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RIGTA: INTERACTIVE ROBOT AS AN INTEGRATION PLATFORM FOR ENGINEERING EDUCATION

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Abstract: This project was developed within the Tecnoacademia Tolima program. In it, the construction of an interactive robot was proposed through the multidisciplinary interaction of the Engineering line; which, based on the experimentation of its students in mobile robotics, propose the creation of a robot with similar characteristics to the robots of industrial applications with programmed movement in a real environment depending on its configuration. Through experimental training, students applied the knowledge acquired in the four training areas, composed of Mechanics and Prototyping, Electronics, Robotics and ICT. This made it possible, by assimilating the concepts, to design experiences within the training environments to determine the behavior of the robot in a controlled environment. From the area of Mechanics and Prototyping, the structure and body of the robot were designed and modeled in 3D. In Electronics and Robotics, the physical characteristics of the prototype were reviewed, including the type and position of sensors, in addition to exploring automation options for movement control and the execution of multimedia content, managing audio and video. Finally, the ICT area designed the template and guidelines for video production, including script, story and animations. The robot, besides being a functional prototype, allowed the students of the Tecnoacademy to strengthen their competencies in science, technology and innovation through the creation of new developments.

INTRODUCTION

The world around us is constantly showing the technological advancement of robotics; from the engineering process and the integration of knowledge new contributions and solutions have been generated in the way we humans currently operate in everyday life, since due to the wide range of scenarios and applications, sequential and industrial processes given with some type of automation need efficient and intelligent quick solutions. The development of new robots in our environment has been introduced in museums, tourism support, libraries, kitchens, as well as robots that are used in companies whose applications range from increasing productivity to process control in tasks where repetitiveness is a priority. In recent years, mobile robotics has impacted education and the ability to acquire knowledge in the learning process, strengthening 21st century skills based on new adaptive and technological skills that are essential in the way students acquire competencies. RIGTA is an educational resource that fosters interactivity and hands-on learning, and promotes understanding of complex engineering concepts through experimentation and application of knowledge through collaborative work in multidisciplinary areas.

Within mobile robotics, the most important and imperative factors to consider are those concerning positioning, trajectory tracking and obstacle avoidance. That is why RIGTA integrates the approaches of the engineering area and demonstrates how young people perceive the applicability of theoretical content from problem solving, the ability to analyze information and creativity through critical thinking to the construction and programming of a mobile and interactive robot in real and meaningful projects.

Nowadays, innovation and technological development are fundamental for the progress and economic growth of countries. In this sense,

Colombia is in a process of transition towards an economy based on innovation, science, technology and education, and is considered one of the leading countries in the region in terms of investment in science and technology. In Colombia, innovation and technological development have become a key tool to face the country's economic, social and environmental challenges (Corredor& De La Hoz, 2019). In this context, the RIGTA project is an example of how such development can be applied in education to improve the training of students oriented in the line of engineering, as a key tool to promote project-based learning and critical thinking. There are several educational projects focused on mobile robotics, such as the Robotics for Life program, which seeks to promote education in the areas of science, technology, engineering and mathematics (STEM) in rural areas of the country. There are also initiatives such as the Educational Robotics Project, which seeks to promote education in mobile robotics in the country's schools.

In 2019, Colombia was ranked as the second most innovative country in Latin America and the Caribbean, after Chile, in the Global Innovation Index (GII). The country also has important research and technological development centers, such as the Center for Research in Information and Communication Technologies (CITIC) and the Center for Research in Advanced Materials (CIMAV) and, in the case of our institution, the Research, Technological Development and Innovation System (SENNOVA), of which the Tecnoacademia strategy is part.

OBJECTIVES

GENERAL OBJECTIVE

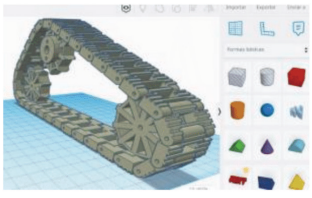
To develop an interactive robot from the integration of multidisciplinary knowledge of the engineering line of the Tecnoacademia Tolima.

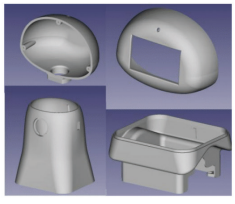
SPECIFIC OBJECTIVES:

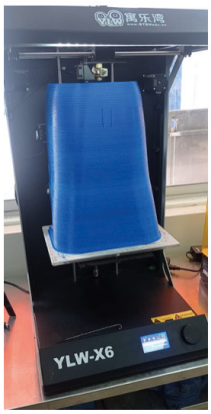
- Design the structural and motor components for the operation of the robot.
- To build the electronic circuits that allow the integration of sensor-actuator models in the robot, according to the designs made.
- Generate the programming algorithms in the prototype that fulfill the processes required for the correct operation of the mobile robot and the execution of the proposed tasks.
- Create multimedia content for each of the training environments according to their specific area of knowledge.

