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Report on RockEU2 workshops

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Executive summary

Among the objectives of RockEU2, targeted workshops are considered as a key instrument for roadmapping towards a sustainable European Robotics League (ERL) and for disseminating best practice related to competitions and challenges in EU. For the ERL, officially launched in June 2016, a broad discussion in the community is necessary, in order to provide recommendations and impact analysis
The “flagship workshop” about robotics competitions and challenges, traditionally organised during the European Robotics Forum (ERF), has been complemented last year by an Expert Forum held in conjunction with RoboCup 2016. At the same time, the workshop for ERF 2017 has been redesigned in order to give more space to panel discussion and to teams participating to E.R.L. in the last year.

Details about this event are reported in this document. In particular, in order to pave the way to the white paper on EU robotics competition and challenges, expected as deliverable of WP6 at the end of RockEU2, a list of preliminary recommendations from the provided networking actions has been collected and reported.

Content

1. Introduction and structure of the document

Workshops are key collaborative events for RockEU2, since they allow presenting and collecting results, sharing analyses, as well as encouraging open discussions to provide consistent output towards the goals of this Coordination and Support Action.

This document is meant to summarise conclusions of workshops organised during 2016 in the framework of RockEU2 WP6, in order not only to gather together experts in robotics competitions, but also to propose recommendations and best practises to be used for the European Robotics League (ERL) and, more in general, for future competitions and challenges in EU.

The following structure has been adopted for the document: the workshop at ERF 2016, already reported in RockEU, is briefly recalled in Section 2. Following that meeting, the RockEU2 Consortium has pushed towards a larger event to draft a first set of recommendations towards successful and sustainable competitions and challenges in Europe. A major event as RoboCup 2016 in Leipizg has been selected as a good venue for this "ERL Experts Forum on the future of robotics competitions", in order to allow large participation, collect ideas from the ground, benefit of the presence of key players in the field of robotics competitions. Section 3 is dedicated to a full report of the ERL Experts Forum, including resulting recommendations. Based on the held events in 2016, a new format for the workshop at ERF 2017 has been proposed, as discussed in Section 4 together with future activities in the second year of RockEU2. Conclusions are reported in Section 5.

2. "Flagship workshop" on robotics competitions and challenges at the European Robotics Forum

As indicated in the workplan of RockEU2, as a heritage of a key contribution of the original RockEU coordination action, a workshop on robotics competitions and challenges has been organised also at the 2016 European Robotics Forum in Ljubljana.

The outcome of this event has been presented in the deliverables of RockEU, given the superposition of RockEU and RockEU2 in the first months of 2016.

The ERF 2016 "Robot Competitions Workshop" was the fifth of the series of Workshops on Robot Competitions, Challenges and Benchmarking, collecting witnesses from euRathlon, EuRoC, RoCKIn.

Please see https://sites.google.com/site/erf2016robocompworkshop/ and refer to RockEU final reports for further details. For additional discussion on the addressed topics, an extended Experts Forum has been proposed after this ERF workshop.

3. Experts Forum at Robocup 2016

3.1. Introduction

3.1.1. Motivation

The "ERL Expert Forum on the Future of Robot Competitions", held in conjunction with RoboCup 2016 in Leipzig (from June 30th to July 3rd), was organised in order to discuss lessons learned and to propose strategies for future robotics competitions and challenges in the European Union (EU), with a special focus on the European Robotics League (ERL).

Fifteen international experts in robotics competitions were invited to share their experiences and findings in dedicated meetings, emphasizing best practices and links to industry, standardisation and the robotics research community. Additional experts were contacted and invited on-site. Notice that the ERL has been officially launched during RoboCup 2016.

Evaluation guidelines (see Section 3.1.3) were proposed to the experts as a general reference for analysing the running events.

3.1.2. Organisation and structure

The Forum was organised considering four morning sessions in order to introduce relevant topics and present both the ERL (www.robotics-league.eu) and RoboCup (www.robocup.org), and four afternoon sessions for discussions. An average attendance of 10 people per session was reported.

