Europe and South African collaboration on the Mechatronics and Robotics systems as part of the SA Robotics Center

Riaan Stopforth*, Alexander Ferrein†‡, and Gerald Steinbauer§

* Mechatronics and Robotics Research Group (MR2G)
Search and Rescue Division and MR2G Bio-Engineering Unit
University of KwaZulu-Natal, South Africa
†Mobile Autonomous Systems & Cognitive Robotics Institute
FH Aachen University of Applied Sciences, Aachen, Germany
‡Centre of AI Research, UKZN and CSIR, South Africa
§ Institute for Software Technology
Graz University of Technology, Graz, Austria
Email: stopforth@ukzn.ac.za, ferrein@fh-aachen.de, steinbauer@ist.tu-graz.at

Abstract—**Mechatronics consist of the integration of mechanical engineering, electronic integration and computer science/engineering. These broad fields are essential for robotic systems, yet it makes it difficult for the researchers to specialize and be experts in all these fields. Collaboration between researchers allow for the integration of experience and specialization, to allow optimized systems. Collaboration between the European countries and South Africa is critical, as each country has different resources available, which the other countries might not have. Applications with the need for approval of any restrictions, can also be obtained easier in some countries compared to others, thus preventing the delays of research. Some problems that have been experienced are discussed, with the Robotics Center of South Africa as a possible solution.**

I. INTRODUCTION OF PROBLEMS EXPERIENCED IN SOUTH AFRICA

Since mechatronics engineering and related fields are multi-disciplinary, it is impossible to be an expert in all the fields. An example is a robotic system that can be used for agriculture purposes. The knowledge about the agriculture sector can be obtained, but this will take time. Some issues that might result in delays, or that the researcher might not be aware of and will need expert advice from is:

- Harvest of land
- Legal requirements
- Protocols and standards
- Best harvesting technique

As there is no collaboration between institutions for the above mentioned example, researchers cause the "re-invention of the wheel" to happen, as different research entities are keeping their research secretive. There is a competitiveness to perform research, which is acceptable, but delays are introduced as institutions have to resolve problems that have been solved by other institutes. This problem was experienced in the robotics community within South Africa in 2010. A robot project was proposed that different institutions across the country could be involved with, with an international competition that could be entered. The result of this collaborative project was that each institution was

designing and developing their own project in a competitive manner, which had some aspects that were exceptional. Other aspects of the projects were poorly developed, as these aspects of the research were not the institution's expertise. The reason for the lack of interest in collaboration has been the lengthy process of developing the collaboration agreements, and determining what and who the intellectual property (IP) belongs to. The patent process is lengthy, resulting in delays in the publication of the work. The cost for patents is exceptionally high which must be renewed on a yearly basis, and sometimes not worth the return received on the research. The above issues raises the question whether it might be better to have public domain / open source research?

The researchers in South Africa have experienced a jealousy among researchers regarding research that solves problems. Top researchers acting as Reviewers of journals have made comments such as "it is impossible for people in Africa to have solved problems we have experienced in the USA", which has given a negative review on research performed. Irrespective of where in the world the research was conducted, there is always a contribution performed; sometimes exceptional results are obtained due to large available funds made available (e.g. DARPA), while others have less results, due to restriction of funding. The research conducted or problem/s solved might be something not as novel as other research, but it was information that was not in the public domain. It is not suggested that the research standards should be lowered, but that the advancement of research should be considered due to the restrictions in specific countries.

As countries such as South Africa have limited funding resources for research, it is observed that a lot more work is required in the research topics. For example, should the topic of the research be the vision system of a robot, the researcher has to first research, design, simulate, optimise, develop and test a platform that will be used for the vision system. Researchers from first world countries who have

visited South African institutions have asked how many people are working on the project, which has usually been only one person. The response has been that in many of the first world countries, a team of researchers would be working on the same research topic, where each researcher would focus on a specific aspect of the research. Due to the extensive expectations required from a researcher, time is limited to complete an MSc Eng degree in one year and a PhD degree in two year (as expected from government and different professional bodies).

