

EuRoC — The Challenge Initiative for European Robotics

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Abstract

The EuRoC initiative is committed to launch three industry-relevant challenges aimed at sharpening the focus of European manufacturing through a number of application experiments, while adopting an innovative approach which ensures benchmarking and performance evaluation. Within an open call framework, three stages of increasing complexity and a total financial support of 7 M€ for competing teams will level the playing field for new contestants, attract new developers and new end users toward customisable robot applications, and provide sustainable solutions for creating and running future European robotics challenges.

1 Background

Since the eighteenth-century Longitude Prize and the 1927 Orteig Prize as well as the challenges of today on driverless vehicles and sub-orbital spaceflight, there are great examples of challenges driving innovation. Aimed at extraordinary breakthroughs, storied outcomes or multiple innovation returns on the total programme costs, all of these initiatives share the strive for questioning the status quo.

The application of challenge-driven approaches are literally infinite. And the buzz surrounding challenges is a beneficial consequence of combining high awards with competition programmes. In the 21st century however, most of the significant challenges have been initiated by American organisations.

With the EuRoC project [1], not only do we intend to change the fact that there have not been many of such prosperous initiatives in Europe, but we are also determined to showcase the potential of such targeted challenges for driving the development of innovative products and services. With this initiative, we are striving to

make a sustainable change in the perception of European citizens, demonstrate the stimulating factors of such initiatives and set the scene for more of these open innovation programmes to come in the future.

In the long run, prize competitions have the potential to become an additional component of the research and development funds of the European Union in the Horizon 2020 framework: on the one side, to promote innovation in research, on the other side, to promote transfer of results achieved in basic science to marketable products and solutions. Importantly, we do not suggest for prize competitions to replace the established grant application process of the European Research Frameworks, but to use prize competitions as an additional tool in the set of measures used in funding research and Innovation.

With the EuRoC initiative, we want to bring Europe to the forefront of prize induced innovation and showcase the potential of such targeted challenges. So far most of the famous challenge programs of the 21st century have been initiated

and conducted by US organizations. Data of McKinsey and Company from 2009 show an exponential increase in funds available for prize competitions.

2 The project

The European manufacturing industry needs competitive solutions to keep global leadership in products and services. Exploiting synergies across application experts, technology suppliers, system integrators and service providers will speed up the process of bringing innovative technologies from research labs to industrial end-users. As an enabler in this context, the EuRoC initiative proposes to launch three industry-relevant challenges:

- Reconfigurable Interactive Manufacturing Cell (Fig. 1)
- Shop Floor Logistics and Manipulation (Fig. 2)
- Plant Servicing and Inspection (Fig. 3)

It aims at sharpening the focus of European manufacturing through a number of application experiments, while adopting an innovative approach which ensures comparative performance evaluation. Each challenge is launched via an open call and is structured in 3 stages.

45 Contestants are selected using a challenge in a simulation environment: the low barrier of entry allows new players to compete with established robotics teams. Matching up the best Contestants with industrial end users, 15 Challenger teams are admitted to the second stage, where the typical team is formed by research experts, technology suppliers, system integrators, plus end users.

Teams are required to benchmark use cases on standard robotic platforms empowered by this consortium. After a mid-term evaluation with public competition, the teams advance to showcasing the use case in a realistic environment. After an open judging process, 6 Challenge Finalists are admitted to run pilot experiments in a real environment at end-user sites to determine the final EuRoC Winner.

A number of challenge advisors and independent experts decide about access to the subsequent stages. A challenge-based approach with multiple stages of increasing complexity and financial support for competing teams will level

the playing field for new contestants, attract new developers and new end users toward customisable robot applications, and provide sustainable solutions to carry out future challenges.