The invited experts are listed below:

Anne Bajart, Head of Sector, Robotics and Artificial Intelligence, DG Connect, European Commission

Agostino De Santis, Researcher, Consorzio C.R.E.A.T.E., I

Francesco Ferro, CEO, Pal Robotics, E

Marta Palau Franco, Project Manager, University of the West of England, GB

Peter Gibbons, Research Associate, University of the West of England, GB

Thilo Kaupisch, Project Manager, German Aerospace Center (DLR), D

Gerhard Kraetzschmar, Professor, Hochschule Bonn-Rhein-Sieg, D

Ivana Kruijff-Korbayova, Senior researcher, German Center for Artificial Intelligence (DFKI)

Reinhard Lafrenz, Secretary General, euRobotics AISBL

Pedro U. Lima, Professor, Instituto Superior Técnico, University of Lisboa, P

Matteo Matteucci, Professor, Politecnico di Milano, I

Philip Piatkiewicz, Project manager, euRobotics AISBL

Juha Roning, Professor, University of Oulu, F

Bruno Siciliano, Professor, Università di Napoli Federico II and Consorzio C.R.E.A.T.E., I

Satoshi Tadokoro, Professor, Tohoku University

Additional involved experts at RoboCup were:

Amit Kumar Pandey, Chief Scientist, Softbank Robotics, F

Byoung Soo Kim, CEO, Robotis, K

A delegation from NEDO (New Energy and Industrial Technology Development Organization), Japan was also present.

The following schedule was proposed for the presentations (morning sessions)

June 30th: S. Tadokoro: Rescue robotics and robot competitions

July 1st: M. Palau Franco: Lessons learned from euRathlon – ERL Emergency Robots

T. Friedrich: RoboCup@Work and ERL Industrial Robots

July 2nd : P.U. Lima: RoboCup@Home and ERL Service Robots

July 3rd : P.U. Lima: RoboCup Soccer

3.1.3. Evaluation guidelines

Before the workshop, the following guidelines had been sent to participants as preparation material for the discussion

The guidelines were provided in order to emphasize key concepts related to the Robocup and European Robotics League concepts and practices. Notice that RoboCup and ERL put in place different synergies, starting from joint tournaments at RoboCup 2016 (see also D6.4).

Guidelines:

1) Understanding and evaluating RoboCup

- How the league works and how is the competition defined?
  - Rules (and judging)
  - Environments (and their generalization for applications)
  - Role of awards, trophies, prize money for innovation and robotics
- Critical success factors of RoboCup
  - organisation
  - competition infrastructure
  - tasks and functionalities
  - playful aspects
- On day 4 (or last day of attendance): differences and commonalities among leagues

2) Personal view about adopted solutions

- List of identified “smart” solutions
- List of identified “robust” solutions
- An identified “cool” solution useful also for public awareness

3) Evaluating the leagues towards best practices

- Clarity of rules and consistency of scores
- Identified significant tasks and weak tasks
- Benchmarking functionalities: contribution from competitions

4) Standardization and industry

- Relevance for industry of the leagues (or a subset of tasks)
- Identified technologies that
  - seem to be de facto standards in the leagues
  - could be transferred to industry in other applications
  - could be borrowed from industry to the leagues and easily deployed

5) Links to research community

- Identified research topics which impacted solutions in this Robocup
- Mutual benefits of research community and teams for benchmarking

6) Education

- Impact on lower education
- Impact on higher education

7) Sustainability

- How much effort (in terms of time) do teams invest? Is it considered fair?

- Are students paid? If not, why do they work for the teams?
- Estimation of team budget: are they sustainable? Why?
- How are teams funded? What about transparency and return of such investments?

Possible sponsors for teams and leagues

8) Visibility and promotion of robotics with a focus on EU

- Role of competitions and challenges in European robotics
- Your opinion about the E.R.L. concept and branding

9) Other (free notes)

3.2. Key findings and proposals

As a result of the discussions during the Forum, the following key points were suggested as topics to be carefully addressed for ERL and other competitions in the EU. The corresponding main recommendations are listed in Section 3.3.

3.2.1. Coping with both engineering and science in competitions

Competitions are proposed in the academic community with the following motivations: fostering innovation, providing a common environment for benchmarking, improving education through hands-on experience, and networking in the scientific and technical community. Some results of robotics competitions impacted both research and industry. However, minor technical issues often penalised performance of the teams, reducing the possible impact on applications. Brilliant algorithms and controllers can be frustrated by technical problems. This suggests taking attention to the difference between scientific contents and technical implementations. In detail, the following four points have been discussed.

a. Research challenges addressed and to be addressed

Competitions are both about science and engineering and address relevant educational issues. Related to science, crucial development have been observed in: mobile robotics, cognitive architecture, sensors often demonstrated during past competitions, where high visibility was provided. The main industrial innovations included the well-known cases of Kiva Systems, rescue robotics for disaster scenarios in Japan, the humanoid NAO. See below the section dedicated to industry for a list of interesting functionalities according to industrial stakeholders.