Some institutions in South Africa, are putting great amounts of pressure on the academic staff to produce publications, as the institutions obtain government subsidies from these publications. The expectations from the academic staff are three to four ISI accredited journal papers, where there is only one academic staff member co-authoring. The number of publications could increase pro-rata depending on the number of academic staff are co-authoring. This expectation is very difficult for younger researchers to achieve. The expectations are too high for them, as they have to often also pursue their own PhD degrees. Furthermore, it is very difficult for any academic member to obtain funding for research, thus resulting a difficulty for the research and therefore for the publication to be generated.

One of the largest problems experienced by research leaders at institutions in countries such as South Africa, is to obtain candidates to pursue the research, as these are the academic's human resources. Once a student has obtained a BSc Eng degree, they are able to obtain work in industry that pay salaries that are more than what senior academic staff receive. Those students who are pursuing postgraduate degrees, are either not able to find work (and therefore not fully committed to pursue their studies), or see the importance to improve themselves and want to solve problems in the world. Students are encouraged to continue with the research that allow business opportunities, which are registered with the assistance of the institution. Different countries have funding opportunities for business development and job creation, which often include tax deductions.

II. ROBOTICS CENTER OF SOUTH AFRICA – A POSSIBLE SOLUTION

The Bristol Robotics Laboratory, Bristol, England is a joint venture of the University of Western England, and Bristol University. The center is the size of a sports hall, and consist of three main sections. The first section is the research and development area. Cubicles of different projects are spread out in this area, where two or more students from different disciplines are working on a project. All students share a common room where they are able to discuss their problems and share possible solutions that could be implemented, or that other student might have experienced. The researchers are also sharing a common laser centering 3D printer, and smaller extrusion type 3D printers for less complex parts.

The second section of the center is the testing area, which allows open space for the creation of different scenarios that the robots will be tested in. Open space is available for the

flying unmanned aerial vehicles (UAVs) to be tested, while disaster scenarios could be created for the testing of search and rescue robots.

The third section to the center is the business development unit, which allocates space to students that have developed research in the first section of the center, and that has feasible IP to allow for the development of a business. The businesses that are being established by the students, in conjunction with their supervisors, allow for space for the candidates to place equipment that they have purchased, and continue with the research and development. The candidates have the opportunity to apply for funding from government and other business development opportunities, which expands the candidate's knowledge and skills in applying their research, and that "money does not grow on trees". Many students think that at research institutions, endless funding is given by government (or the institutions) automatically for the research to be conducted, which is not the case (especially in South Africa).

A similar robotics center is also in Switzerland, called the NCCR-Robotics Center. This center is a conjunction of the University of Zurich, École Polytechnique Fédérale de Lausanne (EPFL) and Swiss Federal Institute of Technology in Zurich (ETHZ). The focus areas of research by these institutions and the center has been on search and rescue robotics, autonomous systems, and bio-engineering related areas. Sixteen researchers with their research groups have joint in the NCCR-Robotics Center to establish similar collaboration as the Bristol Robotics Center, to improve and expand their research areas.

An advantage that these centers have is the network between researchers in different disciplines that are able to get together to solve problems experienced. Having a robotics center in South African, have many similar advantages as those experienced in Bristol, UK and in Switzerland. These advantages include:

- Students, companies etc. will be aware of the robotics center, and there will be more opportunity for collaboration, compared to within the small research groups. Different disciplines and departments (or schools) will be able to have further interaction between them. Different students from different disciplines will be able to bring their expertise together on the different projects (i.e. electronic engineering, mechanical engineering, computer engineering, computer science, materials science etc.) working together on the projects. There will be a selection process, to make sure that the people involved are the serious researchers with relevant expertise.
- The different robotics/ mechatronics/ artificial intelligence / computer etc. research groups can continue as they are at the moment, but will be under the umbrella of this center/laboratory to allow for better collaboration and research output.
- The joint collaboration will allow for joint publications, and therefore more publications, as the joint work will have more value to publish compared to the individual research items. At the moment a lot of the research

conducted by an individual academic, might be of a very small contribution on it's own, but as part of an application for a bigger project, the contribution could be larger.

