GIT: A Peruvian Approach to Out-of-the-Box Robotics

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***Abstract*— Developing countries are starting to improve their industry by acquiring and producing new technologies. In aims to aid in this progress, governments implements several funding programs to motivate research and development. This represents an opportunity for small technological groups to participate in technological projects. In this regard, automation and robotics play a key role and open up the possibility of creating trained human resources as well as publishing scientific works. This paper presents the growth of GIT, a technological innovation group dedicated to research and development of new technologies in Peru. Additionally, the social impact created in the country by this group with projects implemented as robotic solutions is discussed.**

I. Introduction

In the last few years, the market for industrial and service robots has increased at a steady rate and it is expected to keep rising in the future [1]. Following this trend, various private companies opted on collaborating with Universities to invest in technological research [2]. In this regard, since 2007, the Peruvian government started funding programs [3] to aid rising entrepreneurs into the research field. In 2013, Industry and Academia started to collaborate with governmental programs [4] to create a bridge between them to increase technological progress within the country during the next years.

In order to keep up with the state-of-the-art development, a group of undergraduate students from the Mechatronics major at the Pontificia Universidad Católica del Perú (PUCP) started, in 2013, a robotic research group, and, at the beginning of 2015, the group consolidated as *Grupo de Innovación Tecnológica* / *Technological Innovation Group* (GIT), a technology development team which focuses on technological solutions using concepts and applications of robotics for industrial, service and educational requirements. Recently, interdisciplinary research with arts, humanities and cognitive sciences expanded the research span and introduced the undergraduate students to more inclusive projects.

In this paper, we present a brief history of the beginning and growth of GIT, as well as the financial methods used to support the group. Additionally, a resume of the technology production will be presented. Furthermore, the impact of the research and development group within the Academia, Peruvian and International community is discussed. In Fig. 1 some of the developed robots by GIT are introduced.

II. Innovation Technology Group

A. *Background*: In 2009, inside PUCP's new established major of Mechatronics Engineering, sophomore and junior undergraduate students started participating in robotics competitions with the purpose of developing teamwork and technical skills. Most of the required knowledge was self-

