European Robotics Challenges – A retrospective analysis towards a better challenge design in the future

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What is EuRoC about?

Motivation:
- The European manufacturing industry needs competitive solutions to keep global leadership in products and services.
- Collaboration and cross-fertilisation between the industrial and the research community should be strengthened → synergies across these will speed up the process of bringing innovative technologies from research labs to industrial end-users.
- EuRoC wants to act as an enabler in this context.

Procedure:
- Three industry-relevant challenges were launched in April 2014 with open calls for Challengers, Technology Developers, System Integrators and End Users.
- Each of the challenges is divided into three stages of increasing complexity.
- The project will end in December 2017 with one EuRoC winner team.
EuRoC a Challenge

About the three challenges:

- Each challenge involves whole manufacturing supply chains within their field, while favouring technology transfer from academia to industry.
- All registered Challengers from each challenge will undergo benchmarking exercises in the form of a Simulation Contest during Stage I: Qualifying.
- Selected Challengers from each challenge then team up with partners from the industry and share existing resources at three top European platforms in Stage II: Realistic Labs.
- In Stage III: Field Tests, Challenger teams must ensure sustainability and adaptability to end users.

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EuRoC a Competition

EuRoC Winner

FINAL JUDGEMENT

Pilot Experiments [≤ 210K€]

Challenger Teams [≤ 250K€ + 125K€]

Advancing to Field Tests Stage

Advance to Realistic Labs Stage

Applicant Teams [≤ 50K€]

Qualification

Simulation Contest

Challenge 1

Challenge 2

Challenge 3
The Call for Challengers

- **Challengers**: Research Organizations, companies or even private persons, which fulfill the eligibility criteria, and are willing to tackle the EuRoC challenges
- The **Call** was opened on April 1st 2014, and closed on June 30th 2014
- Campaigns for the promotion of the challenge program:
  - Publication of the Call Announcement on the EuRoC website
  - Presentations at relevant networking events
  - Featuring of EuRoC in numerous relevant Challenge Bulletins
  - LinkedIn advertising campaign
  - Organization of the EuRoC Info Days with presentations and Q&A
  - Direct contact with potential challengers
  - .......
- **Results**: 103 applications from 22 different countries
Stage I: The Simulation Contest

Simulation Technology

Virtual Machine (SimulationVM)
OS: Ubuntu 12.04 LTS 32b + ROS Hydro

Gazebo
- Modified standard software
- Custom code
- Security features

Virtual Machine (ChallengerVM)
OS: Ubuntu 12.04 LTS 32b + ROS Hydro

ROS
- cmd
- Telemetry
- Commands

Client code

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Stage I: The Simulation Contest

Simulation Scenarios

- Challenge 1:
  - Track 1: Focus on perception and human robot interaction
  - Track 2: Focus on dual arm and force/torque control (dynamic simulation)

- Challenge 2:
  - Focus on pick&place with uncertainty, planning, mobile manipulation

- Challenge 3:
  - Track 1: Vision based localization and reconstruction
  - Track 2: State estimation, control and navigation
Stage I: The Simulation Contest

- **Support**
  - **Online Evaluation**: Teams were allowed to submit interim solutions to be automatically evaluated.
  - **Score Dashboard**: interim results were published on a dashboard.
  - **Mailing-Lists**: mailing list for posing questions
  - **Forum**: Forum for posting questions and receiving technical assistance

- **Final Submission**:
  - Same tasks as during online evaluation but different scenarios, models, etc.

- **Results**
  - On 2014-11-12 EuRoC received 49 solutions submitted in the 3 challenges.
  - Only 41 did advance to match making
    - Challenge 1: 11 teams
    - Challenge 2: 15 teams
    - Challenge 3: 15 teams
The Call for Technology Developers, System Integrators and End Users

About the Call:

- **End Users** = Manufacturing companies who can provide use cases for the Challenger teams
- **Technology Developers** = Companies or research organizations developing innovative technologies and looking for an application of their technology in the industrial robotics domain
- **System Integrators** = Companies that specialize in either bringing together robotic components/subsystems or developing and commissioning whole robotic systems

