The path to success: Failures in rEal Robots (FinE-R)

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***Abstract*— This paper presents our motivation for organizing the FinE-R workshop at IROS 2015, as well as a summary of all accepted papers. The main workshop goal is to provide an open exchange forum to the robotic community where participants can share their personal "failure to success" stories. We believe that such exchanges are of tremendous importance for the community as they provide a rich source of knowledge on how to avoid future mistakes with possible high impact. On the other hand, the papers accepted in the workshop give a good overview of different types of errors encountered in the robotic fields. Through deep analysis and clear description of failures, the authors of these papers contribute to a learning process by extracting positive experiences and conclusions from negative results leading ultimately to success.**

Keywords: Workshop goals, summary of accepted papers, failure analysis.

I. INTRODUCTION

Along the history there have been many important discoveries that resulted from long trials and error processes, like the ones done for the creation of the electric light bulb by Tomas A. Edison [1] (who is believed to have made thousands of experiments before successfully creating the incandescent lamp). Similarly, other important discoveries came out from analyzing 'failed' results as, for instance, the famous Michelson-Morley experiment in the late 1880's, designed to enhance the accuracy of the prevalent Aether theory. In this case, their efforts to advance the theory led to a continual rejection of their research hypotheses. However, their null results were published in [2] and later played an important role in inspiring new experiments and paradigms, like the special theory of relativity proposed by Albert Einstein in 1905. In each case, the key point for the final success and contribution to the science was the willingness of the researchers to learn from previous mistakes and to share the gained experience with the scientific community.

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As many other sciences, the path to progress in the field of robotics is not free of failures and caveats. These failures provide valuable lessons and insights on future approaches by analyzing errors and finding methods to avoid them. As such, the robotics community could benefit from the experience of those who had faced and overcome similar failures before.

The objective of this workshop is then to provide an international forum for researchers in robotics and its related fields, where they can share their personal experiences on their "failure to success" stories, to present what they have learnt, what others should avoid while experimenting in similar context, and providing tips for better research practices and for creating more successful robots that meet people's expectations.

II. MOTIVATION FOR THE WORKSHOP

Nowadays, in the scientific community only successful theories and positive results have a chance of being regarded as true, and then published in prestigious publications, discarding odd and unexpected findings. However, the success of these theories does not warrant that they are truth neither prove their adequacy to realism. Unfortunately, the current scientific publishing system privileges "successful" results as it is expected that their research findings will be in alignment with well-established literature or with expected outcomes. However, as pointed by [3], research is a "voyage of discovery", which is subject to unpredictability and fallibility, therefore science evolves according to testability, which might result in refutations or confirmations, as well on the absence of anticipated correlations or in failed results, but in any case, it should be clear that both kind of results contribute to the advance of the science.

However, ignoring the huge amount of information that negative results can provide (which, according to [4], are statistically more trustworthy than positive data) is troublesome. Firstly, because by doing so, an important bias in the scientific publications is created since only certain pieces of information are provided. Regrettably, this tendency is yearly increased as pointed by [5], whom after analyzing over 4,600 papers published in different disciplines between 1990 and 2007 found that the proportion of published negative results dropped from 30% to 14% between 1990 and 2007, and with significant differences between disciplines and countries. Secondly, this tendency of omitting information can cause a huge waste of time and resources, as other scientists considering similar questions may perform the same experiments; besides, this can also delay the development of new ideas inspired on the 'unsuccessful' results. Finally, as pointed by [6], this problem is increased by the misconception that publishing negative results might harm scientists' reputations or, furthermore, it might give the perception that a project was poorly designed and the researchers were either unknowledgeable about the subject or incapable of tailoring more robust research hypotheses. To make things worse, some scientists will not report negative results just to avoid their papers to be rejected by the peer-reviewers, who could give priority to other studies with "successful" results or that follow a more popular theory or approach.

Fortunately, the scientific community is becoming aware that negative results are not meaningless and that there is a potential value in sharing also negative results and discussing the lessons learnt after analyzing the failures, as well as in explaining what were the keys to avoid problems and achieve successful results. Some examples of this tendency can be seem in the New Negatives in Plant journal[4] that according to their scope is "an open access, peer reviewed, online journal that publishes hypothesis-driven, scientifically sound studies describing unexpected, controversial, dissenting, and/or null (negative) results in basic plant sciences. The journal also consider studies that validate controversial results or results that cannot reproduce previously published data", or in the new approach supported by the Wealth Health Organization (WHO)[5] that has a new policy of publishing, in their peer reviewed journal, results of clinical trials that include also negative findings.