- There will be an increase of post graduate students. More postgraduate students across the country (or even international) will be attracted, as this will be the central hub for research, increasing the robotic specialists within South Africa.

- As the collaboration will increase, there will be greater opportunities for students to perform research, and possibly obtain jobs afterwards. Resources from different institutions and research members can be shared and combined to allow for a robotic platform to be developed and tested. Funding might also be available to some of the researchers, while the other researchers working on the research topic might have less available. Due to the research collaboration, the research funding can be shared and therefore allow for a greater research output.

- The research output will increase, by not only increasing the postgraduate students graduating, but also by increasing the journal and conference publications on the research.

- There will be an increase in IP related work.

- As the students/members from the different disciplines/units are in the same environment, it gives them the opportunity to discuss and brainstorm ideas with each other. They are able to assist each other or advise each other of ways to solve problems (a major problem students are experiencing at the moment). It must be noted that it is foreseen that there will be more value to have the robotics center to be a virtual one, with the physical research teams and buildings as satellite centers at different institutions around the country. An exchange programme between institutions at a national and international level are suggested, to allow for research teams at each satellite center to be multi-disciplinary. Each satellite center is also able to focus and optimise on a specific aspect of the research topic. Combining the different optimized sections together, will allow for a complete prototype to be developed that can work at the best performance.

- There will be a "start-up business" section in it too, which will allow students to pursue with businesses on the research that they have performed. Students will be allocated space to work from to get their businesses launched, and at least one of the center members (who is probably the student supervisor/s) will be an equal member in the company. Motivation for the academic staff will increase in the work and research that they are doing, and the student will also be willing to pursue, as they need assistance from different universities involved with the center, with patent filing and company registration etc. Any ideas that might develop from these small businesses, must be producing some minimum patent or journal publication, which will also increase the country's science, engineering, math and technology expertise and impact on the world. These small businesses can also apply for start-up funding from government, to cover their costs for equipment or computers that they need etc. The profits that these companies make will be monitored, and as they show a profit, they will be charged appropriately for the use of facilities.

III. CONCLUSION

The proposed Robotics Center in SA is a possible solution to establish better research in the area of robotics in a third world country. There is probably more possibilities to expand this center. The goal is to attract students from the undergrad programmes, get them as post graduate students (which are difficult to find) and therefore increase research output and robotics and mechatronics experts in the field. These aspects will get students to pursue businesses and therefore expand the center, which will keep on growing. Collaboration will also consist not only nationally, but also internationally. Due to the difference in exchange rate between countries, the small amounts of funding from a first world country, can be exceptional and expand research in a third world country.

Robotics researchers will also benefit by building international networks, and obtaining other avenues of funding that will not be usually assessable. Relationships and contacts with institutions in Europe, the USA and similar first world countries, are being pursued by the primary author, who has been pursuing the stable establishment of the robotics center in South Africa. International exchange programme can be implemented for staff and postgraduate students, to give them the ability to identify different techniques and approaches with performing research.

Collaboration, especially with institutions abroad, can be difficult, as it is difficult to test platforms that are being worked on at the same time, in another country. There are possible solutions, where each institutions can have the same equipment and sensory system that will be on the final platform, allowing for the interconnectivity to be consistent. Different institutions are able to program the code for a robotic platform, and simply send the code to another institution that has the physical mechanical platform, to test.

Collaboration allows for the sharing of resources and funds, which might not be required by different research groups at certain time periods of the year. Having academic staff members from different institutions involved with research, allows for the expansion of their collaboration network, and the support from different countries. Furthermore, the robotics center will allow for the researcher to boost their research profiles, as work can be combined to allow for better research output and publications.