ERF Cloud Robotics Workshop

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STRATOS ARAMPATZIS AND SASCHA GRIFFITHS

The cloud robotics workshop at the European Robotics Forum 2019 in Bucharest, Romania, was attended by a large crowd (40 people approx.). The presenters included Stratos Arampatzis (Ortelio), Sascha Griffiths (Ortelio), Pieter Simoens (Universiteit Gent), Ulrich Klank (Magazino), Javier Huarte (DIH Aragon) and Vasco Lopes (Universidade da Beira Interior). Apart from these stimulating presentations, there was lively discussion and the participants' opinions and perspectives were captured using Mentimeter. There was also a short impromptu talk by Giovanni Toffetti Carughi (Zurich University of Applied Sciences).
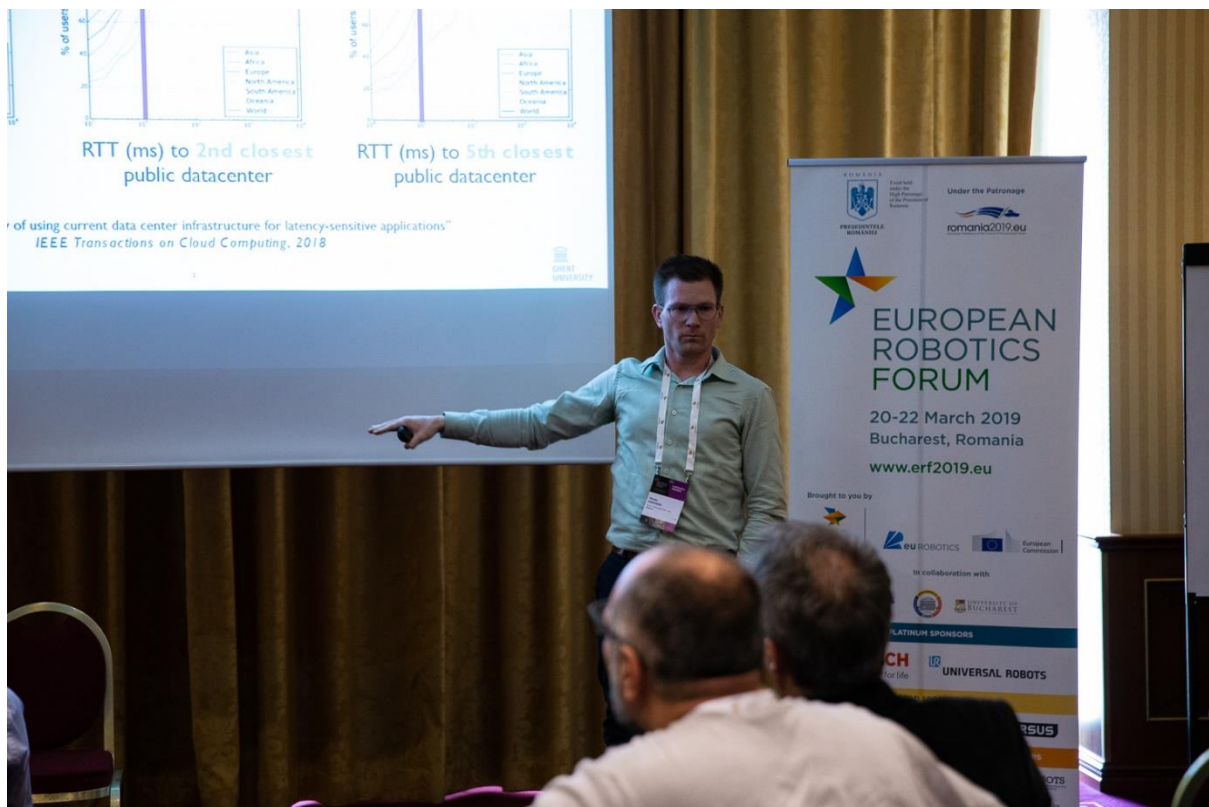

Figure 1: Pieter Simoens speaking about barriers for cloud robotics.

After a few opening words by Stratos Arampatzis (Ortelio), the first talk was delivered by Sascha Griffiths (Ortelio). This was a general introduction to the concepts in and the future vision for cloud robotics. With this context set, Pieter Simoens presented on the main barriers which cloud robotics faces at the moment. Ulrich Klank then spoke about a collaboration between Magazino and Google which dealt with cloud-based cartography for robotics. Javier Huarte reported on the role of cloud robotics in the Aragon Digital Innovation Hub. Vasco Lopes then concluded by telling the audience about blockchain and robotics. Giovanni Toffetti briefly spoke spontaneously at the end of the workshop about deployment methods for robot applications using cloud computing technology[1].