According to previous experience in competitions (in particular, RoboCup and RoCKIn), research challenges successfully addressed and included the following key functionalities: perception, visual tracking, markerless navigation, cooperation, task allocation, real-time active perception. More limited impact was observed on manipulation and control

On the other hand, international challenges focused on humanoid robots, such as the DARPA Robotics Challenge, (http://archive.darpa.mil/roboticschallenge/) stimulated new research in biped locomotion and balance, which are practically not addressed in EU competitions.

With a focus on RobCup, it may be observed that new leagues (as @home) have been introduced in order to have additional challenging applications during the years.

A resulting recommendation from the discussion is therefore to dedicate attention to track the advances in science and technology and reflect them in the new rules and scenarios. New challenges should be present every year.

b. Use of available technology and technology transfer

It has been observed that, while some basic tasks are kept simple, it is common that teams do not use available state-of-the-art technology or algorithms, providing, e.g., own hardware. This has lead in some cases to "reinvent the wheel" in the competitions.

A recommendation from this Forum is therefore the use of technology when available, while focusing on added value given by strategy. Some standard technology could be included in a list by organisers, and possibly provided by a sponsor (technology provider) possibly interested in demonstrating the applicability of its product to different set-ups. As an example, suction cups for a picking challenge could be standard. More in general, technicians could be hired by team to manage standard technology, while original techniques below the state of the art are left to researchers.

For a fair access to technology, allowing teams to focus on architecture, control, strategy etc., a form of sponsorship could be the provision of in-kind contribution by companies: robots, sensors, motors, grippers. On the other hand, for technology transfer to industry of developed solutions, new original technologies demonstrated at competitions could receive prizes.

c. Key functionalities

According to research and industry experts present at the Forum, the desirable key functionalities to be demonstrated during EU competitions are (in order of relevance):

1) Safe interaction and collaboration with humans, i.e.,
    1. Intrinsic thanks to materials and actuators
    2. Obtained via control software (collision avoidance, detection and isolation)
2) Multimodal interaction
3) Accurate and safe navigation

4) Manipulation

Safety is considered the most important key functionality, when robots are used in in human domains, while very accurate manipulation is still not needed in many cases.

A crucial cross-cutting concept is robustness. One of the main goals to be pursued is repeatability and fast set-up time at competitions. Rulebooks could include limits to set-up time as a measure of robustness.

d. Follow-up of EU projects and benchmarking

Competitions have demonstrated to be very good at proving robustness of proposed technical solutions. During a competition, teams must be ready for operating their robots in a specific time slot; while, in an ordinary demonstration without competitors, it is possible to select the best trials and show them on a video, without the pressure from jury and the public.

On the other hand, despite the large number of successful EU research projects in the FP7 and now in Horizon 2020 funding frameworks, it has been difficult to compare results from the different consortia. In fact, there is not yet a solid shared benchmark among projects, and no request for robustness in the demonstrations.

Current EU projects not focused on competitions do not comply with standard benchmarking frameworks proposed by Consortia focused on competitions.

A related recommendation from this Forum is therefore the following: parallel events of ERL tournaments could be used also for benchmarking and real comparison of results from EU-funded research projects: this possibility will allow consortia to show robustness of their results in EU-funded projects without long preparation and possible ad-hoc solutions.

Since it is not possible to find project outcomes which exactly match tasks in competitions, the first step could be the setup of a demonstration at ERL local tournaments, focusing on some tasks which are similar to those proposed for the tournament. Fast deployment and successful demos will constitute a first basis towards benchmarking.

Such demos should be defined together with ERL staff in order to define all rules for time to set-up and number of repeated trials which can prove robustness. In addition, ERL staff may find similarities in different projects and invite consortia to demonstrate similar tasks.

Proposals for new projects should possibly include a budget for participation to competitions, or specific Coordination and Support Actions (CSAs) could be envisaged for such purpose. New CSAs may be proposed for dissemination and match-making towards demonstration of project results in really challenging scenarios.

Moreover, preliminary participation to collateral events of competitions, before enrolling in one league, may allow networking for the possible birth of mixed teams, after common work, meetings and discussion.