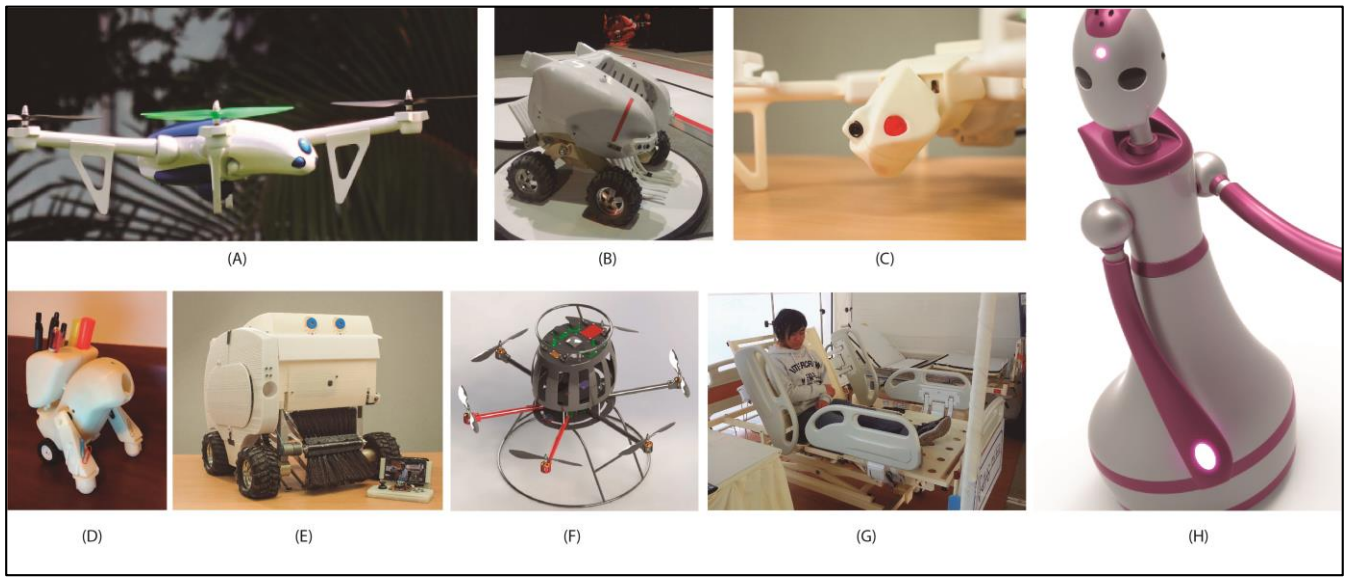

Fig. 1: (A) *Daedalus* (B) *Sunaya* (C) *Daedalus II* (D) *Prime* (E) *Sunaya II* (F) Pollution Drone (G) *SmartBed* (H) *IOmi*

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taught, while the equipment was provided by the school. The most notable events during this period were the World Robot Olympiad (WRO) 2009 and 2010, in which the students represented Peru showcasing high performance in both South Korea, earning the Best Design Award, and The Philippines, receiving 7th place worldwide.

Beginning of the group: In 2012, a small group of junior and senior undergraduate students started working on a free-to-imagine policy where they were provided some robots such as the humanoid robot *Robovie-X*, a small quadcopter and the mobile robot *Pioneer P3-DX* to experiment freely. While the aim during this period was not to produce scientific research, these robots, which were donations from one of the research professors, enabled students to develop hands-on experience in robotic programming and hardware customization.

Growth of the group: As the tendency started to turn towards 3D printed technology, in 2013, PUCP invested in 3D technology [5]. This investment provided an opportunity for quick prototyping. The main objective was for students to start generating scientific and publishable material by means of the research procured through their work.

Maturity: In the following years, production of intellectual property increased, in form of conference proceedings [6] [7] and patents [8] [9] [10] [11]. In addition, two ongoing projects were established as a cooperative work between the government, the university and local industrial companies: SmartBed, an automated hospital bed for disabled and/or ICU (Intensive Care Unit) patients [12]; and Welding Arm, a robotic arm for automated welding and error correction for industrial applications [13].

Consolidation: In 2015, GIT was consolidated to assemble all the research and development produced and ease collaboration between members. The purpose of GIT is to evolve into an Innovation Hub capable of producing technologically transferable projects and scientific research in robotics.

III. Technological Production

During the establishment of GIT, a significant amount of scientific, industrial and design concepts were envisioned. This produced work was beneficial to not only the group, but also the university and Peru's standard regarding robotics.

In 2013, undergraduate students from Mechatronics and Industrial Design joined to create a robot not only to compete in the *IEEE Latin American Robotics Competition* (LARC), Open Category, but also to promote research on social robotics. The team, shown in Fig. 2, was financed by PUCP's Administrative Vice-Dean, and encouraged and consolidated teamwork within group. In this competition, a robot named *Sunaya*, an automated beach cleaning robot; and *Robovie-X*, participated with an outstanding performance. *Sunaya* was the first 90% 3D printed robot developed in the country while *Robovie-X*, hacked for the competition, placed first for two consecutive years at the *IEEE Humanoid Robot Racing*.

Moreover, three undergraduate researches participated at the International Conference of Social Robotics ICSR 2014 to present three conceptual designs: *PePe*, caretaker and aiding robot for plants; *Muqui*, verbal story databank and projector; and *Bug*, a worldwide experiential tourism guide robot.