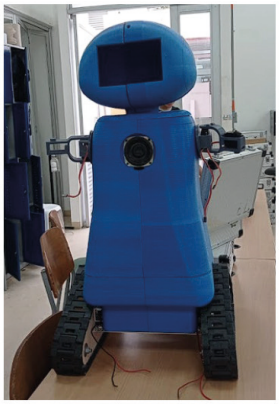
METHODS

The project was based on the project-based learning methodology and was carried out in four phases, using activities designed in a didactic and practical way in each of the areas that make up the Engineering line. In Phase 1, different drive system options were studied, defining that the best option is a three-pinion caterpillar system that allowed having enough stability to overcome small obstacles on the rolling surface. The mechanical power transmission system was designed and modeled in 3D and the mechanical components of the drive system were prototyped. Likewise, the structure and body of the RIGTA project was designed and modeled in 3D, using the 4.0 manufacturing technologies and materials available in the Tecnoacademy environments.

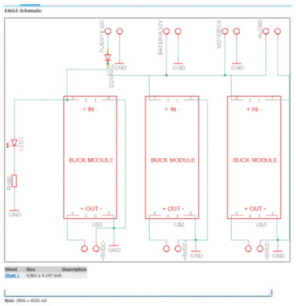


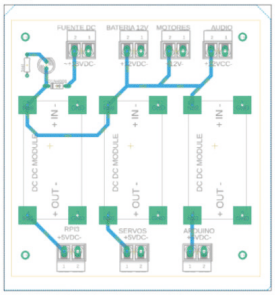


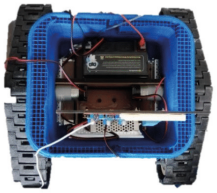




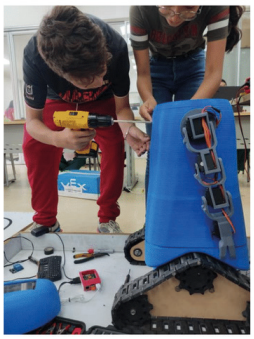
Phase 2: The physical characteristics of the prototype were defined in terms of type and position of sensors to follow a line, avoid obstacles and to be controlled via Bluetooth. The design and structuring of the electronic system was also carried out. Finally, the robot's power card was developed and movement tests were performed by controlling the robot using an Android mobile device and an open source app.

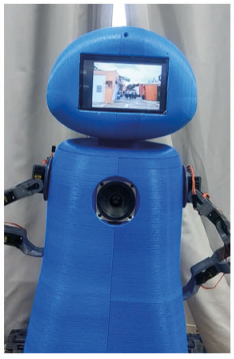


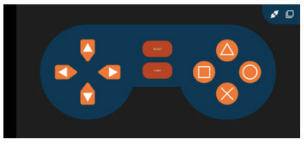




Phase 3: The layout of the motors that control the arms of RIGTA was made for that was arranged to use 5 servomotors in each arm and the different programming routines were made to control the robot and its movement, also the Raspbian OS on the RaspberryPi 3 for screen control. Phase 4: The template and guidelines were designed for the production of the video of each of the areas of the Tecnoacademia: Script, story and animations, finally the integration of the digital content of each of the areas of Tecnoacademia to RIGTA was performed.







RESULTS AND TECHNICAL ANALYSIS OF THE PRODUCT

An interactive robot was developed at the Tecnoacademia Tolima with an attractive and functional design, with structural and motor components that allowed an adequate displacement and maneuverability in the controlled spaces of the Tecnoacademia. The multimedia content created was elaborated in a clear and precise manner, highlighting the strengths and activities carried out by the apprentices in each of the knowledge areas. The implementation of the electronic circuits and the programming algorithms in the prototype were carried out effectively and a correct operation of the mobile robot was achieved. Regarding the technical analysis of the product, the integration of the engineering areas in a STEM

project stands out, which allowed the apprentices to appropriate the concepts and tools necessary for the development of the project in a practical and effective way. In addition, an ABP project-based learning methodology was used, which favored collaborative work and the development of soft skills, such as leadership and effective communication.

The robot has high quality electronic components and an adequate structural design to support the tasks of travel and guidance in the environments of the Tecnoacademia Tolima. The implementation of the programming algorithms allows an efficient interaction between the robot's sensors and actuators to perform the programmable tasks.

CONCLUSIONS

- It was possible to integrate knowledge of the engineering areas for the implementation of a robot for the Tecnoacademia Tolima, fulfilling the general objective of the project.
- The creation of multimedia content for each of the training environments allowed an interactive experience for Tecnoacademia users, facilitating the understanding of the concepts and specific topics of each area.
- According to the technical and pedagogical content of the robot, a creative and effective design could be made to teach the programmatic contents of the areas of mechanics and prototyping, electronics, robotics and ICT of the Tecnoacademia Tolima.
- The generation of programming algorithms allowed the proper control of the prototype and compliance with the processes required for its correct operation, thus achieving a mobile robot capable of guiding users through the environments of the Tecnoacademia Tolima efficiently and effectively.

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