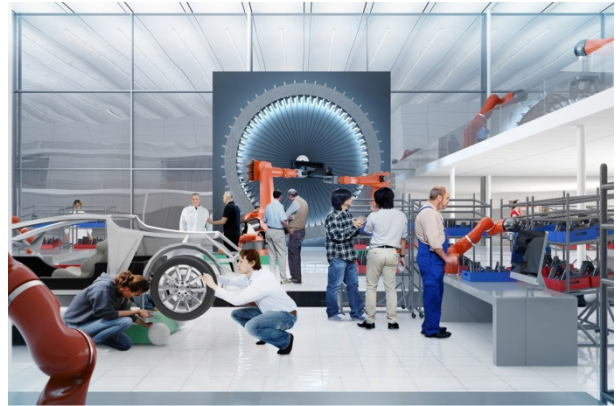


Figure 1 Scenario of Reconfigurable Interactive Manufacturing Cell Challenge



Figure 2 Scenario of Shop Floor Logistics and Manipulation Challenge



Figure 3 Scenario of Plant Servicing and Inspection Challenge

2.1 Motivation

The European society will greatly benefit from this leadership position by making use of these robotics products and services that are aiming at improving their quality of life and work conditions. The adoption of robotics technology will help European manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures. ICT suppliers such as robot manufacturers, system integrators and technology solution providers are important facilitators to improve the efficiency, adaptability and sustainability of manufacturing systems as well as their better integration within business processes in an increasingly globalised industrial context.

To boost robotics and manufacturing in Europe there is a need for a European perspective on the topics that need to be researched and developed. Both the Strategic Research Agenda (SRA) for robotics in Europe [2], published in July 2009 under the auspice of the European Technology Platform (EUROP), and the Factory of the Future multi-annual roadmap [3] deliver this European perspective and are at the same time perfect examples of a successful collaboration among all the actors of the value chain in manufacturing and servicing, i.e. end users (SMEs/industry), system integrators (SMEs/industry), technology suppliers (industry/SMEs) and research experts (academia). During the development of the strategic research agendas of robotics and manufacturing, fertilisation across these groups led to a technology roadmap targeting at realising new product visions and applications scenarios by 2020. However, the implementation of these strategic research agendas and the realisation of the application scenarios and associated product visions require an awareness of the core RTD issues to be solved and a joint effort of academia and industry, including SMEs.

We strongly believe that the definition of competitions and making them visible as “Grand Challenges” will create the required awareness in the community at large. Furthermore, we know from past experience that competitive solutions are in the longer term created only in close collaboration of industry

and academia. Resorting to experimentation on shared research infrastructures, while referring to jointly developed benchmarks, will boost the development of new solutions.

2.2 Objectives

Objective #1: Launch and run three industrially-relevant challenges

As a key factor for driving innovation in European robotics and manufacturing, it is the main objective of this project to strengthen collaboration and cross-fertilisation between the industrial and the research community. Towards this aim we want to launch and run three industrially relevant challenges in European robotics with applicability to the factory of the future. These challenges cover the most promising application scenarios, and thus, product visions, of the European robotics industry (Fig. 4).

Objective #2: Empowering robotics platforms and benchmark infrastructures

The second objective of this project is to empower robotics platforms and benchmark infrastructures to enable innovators to focus on their “challenging” research rather than wasting time with platform-related low-level problems and maintenance. Likewise the environments in which the platforms should operate will be set-up in such a way that they allow for the comparison of different methodological approaches to solving typical manufacturing use cases. On the Robot side system architecture frameworks, programming and simulation frameworks, and open interfaces on lowest levels will be provided. Furthermore, high-level functionality in the areas of perception, planning and control will be provided as to enable the challengers to test and validate their R&D work in meaningful contexts (typical use cases). Software components with the same functionality but different implementation and performance will become interchangeable, and therefore, comparable. By granting numerous researchers and technology developers access to these platforms and benchmark environments and by offering intensive support through hosts and robot manufacturers, it is expected that the platforms will be lifted to unprecedented performance levels towards the end of this

project. For the first time, we will experiment new Internet-based technological solutions for granting access to a very large number of challengers to the simulation as well as to the early stage experimental challenges. We plan to provide, for one specific setup, full and safe remote access for programming the robots over the web as well as for using distributed computing resources. If this concept proves to be viable and efficient, it could open up entirely new perspectives and possibilities for future challenges by exploiting the multiplicative potential of cloud technologies.

by end-user requirements, the researched and developed solutions will be sufficiently general so that they could be applied to other end users, tasks and situations, and enable a fast commercialisation. Robustness will have to increase significantly to let the robots eventually work continuously. Finally, methodologies and tools shall be developed that allow carrying out further comparative challenges. Following this methodology, clear benchmarking criteria and evaluation processes shall be defined. Problems that cannot be solved within the timeframe of this project will be fed into the updating process of the robotics and the Factory of the Future roadmaps.

