Flytrap, for example, can close its leaves quickly by using bistability of the leaves instead of just relying on the actuation. Inchworm achieves adaptive gripping with its prolegs by using the buckling effect. In this talk, I will give an overview of various soft robotic technologies, and some of the soft robots with physically embodied intelligence that are being developed at SNU. These examples will show that the concept of physically embodied intelligence simplifies the design and enables better performance by exploiting the characteristics of the material.

Biography

Kyu-Jin Cho received B.S and M.S. degrees from Seoul National University, Korea and a Ph.D. degree in ME from M.I.T. He was a post-doctoral fellow at Harvard Microrobotics Laboratory. At present, he is a professor of Mechanical and Engineering and the director of Soft Robotics Research Center and Biorobotics Laboratory at Seoul National University. He has been exploring novel soft robot designs, including a water jumping robot, origami robots and a soft wearable robot for the hand, called Exo-Glove Poly. The work on the water jumping robot was published in SCIENCE and covered by over 300 news media world-wide. l perspectives

22. Keynote sessions

Pere Ridao
University of Girona

Underwater 3D Mapping and Intervention

Although commercial Autonomous Underwater Vehicles (AUVs) are currently used routinely for opto / acoustic seafloor mapping in predominantly flat terrains, they cannot operate in areas with significant 3D relief. Currently, only Remotely Operated Vehicles can be used for high resolution optical mapping of steep terrains, as well as for Inspection, Maintenance and Repair applications where manipulation is required. As research advances, some of these tasks solved nowadays with teleoperated vehicles, will be gradually achieved with autonomous robots. The future AUVs have to be able to build high resolution maps of arbitrary underwater 3D structures. From one side, this means that mapping algorithms to build 3D models from the opto / acoustic imagery are required, but also that is required to guide the robot close to the structure to make it visible by the cameras. Even more, future AUVs have to be able to safely move around submerged infrastructures, to inspect them as well as to perform manipulation tasks like grasping objects, turning valves and plugging connectors, paving the way to a new breed of vehicles, the so called Intervention Autonomous Underwater Vehicle.

Biography

Pere Ridao is the director of the Computer Vision and Robotics Research Institute (VICOROB), the head of the Underwater Robotics Research Center (CIRS) at the University of Girona (UdG) and a co-founder of Iqua Robotics SL devoted to the manufacture of Autonomous Underwater Vehicles (AUVs). He served as the chair of the IFAC Technical Committee on Marine Systems (2014-2017) and as the chair of the Spanish network about "Robotics and Automation for the Marine Industry" (AUTOMAR 2011-2015). Dr. Ridao research activity focuses on designing and developing Autonomous Underwater Vehicles for 3D Mapping and Intervention. During his career he has participated in several international research projects (TRIDENT, MORPH, PANDORA, EUMR, IAUV-CONTROL, SUNRISE/ LOON-DOCK, EUROFLEETS, CALDERA), international research networks (FREESUBNET, MOMARNET, ROBOACADEMY, STRONGMAR and EXCELLABUST), national research projects (AIRSUB, RAUVI, TRITON, MERBOTS, TWINBOT) and technology transfer projects (OPTIMAX, INSPECSUB, SOUNDTILES, ROBOTTNET-L3S).

22. Keynote sessions

Philippe Souères
LAAS-CNRS, Toulouse

Humanoid Motion and Human Movement at LAAS-CNRS

The Gepetto team of LAAS-CNRS is leading an interdisciplinary research at the confluence of humanoid robotics, human motor control and biomechanics. On the one hand, we develop advanced motion generation software to endow humanoid robots with the capability of executing safe and complex movements in various situations. On the other hand, we analyze the human movement with the aim to extract functional principles that reveal its organization. Despite the huge difference between the human body and the humanoid structure, considering the anthropomorphic motion as a common research object in engineering and life sciences allows numerous fundamental notions to be analyzed from complementary points of view. This talk will present the Gepetto approach to tackling the fundamental problems of path-planning, motion generation and control, with the aim to demonstrate that humanoid robots have a strong potential of application both in service robotics and in the factory of the future. We will also present a set of results in which the robotics formalism combined with motion analysis techniques is used for modeling the human movement and drawing fruitful links with humanoid robots.

Biography

Philippe Souères is the head of the Robotics Department of the Laboratory for Analysis and Architecture of Sytems (LAAS-CNRS) in Toulouse, France, and the leader of the Gepetto team of LAAS-CNRS, which is specialized in the movement of anthropomorphic systems. With a background in mathematics he has been working on different facets of robot control, with a particular focus on wheeled robots, aerial robots and humanoid robots. Deeply interested in the link between robotics and life sciences, he has conducted several interdisciplinary projects in collaboration with neuroscientists and biomechanics, facing notably the question of spatial cognition and sensorimotor integration.
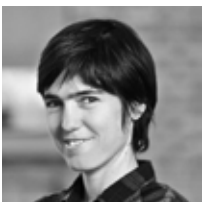
Raquel Urtasun
UBER ATG, Toronto

A Future with Affordable Self-driving Vehicles

We are on the verge of a new era in which robotics and artificial intelligence will play an important role in our daily lives. Self-driving vehicles have the potential to redefine transportation as we understand it today. Our roads will become safer and less congested, while parking spots will be repurposed as leisure zones and parks. However, many technological challenges remain as we pursue this future. In this talk I will showcase the latest advancements made by Uber Advanced Technologies Group's Research Lab in the quest towards self-driving vehicles. In addition, you'll hear my thoughts on the future of research and education in this field, where both industry and academia come together to form the next generation of students and solve the remaining open research problems.

Biography

Raquel Urtasun is the Head of Uber ATG Toronto. She is also a Professor at the University of Toronto, a Canada Research Chair in Machine Learning and Computer Vision and a co-founder of the Vector Institute for AI. She received her Ph.D. from the Ecole Polytechnique Federal de Lausanne (EPFL) in 2006 and did her postdoc at MIT and UC Berkeley. She is a recipient of an NSERC EWR Steacie Award, an NVIDIA Pioneers of AI Award, a Ministry of Education and Innovation Early Researcher Award, three Google Faculty Research Awards, an Amazon Faculty Research Award, a Connaught New Researcher Award, a Fallona Family Research Award and two Best Paper Runner up Prize awarded CVPR in 2013 and 2017.

22. Keynote sessions

Reid Simmons
Carnegie Mellon University

Models of Our Interactions

Human behavior is complex, with people exhibiting a wide variety of behaviors depending on the situation and their internal state and beliefs. This makes human-robot interaction complex, as well, since the robots need to understand human behavior and enable humans to readily understand their behavior. Typically, this interaction is mediated by models of how humans behave in given contexts and how the robots own behavior affects people.   But, where do those models come from and how can they be effectively used? This talk will present and discuss some of the types of models commonly used in human-robot social interaction derived from psychology, sociology, observation, and even drama. The talk will focus on how robots can use such models to non-verbally communicate, in a legible and transparent manner, their intended behavior and internal state, and how such signaling impacts the way people view and interact with social robots.

Biography

Reid Simmons is a Research Professor in the Robotics Institute at Carnegie Mellon University. He recently returned to CMU from a stint as Program Director at the National Science Foundation, where he oversaw the National Robotics Initiative and Smart and Autonomous Systems programs. Dr. Simmons earned his PhD from MIT in 1988 in the field of Artificial Intelligence. Since coming to CMU in 1988, his research has focused on developing self-reliant robots that can autonomously operate over extended periods of time in unknown, unstructured environments. In addition, his research focuses on human-robot social interaction, especially non-verbal communication through affect, proxemics, motion, and gesture. Dr. Simmons is a Fulbright Scholar and a Fellow of the Association for the Advancement of Artificial Intelligence.

Rita Cucchiara
University of Modena and Reggio Emilia

Computer Vision and AI for Robot Visual Intelligence

AI and Robotics have been separate fields up to now. Combining them could transform manufacturing, social and collaborative robotics but AI too. The easier point of convergence is computer vision which has been adopted for many robotic tasks, manipulations, navigation, interaction. The next step, putting together reconstructive vision, recognition and reasoning as well as (deep) learning and mobile robots will put the basis of new robot visual intelligence capabilities. The talk will provide a small overview of the last research results in the world of vision which could inspire new join research in robotics, computer vision and AI. The talk will focus in particular in egocentric vision, for both humans and robot, in human behaviour understanding, pose-based detection and tracking and human expression analysis in RGB and depth data. As well some results in saliency analysis and vision to language translation will be presented to underline the power of deep learning as foundational building block of AI for many perceptive and cognitive tasks towards visual intelligence. Some projects results carried out at AimageLab UNIMORE will be presented and discussed for new potential application in autonomous mobile robots and vehicles and in social robots.

Biography

Rita Cucchiara is full professor of Computer Vision at Department of Engineering "Enzo Ferrari" of University of Modena and Reggio Emilia, where she holds AImageLab, devoted to computer vision and pattern recognition, AI and multimedia, since 1998. She coordinates the RedVision Lab UNIMORE-Ferrari for human-vehicle interaction. She has been the president of Italian association in Computer Vision, Pattern Recognition and Machine Learning (CVPL) from 2016 to 2018 and is currently Director of the Italian CINI Lab in Artificial Intelligence and Intelligent Systems. In 2018 she has been recipient of the Maria Petrou Prize of IAPR.

22. Keynote sessions

Takao Someya
University of Tokyo

Electronic skins for robotics and wearables

The human skin is a large-area, multi-point, multi-modal, stretchable sensor, which has inspired the development of an electronic skin for robots to simultaneously detect pressure and thermal distributions. By improving its conformability, the application of electronic skin has expanded from robots to human body such that an ultrathin semiconductor membrane can be directly laminated onto the skin. Such intimate and conformal integration of electronics with the human skin, namely, smart skin, allows for the continuous monitoring of health conditions. The ultimate goal of the smart skin is to non-invasively measure human activities under natural conditions, which would enable electronic skins and the human skin to interactively reinforce each other. In this talk, I will review recent progresses of stretchable thin-film electronics for applications to robotics and wearables. Furthermore, the issues and the future prospect of smart skins will be addressed.

Biography

Takao Someya received the Ph.D. degree in electrical engineering from the University of Tokyo in 1997. Since 2009, he has been a professor of Department of Electrical and Electronic Engineering, The University of Tokyo. He has been Globalfoundries Visiting Professor, National University of Singapore, since 2016, and Hans Fischer Senior Fellow, Technical University of Munich, since 2017. His current research interests include organic electronics, flexible electronics, wearable sensors, and soft robots. Dr. Someya's "large-area sensor array" electronic thin film was featured in Time Magazine as one of its "Best Inventions of 2005" in its November 21st, 2005 issue.

Yiannis Demiris
Imperial College London

Personalisation in Assistive Robotics

As humans and robots increasingly co-exist in home and rehabilitation settings for extended periods of time, it is crucial to account for the users' constantly evolving profiles and adapt the interaction to the personal characteristics of the individuals involved. I will describe our predictive computational architectures for enabling human robot interaction in joint tasks, and discuss the related computational problems, including user modelling, attention, perspective taking, prediction of forthcoming states, machine learning, explanation generation, and personalised shared autonomy. I will give examples from human robot collaboration experiments in diverse tasks, including robotic wheelchairs for disabled kids and adults, collaboration in musical tasks, activities of daily living (for example dressing tasks), shared control for handheld robots, shared autonomy in driving, among others.

Biography

Yiannis Demiris is a Professor of Human-Centred Robotics at the Department of Electrical and Electronic Engineering, Imperial College London, London, U.K, where he heads the Personal Robotics Laboratory. He received the B.Sc. and Ph.D. degrees from the Department of Artificial Intelligence, of the University of Edinburgh. His current research interests include human–robot interaction, machine learning, user modelling, and assistive robotics, and he has published over 150 journal and peer reviewed conference papers in these areas. Professor Demiris is a Fellow of IET, BCS, and the Royal Statistical Society.

23. Forums

FORUM	ROOM	DATE	TIME
Microsoft AI Transformation	1.R.4	Oct. 2	9:00-11:00
Robotics meets the Humanities	Auditorium	Oct. 2	14:30 - 19:00
Autonomous Driving & Future Mobility Technologies	1.R.4	Oct. 2	14:30 - 16:00
IROS 2018 Industry Forum	Auditorium	Oct. 3	11:30 - 13:30
Entrepreneurship Forum and Start-up Contest - EFSC 2018	1.R.4	Oct. 3	14:30-16:45
ECHORD++ Summit	1.R.3	Oct. 3	16:30 - 18:00
IROS 2018 Government Forum	Auditorium	Oct. 3	17:00 - 19:00
Minesweepers Competitions Presentation Session	1.R.3	Oct. 4	9:00-13:00
Special EU session: Robotics in the European AI strategy and funding opportunities	4.L.3	Oct. 4	11:30-13:00
Legal Issues, Cybersecurity and Policymakers' Implication in AI Robotics	1.R.4	Oct. 4	15:30-19:00
Forum on Smart Cities Robot Competitions	4.L.3	Oct. 4	16:00 - 19:00

ECHORD++: Advances in Robotic Science Supporting Innovation

Organizers: Prof. Dr. Alberto Sanfeliu and Prof. Dra. Ana Puig-Pey (Institut de Robòtica i Informàtica Industrial CSIC-UPC, Spain)

Aim of the Forum

The main objective of the forum is to share the innovative results of the 35 robotic experiments financed under the ECHORD++ European Project and the lessons learned in the innovative procedures developed during these five years.

Format

The participation during the workshop of all the stakeholders involved to link real needs with robotic solutions closer to the market give us the opportunity to share our experience and develop this workshop under the structure of a Networking Session.

Forum on Smart City Robot Competitions

Organizers: Gerhard Kraetzschmar (BRS University, Germany), Matthew Studley (UWE Bristol, UK.), Pedro Lima (IST Lisbon, Portugal)

Program

16:00 - 16:15 - Welcome and Introduction by the Chairs
16:15 - 16:45 - IROS 2018 ERL Consumer Service Robots competition - Pedro U. Lima, Jordi Pagès
16:45 - 17:15 - IROS 2018 ERL Consumer Competition Award Ceremony, conducted by Marta Palau
17:15 - 17:30 - Presentation of the upcoming 2019 ERL Smart City tournament, by Daniele Nardi
17:30 - 17:40 - Professional Service Robots in Smart City Competitions, by Gerhard Kraetzschmar
17:40 - 17:50 - Emergency Service Robots in Smart City Competitions, by Antidio Vigura
17:50 - 19:00 - Debate about the impact of robot competitions on tech transfer, research advances, and student recruiting by companies

Format

Invited talks

23. Forums

Robotics meets the humanities: social relationship, Ethics, Art and Science Fiction

Organizers: Yoshihiko Nakamura (University of Tokyo, Japan), Giulio Sandini (Istituto Italiano di Tecnologia, Italy), Carme Torras (CSIC-Universitat Politècnica de Catalunya, Spain)

Aim of the forum

This forum invites distinguished speakers from the humanities to begin a dialogue with the robotics community. The aim is to understand how we can bridge the unnecessary divide between the two communities and to foresee the many beneficial implications if, and when, we succeed in doing so.