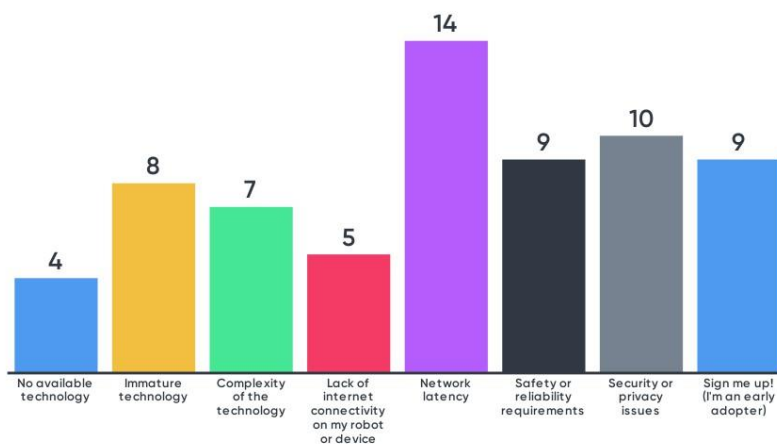[1] https://www.youtube.com/watch?v=NCjp2txUSmc

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. The results can be seen as one of the main outcomes of the workshop.

Approximately 35 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 at all. The workshop participants reported to be 55% academic researchers; 38% were from the industry and 7% self-reported as "other". The majority of participants reported to be working with their own custom made robot (24%), while 17% were working with "service robots", 7% reported working with "Rasberry Pi, Ordoid, Nvidia Tegra, etc.", 6% were using "Humanoids", 5% were users of Softbank's Pepper or NAO and only 4% were working with Drones/UAVs. The programming languages people use to program their robots clearly pointed towards either C++ (28%) or Python (27%). However, JavaScript (9%), C (5%), C# (4%), Android (1%) and Others (7%) were also being used. Naturally, there was quite an interest in Cloud Robotics among the workshop participants (64%). Though, 17% were unsure about their interest and 19% answered that they would like to find the answer to the question: "What is Cloud Robotics"?

After Pieter Simoens had spoken about "barriers" for cloud robotics, we also wanted to know what the participants thought was stopping the technology being deployed more widely. The results are summarised in Figure 2 below.
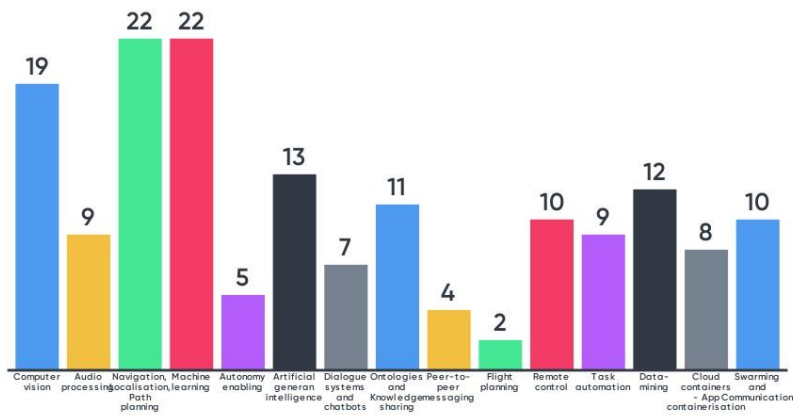

Figure 2: Responses by participants as to what they believe are barriers to the widespread adoption of cloud robotics.

Network latency and security and safety emerged as the main themes. These issues were also addressed in discussions during the workshop. The participants were then directly asked about the acceptable latencies. While there is a clear preference for a "the faster the better" approach, 44% were willing to accept latencies under 100 milliseconds but 33% required a response faster than 100 milliseconds. In contrast, 14% were fine with accepting less than a second and 8% considered the latency not important. Below in Figure 3, one can see the cloud services which participants require currently for their work:

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

Mentimeter

Computer vision: 19
Audio processing: 9
Navigation, Localisation, Path planning: 22
Machine learning: 22
Autonomy enabling: 5
Artificial general intelligence: 13
Dialogue systems and chatbots: 7
Ontologies and Knowledge sharing: 11
Peer-to-peer messaging: 4
Flight planning: 2
Remote control: 10
Task automation: 9
Data-mining: 12
Cloud containers - App containerisation: 8
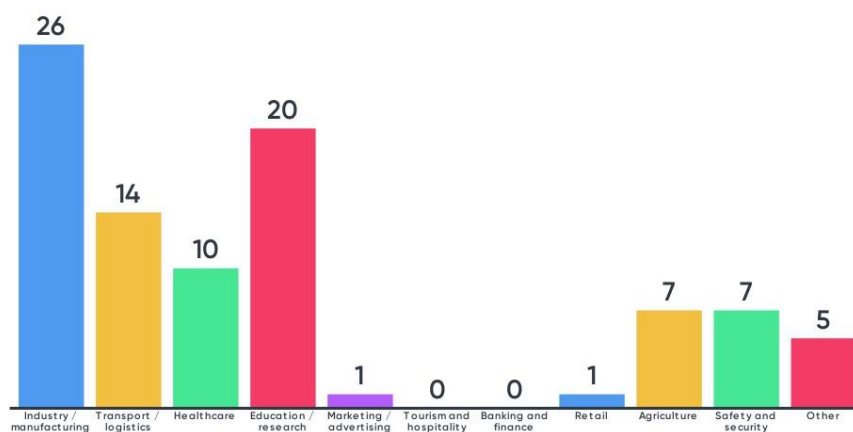Swarming and Communication: 10

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Figure 3: What cloud services would participants use in their work?