3.2.2. Considering HRI and AI in Robotics

Since the early years of robotics competitions, with respect to industrial and collaborative robotics, the focus has been tuned more on cognitive HRI and artificial intelligence for mobile robots than on advanced control. This aspect led to involve different scientific communities. The association of AI and Robotics in future EU programs is also encouraging this form of cooperation.

a. Human-Robot Interaction

Further to human-robot interaction, current research on HRI in competitions is limited to the cognitive side, while safety of physical interaction is expected to be guaranteed as a primary functionality of the platform (i.e. intrinsic lightweight design and limited power, implementation of proper control). As an example, the hand-over of an object is often tackled with slow robot motion without implementing complex safety tactics.

b. Role of Artificial Intelligence

While some applications of AI may be considered standard, given the availability of commercial software products, AI contribution is particularly relevant for robotics competitions, where autonomy is crucial. Competitions are also very important for the AI community. It is expected that in the future robotics and AI will be more coupled in EU calls for research projects. Therefore, also for AI, it is necessary to distinguish research from software tools and specify whether available off-the-shelf algorithms are adopted or not. The “cognitive” functionalities have to be also evaluated (see below the discussion on scoring).

c. Humanoids

Humanoid robots are not as popular in the EU as in the U.S.A. and Asia. Related to competitions, DARPA challenges focused on humanoids opening to non-standard platforms. High-budget teams participated. On the other hand, for limited budgets, no significant improvements are normally observed. It seems that RoboCup 2016 confirmed a trend in this sector, with a substantial part of teams proposing tools already seen in previous events as novel.

While humanoid locomotion is not currently considered for ERL, an interest is kept for upper-bodies able to achieve bimanual robots to manipulate heavy and/or large objects.

3.2.3. Judging and scoring based on lessons learned

For the European Robotics League, the output of RoCKIn project (http://rockinrobotchallenge.eu/). on benchmarking and scoring is relevant and will be reflected in the rulebooks.

a. Achievements/scores

According to the experience of participant to this Forum, it is difficult to decide whether a task is more important than another, or which tasks are significant for a given scenario. The task can be not successful for some kind of objects and successful for others. In addition, some tasks can be not general for proving functionalities: in some tasks, e.g., accuracy of navigation may be more relevant, giving a clear advantage for the overall success of next steps which need good localization.

For objective evaluation, the successful completion (yes/no) of simple subtasks should be considered. This pushes towards the definition of very basic and understandable tasks, where it can be easily recognised whether the goal has been accomplished or not, without intermediate evaluations and personal judgement.

In addition to this binary scoring, special awards could be considered for brilliant performance which achieve, e.g, the goal with a significant innovation (not quantified in advance for scoring) or in very short time (when the time was not requested as a metric and only a timeout was present).

At the moment, relative scoring cannot be addressed for the format of repeated tournaments at ERL, since some points can be collected in a tournament where a key contestant was not participating.

In general, it is recommended that discretional evaluations are removed from rulebooks.

Specific problems emerge when evaluating robots' performance in outdoor scenarios, where environmental conditions could affect the performance, and weather may change during the day.

One possibility to fairly evaluate the relevance of different tasks is represented by adopting the mechanism of peer review, defining weighting coefficients approved by all participants.

Among the different type of scoring systems, it has been noticed that safety has to be guaranteed at the highest possible level (no collision, no harm): in case of physical HRI, every dangerous behaviour (fast motion very close to humans etc.) should be penalized.

Related to scoring for the cognitive architecture (e.g., scores for "grounding" knowledge by the robot), it will be necessary to assess the internal state of the robot (issue of transparency/introspection).

b. Choice of tasks and difficulty

Tasks are expected to be representative of real-world problems. This has to be considered together with the need of having simple and understandable tasks. In addition, the transferability of the solution to other setups should be encouraged.

Simple tasks are important for clear evaluation of achievement and for community building. In fact, challenging tasks reduce the number of participants, while starting from simpler tasks brings people in for a longer period of time and leads to more stable projects.

In order to keep interesting tasks and a good level of participation, new challenges may be announced in advance or reserved as free-style sessions during competitions.

In ERL tournaments, new tasks will be presented for the future editions, including possible trials with or without scoring (if interested in a preliminary indication of performance). Therefore, more challenging tasks can be announced in advance for next tournaments, while including possible trials/demos without scoring.

3.2.4. Competitions and education, for all-age students

A very noticeable success of RoboCup, according to a variety of participants, was the involvement of children and high-school students. Considering the relevant number of students that are part of a team, STEM education is an important communication vehicle for targeting younger audiences and for promoting ERL tournaments and events.