Autonomous Driving & Future Mobility Technologies

Organizers: Christian Laugier (INRIA, France), Philippe Martinet (INRIA, France), Christoph Stiller (Karlsruhe Institute of Tecnhnology, D), Urbano Nunes (University of Coimbra, Portugal), Miguel Angel Sotelo (University Alcala, Spain)

Objectives

Presenting State of the Art of industrial technologies for ADAS, Autonomous Driving and future Mobility services

Format

Invited talks, Panel discussion and Introduction to live demos

Legal Issues, Cybersecurity and Policymakers' Implication in AI Robotics

Organizers: George Dekoulis (AEI, Cyprus)

Objectives

Artificial intelligence (AI) robotic systems offer an unprecedented set of virtues to the society. However, as they are progressively being introduced into our daily lives, the robotic community has constantly been expressing three major concerns:

• Firstly, what is the legal framework that applies to the whole product-cycle of AI robotic products. Great legal issues have already been raised through the operation of AI robots.
• Secondly, serious concerns have been raised by both the industry and the robotic community regarding cybersecurity.
• Finally, how the policymakers are implicated in the different processes. Which are the parameters that determine the design of these policies. How efficient are the existing policies. How these policies are being applied and followed, primarily, by the manufacturers and, whether, the whole process is being monitored through any form of feedback.

Microsoft AI transformation

Organizers: Miguel González Fierro (Microsoft, London)

Summary

Since its foundation, Microsoft has continuously evolved from a software company to a cloud company and recently to an AI company. Interestingly, the transformation from a cloud company to an AI company is fairly recent and it has been produced extremely fast.
The origin of this transformation is just one simple concept: applied innovation. The discoveries from Microsoft Research are successfully integrated into products like Bing, Windows, Azure, Xbox, SQL Server and others. Learnings from customers are refed back into the product stack to achieve better and better products and services.
In this talk, we will address the underlying reasons why Microsoft is making such a massive bet in AI and will explore its AI platform. Finally, we will open a discussion on how the AI transformation in Microsoft can be extrapolated to robotics companies, why these companies have a huge business opportunity ahead and how to take advantage of it.

Speakers

Miguel González-Fierro, Danielle Dean, Mathew Salvaris, Ilia Karmanov

23. Forums

Entrepreneurship Forum and Startup Contest (EFSC 2018)

Organizers: Erwin Prassler (H-BRS/runfun, IEEE RAS past VP for Industrial Activities, Germany), Jon Agirre (Tecnalia, Spain), Fabio Bonsignorio (HERON Robots, Italy), Renaud Champion (Primnext, France)

Purpose of the Event

The event is intended to inspire, educate, enable, and empower researchers, students, young professionals, and anyone else who has the 'start-up bug' in starting companies of their own but is not sure of how to go about it. We also believe that this event will create an ecosystem that will provide the much-needed support for start-ups to launch their initiatives while being realistic about their envisioned ideas and products.

Format

EFSC consist of three stages:
In the first stage, submitted applications will be down-selected to arrive at a pool of qualified applicants based on a defined set of criteria developed by the organizers.
This will be followed by a remote stage where the selected applicants will be paired with coaches based on the proposal content and the expertise of the coaches. The coaches will then critique and provide technical and professional assistance to refine the idea/product pitches.
The final stage would allow for the refined pitches and content to be presented in front of a distinguished panel of venture capitalists, industry, and academic experts who have successfully funded, transitioned and have experience in commercialization of robotics and automation technologies.

IROS 2018 Industry Forum

Organizers: Francesco Ferro (PAL Robotics), Mohamed Abderrahim (UC3M)

Summary

The forum is projected to be a place to share where ideas and perspectives for the future development of Intelligent Robotic Technologies are shared / discussed. It is also aimed to provide different points of view to interested audience about robotics R&D in Industry and showcase successful incubation ecosystems for the development of entrepreneurial robotics projects. In addition to demonstrating that intelligent Industrial Robots are becoming real products for major robotic manufacturers, the forum's speakers will present cases of how small robotic startups and young entrepreneurs can benefit from high-tech ecosystems in Europe. This will assist them to transform their ideas into products and search for finance opportunities to create and help new ventures.
The forum intends to discuss the relationship between education, R&D and Industry showing points of view from big companies and small start-ups. The forum is expected to attract audience from academia, industries, researchers and students, and it is open to all conference attendees.

23. Forms

IROS 2018 Government Forum

Organizers: Paolo Dario (Sant'Anna School of Advanced Studies), Diego Torriccelli (CSIC)

Summary

The objective of the Government Forum is to distribute information about national/regional policies and roadmaps, as well as to discuss about the trends and political opportunities and threats in order to learn from each other, be informed, and better serve the international robotics and automation community.
This will be done by having a number of presentations from different countries and regions. At the end, a panel will take place in which the presented issues will be discussed.

Program

17:00-17:10 Opening remarks: **Paolo Dario** (SSSA, Pisa), **Diego Torricelli** (CSIC, Madrid)
17:10-17:25 European Commission robotics program: **Cecile Huet** (EC, DGCONNECT)
17:25-17:40 USA robotics program: **David Miller** (NSF, USA)
17:40-17:55 Japanese robotic program: **Tomomasa Sato** (NEDO, Robot and AI Department, Japan)
17:55-18:05 Korean robotics program: **Kyung-Hoon Kim** (Republic of Korea)
18:05-18:15 Finnish robotics program: **Cristina Andersson** (Develor, Finland)
18:15-18:25 German robotics program: **Tamim Asfour** (DGR, German Robotics Society)
18:25-18:35 Spanish robotics program: Head of the Department of Energy, Transport, Manufacturing and Digital Society (CDTI, Spain)
18:35-19:00 Round table: Moderated by Paolo Dario

Robotics in the European AI strategy and funding opportunities

Organizer: Cécile Huet

Summary

This session will present the key role Robotics is expected to play in the AI strategy announced by the European Commission on April 25th. This strategy highlights the European strength in embodied AI/robotics, and the importance to join forces and to build on Europe's excellence; therefore, the mobilization of the robotics community is key! The session will also present the funding opportunities for robotics in the EU Research and Innovation programme Horizon2020, as well as the opportunity to contribute to the European AI alliance, a multi-stakeholder forum discussing the future of AI from its various perspectives. Finally, the session will explain how the robotics community can benefit from some important projects such as the AI-on Demand Platform and Digital Innovation Hubs Networks in Robotics.

24. Competitions

Competitions take part in two venues. Most of them are located in the MMCC, at the ground floor, in the indicated areas. Only one indoor competition is in a room. The two outdoor competitions are in CAR-CSIC, at Arganda del Rey. Free shuttle buses connect the MMCC with CAR-CSIC on October 2 and October 3, for attendees being able to visit the competition and demo.

The shuttle bus will depart from the main entrance of the Conference Centre from 9 AM every two hours, at odd hours. The same bus will depart from CAR-CSIC from 10 AM every two hours, at even hours. Last bus leaves CAR-CSIC at 5 PM.

The schedule on October 2 may suffer some alterations at midday. Please, check the schedules in the registration desk or ask to any volunteer of IROS 2018 in the main hall.
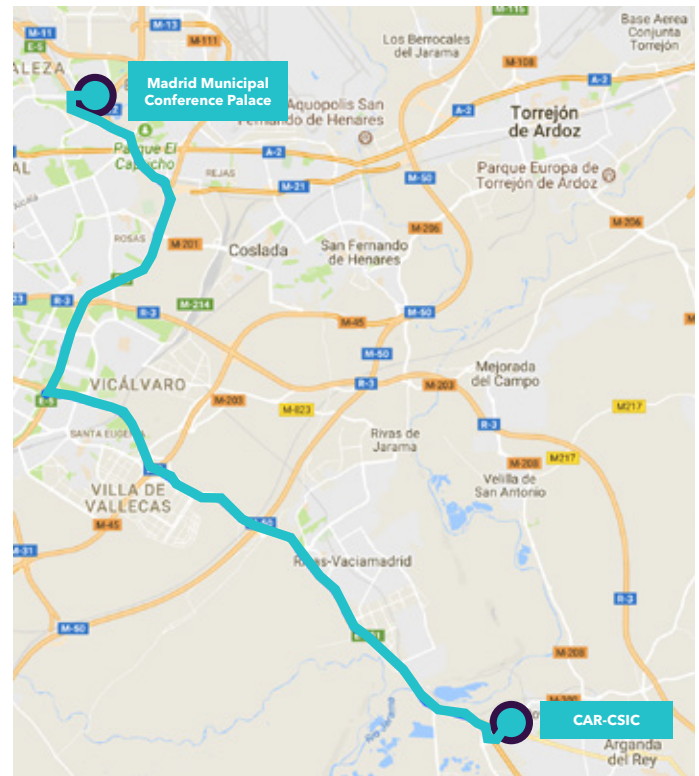
CAR-CSIC address:
Carretera Campo Real, nº 2, Arganda del Rey.

24. Competitions
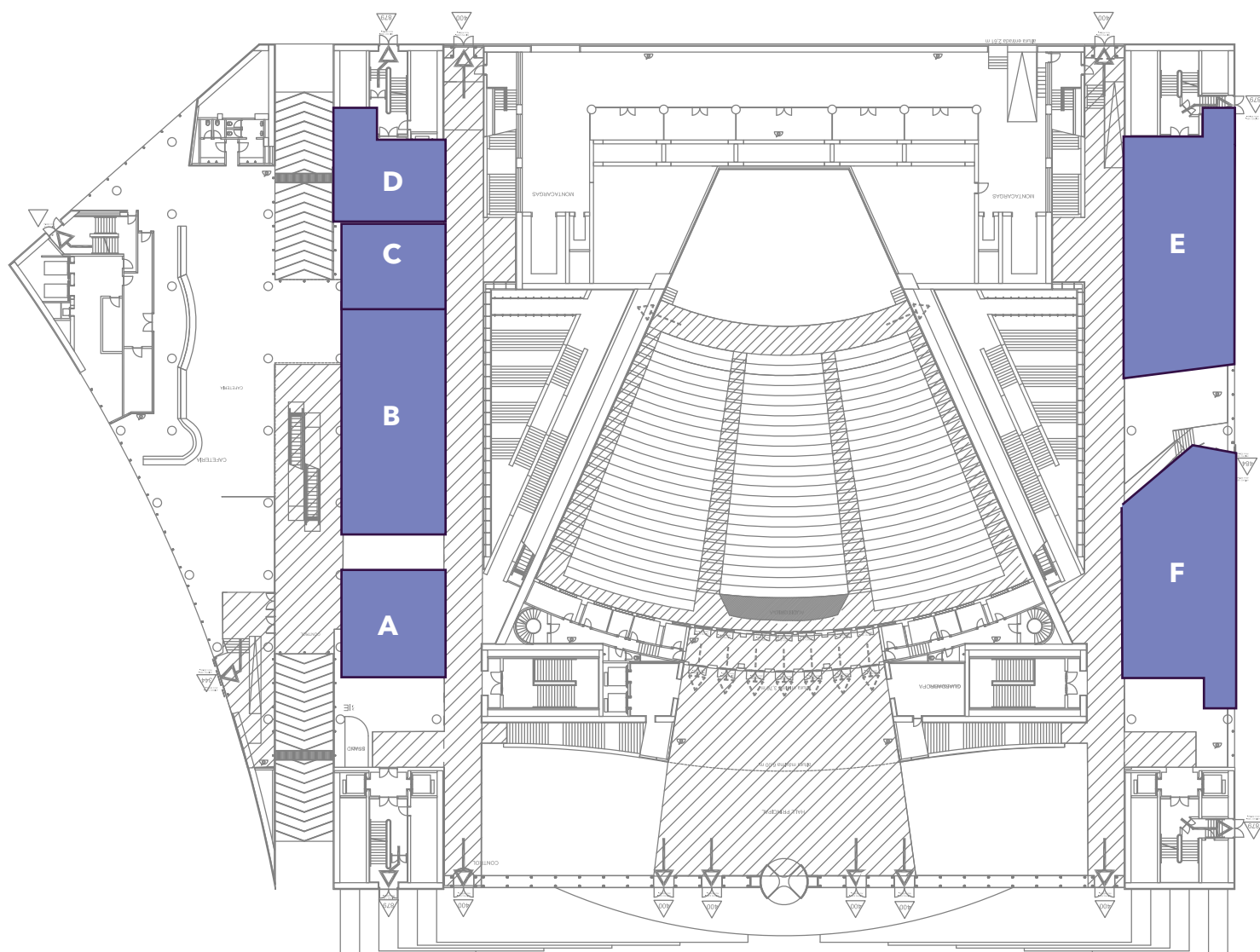
	Oct. 2	Oct. 3	Oct. 4	Location
IROS 2018 FAN Robotic Challenge	10:00-12:00			MMCC, Zone A
European Robotics League	9:00-18:00	9:00-18:00	9:00-17:00	MMCC, Zone B
Mobile Manipulation Hackathon	9:00-18:30	9:00-18:30	9:00-18:30	MMCC, Zone B
MathWorks Mini Drone			9:00-16:00	MMCC, Zone C
Humanoid Robot Application	9:00-17:30	9:00-17:30	9:00-17:30	MMCC, Zone D
Autonomous Drone Racing	9:00-17:00	9:00-17:00	9:00-17:00	MMCC, Zone F
Program A Robot		10:00-13:00		MMCC, Room 1.R.4
Autonomous Vehicles		9:00-17:00		CAR (Arganda)
Minesweepers	9:30-16:00	9:30-16:00		CAR (Arganda)

24. Competitions

IROS 2018 Fan Robotic Challenge

Description

The IROS2018 fan Robotic Challenge is a technical challenge, where robots have to manipulate the official IROS 2018 Spanish fan as good and fast as possible. Two main features will score during this process: a) time and b) degree of opening and closing of the fan.

The challenge has a first phase (October 2017 – March 2018) of video submission, with two modalities of increasing complexity. Prize for winners of both modalities of Phase I will be acceptance of their paper in IROS 2018 –a Special Session will be organized for this.

In Phase II, the objective is to open and close the fan in real-time with the real platform during the conference. This phase is independent of Phase I and all researchers are called for participation. In order to participate in Phase II, it is possible to choose between two different options:

Using your own robot (via streaming): According to the competition schedule, a member of your team should be prepared to execute your algorithm from your research centre.

KUKA robot: This sponsor will provide a robot for the competition. Participants should specify in the application form that they want to be considered to use the KUKA robot. Among the candidates, the company will select the most suitable ones for the competition. KUKA will contact the participants with instructions on how to apply to this competition modality and its benefits, which include travel expenses support.

Three winners will be chosen in Phase II. Prize for Phase II winners is 1.000 €.

Organizers:

David Álvarez Sánchez (UC3M), Fernando Martín Monar (UC3M)

24. Competitions

Autonomous Drone Racing Competition

Description

These guidelines intend to give the participating teams on how each team will be graded to determine the winning team in a manner that is fair to appreciate technologically innovative and well-implemented team's efforts.

I. Each team will have twenty minutes (subject to change depending on the number of participants). For the given twenty minutes, each team will attempt to race as many times as they want. Each attempt must start at the starting position. The team's official score will be selected from the best attempt.

II. Each attempt will be recorded in time. Before each attempt, the team is allowed to turn on their ground computer (if there is one) or any other supporting ground equipment. The power of the drone can be applied prior to each attempt. (This is to accommodate different booting time of each team's systems)

III. The record time of each team's attempt is measured from the time to take off and finish the attempt. If twenty minutes passes without finishing the course, the flight time and the last gate the drone passed is recorded.