Following such examples and taking into account that the scientist community working in the robotics field can also benefit of following a similar approach, we decided to propose FinE-R (Failure in Real Robots), a workshop in the context of IROS[6] (IEEE/RSJ International Conference on Intelligent Robots and Systems) conference. For this, we decided not only to focus on presenting the negative results obtained while working on real robots, but also on how the researchers were able to extract meaningful lessons from their failures and what kind of solutions they proposed to finally overcome their problems. Then, we made the FinE-R's call for papers targeting at the following topics:

- Analysis of failures when participating in robotic challenges.
- Design of robust human-computer interfaces for robots.
- Description of problems and solutions faced when failure is not an option, therefore there is the need of creating an outstanding robot from hardware to software.
- Description of benchmarking and tools for testing and creating robust robots.
- Description of techniques to avoid common but frequently seen errors when deploying robots for industrial or general public environments.
- Description of advanced techniques for failure recovery and troubleshooting.
- Matching the expectations and needs of industries and consumers with the current technology.
- Description of alternatives to techniques and algorithms that are prone to fail.
- Presentation of keys for successful research projects and proposals on robotics.
- Analysis of failed results and projects when using smart algorithms, well-established techniques or brilliant designs.

These proposed topics not only were in line with the idea of learning from failures, that is central to our workshop, but also allowed to differentiate FinE-R from other workshops that are mainly centered on specific and vertical topics or areas of research. With FinE-R we aim at providing a space for sharing practices and experiences of robot design and construction across multiple disciplines, therefore making the workshop more interesting and open to a wider audience.

Finally, it is worth mentioning that it was gratifying for us to read comments from reviewers of the Workshop proposal about the appropriateness and timelines of an initiative such as FinE-R. Some examples of these are:

"This is a very interesting proposal as learning from failure in real-world applications is an important and essential capability for robots. This is not a topic not well addressed so far. It is very good to see a group of people discussing this"

"This workshop will provide such a unique opportunity that we can learn from not only our own failure but also others. We surely need such a workshop. Topics cover wide ranges. Speakers are from well-known organizations. Suggest leaving more time for discussions."

III. SUMMARY OF CONTRIBUTIONS

In this section we summarize the accepted contributions to the first edition of FinE-R. All submissions went through a single blind review process. In average, all papers received three reviews.

A. Skill-based Exception Handling and Error Recovery for Collaborative Industrial Robots

Written by Billesø et al [7], this paper discusses the problem of error handling and recovery in the context of open human workspaces. The authors propose a skill-based exception handling and error recovery approach that allows non-robot expert users to operate a robotic system in open environment where other human co-workers are present. The paper presents the skill-based execution model and describes the situation assessment module which learns and monitors the skill execution. Further, the authors show in details how their exception handler model based on a hierarchical four layered Bayesian network works. Non-expert users can accept or reject a solution of an error handling strategy using a simple GUI. The user preference is learned by the system for future re-use.

B. Using Autonomous Robots to Diagnose Wireless Connectivity

This paper, written by Wang et al [8], presents a method/system for diagnosis of wireless connectivity issues through the use of autonomous robots within the author's building infrastructure. The proposed study and solution is of

[4] http://www.journals.elsevier.com/new-negatives-in-plant-science
[5] http://www.who.int/ictrp/results/reporting/en/
[6] http://www.iros2015.org

interest for most robotic laboratories when dealing with wireless connectivity problems. The authors claim that using this method they were able to improve the diagnosis of wireless connectivity issues as compared to manual methods.

C. Soft, Robust Robots for Children with Autism Spectrum Disorder

In this paper, Hong Tuan and Cabibihan [9] describe an experimental comparison between polyester resin and silicone rubber as casing materials for protecting robotic circuitry and servomechanism. The main motivation of the work is on enhancing physical robustness of social robots when used for therapeutic purposes, more specifically in interaction with children suffering autism spectrum disorder.

D. Adapting Low-Cost Platforms for Robotics Research

In this paper [10], Karimpanal et al. explain the design process of EvoBot, a low-cost, open source, general purpose platform to enable testing and validation of robotics algorithms. It has a differential base with two powered wheels and two casters. It includes Bluetooth, a Wi-Fi enabled camera and several sensors. The paper describes specially the design process and solutions of low-cost platforms for swarm robotics research, as well as the adaptation process of swarm robotics algorithms from simulation to real scenarios. The lessons learned when designing and adapting the robot are also discussed. Finally, the paper addresses how to adapt some common representative tasks for the platform, along with some potential problems and possible solutions.