- Challenge 1.** Reconfigurable Interactive Manufacturing Cell
Challenge 2. Shop Floor Logistics and Manipulation
Challenge 3. Plant Servicing and Inspection

APPLICATION SCENARIOS ▶	ROBOTIC WORKERS	ROBOTIC CO-WORKERS	LOGISTICS ROBOTS	ROBOTS FOR SURVEILLANCE & INTERVENTION	ROBOTS FOR EXPLORATION & INSPECTION	EDUTAINMENT ROBOTS
SECTORS ▼						
INDUSTRIAL	1. ■	2. ■	■	3. ■	■	
PROFESSIONAL SERVICE	■	■	■	■	■	■
DOMESTIC SERVICE		■	■	■		■
SECURITY		■	■	■	■	
SPACE	■	■	■		■	

Figure 4 Match of challenges to SRA [2]

Objective #3: Sustainability and adaptability to end users

The third objective of this project is to develop sustainable solutions: Developed application solutions will be continuously tested and validated, first in realistic (benchmark environments) and then in real environments. Installations throughout the project will see increasing levels of maturity. Although driven

2.3 Stages

The three EuRoC challenges will be organised into three successive stages, as illustrated in Fig. 5 over the 4 years of the project life, while the Challenge chart in Fig. 6 summarises the stage advances.

Stage I – QUALIFYING: Simulation contest

- A call for challenge applications will be issued and published (April 2014)
- In parallel, a call for end users and system integrators will be issued and published (April 2014).
- Applicant teams could be formed by research experts (academia), solution-oriented or innovating companies (industry)
- Admission to qualifying stage is granted on the basis of 1-page pitch: team description and objectives for challenges.
- The simulation contests are ranked according to objective metrics (criteria and grading system). The best 45 contestants (3×15) are selected based on their scores in the tests to become prospective challengers.

- The evaluation will be carried out by the Challenge Advisory Board (CAB) with the help of external reviewers and renowned independent experts, and it will be based on novelty of the application, level of difficulty of the use case, potential market for it, strength of the team, further to the rank in the simulation contest.

Stage II – REALISTIC LABS: Benchmarking, free-style and showcase

- Each Challenger Team will receive a financial support of up to € 375000, i.e. € 250000 for Round A (benchmarking + free-style) and € 125000 for Round B (showcase). The support for B will be granted provided that the work performed in A is satisfactorily assessed.

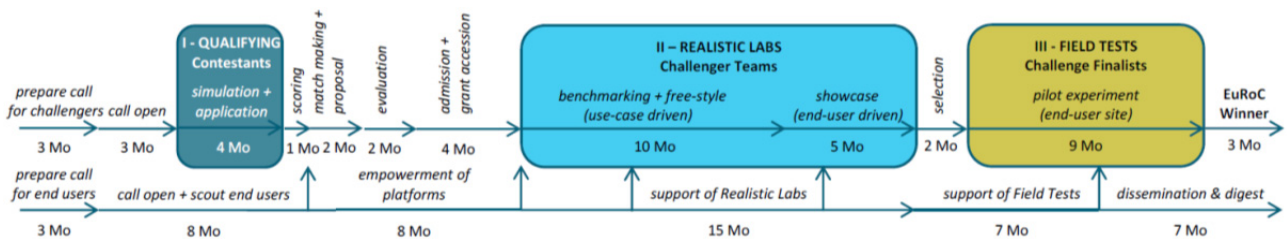


Figure 5 Timeline of the EuRoC project

Advance to next Stage

- Prospective challengers are given an opportunity to form teams with system integrators and end users (match making, first-ranked first-priority) and submit short proposals at 02/2015 with budget information (max. 15 pages), of which the best 3×5 will be selected to become the official Challenger Teams (March 2015).
- The 30 (or less) excluded teams will receive each € 5000 for the effort in helping to devise the right benchmarks/tests/criteria. They can redeem this money at the benchmarking workshop where they can be recruited by the selected Challenger Teams (no challenger will be allowed to become a member in two proposals).