IV. Each attempt is considered "finished" by successful passing the final gate in the correct order. If the drone deviates from the course and does not pass each gate in order, or malfunctions, is not able to sustain safe and controlled flight, or the team operator declares ending the attempt, this attempt is considered "not finished".

V. If the team does not finish the whole sequence, the ID number of the gate that the drone reached and the ending time is recorded.

VI. The winning team shall be the team with shortest flight time if the team finishes the whole course.

VII. For grading teams who did not finish the whole course will be compared with the ID number of the gate it reached. If two or more teams reached the same gate, the team with shorter flight time shall be given higher ranking.

VIII. The judging committee reserves the right to stop any team's attempt if considered dangerous or not following the guidelines. Also the judging committee reserves the right to rule out any attempt's record if any unfair activity is found (e.g. using sensors not allowed, obtain information not open to the all teams, human intervention during the flight and so on).

Organizers

Hyungpil Moon (Sungkyunkwan University, Korea), David Hyunchul Shim (KAIST, Korea), Si Jung Kim (University of Nevada, USA), Pascual Campoy (Universidad Politécnica de Madrid, Spain)

European Robotics League - Consumer Service Robots

Description

The "European Robotics League- Consumer Service Robots" is an innovative concept for robot competitions which stems from its predecessor, the RoCKIn@Home competition, and focuses on tasks that service robots execute in a real home environment. The ERL Consumer is composed of multiple "Local Tournaments", held in different research labs across Europe, with certified test beds, and a few "Major Tournaments". Teams participate in a minimum of two Tournaments (Local and/or Major) per year and get scores based on their performances. Scores of the best two participations in tournaments for each team are added and teams are ranked based on their cumulative score. Prizes for the top teams are awarded during the next year's European Robotics Forum (ERF).

For more information, please visit http://www.robotics-league.eu.

Organizers

Pedro U. Lima (Instituto Superior Técnico, Portugal), Jordi Pages (PAL Robotics, Spain), Meysam Basiri (Instituto Superior Técnico, Portugal)

24. Competitions

Program a Robot 2018

Description

Drones are aerial robots that have gained popularity in recent years. They were born in the military field and with the lowering of their costs have opened up possibilities for commercial use in several civil applications such as infrastructure monitoring, agriculture, surveillance, event recording, etc. They are robots and so they are composed of sensors, actuators and processors on the hardware side. Its intelligence, however, lies on its software.

The Program-A-Robot competition aims at engineering students, grad, master or PhD students, all over the world and its goal is to foster robotics and computer vision providing nice challenges and an opportunity to measure your solution with other fellow competitors. It was born in 2016 as a robotic competition inside Rey Juan Carlos University (2016, Spanish). The second edition (2017,Spanish) was organized inside the Spanish Jornadas Nacionales de Robótica. This year the third edition will be held as part of the IROS 2018.

In 2018 edition this competition proposes two challenges the programming the autonomous intelligence of a drone. In the Cat and Mouse challenge the cat drone has to be programmed to search, chase and stay close to another mobile aerial robot (mouse drone). Several autonomous mice are provided by the organization committee. In the Escape from the Hangar challenge the drone will have to take off inside a hangar and get out of the hangar avoiding the collision with moving walls. It is all about programming, about robot programming.

The participants will program in Python language using the Gazebo simulator and the JdeRobot-Academy software platform. A nice and simple infrastructure using docker and a WebIDE has been developed to simplify the robot programming from your web browser.

It is fostered by JdeRobot Foundation and GMV.

Organizer

José María Cañas Plaza (Rey Juan Carlos University)

Mobile Manipulation Hackaton

Description

Mobile manipulation is gaining traction in recent years, with potential applications in diverse areas including manufacturing, logistics, and healthcare. These applications typically require complex manipulation tasks in both structured and unstructured environments, possibly in cooperation or close interaction with humans. Different fields are involved: perception, navigation, task and path planning, control, error recovery, and human-robot interaction. Each field is an area of research on its own, but the special challenge in mobile manipulation is to obtain an integrated system that can combine a large variety of hardware and software components to increase the range of tasks that the robot can perform. With this hackathon, the researchers from these different fields will have an opportunity to integrate their contributions into a mobile manipulation system, and to perform a live demonstration at IROS 2018.

Mobile robots are now commercial products. For instance, PAL Robotics offers TIAGo (http://tiago.pal-robotics. com/), a mobile robot platform endowed with a 7 DoF arm, a liftable torso and a pan-tilt head that will be made available during IROS for showcasing innovative and robust applications of mobile robotics.

To sum up, the Mobile Manipulation Hackathon is an opportunity to showcase your abilities in mobile manipulation tasks at IROS 2018.

Organizers

Maximo A. Roa (German Aerospace Center – DLR), Mehmet Dogar (University of Leeds),
Nikolaus Correll (University of Colorado at Boulder), Francesco Ferro (PAL Robotics), Antonio Morales (Jaume I University, IROS 2018 LOC).

24. Competitions

Minesweepers

Description

The Minesweepers: Towards a Landmine-free World is an international outdoor robotic competition on humanitarian demining that aims at motivating researchers and developers to work on innovative solutions for this serious problem.

Find all the info at http://www.landminefree.org/

Organizers

Alaa Khamis (General Motors, Canada), Mohamed Aboud (Hadath for Innovation and Entrepreneurship, Egypt)

Humanoid Robot Application Challenge - Robot Magic

Description

Humanoid Application Challenge is to encourage creative applications from around the globe and maximize contribution for humanoid applications.

Organizer

Jacky Baltes (National Taiwan Normal University, ROC)

MathWorks Mini Drone Competition

Description

The MathWorks Minidrone Competition will introduce participants to the Model-Based Design workflow using Simulink. The competition consists of two rounds.

• Round 1 Simulation Only - Teams will work virtually on a problem statement and submit their models to MathWorks.
• Round 2 Simulation and Hardware Deployment - The teams that qualify from Round 1 will be invited to the Round 2 event at IROS 2018, Madrid. Teams will deploy their Simulink model at the live event on the Parrot Mambo Minidrone hardware.

Organizer

Lauren Tabolinsky (MathWorks, USA)

24. Competitions

Autonomous Vehicles Event

Description

Five to six different demonstrations will be conducted focusing on one or several of the following aspects

• Low speed (20 km/h) or medium speed (40-50 km/h)
• Perception (static and moving obstacles, road signs…)
• Localization & mapping
• Control, planning & decision-making
• V2X-based cooperative systems (merging, intersections, roundabouts management)
• V2I cooperation with traffic lights system
• Driver-vehicle interaction

A number of participants (between 5 and 8) will be selected. Short slots of 6-8 minutes will be allocated to every participant team. Before every demonstrator, an initial pre-recorded video of 1-2 minutes will be broadcasted so that every team can explain the highlights of the technology to be shown. 3 rounds of every demonstrator are foreseen and their schedule will be publicized in advance.

Organizers

Christian Laugier (INRIA, France), Philippe Martinet (INRIA, France), Christoph Stiller (Karlsruhe Institute of Tecnhnology, D), Urbano Nunes (University of Coimbra, Portugal), Miguel Angel Sotelo (University Alcala, Spain)

25. Conference Awards

IROS 2018 Awards Ceremony will be held in the Auditorium, 14:00-15:30, on Thursday, October 4. Boxed lunch will be provided at 13:30h on the main hall, ground floor (food is not allowed in the auditorium) on a first come first served basis.
The following is the list of IROS awards to be announced:

IROS 2018 Best Paper Award

This award recognizes the most outstanding paper presented at the conference.

IROS 2018 ABB Best Student Paper Award

This award recognizes the most outstanding paper authored primarily by, and presented by, a student. Sponsored by ABB.

IROS Best Paper Award on Safety, Security, and Rescue Robotics in memory of Motohiro Kisoi

To promote advanced research on safety, security and rescue robotics (SSRR), in memory of Motohiro Kisoi.

IROS Distinguished Service Award

To recognize an individual who has performed outstanding services to the IEEE/RSJ International Conference on Intelligent Robots and Systems.

IROS Harashima Award for Innovative Technologies

To honor Professor Fumio Harashima, the Honorary Founding Chair of the IROS conferences, by recognizing outstanding contributions of an individual of the IROS community who has pioneered activities in robotics and ntelligent systems.

IROS ICROS Best Application Paper Award

Sponsored by the Institute of Control, Robotics, and Systems (ICROS), this award is to recognize excellent robot application.

JTCF Novel Technology Paper Award for Amusement Culture

This award recognizes practical technology contributing to toys, toy models, and amusement culture. Sponsored by the Japan Toy Culture Foundation.

IROS Best Paper Award on Cognitive Robotics Sponsored by KROS

To promote interdisciplinary research on cognition for technical systems and advancements of cognitive robotics in industry, home applications, and daily life.

Toshio Fukuda Young Professional Award

To recognize individuals (from academic institutions, government, industry, or research labs) who, in their early career, have made identifiable contributions that have had a major impact on Intelligent Robots and Systems.

RoboCup Best Paper Award

For work in localization, navigation, mobility, and teamwork technologies, with applications to areas such as team sports, search and rescue, personal and home robotics, education, and others. Sponsored by the RoboCup Federation.

25. Conference Awards

This year, in conjunction with the IROS 2018 Awards ceremony, two honours will be awarded:

IEEE Technical Field Award in Robotics and Automation

Award to be presented by Jim Jefferies, IEEE President.
Recipient: Matthew T. Mason, Carnegie Mellon University, PA, USA.
"For Scientific and educational contributions to the mechanics of manipulation enabling real-world robot autonomy, and for leadership in robotics"

IEEE RAS George Saridis Leadership Award in Robotics and Automation

Award to be presented by Raja Chatila, RAS awards Chair.
Recipient: Bill Hamel, University of Tennessee, TN USA.
"For continued leadership that has significantly contributed to the growth and development of robotics in hazardous environments and to the IEEE Robotics and Automation Society"

26. Workshops

Workshops are scheduled as:

- Full day WS: 9:00 -19:00h
- Morning WS: 9:00-13:30
- Afternoon WS: 14:30-19:00h

Code / Submission #	ROOM code	ROOM name	Schedule
Mo-WS 1 / 375	1.L.2	PARÍS	full day
Mo-WS 2 / 563	1.L.3	BERLÍN	full day
Mo-WS 3 / 2165	4.L.3	RESTAURANTE VIP	full day
Mo-WS 4 / 2181	1.R.3	LA HABANA	full day
Mo-WS 5 / 2201	2.L.2	LONDRES	full day
Mo-WS 6 / 2282	0	AUDITORIUM	full day
Mo-WS 7 / 2286	1.L.5	MADRID	full day
Mo-WS 8 / 2291	4.R.1	BRATISLAVA	full day
Mo-WS 9 / 2296	2.R.1	CARACAS	full day
Mo-WS 10 / 2313	4.L.4	SALA DEL CONSEJO	full day
Mo-WS 11 / 2315	4.R.3	OSLO	full day
Mo-WS 12 / 2316	4.R.5	VARSOVIA	full day
Mo-WS 13 / 2318	2.L.5	KUKA	full day
Mo-WS 14 / 2323	1.R.4	BUENOS AIRES	full day
Mo-WS 15 / 2329	2.R.4	MONTEVIDEO	full day
Mo-WS 16 / 2330	1.R.5	MÉXICO D.F.	full day
Mo-WS 17 / 2334	1.L.1	MÓNACO	full day
Mo-WS 18 / 2336	2.L.3	ÁMSTERDAM	full day
Mo-WS 19 / 228	4.R.4	PRAGA	morning
Mo-WS 20 / 2183	2.R.3	LA PAZ	morning
Mo-WS 21 / 2332	2.R.3	LA PAZ	afternoon
Mo-WS 22 / 2309	4.R.2	ESTOCOLMO	full day
Fr-WS 1 / 2208	2.L.5	KUKA	full day
Fr-WS 2 / 2268	1.L.5	MADRID	full day
Fr-WS 3 / 2283	4.R.4	PRAGA	full day
Fr-WS 4 / 2287	0	AUDITORIUM	full day
Fr-WS 5 / 2299	4.L.3	RESTAURANTE VIP	full day
Fr-WS 6 / 2301	1.R.5	MÉXICO D.F.	full day
Fr-WS 7 / 2302	4.R.5	VARSOVIA	full day
Fr-WS 8 / 2304	4.L.1	BRUSELAS	full day
Fr-WS 9 / 2305	1.L.2	PARÍS	full day
Fr-WS 11 / 2312	2.R.4	MONTEVIDEO	full day
Fr-WS 12 / 2317	2.L.3	AMSTERDAM	full day
Fr-WS 13 / 2322	1.R.3	LA HABANA	full day
Fr-WS 14 / 2337	2.R.1	CARACAS	full day
Fr-WS 15 / 2338	2.L.2	LONDRES	full day
Fr-WS 16 / 355	4.R.2	ESTOCOLMO	afternoon
Fr-WS 17 / 2175	2.R.3	LA PAZ	morning
Fr-WS 18 / 2222	4.R.3	OSLO	afternoon
Fr-WS 19 / 2245	4.L.4	SALA DEL CONSEJO	morning
Fr-WS 20 / 2269	4.R.1	BRATISLAVA	morning
Fr-WS 21 / 2306	1.L.1	MÓNACO	morning
Fr-WS 22 / 2331	2.R.3	LA PAZ	afternoon
Fr-WS 23 / 2333	1.L.3	BERLÍN	afternoon
Fr-WS 24 / 2339	4.R.1	BRATISLAVA	afternoon
Fr-WS 25 / 2342	4.R.3	OSLO	morning
Fr-WS 26 / 2349	4.L.4	SALA DEL CONSEJO	afternoon
Fr-WS 27 / 2350	1.L.1	MÓNACO	afternoon

26. Workshops

MADRID 2018 iROS

Workshops are ordered by code.

Mo-WS1: Examining Sensing Modalities for Robust and Dexterous Object Manipulation

Organizers: Kaiyu Hang (Yale University, USA), Hao Ding (ABB Corporate Research Center, Germany), Miao Li (Wuhan University, China), Danica Kragic (KTH, Sweden), Aaron Dollar (Yale University, USA)

Summary

The aim of this workshop is to bring researchers from both industry and academia to pave the foundations and to define the core open problems for multi-modal sensing object manipulation, such as perception, representation, learning, control, and planning. This workshop will also discuss advantages, limitations, challenges and progress with different approaches along these lines.

Mo-WS2: Task-Informed Grasping for Rigid and Deformable Object Manipulation

Organizers: Amir Masoud Ghalamzan Esfahani (University of Birmingham, UK), Farshid Alambeigi (Johns Hopkins University, USA), Sahba Aghajani Pedram (University of California, Los Angeles, USA), Renaud Detry (Jet Propulsion Laboratory, USA), Veronica J. Santos (University of California, Los Angeles, USA), Rustam Stolkin (University of Birmingham, UK)

Summary

Smart grasping and manipulation (i.e. making stable contacts on an object's surface and acting smartly on it) are crucial for robots functioning in our society. Recent advances in robotic grasping have shown promising results; however, for making robots see, perceive, decide and act in a way a human or a primate does, many challenges still need to be addressed. Cognitive science revealed that primates anticipate the outcome of grasping actions. This permits successful manipulation of deformable and rigid-body objects. For instance, to tie a knot or simultaneous manipulation and cutting a deformable tissue during medical procedures, a human predicts that grasping parts of the deformable object enables successful task completion. To better integrate robots into our society, TIG must be properly understood and addressed to mimic human predictive grasp planning.