E. Improvements and considerations related to human-robot interaction in the design of a new version of the robotic head Muecas

In this paper [11], Felipe Cid and Pedro Núñez describe some design improvements for a robotic head called “Muecas”. These improvements include both actuators and sensors aimed at providing the system with better communication capabilities for an enhanced human-robot interaction. The authors support their design decisions on some psychological theories based on emotional and communicational phenomena. The paper focuses on incremental design cycles for improving existent robotic platforms by incorporating new features and functions based on the lessons learned from the past.

F. Lessons from the Design and Testing of a Novel Spring Powered Passive Robot Joint

This article [12], written by Short et al, narrates the researchers’ journey towards the design, building and testing of a torsional spring joint. It focuses on the problems encountered during this process, as well as the lessons learned for the future.

One problem engineers are often dealing with is the short time schedule they have to make certain assumptions and estimations. This can often lead to troubles in the assembly and testing phase. As such, the spring joint prototype designed by the authors went twice through a cycle of assembly, testing, and redesign before the arriving at the final stage. During this process, the authors mention that they identified three problems and reported five learned lessons from their design experience.

G. Design, Simulation and Implementation of a 3-PUU Parallel Mechanism for a Macro/mini Manipulator

In [13], Zheng et al. present the design of a 3-PUU parallel mechanism which is used as a mini manipulator in a macro/mini manipulator configuration. The mechanism is suitable for applications requiring precision force control. The paper describes the shortcomings in the initial attempt to design the system and further discusses new methods and strategies adopted by the authors to overcome these deficiencies. The mechanism is a parallel kinematic mechanism for pure translation motion of the end effector platform. This is achieved through three prismatic actuators and three universal joints. The authors faced difficulties in achieving pure translation motion at the end effector and they successfully trace the source of the problems to be mathematical singularities and irregularities in the construction of the universal joints purchased off the shelf. The authors further demonstrate how they learn from the initial attempt failures and device a new parallelogram based configuration for the universal joint mechanism in order to reduce backlash.

H. Intelligence Level Performance Standards Research for Autonomous Vehicles

In this paper [14], written by Bostelman et al, the authors discuss standards development for performance of Autonomous Guided Vehicles (AGV) and optical measurement systems that are used to measure such vehicle performance. The paper discusses benchmarking standards for AGV and the issues faced with developing such a standard. The paper focuses on standards in four areas. Firstly, standards for vehicle navigation in order to measure uncertainties in navigation performance are detailed as currently this information isn't provided by the manufacturers. Secondly, standards to determine uncertainties in vehicle docking by measuring relative displacement from each of the points are described. Thirdly, standards for obstacle detection and avoidance are presented to study the reaction of AGV in different situations such as when a human is detected and interaction with machines that are operated manually. And finally, standards for 6DOF optical measurement of dynamic systems are discussed as these systems are needed for performing ground truth measurements of AGV performance. Experiments carried out for vehicle navigation, vehicle docking and optical measurement systems standards are also presented.

I. Gualzru's path to the Advertisement World

Presented by Fernández et al [15], in this paper the authors describes the genesis of Gualzru, a 1.60 m robot with an external cover built of resin and fiber glass, and a differential base with two powered wheels and two casters. It is commissioned by a large Spanish technological company to provide advertisements in open public spaces. The lessons learned during the three years of development from different points of view are explained including hardware, software, architectural decisions and team collaboration issues.

IV. Conclusion and Future Work

With this first edition of the FinE-R (Failure in Real Robots) workshop we pretend to open a door for researchers to address the analysis and discussion of failures and methodologies when creating or designing robots. The workshop allows for sharing research experiences with scientists facing similar situations and problems. In this paper we also have provided a summary of the accepted contributions, in which the authors were asked to describe their path to success roadmap and to provide clear explanations of what they learnt while deploying their robotic projects that could be of interest for other researchers working in the same area.

Taking into account the quality of the accepted papers, the good response from the reviewers, program committee, and scientific community, as well as the importance that brings doing a deep analysis not only on the successful results but also on the path followed to reach them, as future work, we plan to continue organizing FinE-R in the context of IROS conferences. Our desire is that by keeping open this forum, the expertise of worldwide researchers gained along several years of working on robotic projects can be share with the scientific community. By doing so, not only better research projects can be conducted, but specially common or subtle failures can be avoided. In addition, we plan to open a special session or discussion panel where people participating on shared tasks or competitions like the DARPA Robotics Challenge[7], can explaining their experiences and problems encountered.

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