- A mid-term evaluation will take place after Round A (May 2016) so as to allow for a comparative assessment, with public competition @ Automatica. The event will be attended by the CAB and four renowned independent experts for each challenge, who will decide admission to Round B.
- Round B concerns with an end-user driven task aimed at showcasing customizability under realistic manufacturing conditions.

Advance to final Stage

- A suitable challenge workshop will take place at each site (10/2016) with the attendance of the Challenge Advisor at-Large (CAL), the Challenge Advisor for European Robotics Industries (CAERI),

the Challenge Advisor for that challenge and four renowned independent experts.

- Challenger Teams will be ranked according to objective metrics (criteria and grading system) the day after the workshop in a one-day on-site evaluation panel.
- Upon approval by the EC, 3 x 2 Challenge Finalists will be selected for the Field Tests stage of each challenge (December 2016).
- The remaining 9 applications developed in the Challenge stage represent very good candidates for exploitation by end users, but will no longer be funded by EuRoC; these 9 Challenger Teams are expected to exploit their results independently (December 2016).

Stage III – FIELD TESTS: Pilot Experiments

- This last stage involves much engineering effort because the general solutions developed during the Realistic Labs stage will be customised for end users and tested on the field. Only the 6 finalist teams will receive additional funding to carry out this last step from realistic to real manufacturing conditions.
- The field tests will be carried out in 9 months under real (not “only” realistic) manufacturing conditions, and showcased minimum at one end-user site per challenge.
- This stage could be interpreted as prize money (€ 210000 for each Challenge Finalist), but it always comes with the obligation to prove reusability and adaptability of the benchmarked solutions in practice at real end-user site.