Mo-WS3: The Utility of Body, Interaction, and Self Learning in Robotics

Organizers: Pablo Lanillos (Technical University of Munich, Germany), Matej Hoffmann (Czech Technical University, Czech Republic), Jun Tani (Okinawa Institute of Science and Technology, Japan), Giulio Sandini (Italian Institute of Technology, Italy), Gordon Cheng (Technical University of Munich, Germany)

Summary

This workshop offers cutting-edge robotics science and a pinch of the robots of the future in society: robots that autonomously learn to recognize their body, systems able to learn the consequences of their actions just by interacting with the world, body online calibration algorithms, robots with episodic memory and even robots able to learn alongside with humans with physical and affective safety. If you are interested in how animals and humans learn their body and to interact with the environment and how these techniques are applied to robots, BODIS is your workshop.

Mo-WS4: Haptic-Enabled Shared Control of Robotic Systems: A Compromise Between Teleoperation and Autonomy

Organizers: Marco Cognetti (CNRS, France), Jee-Hwan Ryu (Korea University of Technology and Education, Republic of Korea), Domenico Prattichizzo (University of Siena, Italy), Claudio Pacchierotti (CNRS, France)

Summary

As teleoperation systems become more sophisticated and flexible, the environments and applications where they can be employed become less structured and predictable. This desirable evolution toward more challenging robotic tasks requires an increasing degree of training, skills, and concentration from the human operator. This workshop aims at providing a scientific space to discuss this promising field, as well as fostering a lively discussion about the theoretical, technological, and translational aspects of this approach. The workshop brings together highly-renowned scientists and engineers from the fields of robotics, haptics, and control systems. Indeed, we believe that there is a strong need of cross-fertilization between scientists working on shared control from the above mentioned fields. This workshop will bring together people working on industrial manipulators, medical robotics, underwater robotics, human-robot interaction, active constraints, multi robot, mobile robotics, perception — all using very similar tools to control their robotic systems, but with very little chance of meeting each other and foster collaborations.

Mo-WS5: Controlling Soft Robots: Model-based vs. Model-free Approaches

Organizers: Concepción A. Monje (University Carlos III of Madrid, Spain), Christian Ott (DLR, Germany), Helmut Hauser (University of Bristol, UK), Cecilia Laschi (Scuola Superiore Sant'Anna, Italy)

Summary

Classical control approaches in robotics are nonlinear model based. However, the highly complex and nonlinear models necessary for a soft robotic system make this approach a difficult task and therefore seem to come to a limit in the presence of a soft robot. Therefore, other methods have been applied seemingly being more useful in this context, such as learning-based control algorithms, model-free approaches like bang bang control, control algorithms motivated by neuroscience, or morphological computation. These methods add new perspectives to the well-known model-based approach. We want to provide an inter- and cross-disciplinary platform to discuss techniques, conventional as well as novel, that are currently applied and developed and discuss limitations, potentials and future directions.

The workshop will bring together experts in the above mentioned control methods as well as people with neuro-scientific and biology background in order to discuss the following issues:

- How are control loops set up in biology (from a biological and neuroscientifical point of view)?
- Requirements of each method in order to apply them on a real system.
- Is there a theoretical background, proving that the method works? -passivity, robustness, Lyapynov stability, others.
- Limitation of the control approaches.
- Are there specific tasks / trajectories / applications for which each method is applicable?

Mo-WS6: Towards Robots that Exhibit Manipulation Intelligence

Organizers: Michael Beetz (University of Bremen, Germany), Georg Bartels (University of Bremen, Germany), Oussama Khatib (Stanford University, USA), Alin Albu-Schäffer (DLR, Germany), Marc Toussaint (University of Stuttgart, Germany)

Summary

The research field of mobile manipulation is at an exciting stage. Researchers have endowed robots with sophisticated motion capabilities. Those capabilities are the prerequisites for robots to perform real¬world actions like cooking meals, assembling products, helping dress people, or doing laundry. However, there are still many open research questions. For instance, the robot control systems providing those motion capabilities typically have to be parameterized with action¬ and context¬-specific mathematical models. Unfortunately, it is still an open question how to autonomously translate a given manipulation problem and a perceived geometric scene into a meaningful mathematical model for motion generation. As a result, endowing a robot with a new manipulation skill or transferring a skill to a new context requires human creative input. To overcome this bottleneck in the development of mobile manipulation applications, robots need 'manipulation intelligence.'

This workshop aims to bring together researchers that are fascinated and driven by the question of how to build this next generation of robot control systems. Specifically, we invite researchers working on robot control, machine learning, task and motion planning, and knowledge-¬based robotics who try to combine these technologies. The main objectives of this workshop are to formulate key research questions, identify potential synergies, and outline a road map for young researchers towards robots that exhibit manipulation intelligence.

Mo-WS7: 10th Planning, Perception and Navigation for Intelligent Vehicles (PPNIV´18)

Organizers: Philippe Martinet (INRIA, France), Christian Laugier (INRIA, France), Christoph Stiller (KIT, Germany), Urbano Nunes (IST, Portugal), Miguel Ángel Sotelo Vázquez (University of Alcalá, Spain)

Summary

The purpose of this workshop is to discuss topics related to the challenging problems of autonomous navigation and of driving assistance in open and dynamic environments. Technologies related to application fields such as unmanned outdoor vehicles or intelligent road vehicles will be considered from both the theoretical and technological point of views. Several research questions located on the cutting edge of the state of the art will be addressed. Among the many application areas that robotics is addressing, transportation of people and goods seem to be a domain that will dramatically benefit from intelligent automation. Fully automatic driving is emerging as the approach to dramatically improve efficiency while at the same time leading to the goal of zero fatalities. This workshop will address robotics technologies, which are at the very core of this major shift in the automobile paradigm.

26. Workshops

Mo-WS8: Variable Impedance Robot Skills: Control & Learning

Organizers: Fares J. Abu-Dakka (Istituto Italiano di Tecnologia, Italy), Mohamed Abderrahim (University Carlos III of Madrid, Spain), Dongheui Lee (Technical University of Munich, Germany), Ryojun Ikeura (Mie University, Japan)

Summary

Day by day realistic applications (e.g., disaster response, services and logistics applications, etc.) are bringing robots into unstructured environments (e.g., houses, hospitals, museums, etc.) where they are expected to perform complex manipulation tasks. This growth in robot applications and technologies is changing the classical view of robots as caged manipulators in industrial settings. Indeed, robots are now required to directly interact with unstructured environments (and possibly interact and collaborate with humans). This demands to use advanced interaction methodologies.

The aim of this workshop is to bring together experts as a means to examine current research on how to successfully transfer compliant motions from humans to robots, allowing for safe and energy-efficient interactions. In this manner, we enable robots to perform in many scenarios, not only the ones that need physical interaction with the human but also in industrial settings. In addition, this workshop targets the sharing of experiences and achievements of bringing robots to human daily life from scientists and researchers from both control theory and machine learning fields. Last but not least, the workshop aims to discuss the state-of-the-art of variable impedance robot skills, the advantages that can be achieved from robot learning methods, and the future research directions.

Mo-WS9: Language and Robotics

Organizers: Takato Horii (University of Electro-Communications, Japan), Emre Ugur (Bogazici University, Turkey), Tadahiro Taniguchi (Ritsumeikan University, Japan), Xavier Hinaut (INRIA, France), Tetsunari Inamura (National Institute of Informatics, Japan), Takayuki Nagai (University of Electro-Communications, Japan), Michael Spranger (Sony Computer Science Laboratories, Japan), Michael Beetz (University of Bremen, Germany)

Summary

Language acquisition, understanding, and usage are crucial not only for human-human interaction but also human-robot interaction. Integrating high-level and low-level cognitive capabilities and enabling a robot to understand its environment semantically and commands given by users is essential for developing robotic systems that can adaptively act in our daily environment. "Langauge" is the key to the robots that can communicate and collaborate with us.

The goal of this workshop is to bring together researchers from robotics, natural language processing, machine learning, and cognitive science to examine the challenges and opportunities emerging from the interdisciplinary research field covering language and robotics.

In this workshop, we will investigate how we can create a robot that can acquire, use and understand language. Future robots are expected to have such abilities in a wide range of human-robot interactions. To this end, we aim to share knowledge about the state-of-the-art machine learning methods that contribute to modeling language-related capabilities in robotics and to exchange views among cutting-edge robotics researchers with a special emphasis on language in robotics

Mo-WS10: Assistive Technologies for Precision Neurosurgery: Current Successes and Future Challenges

Organizers: Ferdinando Rodriguez y Baena (Imperial College London, UK), Elena De Momi (Politecnico di Milano, Italy), Riccardo Secoli (Imperial College London, UK)

Summary

The World Economic Summit [Bloom, D. E., et al., The Global Economic Burden of Noncommunicable Diseases, Geneva, 2011] reports that the five main chronic, non-communicative diseases (mental illness, cardiovascular disease, cancer, chronic respiratory diseases and diabetes) will cost $47 trillion globally by 2030, with $16 trillion attributed to mental illness. Costs in the United States today are estimated at more than $900 billion annually [PricewaterhouseCoopers, The Annual Cost of Brain Disease in 2012], while "the European Brain Council estimates the cost of brain disease in Europe since January 2014 at nearly €750 billion and rising fast. Europe's ageing population is increasingly in need of effective care and therapies for brain diseases, including stroke, Parkinson's disease, and Alzheimer's disease, which represent 35% of the burden of all diseases in Europe" [Banks, J. Neurotechnological Revolution, 2015].
Due to these startling statistics, the world is in desperate need of new technologies, which can drastically improve our ability to tackle brain disease.
This workshop aims to survey the most promising technological breakthroughs arising from the last decades' worth of scientific and clinical innovation, to ascertain the current neurosurgical landscape and identify existing open challenges and possible ways to address them with robotics. Invited speakers represent academic, clinical and commercial entities, which are at the forefront of neurosurgery today, covering tool sensorization, new brain models and modelling approaches, new mechanisms and new clinical applications that may improve the quality of life of patients.

Mo-WS11: Hands in the Real World: Connecting End-Effector Design, Sensitivity, and Behavior

Organizers: Hannah Stuart (University of California, Berkeley, USA), Manuel Giuseppe Catalano (Istituto Italiano di Tecnologia, Italy), Francesca Negrello (Istituto Italiano di Tecnologia, Italy)

Summary

This workshop focuses on the field application of robotic end-effectors, lying at the intersection of cutting-edge hardware, behavior and sensitivity. We believe that to overcome traditional end-effector limitations, it is essential to create interconnections between these pillars of robot design.
Experts in controls and sensitivity can inspire new approaches to resilient functionality. Mechanical hardware designers can likewise enable new possibilities in control, through the development of novel hands that can be effectively used outside of the lab. Additionally, what are the trends in performance qualification, and how might this become more efficient and universal. This is a fundamental challenge for hands applied in the field, as contact conditions and environmental circumstances largely influence performance.
The workshop has a strong focus on real applications, therefore it is at the natural intersection between academia and industry. The discussion will involve potential end-users and developers, to identify the applications where soft hands can make the difference, and the needs to expand their use. Young scholars will also be welcomed to contribute through a poster/demo session, and spotlight talks for top contenders. This will give them the opportunity to receive feedback from experts and peers in different realms of manipulation research. These scholars are also important in creating new ideas that may elucidate different directions in the field.

Mo-WS12: The Intelligence of Touch: Haptics, Tactile, Interaction. Building the Global Picture!

Organizers: Claudio Castellini (DLR, Germany), Philipp Beckerle (Technische Universität Darmstadt, Germany), Tamim Asfour (KIT, Germany)

Summary
The sense of touch is a wonderful capability through which human beings communicate in ways that are simply unimaginable using sight or hearing. Through touch we explore the world, we socialize, we define our own self and separate it from whatever is not us. Due to the incredibly high number of touch receptors human beings are endowed with, the interpretation of touch signals is a fascinating research topic. Moreover, building machines with something comparable is a formidable challenge. Researchers are devising touch sensors which more and more resemble the capabilities of human touch, at least functionally. But how to exploit this extraordinary flow of information?
This workshop revolves around three "levels" of touch information processing:
• the syntax of touch what kind of information is conveyed? How? What information goes beyond function, e.g., affective touch?
• the concrete semantics of touch touch-based object detection and recognition, intent detection, haptic exploration; and
• the abstract semantics of touch what feelings does touch elicit, how, and how is this relevant to robotics and human-robotic interaction especially?

Mo-WS13: Closing the Loop on Human-Robot Symbiosis: Human/Robot in-the-loop Machine Learning

Organizers: Ali Shafti (Imperial College London, UK), Roberto Calandra (University of California Berkeley, USA), Marc Peter Deisenroth (Imperial College London, UK), Aldo Faisal (Imperial College London, UK)

Summary
Outside of the classic industrial environments, robots are not expected to operate in the vacuum and isolated from people. Robots are instead performing their tasks close to and in collaboration with or assistance of humans; be this delivery drones, self-driving cars, robot assisted care or collaborative industrial settings. We take inspiration from us humans: We interact in a perception-action loop, where actions have consequences and thus require prediction and reactions. This requires developing a meaningful model of the humans we are interacting with from observations and interactions. Thus, learning is the glue that enables us to link desired outcomes with purposeful actions; and in a digital, data-driven world, machine learning is at the core. We will explore in this workshop, using cross-disciplinary work, how to close-the-loop of modelling and predicting human interactions as well as human-robot interactions.
A major challenge in analyzing such behavior is to discover some underlying simplicity in a complex and highly variable stream of behavioral actions. The gain of such an analysis is that the underlying simplicity is often a reflection of the mechanism driving behavior. We believe that advanced statistical and probabilistic methods can be used to analyse the unconstrained natural statistics of behaviour. Similar methods need to be applied to robotic systems, understanding their behaviour in conjunction and interaction with the human, to ensure compatibility and complementarity within the human-robot interaction, which is in this case, happening as a closed-loop.