Fig. 2: Sunaya and Robovie-X with early GIT members at LARC2013

Furthermore, *Prime* was presented as a conference paper [7]. Likewise, *Sunaya*, and *Sunaya II*, the upgraded version of *Sunaya*, allowed PUCP to promote their research prowess as well as offering hands-on experience on robotic engineering. *Daedalus*, and *Daedalus II*, facilitated studies on social robotics. Both upgrades of these robots were patented as Industrial Design models [8] [11] [10]. Finally, IOmi, a life-sized humanoid bibliotheca guide robot is currently being developed by GIT. It is expected to be a technological attraction as well as enabling social research on the acceptance of robots within a specific community. Both will provide rich data on the fields of robotics as the research on Latin-American contexts is still on initial stages. On the other hand, two projects aimed at measuring contamination are being developed: a pollution evaluation hexacopter, winner of the Innovation Technology Award [14] and presented at TEDx Tukuy; and an unmanned submarine ROV funded by the government, for underwater analysis of pollution [15]. Finally, after building up a considerable portfolio of projects, the school started investing on large-scale projects within GIT, acquiring a Baxter robot, two Nao Robots, a pair of Kinova robotic arms, and a Summit mobile robot. With this, the possibility of advanced research projects to be on progress will drastically increase.

IV. Financial Support

From the beginning of the research group to its consolidation, the financial aid obtained ranged from self-funded projects to government funding. The type of funding, as well as the scope of the projects developed with each financial aid is listed in this section.

Government Funding: The Peruvian government, with the aid of the National Council for Science, Technology and Technological Innovation (CONCYTEC), started providing funding for medium to large scale projects since 2006: i) Fund for Innovation, Science and Technology (FINCYT): Promotes the collaboration between academic institutions, private companies and the government to develop transferable technologies to increase the technological level of the industrial sector in the country; ii) National Fund for Scientific Development, Technological Innovation and Technology (FONDECYT): Aimed at encouraging and promoting the development of basic scientific and technological research; iii)

Fund for Research and Development for Competitiveness (FIDECOM): Promotes research and development of innovative production methods to improve commercial competitiveness.

University Funding: At PUCP, several funding programs can be obtaining depending on the academic level, or research impact within the community. As such, most of the developed projects were implemented with the aid of the university. In addition, the school is very receptive for new publishable works and, alongside its intellectual property office, most of the intellectual work is protected and backed up by PUCP.

Self-Funding: While it is difficult to acquire high cost material with a student budged, some small parts or even small robots can be purchased by the members of GIT. These acquisitions contribute to the growth of the group as most of these objects are now used as teaching/learning tools for newcomers, lowering the learning curve and providing the necessary hands-on experience for working on larger projects.

V. National and International Impact

Almost all research done by GIT had a level of impact within the community which can be categorized in: academic, national and international impact.

Academic Impact: Most research developed at GIT conveyed into scientific publishable work presented at international conferences, such as: ICSR and HRI in case of social robotics, and LARS for the educational project involving robots [6]. The novelty and impact of GIT was the interdisciplinary research involving engineering, arts, humanities and cognitive sciences.

National Impact: The first developed robotic projects starred in TV and newspapers interviews. The exposure of those results, presented as friendly as possible to a wider audience, encouraged the Government and private companies to invest in the technology produced by this team. Some robots evolved into icons, such as Sunaya, that identified GIT as a robotic research group.

International Impact: The most astounding innovation produced by GIT, according to international researchers' feedback, was the out-of-the-box approach used to design robots for social interaction. Robots embedded with rich Peruvian culture proposed a new and fresh standing point to solve situations differently as it was previously conceived. Conversely, the international open source community aided in shortening the technological drift between developing countries and developed ones on the field of robotics.

VI. Conclusions

It is not required to procure high-end equipment for a robotic research to be valid, as the main asset is human resource and it should be cultivated from early stages. However, it is extremely important to foresee a well-structured project, as this will provide substantial evidence for funders to invest on projects. Media and public talk is important to promote and generate awareness of robotics, and to consolidate a growing group as GIT. In a country which research and development was not a primordial concern until the last decade, it is essential to display the advancement on this relatively new field to encourage public opinion on backing up technological projects.

Finally, as per the experiences gathered over the maturation of this group, many ideas proposed by this Peruvian team resulted in novelty and out-of-the-box approaches to international standards, shifting the preconception about Peruvian research regarding robotics.

VII. Future Work

It is within the scope of GIT to promote robotic research alongside with training new and capable human resources to contribute to the growth of a developing country such as Peru. For this purpose, the group is looking forward to establish alliances with international pairs in order to promote exchange of students, ideas, and project collaborations.

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