

# ERF Cloud Robotics Workshop

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The cloud robotics workshop at the European Robotics Forum 2022 in Rotterdam was the fourth in a series of similar workshops organised in previous ERFs. It was attended by a good crowd (50 people approx.), with most of them actively participating in the interactive sessions and in the discussion. The presenters of the workshop included Stratos Arampatzis (Ortelio Ltd), Giovanni Toffetti (ZHAW), Silvio Cretti (Fondazione Bruno Kessler), Rene Beltman (Lely NV), and Vassilis Mizaridis (Noosware BV). Apart from the given stimulating presentations, there was lively discussion and the participants' opinions and perspectives were captured using the use of AhaSlides software, through which 36 of the participants provided their feedback.

After a few opening words by Stratos Arampatzis (Ortelio) and Giovanni Toffetti (ZHAW), the first talk was delivered by Silvio Cretti (FBK). The talk was about how cloud orchestration can support robotics applications, and on how such applications can gain in resource efficiency and in intelligence. With this context set, Rene Beltman (Lely) presented the practical application of cloud robotics in Lely, where user driven demand made the use of the cloud a practical necessity to operate their robots. Giovanni Toffetti (ZHAW) then spoke about the use of cloud based resources when teaching robotics to University students at ZHAW. Finally, Vassilis Mizaridis (Noosware) talked about one practical application of cloud robotics, namely cloud SLAM, as this is being developed for his PhD thesis



*Photo 1: Silvio Cretti discusses cloud orchestration for robots*



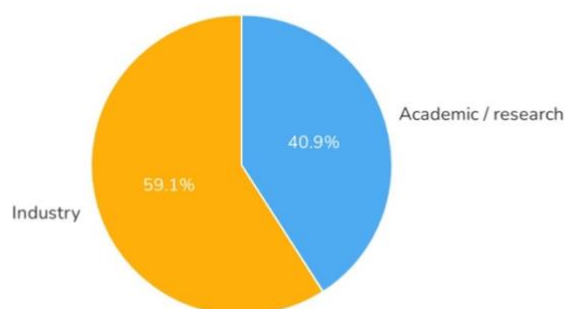
Photo 2: Giovanni Toffetti talks about the use of cloud robotics in academic education

The presentations were meant to create a context for a lively discussion. Between presentations, the organizers asked a number of questions for which the answers were captured using an interactive tool for polls (AhaSlides). The results can be seen as one of the main outcomes of the workshop.

36 of the workshop participants responded to the interactive poll questions. There was some variation within the number of respondents for each question, i.e. not all participants answered every question, and not all workshop participants took the survey. The workshop participants reported to be 60% from the industry and 40% to be academic researchers; this is practically the reversed result of previous ERF workshops on cloud robotics, which indicates that industry is getting more interested in cloud robotics.

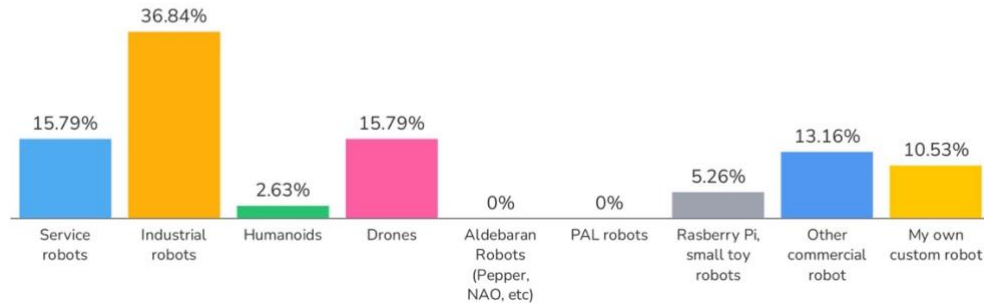


## What is your role / position?



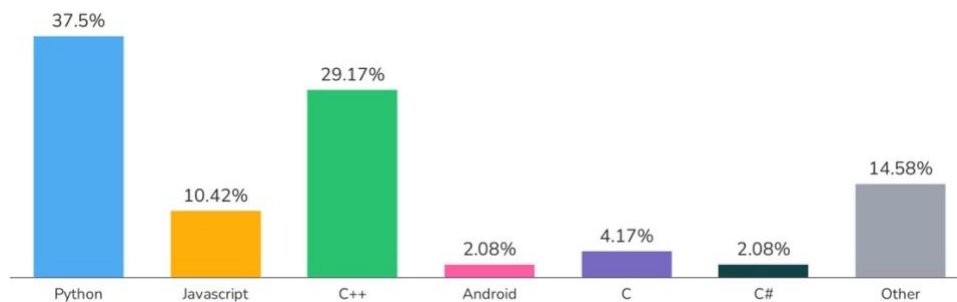
This situation was also reflected in the next question, where industrial robots was the type of robots more used by the audience, with drones and service robots taking the second place. Again this is a change from previous workshops, where custom made robots were mainly used, with service robots coming second, and only with 4% working with Drones/UAVs.