Mo-WS14: User-Centered Methods in Human-Robot Interaction

Organizers: Gionata Salvietti (University of Siena, Italy), Philipp Beckerle (Technische Universität Darmstadt, Germany), Matteo Bianchi (University of Pisa, Italy)

Summary
The aim of this workshop is to provide practical tools for the evaluation of human factors in human-robot interaction scenarios to robotics experts. Therefore, scientists from communities outside robotics are involved in the workshop, e.g., from neuroscience and psychology. Robotics experts will also participate to discuss innovative approaches for a human-aware design and control of artificial systems and user-in-the loop-robotic interaction. The full-day workshop will have three sessions representing the three main aspects of a collaborative system, i.e., humans, robots and interfaces. Invited experts will present their approaches and results in a mixture of research talks and methodical tutorials, which especially focus on methods to understand human perception, cognition, and behavior, and how to leverage on these for a more informed design of collaborative robots architectures and human-in-the-loop controllers and interfaces. At the end, a discussion session will integrate the insights from the different expertise represented in the workshop, and will aim at bridging the gap between complementary yet related research fields for the foundations of a multi-disciplinary human-centered approach to robotics. During such discussion session, we will tackle all the research questions and issues of overall relevance, involving the audience, speakers, and organizers, with special attention to young researchers and students. This will help in pursuing the long-term objective of the workshop to stimulate and foster the dialogue between disciplines with intensive discussions

Mo-WS15: Assistance and Service Robotics in a Human Environment: From Personal Mobility Aids to Rehabilitation-Oriented Robotics

Organizers: Marie Babel (INRIA - INSA Rennes, France), Fabio Morbidi (Université de Picardie Jules Verne, France), David Daney (Inria Bordeaux - Sud Ouest, France), Samer Mohammed (University Paris Est Créteil, France), Francis Colas (INRIA Nancy Grand Est, France), Yacine Amirat (University of Paris Est Créteil, France)

Summary

Assistive Robotics is a growing area of research, ranging, from intelligent aid systems such as exoskeletons, wearable haptic devices and path planners for autonomous wheelchairs. The proposed workshop focuses on Robotics for people assistance with a particular focus on frail people. This is indeed a critical and urgent problem in our aging society (it is projected that the combined senior and geriatric population will reach 2.1 billion by 2050). The idea is then to gather experts from various fields to discuss issues related to the challenging problem of assisting people in their everyday life. Topics related to physical human-robot interaction, mobility assistance, guidance, healthcare and well-being will be covered. Fundamental and technological research on (semi-) autonomous indoor vehicles, sensor and actuator networks, wearable and ubiquitous computing, brain-computer interfaces (BCI), and ambient intelligence will be of special interest. The objective of the workshop is to provide an overview of the main challenges, relevant applications and open opportunities in Assistance and Service Robotics in a Human Environment.

Mo-WS16: RoboAssist 2018: Wearable Robotics for Motion Assistance and Rehabilitation

Organizers: Samer Mohammed (University of Paris Est Créteil, France), Nicola Vitiello (Scuola Superiore Sant´Anna, France), Juan Camilo Moreno (CSIC, Spain), Conor James Walsh (Harvard University, USA)

Summary

The purpose of this new edition of the RoboAssist workshop is to discuss the new technological challenges that affect the development of the existing wearable robot devices such as technologies enabling better sensing and interpretation of human-robot interaction, new controllable actuators enabling a better interaction, and the enhanced computing power enabling complex reasoning and control strategies. Also, it is worth noting the emerging area of soft wearable robots. This rapidly emerging field will not replace traditional exoskeletons but offers new possibilities to augment the performance of healthy individuals but also restore function for impaired individuals with residual capacity, i.e. where only small to moderate levels of assistance is needed to improve function ability.

Mo-WS17: Latest Advances in Big Activity Data Sources for Robotics and New Challenges

Organizers: Asil Kaan Bozcuoglu (University of Bremen, Germany), Tamim Asfour (KIT, Germany), Karinne Ramirez-Amaro (Technical University of Munich, Germany), Gordon Cheng (Technical University of Munich, Germany)

Summary

Recently, we have witnessed that robots start to execute human-level complex tasks such as making popcorn, baking pizza and carrying out chemical experiments. Although these executions are milestones by themselves, robots still have limitations in terms of flexibility, speed and adaptability. To attack these limitations, we believe that big data sources, which contain activities from robots, human tracking and virtual reality, play an important role. Having a big activity data source on site can help robots in many ways such as learning motion parameterizations, adapting to different conditions and generalizing their existing knowledge. Although we see many applications which start to make use of big data, the research community is still in the phase of "re-inventing the wheel" by designing new data structures, collecting similar data and implementing interfaces between data and learning/control routines. Our main goal in this workshop is to gather the interested researchers from IROS attendees and make a step towards the standardization of research tools and data formats to strengthen the joint research efforts.

Mo-WS18: Modelling and Control of Dynamic Legged Locomotion: Insights from Template (Simplified) Models

Organizers: Mohammad Shahbazi (Istituto Italiano di Tecnologia, Italy), Hartmut Geyer (Carnegie Mellon University, USA), Shuuji Kajita (AIST, Japan), Nikos Tsagarakis (Istituto Italiano di Tecnologia, Italy)

Summary

Modeling and control of dynamic legged locomotion are more difficult than the traditional types of locomotion in that, a dynamically stable locomotor renders the stability only cyclically. This feature requires a larger prediction horizon for control and stability analysis, which complicates matters. Researchers have approached this class of problems from different points of view, which may be categorized into methods using the "true" model of the system and methods that consider a template (simplified) model. The study of legged locomotion using template models, such as LIP, SLIP, Compass Gait, and Cart-Table models, provides insight into the fundamental principles that underlie legged locomotion. The resulting platform-independent reductive models typically admit analytical representations that are more tractable than the original higher-order robot models. Significant achievements in the locomotion skills of dynamic robots have been made following both perspectives briefly mentioned above. However, there is still much to be done to meet the agility, efficiency and speed demonstrated by animals and humans, when it comes to accommodating real world environments. Are we prepared for the next Fukushima-like incidents?

The workshop will discuss recent achievements in dynamic legged locomotion in robotics and biomechanics communities, with a focus on the role of simplified models.

Mo-WS19: Humanoid Robot Falling: Fall Detection, Damage Prevention, and Recovery Actions (AM)

Organizers: Dimitrios Kanoulas (Istituto Italiano di Tecnologia, Italy), Jinoh Lee (Istituto Italiano di Tecnologia, Italy), Abderrahmane Kheddar (CNRS-AIST JRL, Japan), Yohei Kakiuchi (University of Tokyo, Japan)

Summary

Research on humanoid robots has focused mainly on reliable perception, planning, and control methods for completing challenging tasks. The DARPA Robotics Challenge 2015 showed that when the tether is removed, legged robots may inevitable fall over during a task in an unstructured environment; either when they walk on a flat or rough terrain, or when they are cutting a wall with a drill, opening a door, and turning a valve. In a lot of cases if a humanoid robot falls over, it may end up with a serious damage for itself or the environment. If not, the robot in a real world scenario should recover, stand up, and complete the task. Being able to detect such a fall, apply the appropriate actions to prevent a big damage both on the robot and the environment around it, and recover if possible, are necessary for a real world application, where humanoid robots will need to deal with even rougher terrain and more complicated manipulation tasks under significant uncertainty either for static or dynamically changing environments.

This workshop will provide a platform for researchers from all areas in robotics to disseminate and exchange ideas, evaluating their advantages and drawbacks. This will include from the mechanical design and biomechanics to the perception, planning, and whole-body control methods on real robots and simulations for fall detection, damage prevention, and recovery actions in a falling over scenario. The aim is to foster collaboration among researchers that are working on humanoid robots to advance the very limited state-of-the-art work in this area.

Mo-WS20: 1st Workshop on Proximity Perception in Robotics (AM)

Organizers: Stefan Escaida Navarro (INRIA, France), Stephan Mühlbacher-Karrer (Joanneum Research - Robotics, Austria), Hubert Zangl (Alpen-Adria-Universitaet Klagenfurt, Austria), Björn Hein (KIT, Germany), Hosam Alagi (KIT, Germany)

Summary

This workshop aims to offer a point of convergence for the different streams pertaining to Proximity Perception, which are currently active in the robotics community. We expect that Proximity Perception technologies will play an essential role for service and industrial robotics as well as for human-robot collaboration and compliant robotics applications in the near future. A similar trend could already be observed for Tactile Perception. On the one hand, designs of robotic graspers that include Proximity Sensors allow for novel control strategies for exploration, grasping and manipulation. On the other hand, the sensors will allow safety features to fulfill leading technical specifications such as ISO/TS 15066 for the operation of collaborative robots and improve the autonomy and perception of robotic systems in all fields.

26. Workshops

Mo-WS21: From Freezing to Jostling Robots: Current Challenges and New Paradigms for Safe Robot Navigation in Dense Crowds (PM)

Organizers: Julien Pettre (INRIA – IRISA, France), Jean-Bernard Hayet (CIMAT), Marie Babel (INRIA – IRISA, France), Paolo Salaris (INRIA - Sophia Antipolis, France), Pericle Salvini (LASA - EPFL, Switzerland)

Summary

With state-of-the-art navigation algorithms, mobile robots can navigate safely among groups of people up to low-to-medium crowd density scenarios. When the density of people is not controlled, and when the level of density is high, most robots, when faced to human agents in their near vicinity, are programmed to stop to avoid collisions (the "freezing robot" problem). In those cases, the lack of static cues and the proximity of the human agents make it very challenging or even impossible to track and predict the motion of people around the robot.

However, a freezing robot becomes a static obstacle itself, further complicating the navigation problem for the humans around. Its navigation system should be designed in such a way that the robot is able to continue its task even in dense crowds. This objective goes well beyond state-of-the-art perception and control capabilities and probably requires completely new navigation, perception, cognition paradigms.

The central question of this workshop will be: How to overcome the perception and navigation problems mentioned above so that a mobile robot can engage in these crowded situations, and behave as safely as possible, so as to limit the number and types of contacts which may occur with the people in the space?

Mo-WS22: RoboTac: New Progress in Tactile Perception and Learning in Robotics

Organizers: Mohsen Kaboli (Technical University of Munich, Germany), Jeannette Bohg (Stanford University, USA), Qiang Li (Bielefeld University, Germany), Filipe Fernandes Veiga (Technische Universität Darmstadt, Germany), Zhe Su (University of Southern California, USA), Gordon Cheng (Technical University of Munich, Germany)

Summary

The sense of touch plays an important role in our daily lives from perceiving the environment, grasping and manipulating objects to identifying, learning about and interacting with them. Compensating for the lack of touch with other human senses is difficult. For robotic systems that interact with dynamic environments and objects therein, it is crucial to recognize objects via their physical properties (such as surface texture, stiffness, center of mass, and thermal conductivity) and to be able to safely manipulate them. However, these are difficult to achieve even with advanced vision techniques, which are often marred by occlusion, poor lighting situations, and a lack of precision. As an alternative, tactile sensing can simultaneously provide rich and direct feedback to the robotic systems. Moreover, the robots with the sense of touch need to learn continuously and efficiently from tactile experience and update their models of the objects and environment (Tactile Transfer knowledge). This tactile learning strategy keeps a robot stable and adaptable to respond to new stimuli receiving from the surrounding.

26. Workshops

Fr-WS1: 2nd Workshop on Multi-Robot Perception-Driven Control and Planning

Organizers: Javier Alonso-Mora (Delft University of Technology, The Netherlands), Eduardo Montijano (Universidad de Zaragoza, Spain), Daniela Rus (MIT, USA), Mac Schwager (Stanford University, USA)

Summary

Multi-robot research is gaining more and more strength within the robotics community every year. Collaborative robots are becoming essential in multitude of tasks such as production, environmental monitoring and transportation. In such dynamic environments, the problem of accurate perception requires novel methodologies involving planning and control of the team.

The last years have witnessed the appearance of several novel control and planning techniques specifically oriented to perception problems, such as next best view, extremum seeking or informative path planning. The complexity of most of the existing solutions grows exponentially in multi-robot setups, where the number of control variables increases with the size of the team. Moreover, local perception, partial information and limited communications, among other factors, make the general problem even harder to solve. Currently, it is not clear what can be reasonable tradeoffs between overall performance and scalability, nor there is consensus about what are the best tools to tackle these problems.

Thus, the primary objective of this workshop is to provide an overview of the latest theoretical and algorithmic solutions developed for motion planning and control of multi-robot systems, where perception and communication play a fundamental role in the problem definition.

Fr-WS2: Vision-based Drones: What's next?

Organizers: Giuseppe Loianno (New York University, USA), Davide Scaramuzza (University of Zurich, Switzerland), Vijay Kumar (University of Pennsylvania, USA)

Summary

This workshop will focus on the future challenges, visionary, cutting-edge and technological ideas in the area of vision-based drones. There are still several open research and scientific questions related to the best and efficient environment representations for navigation and toward unified solutions for manipulation, transportation, locomotion, human-robot interaction, and heterogeneity. How can drones autonomy change the human mobility? How can these machines interact with humans during a task predicting his future behavior and provide situational awareness relaxing communication constraints? What algorithms can automatically establish the best heterogeneity degree in terms of vehicles and sensors in a mission? How do we co-design perception and action loops for fast navigation of nano scale aerial platforms? What role should machine learning play for autonomy? The main goal is to encourage discussion between experts in the field on the previous topics and set upcoming new research topics and ideas, and roadmap for the upcoming 5-10 years. The workshop will feature, in addition to contributed and invited talks, real-time demos provided both from academia and industry actively working in this field.

Fr-WS3: ImPACT Tough Robotics Challenge: A National Project of Disaster Robotics Aiming at Social Innovation in Safety and Security

Organizers: Satoshi Tadokoro (Tohoku University. Japan), Fumitoshi Matsuno (Kyoto University, Japan)

Summary

ImPACT Tough Robotics Challenge is a national project of Japan Cabinet Office (period: 2014-18, researchers: 62 PIs and 300 researchers, budget: 30 million USD in total) that focuses on tough technologies of robotics to give solutions to disaster response, recovery and preparedness. This workshop introduces the outcome of the ImPACT-TRC.

Natural and man-made disasters are a serious problem for our society. Robotics is widely recognized as potentially effective countermeasure to solve this problem. It has, however, limited capability due to the fragility of this technology. Many robot technologies can work only under well-prepared conditions, which do not occur in disaster sites. This project aims at making such technologies tougher by removing constraints. For example, robots must have high accessibility in extreme conditions, which is achieved by synthesizing high-performance mechanisms, sensing, intelligence, actuation, human interfaces, etc. Sensing in adverse conditions is important, e.g. hearing a noise, SLAM in a narrow space, understanding the situation by touching the complex field. Strong mechanisms and high durability are not an objective of this project.

26. Workshops

Fr-WS4: Machine Learning in Robot Motion Planning

Organizers: Sanjiban Choudhury (University of Washington, USA), Debadeepta Dey (Microsoft, USA), Siddhartha Srinivasa (University of Washington, USa), Marc Toussaint (University of Stuttgart, Germany), Byron Boots (Georgia Institute of Technology, USA)

Summary
Motion planning has a rich and varied history. The bulk of the research in planning has focused on development of tractable algorithms with provable worst-case performance guarantees. In contrast, well-understood theory and practice in machine learning is concerned with expected performance (e.g. supervised learning). As affordable sensors, actuators and robots that navigate, interact and collect data proliferate, we are motivated to examine new algorithmic questions such as " What roles can statistical techniques play in overcoming traditional bottlenecks in planning?", " How do we maintain worst-case performance guarantees while leveraging learning to improve expected performance?" and " How can common limitations inherited from data-driven methods (e.g. covariate shift) be mitigated while combining with traditional planning methods? "
Both areas have much to contribute to each other in terms of methods, approaches, and insights, and yet motion planning and machine learning communities remain largely disjoint groups. There are four technical goals for this workshop in addition to encouraging dialogue between both communities:
• Formalize paradigms in motion planning where statistical methods can play an essential role.
• Identify learning algorithms that can alleviate planning bottlenecks.
• Better understand common pitfalls of naively combining learning and planning and explore strategies for mitigation.
• Arrive at a set of critical open questions that are at the intersection of the two fields

Fr-WS5: Robots for Assisted Living

Organizers: Sylvain Calinon (Idiap Research Institute, Switzerland), Sanja Dogramadzi (University of the West of England, UK), Carme Torras (CSIC-UPC, Spain), Tomohiro Shibata (Kyushu Institute of Technology, Japan), Yiannis Demiris (Imperial College London, UK)

Summary
With the increase in life expectancy and the shortage of caregivers in developed countries, robotic assistive technologies are getting rising attention in many different contexts worldwide.
This workshop aims at bringing together persons working in the field of assistive robotics for healthcare and daily living, with the goal of discussing ongoing challenges, research directions, requirements and applications in this rapidly growing field. Robotics for assisted living spans a wide range of robotics expertise, including (physical) human-robot interaction, safety, verbal and nonverbal communication, interfaces, adaptive and compliant control, learning and adaptation for personalized assistance, analysis and recognition of daily living activities.
A tight integration of these diverse components is required to build adaptive and personalized assistive systems. This workshop aims at providing an overview of the current state of the art, discuss the available technologies and frameworks that can help at integrating these different components, the potential barriers (both at technical and technology transfer levels), and the next challenges that we need to tackle to bring robots into different healthcare and assisted living scenarios.