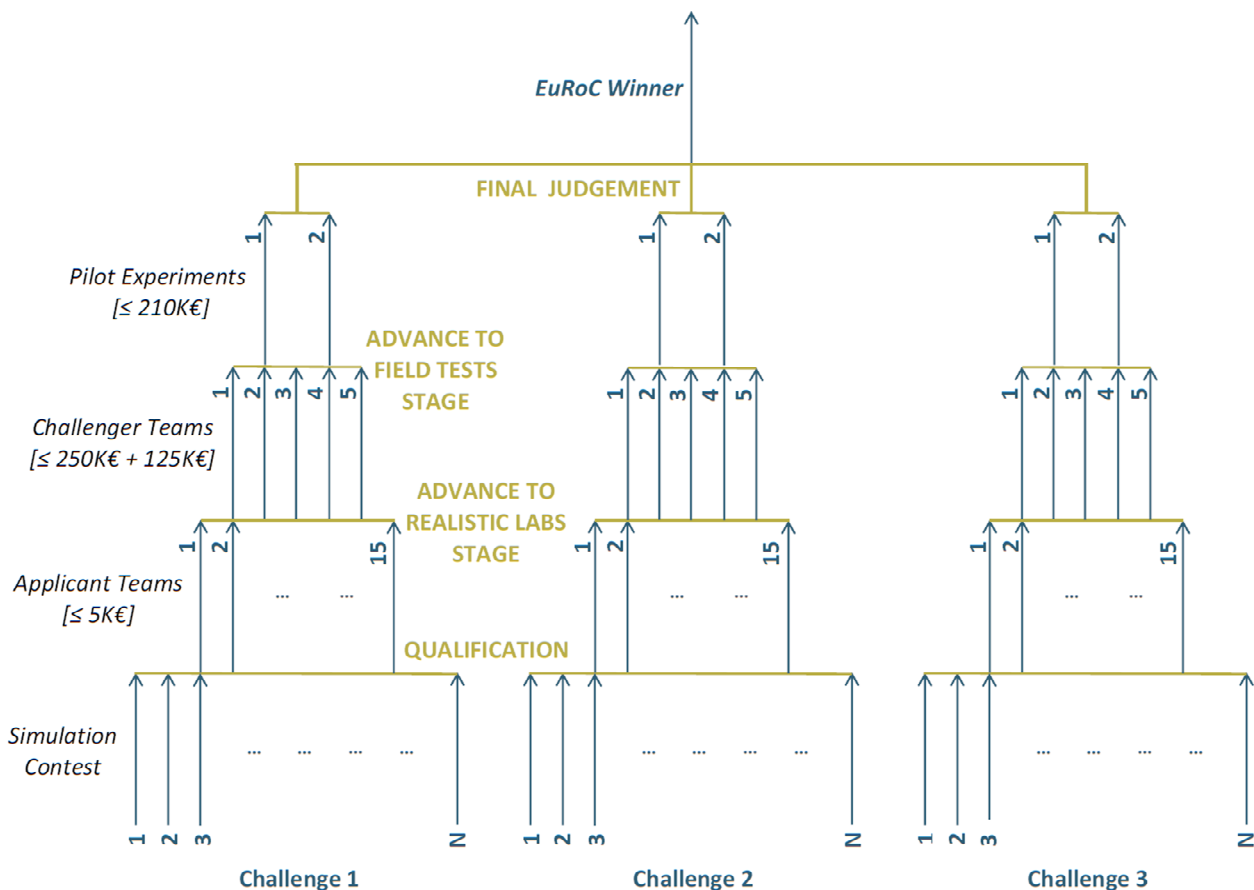


Figure 6 The Challenge chart

- In the end, 6 high-value projects (pilot experiments) on 6 different use cases are brought to fruition, which are (very) close to commercialisation.
- Meanwhile, the other 9 teams not receiving any funding will still be allowed access to the benchmark sites as to encourage them to bring their demonstrators closer to a commercial product or service.

EuRoC Winner

- The results of the field test will be demonstrated by the Challenge Finalists to the public during a final challenge workshop at IPA site (September 2017). The other 9 Challenger Teams will be invited to this workshop for further demonstration of their benchmarking results.
- At the end of the final challenge workshop, the 6 Challenge Finalists will undergo a final evaluation by a Board of Judges (BoJ).
- Judging will be based on criteria such as technical feasibility, market and competition, potential of exploitation, benefit to the society, team skills, etc.
- A EuRoC Winner will be selected by the BoJ and be awarded during a public final dissemination event at the EC site (December 2017).

3 Conclusion

During the runtime of EuRoC the cost of the hardware and the infrastructure will be covered according to the project funding and through in-kind contributions of the beneficiaries. As we expect the challenges and platform concepts for benchmarking becoming a huge success in the European robotics community we have to identify and define ways of continuing such activities. We are committed to ensure a sustainable effect of having challenges, common robotics platforms and access models as well as infrastructures and common benchmarks beyond the project runtime as an instrument for the European robotics community to conduct research and technology transfers more easily than recent ini-

tiatives of this kind [4] and possibly within follow-up Horizon 2020 activities.

An evaluation study among stakeholders will be carried out as to assess the success of the EuRoC project. In particular, the results will be critically analysed in the face of the (current) euRobotics aisbl [5] and (future) Robotics Public-Private-Partnership (PPP) activities [6] on benchmarking. Contributions to the topic group of euRobotics aisbl dealing with robotics benchmarking and challenges will be provided, while the adhesion or the set-up of a benchmarking task force in the Robotics PPP will be sought where all the projects engaged in the second stage of the challenges will be encouraged to share benchmarking and metrics.

Acknowledgments

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References

- [1] www.euroc-project.eu
- [2] www.robotics-platform.eu
- [3] www.manufuture.org
- [4] www.echord.info
- [5] www.eurobotics-project.eu
- [6] www.eu-robotics.net/ppp/robotics-ppp