## What robot do you use or program?



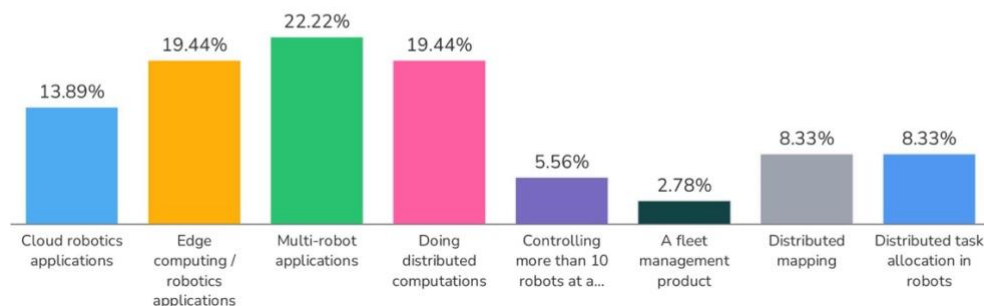
The most commonly used programming languages remained Python (37%) and C++ (29%), with Python showing a minor increase since last years. JavaScript remained a distant third (10%), similar to the past.

## Which programming language do you use?



Closing this set of questions, participants responded that they are using a wide spectrum of cloud robotics applications, as seen in the figure below.

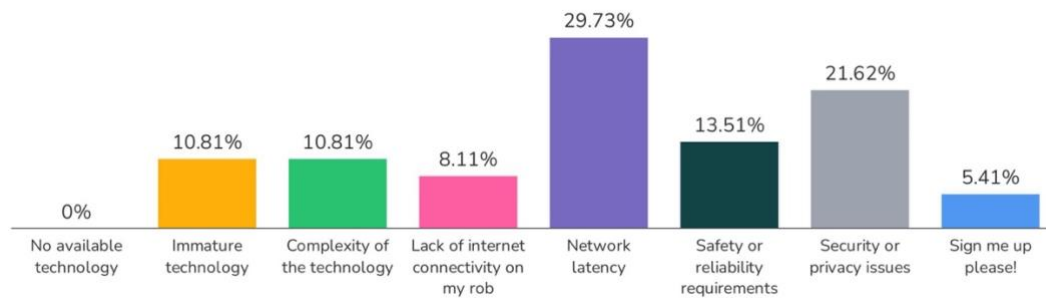
## Are you using any of the following?



In relation to what is stopping people from using cloud robotics, network latency and security remained the two top reasons, with safety and reliability third.



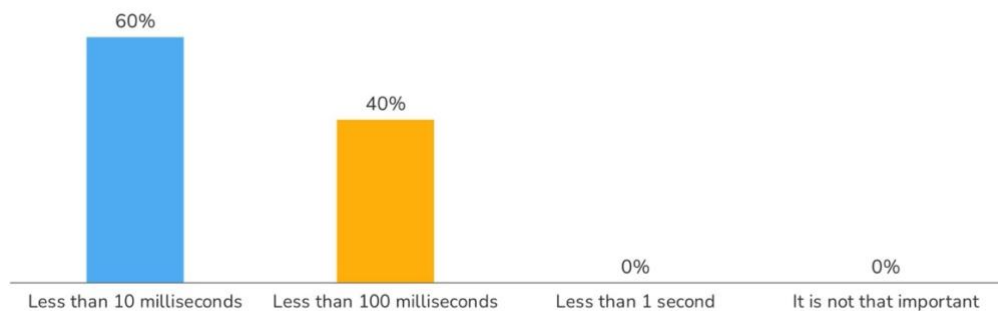
### What is stopping you from using cloud robotics in your work or research?



The participants were then directly asked about the acceptable latencies. 60% of them prefer latencies under 10 milliseconds (almost double the percentage from previous workshops) and 40% under 100 milliseconds. So while there is a clear preference for a “the faster the better” approach, like in previous workshops, the low latency requirements have been strengthened, and this might also reflect the increased industrial participation in the workshop, but also the advances in connectivity (such as these brought by 5G).