Fr-WS6: Collaboratively Working towards Ontology-based Standards for Robotics and Automation

Organizers: Julita Bermejo (Universidad Politecnica de Madrid, Spain), Abdelghani Chibani (Université Paris-Est Creteil, France), Paulo Gonçalves (Instituto Politecnico de Castelo Branco, Portugal), Howard Li (University of New Brunswick, Canada), Sara Rene Jordan (Virginia Tech, USA), Alberto Olivares (Universidad de Castilla-La Mancha, Spain), Joanna Isabelle Olszewska (University of Gloucestershire, UK), Edson Prestes (Universida de Federal do Rio Grande do Sul, Brasil), Sandro Rama Fiorini (Université Paris-Est Creteil, France), Ricardo Sanz (Universidad Politecnica de Madrid, Spain)

Summary

Day by day, new machines and systems are being developed to help and assist humans in a myriad of activities. Future robotic systems need to work in teams and communicate with humans and other robots to share information and coordinate activities. In particular, there is an increasing demand from government agencies and the private sector alike to use Unmanned Aerial Vehicles (UAVs), Unmanned Ground Vehicles (UGVs), Unmanned Surface Vehicles (USVs), and Autonomous Underwater Vehicles (AUVs) for tasks including homeland security, reconnaissance, search and rescue, surveillance, data collection, and urban planning. As these systems will interact with humans in several scenarios, it is urgent to discuss the ethical aspects in their development related to, for instance, accountability, privacy and data protection, alignment to human values in both design and function. Ontology-based models for this domain would enable, for example, a clear communication among different stakeholders, the formulations of laws, the building of AI-based and Robotics systems with full alignment with what stakeholders expect, in terms of benefits and increase of human well-being.

Fr-WS7: Autonomous Dialogue Technologies in Symbiotic Human-Robot Interaction

Organizers: Hiroshi Ishiguro (Osaka University, Japan), Tatsuya Kawahara (Kyoto University, Japan), Yutaka Nakamura (Osaka University, Japan)

Summary

The focus of robotics research is shifting from industrial robots to robots working in daily situations and one of the most important issues is to develop autonomous social robots capable to interact with and live together with humans, i.e., symbiotic robots with humans. The aim of this workshop is to introduce research activities in "Symbiotic Human-Robot Interaction," and discuss the future challenges in this research area.

One of the goals of this research area is providing communication support for people, such as companion robots for elderly people who need psychological support as much as physical support. For this aim, various humanoids, including android robots, have been studied for a few decades, and full-scale social implementations are about to begin.

In this workshop, organizers will demonstrate one of our androids, the world-famous, state-of-the art communication robots and bring you a brainstorming workshop. We will discuss the future of everyday robots, key technologies to make them able to be true companions living together with us.

Fr-WS8: Semantic Policy and Action Representations for Autonomous Robots

Organizers: Eren Erdal Aksoy (Halmstad University, Sweden), Yezhou Yang (Arizona State University, USA), Karinne Ramirez-Amaro (Technical University of Munich, Germany), Neil Dantam (Colorado School of Mines, USA), Gordon Cheng (Technical University of Munich, Germany)

Summary

Action semantics stands as a potential glue for bridging the gap between a symbolic action representation and its corresponding continuous signal level description. Semantic representation provides a tool for capturing the essence of an action by revealing the inherent characteristics. Thus, semantic features help robots to understand, learn, and generate policies to imitate actions even in various styles with different objects. Thus, more descriptive semantics yields robots with greater capability and autonomy. In this full-day workshop, we aim at answering two major questions.
1) What have we learned from action semantics? In recent years, there has been a substantial contribution in semantic policy and action representation in the fields of robotics, computer vision, and machine learning. In this respect, we would like to invite experts in academia and motivate them to comment on the recent advances in semantic reasoning by addressing the problem of linking continuous sensory experiences and symbolic constructions to couple perception and execution of actions. This is of fundamental importance to ease the symbol grounding problem in robotics.
2) How much of semantic policy and action representation have been transferred from controlled lab setups to industrial environments? We would like to invite researchers from industry and initiate a discussion between academic and industrial communities. Such a provocative discussion catalyzes the interaction between the two communities by addressing the scalability and generalization problems which still remain unsolved. In this respect, we would like to discuss how to transfer our current knowledge and experience about semantic policies to new domains, for instance, industrial assembly tasks, with very little human intervention.

Fr-WS9: Robotics for Logistics in Warehouses and Environments Shared with Humans

Organizers: Luigi Villani (Università di Napoli Federico II, France), Martin Magnusson (Örebro University, Sweden), Erwin Prassler (Bonn-Rhein-Sieg University of Applied Sciences, German), David Puljiz (Karlsruhe Institute of Technology, Germany), Jesús Julián Alfonso De la Riva (ITAINNOVA, Spain)

Summary

The world of logistics and distribution is a strongly growing sector for suppliers of robot technologies and a field full of interesting challenges for robotics research. Robots today are able to perceive, recognize, pick and manipulate a wide variety of objects. They are able to navigate and move things in less and less structured environments. They can collaborate with human operators in shared workspaces, interacting safely with employees and customers. These advances in robotic technologies, together with their relatively low costs, make robotic solutions appealing not only for all the components of the logistics supply chain, including warehouses, distribution centers, sorting centers, last-mile delivery, but also for intra-logistic operations in retail stores, care facilities, and hospitals.
The European Union's H2020 research and innovation program funded a number of projects related to robotics for logistics in warehouses and environments shared with humans. Four of them (ILIAD, REFILLS, RpPod, SafeLog), involving research institutions, logistic companies, robot manufacturers, end-users from different European countries, are committed to the workshop organization.
Starting from the research and technological issues of the above projects, that will be reported by the protagonists, this workshop intends to share knowledge about technological opportunities and challenges regarding robotics for logistics. The aim is to bring together and confront the experience of researchers, end users, logistics and robotics companies working on novel approaches, through a mixture of talks from invited speakers, an interactive poster session and a round-table discussion.

Fr-WS11: Continuum and Soft Robots (CSR) for Medical Interventions: Modelling, Fabrication, and Control

Organizers: Kanty Rabenorosoa (Université Bourgogne Franche-Comté, CNRS, France), Jessica Burgner-Kahrs (Gottfried Wilhelm Leibniz Universität Hannover, Germany), Matteo Cianchetti (Scuola Superiore Sant'Anna, Italy), Caleb Rucker (University of Tennessee, USA)

Summary

In recent decades, the development of MIS (Minimal Invasive Surgeries) and NOTES (Natural Orifices Transluminal Endoscopic Surgeries) has been accompanied by a proliferation of innovative medical robot designs, especially based on incorporating continuum and soft design elements. However, researchers have not yet reached consensus on do not have broadly agreed methods for design, modeling, and simulation of soft and continuum robot structures bodies. In addition, the challenges of sensing, actuation, and control in soft and continuum bodied robots are still being overcome

The objective of this workshop is for participants to review and discuss the most recent advances in terms of novel design and mechanism paradigms. Modeling approaches, stability, and control the stability issue, and the control strategy, which are intimately linked, will be covered, as well as open challenges like follow-the-leader deployment, variable stiffness mechanism, variable stiffness control, reconfigurable structure, data-driven approach for robot control, and advance in the development of materials.

Fr-WS12: Soft Robotic Modeling and Control: Bringing Together Articulated Soft Robots and Soft-Bodied Robots

Organizers: Robert Kevin Katzschmann (MIT, USA), Cosimo Della Santina (Centro E. Piaggio, Italy), Daniela Rus (MIT, USA)

Summary

The main aim of the workshop is to inspire new approaches in modeling and controlling of soft robots. We will bring together recognized experts in both modeling and control of soft robots, trying to answer questions such as: to which extent techniques and principles developed for articulated soft robots can be extended to the control of continuously deformable soft robots? In return, what methods developed for soft-bodied robots find application in the other field? What are the remaining problems that will require a specific treatment and analysis? Which are the new challenges in these fields? Selected experts will give talks on the relevant topics. A final open discussion session will review and analyze all the insights presented during the workshop, aiming at fostering discussions between different areas of expertise. The organization of a special issue in IJRR is planned to present the outcome of these discussions.

Fr-WS13: Shape Changing Robotic Structures and Interfaces

Organizers: Helge Arne Wurdemann (University College London, UK), Anne Roudaut (University of Bristol, UK), Sanja Dogramadzi (University of the West of England, UK), Jamie Paik (Ecole Polytechnique Federale de Lausanne, Switzerland), Audrey Girouard (Carleton University, Canada), Kaspar Althoefer (Queen Mary University of London, UK), Van Ho (Japan Advanced Institute of Science and Technology, Japan)

Summary

Shape-changing robotic structures and shape-changing interfaces (as known in the Human-Computer Interaction community) are transforming systems that physically change shape exploiting 21st century robotics, including soft robotics, reconfigurable mechanisms, but also hinges on research areas such as modelling, control and material science. The design and fabrication process makes use of elements found in the field of reconfigurable mechanisms or soft material robotics or in a combination of both. Change in physical geometry can add new capabilities to these systems making them ideal for application in areas such as healthcare, production, homecare, autonomous vehicles and for interfaces with computers and machines.

Discussions at the seminar will be based around three key themes: (1) The technologies involved in shape-change, including soft, modular and reconfigurable robotics, smart materials, and actuation systems; (2) the design of shape-changing systems, including their key application areas, and their industrial and interaction design; and (3) current and future application areas. We will explore the synergies that will arise from bringing together soft and reconfigurable robotics and identify the advantages that these shape-changing robotic structures and interfaces bring to different areas of application. We believe that the true power of shape changing systems can be magnified many-fold by bringing together those different fields of science. Through coordination of research, we can reach further and faster resulting in an acceleration of research.

26. Workshops

Fr-WS14: Development of Agile Robots

Organizers: Navvab Kashiri (Istituto Italiano di Tecnologia, Italy), Jörn Malzahn (Istituto Italiano di Tecnologia, Italy), Nikos Tsagarakis (Istituto Italiano di Tecnologia, Italy)

Summary

The improvements in design and control of robotic systems achieved over the past few decades in software/hardware development, result in rapid functioning of robots in designed and structured environments e.g. in industry. In contrast, the manipulation/locomotion agility of even the most dynamic robots when operating in unstructured environments, is yet many times lower than that of most of biological systems, i.e. humans and animals. Such a deficiency results in slow performance of robotic platforms in real-world scenarios, ranging from disaster-response cases to health-care and service tasks. It consequently leads to failure in fulfilling the tasks, as it is often crucial for the robot to quickly respond/react. The progress in robot agility can therefore considerably influence the viable exploitation of robotics in all real-world applications demanding responsiveness and agility. To this end, it is necessary to utilize novel design and control approaches. The proposed workshop focuses on a set of state-of-the-art interdisciplinary topics required for novel robot design and control, to allow for the development of agile robotic systems capable of executing dynamic motions and quickly responding to external/internal state changes.

Fr-WS15: Experimental Robotic Grasping and Manipulation: Benchmarks, Datasets, and Competitions

Organizers: Yu Sun (University of South Florida, USA), Hyungpil Moon (Sungkyunkwan University, Republic of Korea), Joe Falco (NIST, Japan), Berk Calli (Yale University, USA)

Summary

The workshop will focus on promoting comparable researches in robotic grasping and manipulation. Recently, there is a worldwide trend on designing benchmarks for performance evaluation, establishing community consensus for tasks and rules in competitions, collecting and organizing grasping and manipulation datasets for learning, evaluations, and comparisons. In the last several years, a number of groups in the robotics society have produced high-quality grasping evaluation objects (such as YCB object set), benchmarking metrics (such as the NIST grasping and manipulation performance metrics and benchmarks), daily-living manipulation evaluation tasks (such as the IROS RGMC tasks), manufacturing evaluation tasks (such as the IROS RGMC tasks and WRC tasks), and grasping and manipulation datasets (such as the MIT pushing dataset, IIT robotic hand dataset, USF manipulation dataset, Upenn tactile dataset and Harvard tactile dataset). These are great assets and very valuable for the progression of research in robotic grasping and manipulation. The objectives of the workshop are to bring together researchers from different domains for their common interests in experimental robotic grasping and manipulation, to consolidate their efforts, achievements, and resources, to address the need in promoting comparable research, and to produce fair, easily-implementable, and widely-acceptable benchmarks and evaluation tasks.

Fr-WS16: Human-Aiding Robotics: Open Issues and Future Direction (PM)

Organizers: Angela Faragasso (University of Tokyo, Japan), Robin Murphy (Texas A&M University, USA), Hajime Asama (University of Tokyo, Japan)

Summary

Robotic technologies have been steadily gaining capability over the last decade and their use has been expanded from manufacturing to rescue, military operations, assistance. Their integration in our daily life is constantly increasing. The advent of robotics has not only improved the quality and efficiency of many activities through powerful automation and mechanisation of menial jobs, but has also made it possible to accomplish tasks which were not possible before. Robotics is a multidisciplinary and emerging discipline which aims to help humans in solving complex problems and facilitate a higher quality of life for everyone. However, despite all the research effort and the advanced technologies, many of the developed solutions are not used in real scenarios.

This workshop aims to involve different areas of robotics, which aim to meliorate the quality of human lives by employing the use of robots. The workshop will explore the latest technologies in a multidisciplinary fashion to underline the reasons which are preventing the use of those sophisticate solutions in real applications. There are many challenges related to complexity and cost which limit widespread adoption and utilisation of the developed systems. Moreover, the use of fully autonomous systems able to operate without human intervention, thanks to the ability of learning and adaptation, leads to legal, social and ethical issues. Are collaborative systems, in which humans and robots coexist and execute the tasks together, the real solution to this problem?

26. Workshops

Fr-WS17: Workshop on Crossmodal Learning for Intelligent Robotics (AM)

Organizers: German Ignacio Parisi (University of Hamburg, Germany), Pablo Barros (University of Hamburg, Gernamy), Doreen Jirak (University of Hamburg, Germany), Jun Tani (Okinawa Institute of Science and Technology, Japan), Yoonsuck Choe (Texas A&M University, USA)

Summary

The ability to efficiently process crossmodal information is a key feature of the human brain that provides a robust perceptual experience and behavioural responses. Consequently, the processing and integration of multisensory information streams such as vision, audio, haptics and proprioception play a crucial role in the development of autonomous agents and cognitive robots, yielding an efficient interaction with the environment also under conditions of sensory uncertainty.