In general, it is important to propose a "parallel program" (i.e. demos, school visits, special events) during tournaments.

a. School camp at local events

The distributed nature of ERL tournaments allows a large community involvement, of researchers, students and general public

It is recommended to organise preparation camps before the events and local education camps as side events during tournaments, allowing both wide involvement of scholars and sustainability (reduced travel expenses).

b. Engagement and sustainability

The participation in competitions is valuable experience for undergraduate and graduate students as it gives them the opportunity to challenge themselves, compare their robots with other teams' robots and do networking.

Support from universities is necessary. Countries should be encouraged to fund participation in robotics competitions as they do in sports.

Therefore, research and industry groups should meet at the national level to stimulate the National Ministry of Education.

In addition, it is recommended to monitor calls (in particular for CSAs) allowing budget for involving schools in competitions. Additional calls should be monitored in EU programs dedicated to creativity beyond schooling, proposing competitions (or parallel events of ERL) as hubs for such projects.

c. Classes in the curriculum

Teams are often abandoned by graduates: it is suggested to lower entry barriers, giving to students of the early study years educational packages aimed at gaining knowledge for participation to robotics competitions (e.g., an "ERL-branded" course with foundations of coding and mechatronics).

While a general formulation could be shared among ERL organisers, this is a goal to be pursued at local or national level, complying with each country education system.

d. Dedicated funding

Similar to funding for demos of projects, funding for parallel events related to teaching coding and mechatronics could be a part of specific projects.

Research groups (not only from RockEU2 Consortium) active in the organisation of competitions should monitor Horizon 2020 programs dedicated to schools and involve research centres focused on education in the different countries.

3.2.5. Sustainability and dissemination

While participation to competitions is not primarily motivated by a measurable return for the teams, costs for keeping teams and improving previous results may become large. Sponsors or dedicated funding have to be envisaged.

a. Collaboration and structure of the teams

Among social aspects in robotics competitions, relevant issues are related to cooperation among teammates, giving the changes in teams' structures during years and the pressure for fast deployment. It has been mentioned that other professional figures could be involved in the competitions, while sustainability of such possibility is to be verified. In any case, since team components change almost every year, and an "oral tradition" preserves experience, it may become difficult or long to improve performance every year.

Continuity and overlap in a team is a primary need for quality of developed functionalities. Therefore, ERL as a regular event may considered a better approach for teams, reducing the number of people leaving among two events. However, since competitions do not always need original contributions from personnel dedicated to research, the topic of balancing the team with students and technician is significant.

Rehearsal camps and integration weeks before competitions should be encouraged also for "bootstrapping" and for improving team spirit. In any case, the topic of dedicated funding for keeping some reference technical roles in the teams is crucial.

The increasing interest among students to participate in robotics challenges may be stimulated by the presence of companies sponsoring teams or the whole league, since these may be interested in hiring brilliant young researchers.

b. Funding from EU

The EU still does not have an instrument for competitions in Horizon 2020 framework that allows funding teams. Prizes are allowed. Moreover, since commercial advantage is not allowed, competitions with a single standard platform cannot be funded.

For such reasons, CSAs could be used for organization of events and parallel programs, but not for direct reimbursement to teams, which should mostly rely on sponsors.

The possible use of money prizes should be monitored. Current travel budget for students is not enough to cover all expenses. Future calls should allow EU funding for team personnel, e.g., technicians, as suggested above in the text

Dedicated associations for technology competitions should be promoted as in Asia, U.S.A., Australia.

c. Sponsorship (see next section on industry)

According to previous experience, direct participation of personnel from companies to teams in competitions is not preferred, since in most cases companies do not want to be directly involved. In fact, this can cause bad reputation for the company, in case of bad performance. Therefore, companies may be happy to sponsor teams or leagues instead of participating directly.

Companies of course want to work with the best performing teams, and dissemination of results becomes central.

In general, to see development it may be necessary to wait for a number of tournaments. ERL, with more frequent tournaments, may allow a better engineering and exchangeability of proposed solutions. Some de facto standards as the use of ROS may be helpful in this sense.

In order to attract sponsors, among possible practical suggestion, an alive visibility of the event is desirable.

First, to have a website is very important: this should include rankings, videos of brilliant performance, special sections as “best performing robots” (as in sports, featuring “superstar teams”), and links to EU projects to propose results for demos in parallel events of tournaments (as discussed above).

Some “tradition” attracts sponsors; leagues must professionally manage: branding (create a brand and always use that brand), use of social media, presence on local media, advertising via different channels.