- The Call was opened on April 1st 2014, and closed on November 30th 2014

- **Campaigns for the promotion of the challenge program:**
  - Publication of the Call Announcements on the EuRoC website
  - Presentations at relevant networking events
  - Featuring of EuRoC in numerous relevant Challenge Bulletins
  - LinkedIn advertising campaign
  - Organization of the EuRoC Info Days with presentations and Q&A
  - Organization of several Webinars
  - Contact with official EU National Contact Points and dissemination of materials through their networks
  - Encouraging of Challenger teams to contact companies they are in touch with directly

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The Call for Technology Developers, System Integrators and End Users

Results:

Technology Developers:
- 20 applications in total (some for more than one challenge!)
  - Challenge 1: 10 applications
  - Challenge 2: 8 applications
  - Challenge 3: 10 applications

System Integrators:
- 12 applications in total for Challenge 1

End Users:
- 77 use cases in total
  - Challenge 1: 26 use cases
  - Challenge 2: 18 use cases
  - Challenge 3: 33 use cases
The Call for Technology Developers, System Integrators and End Users

Comparison of applicant numbers per challenge:

- **Challenge 1:**
  - Challengers: 30
  - TDs: 10
  - End Users: 26
  - SIs: 12

- **Challenge 2:**
  - Challengers: 39
  - TDs: 8
  - End Users: 18

- **Challenge 3:**
  - Challengers: 34
  - TDs: 10
  - End Users: 33

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The Matchmaking process for Stage II

Stage I – Qualifying: Simulation Contest

- Matchmaking e.g. during a Brokerage Workshop in December organized by the EuRoC Consortium
- The resulting teams submitted proposals 36 proposals by February 09th 2015, which are currently being evaluated and rated by independent experts

Stage II – Realistic Labs: Benchmarking, Freestyle and Showcase

Match-making + Proposals

- Challenge 1: 11 Challengers
- Challenge 2: 15 Challengers
- Challenge 3: 11 Challengers

Evaluation and selection of Proposals

- Challenge 1: 10 Challengers
- Challenge 2: 12 Challengers
- Challenge 3: 14 Challengers

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Outlook Stage III

● Realistic Labs:
  ● Go into the labs and solve three tasks:
    ● Benchmarking:
      – mandatory task for all teams
      – benchmarking of algorithms, approaches
    ● Free-Style:
      – Show what you can
      – Bragging rights
    ● Show-Casing
      – prototypical implementation of use case
## SWOT - Analysis of Stage I

### Strengths
- Involvement of the entire value chain
- Simulation Contest as a Gateway
  - "Pre-selection of candidates by contest increases chance of actual proposals [going through] based on problem solving skills [of contestant, and not her/his proposal writing skills]"
- Gathering of Use Cases, Technology and Expertise Descriptions
- Match-making
  - Quote End-User "We get the research partner on a silver platter"
  - Quote Challenger "It is like being in a three star restaurant and getting a menu of use cases to choose from."
- Support by Core-Consortium
- Low-Threshold for participation/High Threshold for Advancement

### Weaknesses
- Simulation Technology:
  - There were some problems with regard to the simulation infrastructure
- Level of Difficulty:
  - There were inconsistency wrt to level of difficulty of simulation tasks across the three challenges

### Opportunities
- Networking
  - There was a lot of networking done, which resulted in a couple of FoF and ICT proposals.
- Market Research:
  - Submitted use cases reflected real needs by manufacturing companies.
- Educational Impact
  - Involvement of students to solve simulation tasks.
  - Providing simulation environment and tasks as educational tools for universities.
- Dissemination of Technologies
  - Enforcing the usage of the same simulation environment (Gazebo) and ROS as middleware reinforced the market penetration of these tools in research.

### Threats
- Time Table
  - The time table for implementing EuRoC is very ambitious
- Resources for Use Cases
  - The use cases selected are very challenging and might require more resources than budgeted
Lessons Learned

- Improve time table for challenges:
  - Relax time table by introducing more buffers between stages and phases
  - Allocate more time and resources to design of the challenges
    - Rules
    - Benchmarks
    - Simulation environment

- Simulation Introduction Day
  - Either a hosted event or a training webinar to familiarize challengers with simulation environment and tasks

- Better dissemination to industry
  - More cohosted national events and less newsletters

Feedback on how to improve EuRoC and/or suggestions for new challenge topics welcome!

Send suggestions to project-office@robotics-challenges.eu