This half-day workshop focuses on presenting and discussing new findings, theories, systems, and trends in crossmodal learning applied to neurocognitive robotics. The workshop will feature a list of invited speakers with outstanding expertise in crossmodal learning.

Fr-WS18: Robot Safety: Filling the Gap Between Technology Offer and Industry Needs for a Fully Deployable Human Robot Collaboration (PM)

Organizers: Fabien Albert (AIRBUS), Cristina Cristalli (Loccioni Group – AEA, Italy)

Summary

A new generation of collaborative robots has been developed, with the aim of enabling HRI, through a safe workspace sharing between the human operator and the robot. However, depending on the tool used by the robot or on the application itself, even collaborative robots need additional safety sensors or physical barriers in order to be safe, according to ISO standards. On the other hand, a lot of algorithms and technologies have been developed, both at academic and industrial level, to improve safe human-robot interaction.

The workshop aims at collecting contributions from the invited speakers coming from the industrial, academic and regulatory sectors, encouraging an open discussion on what are the blocking points/requirements for these technologies and algorithms to be used in real applications. These inputs will help the robotics community in defining the way forward in order to achieve a safe and largely deployable HRI within industrial contexts. The expected output is a "manifesto" from both industrial and academic points of view to advance proposals and request feedbacks to the regulatory committees. The manifesto will permit to initiate changes in safety for robotics and unlock industrial applications.

Fr-WS19: New Horizons for Underwater Intervention Missions: From Current Technologies to Future Applications (AM)

Organizers: Pedro J Sanz (University Jaume I, Spain), Oussama Khatib (Stanford University, USA), Hyun-Taek Choi (Korea Institute of Oceans Science and Technology, Republic of Korea), Sadao Kawamura (Ritsumeikan University, Japan), Pere Ridao (University of Girona, Spain)

Summary

In brief, this Workshop aims to become a source of inspiration for all those people interested in marine robotics from any research perspective. It is a half-day Workshop consisting of a combination of invited keynote talks, poster presentations, and a panel discussion.

While commercially available Autonomous Underwater Vehicles (AUVs) are routinely used in survey missions, a new set of applications exist which clearly demand intervention capabilities. The maintenance of permanent underwater observatories, submerged oil wells, cabled sensor networks, pipes and the deployment and recovery of benthic stations are but a few of them. Nowadays, these tasks are addressed using manned submersibles or work-class ROVs (Remotely Operated Vehicles), equipped with teleoperated arms.

Current Intervention-AUVs (I-AUVs) prototypes are usually big and complex systems exhibiting only a limited set of functionalities including docking and fixed based manipulation on a subsea panel, as well as search and recovery of simple objects. On the other hand, as in the case of human manipulation, more sophisticated applications, like transporting and manipulating bulky objects, or assembling complex structures underwater, would require several I-AUVs working cooperatively.

26. Workshops

Fr-WS20: Human-Robot Cooperation and Collaboration in Manipulation: Advancements and Challenges (AM)

Organizers: Valerio Ortenzi (Queensland University of Technology, Australia), Marco Controzzi (Scuola Superiore Sant'Anna, Italy), Naresh Marturi (University of Birmingham, UK), Yasemin Bekiroglu (Vicarious AI, USA), Peter Corke (Queensland University of Technology, Australia), Andrea Cherubini (LIRMM - Universite de Montpellier, France)

Summary

During this workshop, we will focus on how to achieve safe and efficient human-robot collaboration in manipulation tasks and discuss key questions such as, what makes human collaboration so successful and how to transport and replicate it to robots, what is still missing in robotic manipulation to become optimally collaborative without separation and safety fencing, what the main approaches to collaborative manipulation are. Complementing humans sharing a workspace to accomplish a task more effectively involves challenges. The robot should be intuitive and safe through hardware and actions. Robots should recover and learn from errors. Based on a model of the task, the robot should coordinate its actions with its teammate's actions within the model through communication (e.g., motion, speech). In addition, humans and robots can take different responsibilities such as: humans as supervisors providing information, instructions, decisions; humans and robots as peers working together at the same level to achieve a common goal; robots as assistants where humans lead.

Fr-WS21: Hand-Shaking Advanced Control in Marine Robotics Applications (AM)

Organizers: Enrica Zereik (CNR, Italy), Fabio Paolo Bonsignorio (Heron Robots and Scuola Superiore Sant'Anna, Italy)

Summary

The main objective of the proposed workshop consists in gathering together the Control engineering and science and Marine Robotics communities, allowing a productive exchange among people with different backgrounds. In particular, the aim is to let experts in advanced automatic control techniques and theory, more specifically focused on theoretical developments in the field, to present the recent advancements and new trends within theircommunity; at the same time, experts in marine robotics can present their current work and achievements, highlighting the currently unsolved problems and challenges in the advanced guidance navigation and control of the single marine platforms, as well as the challenges concerning the control of teams of heterogeneous robots. Discussion among all these experts in various fields will foster the exchange of different perspectives and the birth of new ideas and research lines. The workshop schedule is foreseen in many rounds, each one planning the lectures by one Automatic Control expert and one Marine Robotics expert, followed by an open discussion in which lecturers and participants can exchange ideas on what they just listen to and pose new problems or challenges.

Fr-WS22: Robots that Learn and Reason: Towards Learning Logic Rules from Noisy Data (PM)

Organizers: Plinio Moreno (IST, Portugal), Kristian Kersting (Fraunhofer IAIS and University of Bonn, Germany), José Santos-Victor (IST, Portugal), Alexandre Bernardino (IST, Portugal), Rodrigo Ventura (IST, Portugal)

Summary

The main objective of this workshop is to (re-)discuss the association of rules (i.e. concepts, abstractions) to sensorimotor robot's data, in the context of the recent developments presented in the article "Learning abstract hierarchical compositional visual concepts". These recent developments have shown that is possible, on the one hand, to learn associations between visual input and logical recombination operators in a hierarchical, fully grounded and with very little supervision. The connections between logic programming and robotics have been studied for a while, but the association between noisy and ambiguous data and symbolic rules has been performed by humans, using educated guesses and previous experiences. This is similar to the previous approaches in computer vision, where the image features were usually developed and selected by humans. Currently, deep learning approaches work in an end-to-end fashion so the image feature selection is done by the learning algorithm as well. Thus, the big question to be discussed is: "Are robots ready to learn symbolic rules and their association to noisy and ambiguous data in an end-to-end manner?". Addressing this question has several issues to be considered, so we propose to have two sides: (i) The pragmatic and engineering approach, and (ii) the long-term quest of a solution.

26. Workshops

Fr-WS23: Unconventional Sensing and Processing for Robotic Visual Perception (PM)

Organizers: Yulia Sandamirskaya (ETH Zurich, Switzerland), Julien Martel (ETH Zurich, Switzerland)

Summary

In the last decade, the developments in material technologies, lithographic processes, and assisted VLSI design techniques has enabled the conception and fabrication of new visual sensors and processors. These devices provide new ways to sense and transform visual information, thus bringing immense advantages for a variety of applications, for instance: to capture fast motion, to image in wild lightning conditions or to capture the three-dimensional structure of a scene. Concrete examples of such unconventional visual sensors and processors include Dynamic Vision Sensors (DVS), Light-Field Cameras, Multi-Spectral Imagers, Near-Focal Plane Sensor-Processors, and many others.

These sensors call for new algorithms that exploit the nature and the new format of the information they report. On the application side, the integration in robotic systems of these sensors with these novel algorithms is needed. This workshop aims at building a bridge between the communities involved in a) the design of such unconventional sensors and processors, b) the design of new algorithms to equip them with ``intelligence'' and c) the robotics community that can benefit from their use.

In this workshop, we bring together top speakers from these three communities and ask them to showcase their technology in interactive demonstrations, accompanied by short inspiring talks.

Fr-WS24: Automating Robot Experiments: Manipulation and Learning (PM)

Organizers: Oliver Kroemer (Carnegie Mellon University, USA), Lerrel Joseph Pinto (Carnegie Mellon University, USA), Katharina Muelling (Carnegie Mellon University, USA)

Summary

Modern robotics research requires massive amounts of data. New algorithms are constantly being developed and the requirements for rigorous benchmarking experiments are steadily increasing. Many of these algorithms are themselves data-driven learning methods, which compounds the need for both training and testing data. Acquiring large amounts of data is unfortunately not a trivial task for many areas of robotics research, especially when the data collection involves the robot interacting with its environment. Manipulation experiments often require objects to be reset between trials. Similarly, learning locomotion on deformable terrain may require the ground to be reset between experiments. In practice, the resetting of the environment is often performed manually by researchers, which is a tedious and time-consuming process. The reliance on manual human intervention is often a major bottleneck in the experiment pipeline and tends to be the critical factor in limiting the amount of data that can be reasonably acquired. Hence, to collect the required data and perform rigorous evaluations, we will need to automate robot experiments. In this workshop, we will bring together members of the robotics research community to discuss different approaches for increasing the autonomy of robot experiments. We will discuss techniques for controlling experiment environments, performing simulated evaluations, and running experiments autonomously for extended periods of time. The workshop will address the following questions:

- What are the key challenges for automating robot experiments?
- What are common techniques for increasing the autonomy of the evaluation process?
- What safety factors need to be considered when running robot experiments autonomously?
- What is the role of simulation in training and evaluating methods?
- What other approaches can be used to address the data limitations in robotics research?

26. Workshops

Fr-WS25: Robotic Co-workers 4.0: Human Safety and Comfort in Human-Robot Interactive Social Environments (AM)

Organizers: Trung-Dung Ngo (University of Prince Edward Island, Canada), Rachid Alami (CNRS, France), Goldie Nejat (University of Toronto, Canada), Yongsheng Ou (Chinese Academy of Sciences, China), Takayuki Kanda (ATR, Japan), Xuan-Tung Truong (University of Brunei Darussalam, Brunei Darussalam)

Summary

Professional and personal service robots are becoming enabling assistive technologies for social interactive environments. However, the first and the most challenging issue with respect to deploying service robots in human populated environments is how to guarantee human safety and comfort in human-robot shared workspaces. Human physical safety is concerned with how to maintain the minimum physical distance between robots and humans, while human psychological comfort implies that robots should not cause stress and discomfort to humans when working with or around them. Human risks and their inconveniences when working in an interactive social environment essentially come from unavoidable situations due to robot malfunctioning operations caused by either misunderstanding and misinterpreting information extracted from sensing and perception or failures of path planning and motion control.

The primary objective of this workshop is to create an open interactive forum for researchers, engineers, developers and entrepreneurs of professional and personal service robots as well as psychologists and sociologists who are interested in the impacts of robotics and AI. Our goal is to gather speakers and an audience from multiple disciplines to discuss about challenges and methodologies of how to guarantee human safety and comfort in order to accelerate deployment of service robots into human-robot shared work spaces. Last but not least, through this workshop, we aim to deliver our main message to all the targeted audience that human safety and comfort must be critically considered because it is one of the most important issues we must address in order to deploy robotic co-workers in human-robot shared work spaces, especially when human society is moving towards cyber-societies in which humans and robots will harmoniously live and work together.

Fr-WS26: Towards Intelligent Social Robots: From Naive Robots to Robot Sapiens (PM)

Organizers: Amir Aly (Ritsumeikan University, Japan), Sascha Griffiths (Universität Hamburg, Germany), Verena Nitsch (Bundeswehr University Munich, Germany), Katerina Pastra (Cognitve Systems Research Institute, Greece), Tadahiro Taniguchi (Ritsumeikan University, Japan)

Summary

Robots that cook creatively, clean up our rooms dutifully, entertain our guests wittily and keep us company loyally. Robots that assist the elderly and their caretakers in their daily chores and provide support in times of need. Researchers around the world have envisioned such robot companions for a long time. Thanks to numerous innovations in sensor technology and software development, robots are now increasingly able to plan complex tasks in unknown environments, learn from experience and adapt to changes in the environment. The greatest challenges in robotics now lie in the development of robot skills that enable robots to work effectively in close cooperation with humans.

Aside from the numerous technical challenges, which must be overcome before this vision can become a reality, multi-disciplinary research efforts are also invested into the social engineering of robots. In order to engineer "smart" robots that we accept, trust and welcome into our homes, it is paramount that we identify and investigate the factors that affect social interactions between humans and robots. For this purpose, computer scientists and engineers collaborate increasingly closely with psychologists. Together they tackle important questions that will determine whether robots will be perceived as helpful and reliable companions or as irritating nuisances. How should robots look, behave and communicate with us? What are our expectations of robot behavior in a social context?

Fr-WS27: RoboCup Humanoid League (PM)

Organizers: Ludovic Hofer (Bordeaux University, France), Reinhard Gerndt (Ostfalia University of Applied Sciences, Germany)

Summary

The RoboCup Humanoid League is targeting soccer games as a challenging benchmark in humanoid robotics design and control. Playing soccer requires advanced kinematic and dynamic control, reliable perception and planning and high-level cooperation between robots to follow a joint strategy. For the year 2050 plans foresee a game against the 2050 human soccer champion. The workshop shall help to break down the work for the coming 30 years until 2050 into manageable tasks and steps that allow planning and assessing the progress. The workshop shall identify crucial research questions and clarify the order and timing required to reach the goal and thereby provide a framework for the humanoid robotics community to independently focus on their own research interests while still working towards the joint goal.
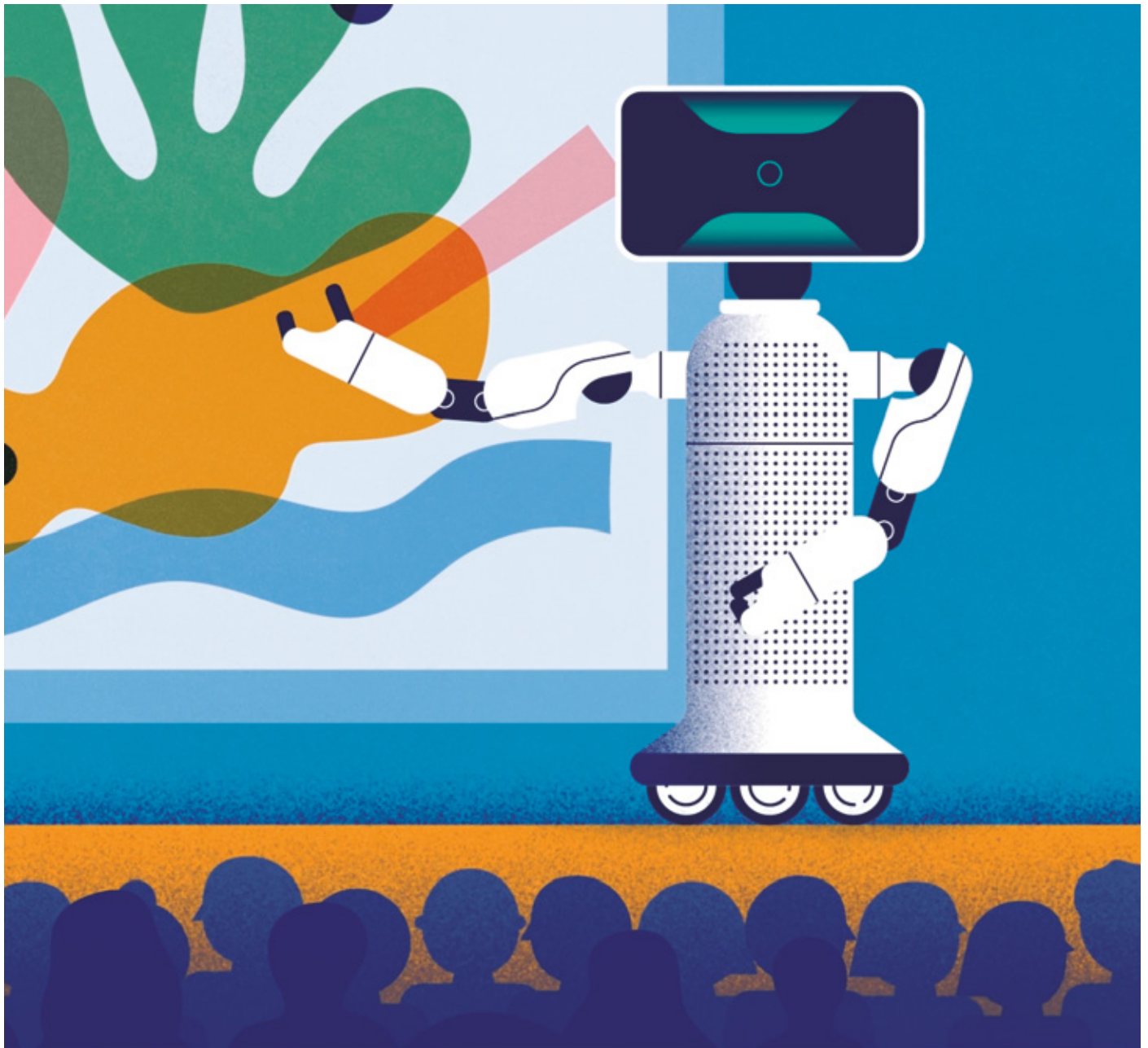
27. Tutorials