Parallel events may play a central role in promoting competitions. ERL will prepare specific documents for attracting sponsors and preparing draft of contracts.

As an additional general suggestion, a dedicated budget for dissemination is critical and has to be properly estimated in the organisation of tournaments, in order to provide the needed visibility both for the teams and the sponsors.

d. Participation fees

Small registration fees are suggested for participation in competitions. This is in order to guarantee that teams registered do not withdraw before the competition, and at the same allow maximum participation of teams.

3.2.6. Competitions and industry in EU

After a discussion on the interest of industry in robotic competitions, different stages and levels for industry participation have been envisaged and summarized in the following.

a. Abstraction of industrial problems for competitions

Companies do not want to reveal secrets on what they are working on; in order to participate in competitions, they have to find an abstraction of the topic which contains the core of their problem. *Organisers of competitions should both collect hints from industry and verify interest in previously demonstrated results.*

b. Match-making among research groups, technology providers, end-users, sponsors

An important distinction of possible industrial partners is among technology developers and end-users. The first may consider an exchange with the teams (providing technology or receiving inputs by the team), while the latter are just looking for solutions for their problems.

Brokerage events should be organised at local tournaments and at major conferences to allow technology developers and end-users to meet teams. This approach was very successful in EuRoC (http://www.euroc-project.eu/).

c. Reputation and motivation for participation, ROI and recruitment

Inputs were collected from companies participating in the Forum. In general, it is very difficult to calculate the return on investment (ROI) of sponsorship, but some hints were provided to the organisers in order to attract sponsors.

Manufacturers as PAL Robotics (http://pal-robotics.com/en/home/) are interested in borrowing (lend) their robotics platform to teams to allow and extensive use of it. On the other hand, marketing-visibility budget is considered for sponsoring a whole league.

For attracting this type of sponsorship, visibility has to be guaranteed, not limited to short press release and keeping visibility alive during the event (TV interviews guaranteed, etc).

The collaboration of sponsors with teams may be developed also after the events, e.g. for recruiting researchers/engineers, which constitute a key outcome for industry.

Providing visibility to results and trials may allow companies to appreciate the teams while, at the same time, possibly selecting students for future hiring. Competitions provide both solutions to companies as well as good engineers to hire.

Also, due to the relatively small size of market, outdoor rescue robotics is different with respect to other domains of robotics, with focus on government/public sector.

d. Most important developments for industry

The functionalities listed in Section 1 have been confirmed as crucial by industrial participants. In addition, technologies and functionalities may present different opportunities to industrial sectors, depending on their focus.

Mechatronic components (sensors, motors) or plug-and-play boards are suggested as technologies which can widely benefit from visibility at competitions. Modular concepts allow creative and “cool” solutions, with parts ready for the market.

On the other hand, robotics manufacturers can be interested in collecting results to be moved to bigger platforms (e.g., KUKA http://www.kuka-robotics.com with youBot). According to the experience of involved industrial experts, companies are learning slowly from competitions in terms of functionalities to be borrowed to their platforms. Due to time pressure and change of personnel in teams, it is not always possible to see progress in architectures and functionalities.

The different leagues in ERL have of course a different link to industrial and service robotics, with different optimality criteria for evaluation (accuracy of perception, cost, safety etc.).

e. Standardisation, patents, open-source

Standardisation is expected to stop creativity on hardware development at competitions. However, it decreases the learning curve to approach competitions from scratch. Related to software, for exchangeability of proposed solutions, the use of the de facto standard ROS may be helpful

In general, a standard platform already specifies part of the solution for a given problem or tasks. On the other hand, modifications to standard platforms may become relevant and it can be even more difficult to port results from different teams.

In addition to standard platforms, some designs recognised as effective may become de facto standard in leagues (type of wheel etc.). This kind of innovation may lead to patenting.

The use of available technology has to be encouraged. On the other hand, awards for open source solutions may encourage original development. Organisers of leagues must monitor improvements on hardware and software to see whether new scenario and rules are necessary for next tournaments or leagues (as an example, the Robocup@Home league was originated from the middle-size soccer league).

A possible solution that was suggested is to keep both standard and open platforms on the same task. This empathises functionalities of new hardware, and the competitions will be not only about software.