As one can see there is a wide variety of services which can be delivered via cloud robotics services and no clear preferences for services can be determined, although some answers are more popular than others.

The application domains in which participants work are summarised in Figure 4. A quarter of participants worked in "Industry/manufacturing" (26%) and many were from "Education/research" (20%) with other areas such as "Transport/logistics" (14%) and "Healthcare" (10%) also making up a mentionable portion.

What is your application domain?

Mentimeter

Industry / manufacturing: 26
Transport / logistics: 14
Healthcare: 10
Education / research: 20
Marketing / advertising: 1
Tourism and hospitality: 0
Banking and finance: 0
Retail: 1
Agriculture: 7
Safety and security: 7
Other: 5

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Figure 4: The participants' application domains.

Figure 5 captures the participants' 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.
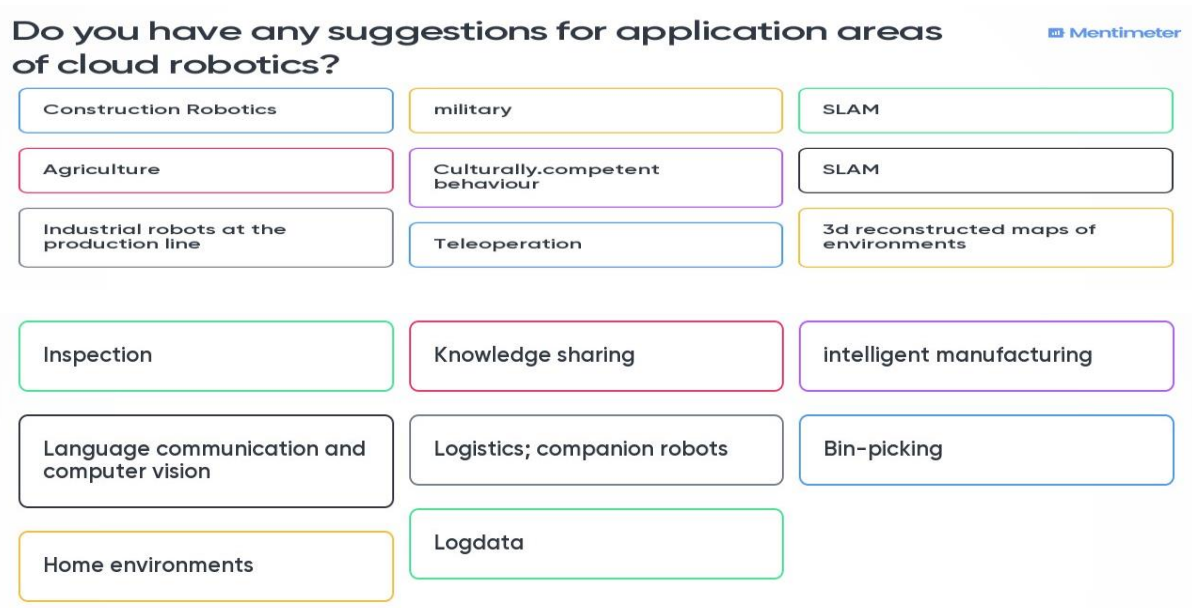

Figure 5: Suggestions for further application areas for cloud robotics.

The topic of deploying software via the cloud through a means of a robot app store was discussed in the following questions. 33% of participants said they would pay for a robot app, while 50% would only pay if it is useful and 17% said that they would not pay for robot apps. Naturally, the organizers also asked what people would pay for cloud robotics services. There was a variety of answers with many answering that they would rather have software on their own edge, server or computer (41%) and 19% would prefer their own cloud container with options for customization for which they would be willing to pay 30 – 100 € monthly. However, 15% of participants were willing to pay 0 – 10 € per month and 11% were willing to pay 10 – 100 € per month for a general cloud robotics service. Given the option of an annual fee (e.g. 500€), 7% % would pay for cloud services if this model was offered to them. Only 7% of people answered that they would not pay for cloud services and would prefer everything to be free.

Two themes which emerged as important in the discussion were latency and security, as well as how software should be deployed. Further, a contribution from the audience reminded the participants that cloud robotics should be viewed as a combination of both cloud computing and robotics and that both fields need to be understood for cloud robotics to use its full potential. Overall, the workshop was well attended. Further workshops of its kind are planned, and discussions have been held to suggest a Topic Group on Cloud Robotics within euRobotics.