Tutorials are scheduled as:

- Full day TUT: 9:00 -19:00h
- Morning TUT: 9:00-13:30
- Afternoon TUT: 14:30-19:00h

Code / Submission #	ROOM code	ROOM name	Schedule
Mo-TUT 1 / 2319	2.R.2	BOGOTÁ	full day
Mo-TUT 2 / 2200	4.L.1	BRUSELAS	morning
Mo-TUT 3 / 2295	4.L.1	BRUSELAS	afternoon
Mo-TUT 4 / 2346	4.R.4	PRAGA	afternoon
Fr-TUT 1 / 2325	1.R.4	BUENOS AIRES	full day
Fr-TUT 2 / 2340	2.R.2	BOGOTÁ	full day
Fr-TUT 3 / 758	4.R.2	ESTOCOLMO	morning
Fr-TUT 4 / 2241	1.L.3	BERLÍN	morning

Tutorials: summaries

Mo-TUT-1: A Hands-on Tutorial on XBotCore: A Real-Time Cross-robot and Cross-framework Software Architecture

Organizers: Luca Muratore (Istituto Italiano di Tecnologia, Italy), Arturo Laurenzi (Istituto Italiano di Tecnologia, Italy), Giuseppe Francesco Rigano (Istituto Italiano di Tecnologia, Italy), Enrico Mingo Hoffman (Istituto Italiano di Tecnologia, Italy), Nikos Tsagarakis (Istituto Italiano di Tecnologia, Italy)

Summary
The tutorial has the goal to demonstrate the main tools and capabilities of the XBotCore Real-Time (RT) software framework, released in 2016 as an open-source project and successfully deployed in three European founded project: WALK-MAN (FP7-ICT-2013-10 - https://www.walk-man.eu/), CogIMon (H2020 - https://cogimon.eu/) and CENTAURO (H2020 - https://www.centauro-project.eu/).
XBotCore is considered a cross-robot and cross-framework software architecture: it is possible to reuse its components among different robotic platforms without any code changes, and to seamlessly integrate it with state-of-the-art, widely spread control frameworks like ROS, YARP and OROCOS . It also offers a built-in model plugin for the Gazebo simulator in order to go seemly from the simulation implementation to the real robot experiment without code modification.

Mo-TUT-2: From Least Squares Regression to High-dimensional Motion Primitives (AM)

Organizers: Freek Stulp (DLR, Germany), Sylvain Calinon (Idiap Research Institute, Switzerland), Gerhard Neumann (University of Lincoln, USA)

Summary
The objective of this tutorial is to provide an intuitive understanding of the most commonly used motion primitive representations in robotics, as well as the regression algorithms on which they are based. This understanding will be achieved by visual, constructive explanations of the theory and design rationale behind the representations and algorithms. Open-source implementations of the algorithms are demonstrated, so that the audience can see the potential (and pitfalls) of these algorithms, and how they can be applied to programming by demonstration. The representations and algorithms that will be presented are listed below under "Topics of interest".
When explaining the regression algorithms, an emphasis is placed on the relationships between these representations and algorithms. In particular, the role of (weighted) least squares in many of these algorithms is made explicit, and we show that all algorithms use essentially the same underlying model. By emphasizing similarities, rather than differences, we will be able to present a large number of algorithms as being variations on a common theme based on shared first-order principles.
The motion primitive part will first explain the role of regression in programming by demonstration. We present several commonly used motion primitive representations, and emphasize the similarities between them. We

present how motion primitives can be adapted to task variations, how controllers can be designed around them, how shared control can be achieved with them, and how they can be applied to real-world applications such as manipulation.

Mo-TUT-3: Creating and Understanding 3D Annotated Scene Meshes (PM)

Organizers: Zhiyuan Zhang (Singapore University of Technology and Design, Singapore), Binh-Son Hua (Singapore University of Technology and Design, Singapore), Duc Thanh Nguyen (Deakin University, Australia), Lap-Fai Yu (University of Massachusetts Boston, USA), Sai-Kit Yeung (Singapore University of Technology and Design, Singapore), Daniela Rus (MIT, USA)

Summary

Capturing, reconstructing, and annotating 3D scenes from real world are often known as daunting tasks in preparing a high-quality dataset for 3D scene understanding despite recent advances in color and depth sensors. In contrast to 2D image datasets which have been readily and widely available, 3D scene mesh datasets for training and testing robotics algorithms have been scarce since creating such datasets often requires huge efforts in building a robust 3D scene reconstruction and annotation pipeline.

This tutorial aims to equip its audience with general knowledge about the state-of-the-art approaches in 3D scene reconstruction and annotation, as well as the technical and implementation knowledge about how to build a complete pipeline to reconstruct and annotate 3D scenes. Several topics for building the pipeline will be extensively discussed, including data capturing, real-time and offline reconstruction, automatic and interactive annotation, quality control and benchmarking metrics. A WebGL annotation tool for 3D scene segmentation will also be demonstrated during the tutorial. Finally, as an application of the annotated scene data, we will discuss the state-of-the-art techniques in 3D deep learning, particularly in deep learning for 3D point clouds.

Mo-TUT-4: Securing Robotics with SROS2 (PM)

Organizers: Ruffin White (University of California San Diego, USA), Gianluca Caiazza (Ca Foscari University of Venice, Italy), Agostino Cortesi (Ca Foscari University of Venice, Italy), Henrik Iskov Christensen (University of California San Diego, USA)

Summary

This tutorial will provide a formal introduction to SROS2 for roboticists as an effort towards advancing the state of security in the robotics community. The objectives of this session will be multifaceted; primary hands-on instruction in setup and use of newer security features and tooling within ROS2, while secondary and tertiary objective include insighting more contributors to join the the project as well as soliciting further feedback.

Fr-TUT-1: Aerial Robotic Manipulation

Organizer: Guillermo Heredia (University of Seville, Spain)

Summary

This tutorial provides an introduction to the theory and practice of aerial manipulation. Aerial manipulators are aerial robots with attached mechatronic devices as robotic arms or grippers, which are able to grasp, transport, position and manipulate objects and apply forces to the environment. The design, control, sensing and motion planning of aerial manipulators present differences and challenges with respect to aerial robots that are the focus of this tutorial. The mechatronic design of aerial manipulators is severely limited by the payload of the aerial platform. Installing arms with several DOFs involves the use of compact actuators, which also constraint the payload of the arm itself and its capacity to apply forces. Then, aerial manipulator controllers have to deal with the dynamic coupling of the movement of the arms, the disturbances of the contact forces and the weight of grasped objects. Additionally, to the usual sensors in aerial robots, proprioceptive sensing of the state of the arms and mechanical devices is important for controller development. As aerial manipulators fly and interact closely with the environment, perception for estimation of relative pose with respect to the objects and the environment is critical. Motion planning and reactive replanning in aerial manipulators is also necessary to deal with their safe operation close to obstacles in partially unknown environments.

This tutorial aims at addressing all these issues from a practical point of view, introducing the different problems and presenting solutions that have been tested in practice in different applications.

Fr-TUT-2: Collaborative Robotics Toolkit (CRTK) and Open Platforms for Medical Robotics Research

Organizers: Peter Kazanzides (Johns Hopkins University, USA), Blake Hannaford (University of Washington, USA), Gregory Scott Fischer (Worcester Polytechnic Institute, USA)

Summary

The objectives are to provide an in-depth tutorial on recent advances in open platforms for medical robotics research. This originated with two widely used open platforms, the Raven II robot and da Vinci Research Kit (dVRK), which are installed at more than 40 institutions worldwide, but has broadened to include other robots and devices, including simulated robots. The tutorial will first present the Collaborative Robotics Toolkit (CRTK), which defines a common API to the Raven, dVRK and other systems. It will cover the concepts and design of CRTK, followed by its ROS implementation. The integration of CRTK with popular simulation/visualization platforms, including rviz, Gazebo, and Matlab, will be covered in depth and attendees will have an opportunity for hands on experimentation, using haptic input devices to teleoperate simulated robots and remote Raven II and dVRK robots. The tutorial will include a Community Tips session, consisting of presentations from researchers who have developed hardware and software extensions to these platforms that could be of interest to the community. This session will provide a forum for community dissemination of this collective knowledge.
The tutorial will also include a Contribution Guide session, which will explain best practices of software configuration management, including git workflows, and information about how to contribute to the evolving software infrastructure. In addition, the tutorial will cover the architecture and low-level programming environment of the Raven II and dVRK robots.

Fr-TUT-3: Robot Audition: Open Source Software HARK (AM)

Organizers: Kazuhiro Nakadai (Honda Research Institute, Japan), Hiroshi G. Okuno (Waseda University, Japan), Makoto Kumon (Kumamoto Graduate School of Science and Technology, Japan), Gokhan Ince (Istanbul Technical University, Turkey), Osamu Sugiyama (Tokyo Institute of Technology, Japan), Katsutoshi Itoyama (Kyoto University, Japan), Ryosuke Kojima (Tokyo Institute of Technology, Japan), Reiji Suzuki (Nagoya University, japan), Kotaro Hoshiba (Kanagawa University, Japan)

Summary

Auditory processing is essential for a robot to communicate with people. However, most studies in robotics used a head set microphone attached close to the mouth. Robot audition, thus, proposed to solve such a problem in 2000 and was registered as a keyword in IEEE Robotics and Automation Society (RAS) in 2014. We have developed a lot of robots to solve such as ambient noise, speech noise, ego-noise, reverberation, and so on, and published papers mainly in robotics conferences such as IROS, ICRA, and Humanoids. The methods in those publications are collected as open source software called HARK (HRI-JP Audition for Robots with Kyoto University). HARK was released in 2008 aiming to become an audio-equivalent to OpenCV, and the total number of downloads has exceeded 12,000 as of December 2017. HARK has been applied to various fields such as human-robot verbal interaction, drones, ICT and IVI systems, ecological and ethological research areas, etc.
This tutorial will consist of lectures, practices, introduction of case studies, and live demonstrations, and thus it will provide participants with its basic concepts as well as practical knowledge on HARK. We are happy if this tutorial will be a good opportunity to lower the barrier for researcher of robot audition, to increase the awareness of HARK, and to expand to more applications of HARK into various fields to realize its full potential.

Fr-TUT-4: Screw Theory for Robotics: A Practical Approach for Modern Robot Mechanics (AM)

Organizers: Jose M. Pardos-Gotor (University Carlos III of Madrid, Spain), Kevin Lynch (Northwestern University, USA), Bruno Siciliano (Universitá degli Studi di Napoli Federico II, Italy), Peter Corke (Queensland University of Technology, Australia), Jon Selig (London South Bank University, UK), Alberto Jardon (University Carlos III of Madrid, Spain)

Summary

This tutorial will teach attendees how to apply the tools derived from Screw Theory to develop their own research in robotics. The basic theoretical notions will be presented, but with great emphasis on examples, applications and exercises with commercial robots (e.g. PUMA, GANTRY, SCARA, COLLABORATIVE).
The importance of Screw Theory in robotics is recognised, but in practice, very few teach it to engineering students and, therefore, not many postgraduates know how to use it. However, in a variety of areas of robotics, the methods and formalisms based on the geometry and algebra of the screws have proven to be superior to other techniques and have led to significant advances.
This tutorial will demonstrate with practical examples of actual industrial robots, that many robotics problems addressed today only with numerical iterative solutions, are better solved with closed-form geometric solutions based on Screw Theory.

IROS MACAU 2019

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Call for Papers

The 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2019) will be held on November 3 – 8, 2019 in The Venetian Macao, Macau, China. IROS is one of the largest and most impacting robotics research conferences worldwide. It provides an international forum for the international robotics research community to explore the frontier of science and technology in intelligent robots and smart machines. In addition to technical sessions and multi-media presentations, IROS conferences also hold panel discussions, forums, workshops, tutorials, exhibits, and technical tours to enrich the fruitful discussions among conference attendees.

Innovative research results on topics related (but not limited) to the following are invited: robot design, robot kinematics/dynamics/control, system integration, AI in robotics, sensor/actuator networks, distributed and cloud robotics, bio-inspired systems, service robots, robotics in automation, biomedical applications, autonomous vehicles (land, sea, and air), robot perception, manipulation with multifinger hands, micro/nano systems, sensor information, multimodal interface and human robot interaction, and robot vision.

Call for Contributions
Papers: Prospective authors are invited to submit high-quality papers reporting original results under the broad theme, and in all areas of intelligent robot elements, systems, and applications. Best Conference Papers and Best Student Papers will be awarded. Detailed instructions for submissions are available on the conference website.

Tutorials and workshops: As with previous IROS conferences, the organizers intend to arrange an extensive program of workshops and tutorials to be held prior to the conference. Proposals for tutorials and workshops that address topics related to the conference theme are welcome.

Competitions: For organizers of robot competitions, please contact the conference competition chairs with a proposal.

Exhibits: IROS 2019 offers an excellent opportunity for robot companies to showcase their products and services. Ample exhibition space is available at The Venetian Macao with convenient access to the meeting space for the conference technical program. Information on exhibiting can be found on the IROS 2019 website.

Important Dates

Organized Sessions/Forums & Competition Proposals	**February 1, 2019**
Notification of Organized Sessions/Forums & Competition Acceptance	**February 20, 2019**
RA-Letters with IROS Option Submission	**February 24, 2019**
Paper Submission	**March 1, 2019**
Workshop/Tutorial Proposals	**March 15, 2019**
Notification of Workshop/Tutorial Acceptance	**April 23, 2019**
Notification of Paper Acceptance	**June 30, 2019**
Final Paper Submission	**July 31, 2019**

All deadlines are 23:59 PST.

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