3.3. Summary of recommendations from the Expert Forum

Summarising the discussion during the Forum, the following key recommendations have been identified:

1) *Organisers of competitions should track advances both in science and technology (in collaborative projects, conferences, industry) in order to reflect them in new rules and scenarios. New challenges should be present every year.*

2) *Teams should use standard technology when available (no "reinventing the wheel"). This would allow to focus on architecture, control, strategy etc.. Forms of sponsorship could include in-kind contribution by companies: sensors, motors, grippers.*

3) *For fostering technology transfer to industry of developed original solutions demonstrated at competitions, money prizes could be proposed for new technology with robust performance.*

4) *Robustness is among the main goals to be pursued*

5) *It is important to have a "parallel program" during competitions, including demos, school visits, special events.*

6) *Parallel events suggested for the ERL tournaments have to be used also for benchmarking and real comparison of results from EU-funded research projects, where consortia have to show robustness without long preparation and ad-hoc solutions.*

7) *Proposals for new EU projects should possibly include a budget for participation to competitions, or specific Coordination and Support Actions (CSAs) could be envisaged for such purpose. New CSAs may be proposed for dissemination and match-making towards demonstration of project results in really challenging scenarios.*

8) *Human–robot interaction in competitions is focused on cognitive interaction: safety of physical interaction is expected to be guaranteed as a primary functionality of the platform*

9) *Also for Artificial Intelligence, it is necessary to distinguish research from software tools*

10) *For objective evaluation, the successful completion (yes/no) should be considered. This pushes towards the definition of very basic tasks, where it can be recognised whether the goal has been accomplished or not.*

11) *In general, it is recommended that discretional evaluations are removed from rules.*

12) *Simple tasks are expected, for community building and for scoring*

13) *One possibility to fairly evaluate the relevance of different tasks is represented by adopting the mechanism of peer review, defining weighting coefficients approved by all participants.*

14) *Among the different type of scores, it has been noticed that safety has to be guaranteed in any case: in case of physical HRI, collision or dangerous behaviours should be severely penalised.*

15) *New tasks for next editions, as already suggested for ERL, could be proposed in advance to verify early performance of teams*

16) *The organisation of specific events for scholars appears sustainable with distributed tournaments (reduced travel expenses, venue already booked and available)*

17) *For possible classes in the curriculum dedicated to basic mechatronics and coding for robotics competitions, research and industry groups should meet at the national level to stimulate the National Ministry of Education.*

18) *Dedicated associations for technology competitions should be promoted as in Asia, U.S.A., Australia.*

19) *It is recommended to monitor calls (in particular for CSAs) allowing budget for involving schools in competitions as a form of STEM education.*

20) *Providing visibility to results and trials through local media may allow companies to appreciate the teams while, at the same time, possibly selecting students for future hiring. This could result in an increased interest among students to participate and in the possibility of obtaining sponsorships.*

21) *Rehearsal camps and integration weeks before competitions should be encouraged also for improving team spirit.*

22) *In any case, the topic of dedicated funding for keeping some technical roles in the teams is crucial.*

23) *Given the current regulations of Horizon 2020 funding framework, the use of money prizes may be considered as a possible alternative to funding teams.*

24) *Brokerage events should be organised at local tournaments and at major conferences to allow technology developers and end-users to meet teams.*

25) *In order to attract industry, tasks have to represent an abstraction of the problems the industrial sector is interested to solve. Tasks must contain the core of a problem without focusing on details.*

26) *For attracting industrial sponsorship, visibility has to be guaranteed (more than short press release), keeping visibility alive during the event (TV interviews guaranteed etc).*

27) *A dedicated budget for dissemination has to be properly estimated in the organisation of tournaments, in order to provide the needed visibility for the teams and the sponsors.*

28) *Further to the use of a standard platform, it should be allowed to consider two options during competitions, i.e., standard platform and open platform on the same tasks. This will emphasize functionalities of new hardware, and the competition will be not only on software.*

29) *The ERL website has to be kept alive, including rankings and "superstar" teams including the best performing teams in different tasks*

30) *It is recommended to prepare a questionnaire for candidate sponsors and legally-sound contract proposals for sponsorship.*

31) *When using social media and, more in general, for media coverage, sensationalism should be avoided.*

32) *The brand of the competitions has to be always used and promoted*

33) *Small registration fees are expected for participation to competitions*

It is expected that such recommendations represent a base for guiding discussion in the second year of RockEU2.

4. Additional workshops and dissemination

4.1. Summer school ERL-ER/TRADR 2016 and other events

In addition to the main workshops, an additional relevant event in the first year was the ERL Emergency / TRADR Summer school 2016, a shared event with TRADR EU-FP7 project,held at University of Oulu's facilities in Oulu (Finland) from the 22nd to the 26th August 2016.

