

# The 2016 IEEE RAS Summer School Activities

By M. Ani Hsieh

I would like to first take this opportunity to thank Paolo Fiorini for his invaluable leadership, service, and mentorship. Paolo stepped down as the IEEE Robotics and Automation Society's (RAS) Education Committee chair after several years of service. During his tenure, we saw the IEEE RAS Summer School Program, now called the RAS Technical Education Program (TEP), establish itself as a core part of the Society's activities. Please join me in thanking Paolo for his service, and let's welcome Angelika Peer as the new cochair of the RAS Education Committee.

As we approach the end of 2016, this is a great opportunity to highlight recent activities undertaken by this year's newly awarded TEPs:

- the Marine Robotics Research Summer School (MRRSS)
- the Summer School on Control of Surgical Robots (COSUR 2016)
- the 2016 IEEE RAS Summer School on Multirobot Systems.

We strongly encourage those of you who are thinking about proposing an RAS TEP to apply. Guidelines in preparing a proposal can be found at <http://www.ieee-ras.org/educational-resources-outreach/summer-schools>. As the deadline for next year's proposals approaches, we will have more information. Stay tuned!

## MRRSS

Underwater-robot systems, including autonomous underwater vehicles (AUVs),

remotely operated vehicles, and autonomous gliders, have become required tools for many scientific sampling studies in the fields of marine biology, oceanography, and archeology. To fully realize their potential, these robot systems and their related technologies are being innovated in a limited number of research laboratories across the country. However, developing and testing new technology remain cumbersome, time consuming, and resource intensive. The goal of the MRRSS is to train the next generation of underwater-robot engineers and scientists.

The inaugural MRRSS was a two-week program developed and implemented by Christopher Clark from Harvey Mudd College in Claremont, California, and Ryan N. Smith from Fort Lewis College in Durango, Colorado. The program was hosted by Harvey Mudd College 4–15 July 2016. Ten students and five invited speakers participated in the event. The MRRSS combined in-class instruction, hands-on demonstrations, laboratory testing, and full-scale ocean experiments. The focus was on providing the students with firsthand experience in marine robotics from planning to field execution.

In the classroom, students successfully integrated a secondary central processing unit into a commercially available AUV, installed Linux and the robotic operating system, and demonstrated simple autonomy in the field with the vehicle. Prior to attending the MRRSS, 80% of the students had never deployed a marine robot. However, at the end of the program, we successfully

executed more than 35 autonomous missions with both surface and underwater vehicles. Two students were able to demonstrate multivehicle cooperation for optimal sampling, and one student nearly succeeded in demonstrating a 24-h continuous sampling mission with a custom-built autonomous surface vehicle.

As the culminating research experience, students were tasked with creating a bathymetry map of a section of Big Fisherman's Cove, Santa Catalina Island, California, with the shortest path or combination of paths. Data were compared with a ground-truth map created by the program's organizers, and scores were assigned based on a cost function that rewarded short paths and low root-mean-square errors over the created map. The students presented their results from these field trials and other work completed during the program.

More information on MRRSS is available at <http://www.hmc.edu/lair/MRRSS/index.html>.

## COSUR 2016

The Summer School on Control of Surgical Robots was held 5–9 September 2016 in Verona, Italy. The summer school focused on the specific aspects of sensing and control of teleoperated surgical robots. Theoretical lectures and practical laboratories were combined with seminars on the ongoing European project on robotic surgery, the perspectives of leading robotic surgeons, and lectures on the impact of novel technologies and their business



**Figure 1.** (a) Lecturers and (b) participants at the 2016 IEEE RAS Summer School on Multirobot Systems.

opportunities. The summer school received 55 applications, and 40 students were accepted based on their experience and motivation; 24 were IEEE RAS student members. Of those accepted, seven were female, three were postdocs, and two were master's degree students. The summer school was evaluated by 29 students, and the total average score was 8.3 out of 10 in nine categories. A more detailed analysis of the students' comments will allow us to fine-tune the balance among theory, practice, and general lectures for the next summer school.

For more information, visit <http://metropolis.scienze.univr.it/altair/events/cosur-2016/>.

### 2016 IEEE RAS Summer School on Multirobot Systems

The 2016 IEEE RAS Summer School on Multirobot Systems was the first of its kind and was held 6–10 June 2016 at the School of Computing of the National University of Singapore (NUS) (Figure 1). It was jointly organized by the NUS; the Institute for Infocomm Research of the Agency for Science, Technology, and Research in Singapore; the Singapore University of Technology and Design; and the IEEE RAS Technical Committee on Multirobot Systems and was financially supported by the RAS.

The aim of the summer school was to promote multirobot systems research that will enable students, academic researchers, and industrial practitioners to realize its necessity for improving our quality of life. Participants were introduced to the exciting possibilities surrounding the use of multirobot systems in real-world application domains and the challenges and issues faced by the multirobot systems community in putting theory into practice and scaling up algorithms for single robots to those for multirobots.

The main technical objective of the summer school was to cover the motivation driving research on multirobot systems, existing projects and results, and open research problems. Research themes included

- “Sensing/Perception and Estimation,” Robert Fitch, Geoffrey Hollinger, and Bryan Kian Hsiang Low
- “Task Allocation and Role Assignment,” Somchaya Liemhetcharat, Nora Ayanian, and Dylan Shell
- “Control,” Lorenzo Sabattini and Paolo Robuffo Giordano
- “Planning and Decision Making,” Matthijs Spaan and Kostas Bekris
- “Swarm Intelligence,” Roderich Gross and Roland Bouffanais.

These five themes were addressed in lectures, practical sessions, student

posters, and spotlight presentations and covered the issues of coordination and cooperation, learning, scalability, and communication.

The summer school received 104 applications and accepted 72 students, which was 80% more than the expected number (i.e., 40). Thirty-five IEEE RAS student members participated. The regional breakdown of the students according to their institutions was

- 32 from Singapore
- 11 from Asia (excluding Singapore)
- six from Africa and the Middle East
- eight from Europe
- seven from North and South America
- eight Australia and New Zealand.

The summer school was evaluated by 38 participants, and the overall rating was 4.03 out of 5.

The link to the summer school is <http://www.comp.nus.edu.sg/~lowkh/mrsss.html>.

**Underwater-robot systems have become required tools for many scientific sampling studies in the fields of marine biology, oceanography, and archeology.**