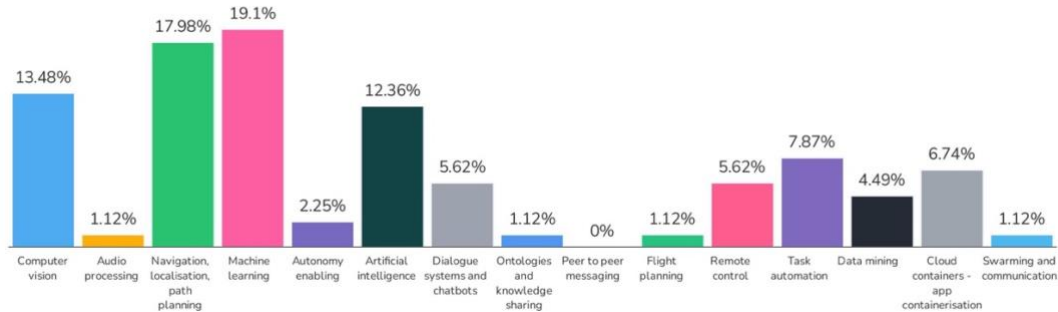


### What kind of a response delay are you looking for?



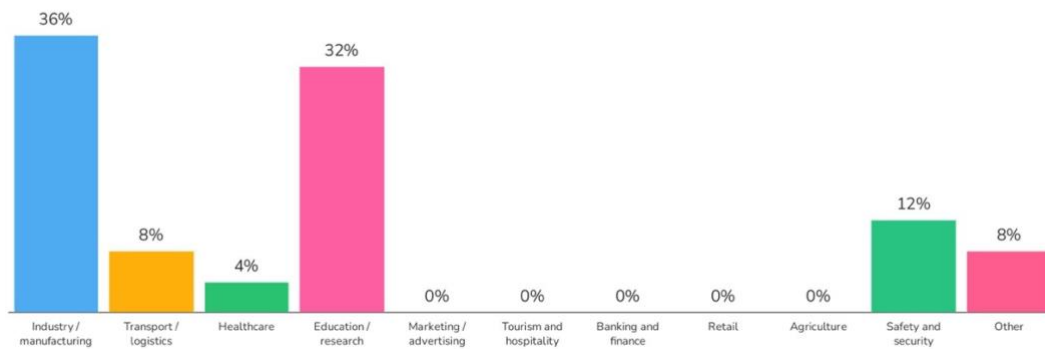
A wide variety of services which can be delivered via cloud robotics appeared to be in demand by the audience, with the three top services being 1) Navigation, Localisation and Path planning, 2) Machine Learning and 3) Computer Vision, which was exactly the case in previous workshops as well.

## What cloud services do you currently need for your work, research or development?



The application domains in which participants work are summarised in the next Figure. Again, like in previous workshops, industry / manufacturing and Education are the fields of most participants.

## What is your application domain?



Finally the participants were asked for suggestions for application areas in which cloud robotics could be useful. As one can see the answers are quite varied and there are many areas in which cloud robotics can have a larger impact in the future.

AhaSlides

### Do you have any suggestions for application areas of cloud robotics?

Fleet management  
Teaching

Data collection for machine learning

CI/CD with simulation (e.g., Gazebo?) tests involving navigation / manipulation integrated in the pipelines beyond typical SW unit tests?

Cheap(er) robots  
Software updates

Multi - robot collaboration

Optimization of industrial processes

Digital Twins

Cloud perception to reduce robot costs

Now

Social companions

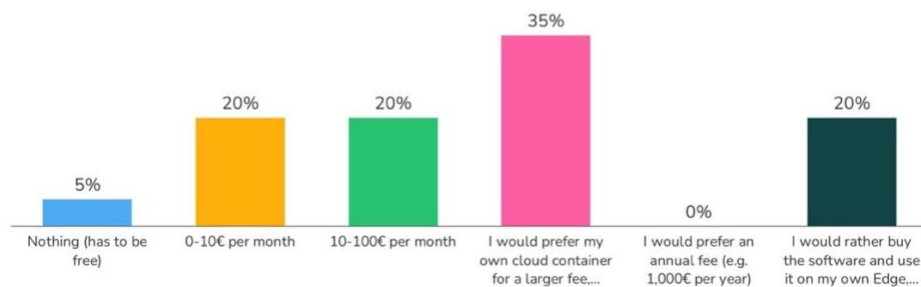
Values Sensitive Design methods

Predictive maintenance

The topic of deploying software via the cloud through a means of a robot app store was discussed in the following question. We asked what people would pay for cloud robotics services, with many participants answering that they would rather have software on their own edge, server or computer or would prefer their own cloud container with options for customization. This was also generally the picture in previous workshops as well, but with the amounts that people were willing to pay for cloud services on the rise.

AhaSlides

## How much would you pay for cloud robotics services?



Some issues that were discussed during the workshop is that most robotic applications today are distributed to a good extent, so "cloud robotics" can happen even if no public cloud is involved and we are just using a local cluster. Size and placement of components (mobile, robot, edge, cloud) is one dimension; type of connectivity another (LAN, VPN, tunnelling, bridging); ROS version is an issue; the reduction of "sensing" or "sensor" costs that can be achieved by cloud robotics is especially important to companies; Connection to the IoT community, and synergies of cloud robotics with IoT environments are constantly emerging and are quite important to facilitate deployment; "DevOps" considerations (containerization, component and service updates, availability, fleet management, monitoring, diagnostic, orchestration) is another important parameter when deploying cloud robotics applications. In short, cloud robotics applications have widened their scope in the last years, with a corresponding variety of applications and needs.

Hence, a task remains for the Cloud Robotics Thematic Working Group of euRobotics to produce a white paper where we characterize "cloud robotics" in its several dimensions, applications, and trends.



*Photo 3: Stratos Arampatzis asks participants for suggestions for cloud robotics applications*