Notice that this event was open, with registration not limited to ERL Emergency or TRADR partners.

To complete the academic program of the summer school, six speakers were invited to give a lecture to the attendees on different topics.

- Jan Peters from the Technische Universität Darmstadt (Germany). He gave a lecture on learning in complex robotic systems.
- Ivana Kruijff-Korbayová from the Universität des Saarlandes (Germany). She gave a lecture about the TRADR project.
- Abel Gawel from ETH Zurich (Switzerland). He gave the lectures of the practical sessions.
- Marta Palau Franco from the University of the West of England, Bristol (United Kingdom). She gave a lecture about ERL Emergency Robots competition and the European Robotics League.
- Matthijs Spaan from Delft University of Technology (Netherlands). He gave a lecture about planning under uncertainty.

- Cesar Dario Cadena Lerma from ETH Zurich (Switzerland). He gave a lecture about Robust SLAM and multimodal mapping.
- Antonio Jimenez Bellido from FADA-CATEC (Spain). He gave a lecture about aerial safety regulations.

In addition Antti Tikanmäki, representative of Probot Ltd. and Anssi Kemppainen representative of Aquamarine gave a talk and a demo about the practicalities ground and marine robots.

Please refer to related deliverable D4.2 for full details

Moreover, as an additional tool for dissemination and discussion, a number of presentations by WP6 partners events allowed specific dissemination for the ERL concepts.

See the periodic report and deliverables on dissemination for full details.

4.2. Plan for the second year of RockEU2

The white paper on robotics competitions (final deliverable) will be based on frameworks and recommendations finalised during the second year of RockEU2. For additional insights, a workshop has been scheduled for next European Robotics Forum 2017 in Edinburgh. The aim of this workshop will be to analyse the competitions currently running within the European Robotics League together with the EuRoC challenges, and discuss their outcomes based on both the experiences of successful teams and the draft recommendations in Section 3.3, to be sent to speakers before the event.

With respect to previous workshops, a significant space is reserved to teams active in current competitions and challenges, and a panel discussion is scheduled in order to analyse whether suggested recommendations and best practises are in place. In particular, the key topics of sustainability and benchmarking in competitions will be discussed.

The workshop will foresee a session with oral presentations by the teams and open questions, and a panel discussion.

In detail, the preliminary schedule is the following. Participants will be confirmed according to the schedule provided by ERF organisers.

Start: 8:30

8:30 Introduction to the RockEU2 recommendations on Competitions in EU (10 min)

Position statements by selected participants

8:40 Slot I – competitions/The European Robotics League

Status of ERL and main results: 10 minutes

8:50 Team from ERL – Industrial Robots

9:00 Team from ERL – Service Robots

9:10 Team from ERL – Emergency Robots

09:20 Slot II – challenges/EuRoC

Status of EuRoC and main results (10 min)

Position statements by selected participants

9:30 Team from Challenge 1 – Reconfigurable Interactive Manufacturing Cell

9:40 Team from Challenge 2 – Shop Floor Logistics and Manipulation

9:50 Team from Challenge 3 – Plant Servicing and Inspection

10:30: break

10:45 Panel discussion: "To what extent are suggested best practices in place (or not yet)"

Topics: scoring, use of technology, sustainability, new project proposals and participation

in competitions, industry viewpoints and sponsorship.

Invited stakeholders include experts from Academia, EU Commission, Industry (see below)

12:15 end – lunch

The event is organised by WP6 partners CREATE, IST-ID, POLIMI, UWE, with the participation of BRSU, KUKA and UNIROMA.

For additional details see: https://sites.google.com/site/erf2017robocompworkshop/
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5. Conclusion

The main outcome of the RockEU2 workshops has been discussed in this document. Results from the first year represent a base for addressing key topics in the second year and provide recommendations for the ERL. In particular, in addition to the main workshop at ERF, the ERL Experts Forum in Leipzig allowed to gather a number of

experts to provide a first list of recommendations. In order to collect feedback from participating teams and address key actions for a sustainable and successful ERL, next workshop at ERF will be dedicated to listening directly from participant teams to ERL and EuRoC, and discussing with experts whether suggested best practices and recommendations provided results allowing to draft a consistent framework for robotics competitions and challenges in EU.

Additional insights are expected, to be reported in the final deliverables at month 24.