2022 IEEE Robotics and Automation Society Summer School on Multi-Robot Systems in Prague

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In recent decades, robotic systems have been used for an increasing number of applications, often involving multiple robots. Although multi-robot systems (MRS) provide benefits like redundancy, robustness, and fault tolerance, they come with numerous challenges. These challenges present new research possibilities and are of great interest to the IEEE Robotics and Automation Society (RAS). The IEEE RAS Summer School on MRS aims to gather the knowledge and expertise of the robotics community and bridge the gap between theory and practice.

The first IEEE RAS Summer School was held in June 2016 in Singapore and was supported by the IEEE RAS Technical Committee (TC) on MRS. In 2019, 2020, and 2022, the IEEE RAS Summer School on MRS was organized by the MRS Group at the Department of Cybernetics, Faculty of Electrical Engineering (FEE), Czech Technical University (CTU) in Prague.

The 2022 session was held on 1–5 August (Figure 1). It combined lectures with hands-on experiments, while providing a space for knowledge sharing and networking among researchers, students, engineers, and drone enthusiasts from around the world. The practical activities culminated with outdoor

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FIGURE 1. The participants and lecturers during the 2022 session of the summer school.

field experiments on the final day of the school.

LECTURES

The summer school hosted nine researchers from top robotics laboratories across the world to present lectures on various interesting topics (http://mrs.felk.cvut.cz/summer-school-2022):

- Aníbal Ollero (University of Seville, Spain)
- Martin Saska (CTU, Czech Republic)
- Vito Trianni (Institute of Cognitive Sciences and Technologies, Italy)
- Guido de Croon (Delft University of Technology, The Netherlands)
- Tomáš Svoboda (CTU, Czech Republic)
- Rachid Alami (Laboratory for Analysis and Architecture of Systems, France)
- Lino Forte Marques (University of Coimbra, Portugal)
- Konstantinos Alexis (Norwegian University of Science and Technology, Norway)
- Alyssa Pierson (Boston University, USA).

GROUP PROJECT AND OUTDOOR COMPETITION

One of the main goals of the summer school is to enrich the participants with the knowledge and skills necessary to put ideas into practice. The 2022 practical session focused on a power line inspection task inspired by the AerialCore project (https://aerial-core.eu/) (Figures 2 and 3). The task was designed as a competition where a fleet of unmanned aerial vehicles (UAVs) was required to visit several target regions (locations for inspection around a power line). The competition was organized in two parts: first, the participants were asked to design, develop, and test their solutions in the Gazebo robotic simulator using the MRS UAV system (https://github.com/ctu-mrs/mrs_uav_system) as a framework; second, the participants deployed their solutions in outdoor field experiments using MRS UAV platforms. The results were provided in real time (Figures 4 and 5). The competition required participants

FIGURE 2. The outdoor field experiment with unmanned aerial vehicles (UAVs) performing an inspection task. Photo by Petr Neugebauer, FEE, CTU.

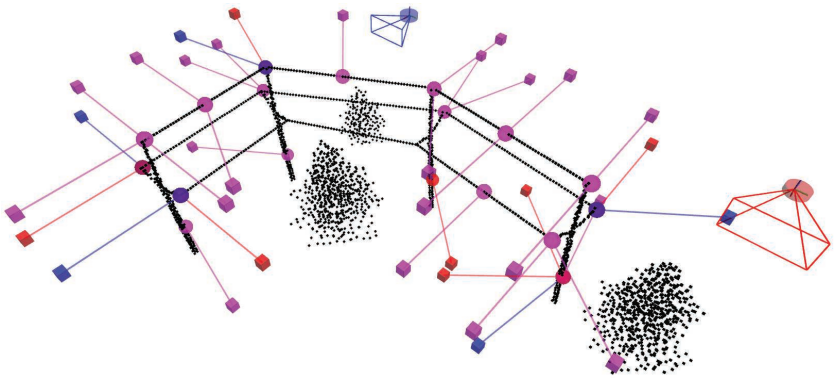

FIGURE 3. A schematic representation of UAVs with fields of view (red and blue pyramids), inspection points and viewpoints (colored spheres and boxes), mock-up poles, and obstacles (black points).

FIGURE 4. The participants attending outdoor experiments.

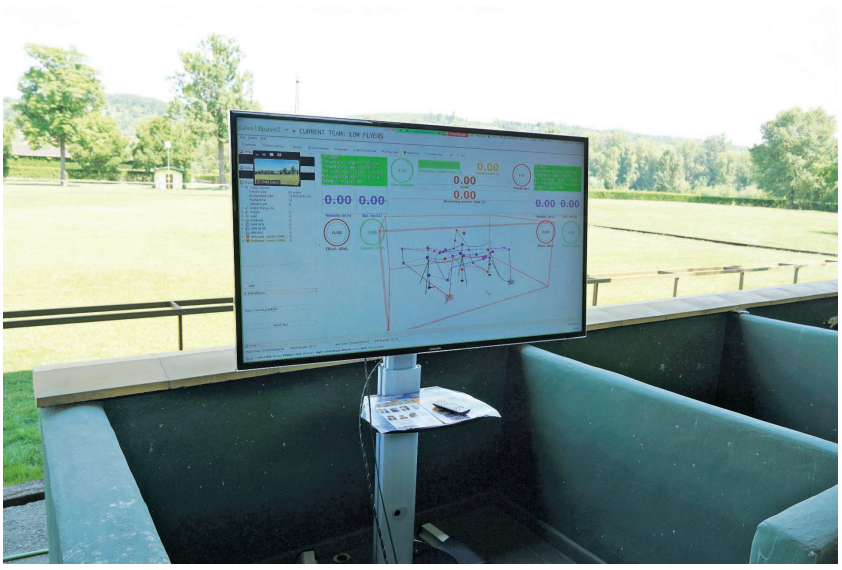

FIGURE 5. The scores of teams displayed in real time.

to explore the challenges of task allocation, trajectory generation, and collision avoidance. A detailed description of the task and the files to run the corresponding Gazebo simulation are available on the MRS GitHub (https://github.com/ctu-mrs/summer-school-2022).

OTHER ACTIVITIES

Several workshops led by doctoral candidates were organized to encourage the exchange of ideas and disseminate research among the participants. Topics included

- onboard perception, state estimation, navigation, and control in varying real-world conditions
- multi-robot cooperation and human–robot cooperation in different environments and applications
- computer vision-based methods for UAV navigation, localization, and cooperation.

Laboratory tours and robot demonstrations from several FEE CTU labs were organized to allow the participants to explore new research areas and key technologies developed at CTU.

SUMMARY

One of the primary objectives of the summer school is to bring together individuals of diverse backgrounds and encourage networking within the scientific community. In 2022, a total of 163 participants from 31 different countries attended the summer school in person, with 13 participants attending the event remotely via a live stream on YouTube (https://youtube.com/playlist?list=PLPjuFI-_2rxx6N8eg1JJGT2LEWBEvZXeG) and communication over Zoom.

Additionally, 46 participants took part in a questionnaire (http://mrs.felk.cvut.cz/summer-school-questionnaire-results) created by the organizing committee regarding the distribution of scientific experience in their field of research.

The next IEEE RAS Summer School on MRS (http://mrs.felk.cvut.cz/summer-school-2023/) will be held on 7–11 August 2023.

ACKNOWLEDGMENT

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