Programmable Floor Robot Robotito and its Tangible and Virtual Interface

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Fig. 1. Preschool children and their teacher programming trajectories using color cards.

Robotito is an omnidirectional robot designed and developed at Universidad de la República, Uruguay. It is part of a research line in educational robotics aimed at developing free software and open hardware robots for educational use. It was developed in 2018 and has been used in various research projects and educational activities since then. The demo aims to present the robot and its two programming interfaces (tangible and digital interface) to the IDC community to discuss its use in research and education, identify possible extensions and improvements, and encourage international collaborations.

CCS Concepts: • **Human-centered computing** → **Interactive systems and tools**; • **Social and professional topics** → *Children.*

Additional Key Words and Phrases: Educational robotics, young children, tangible and digital programming interface

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1 INTRODUCTION

Technology that supports educational activities and helps young children develop relevant skills has always been a focus of interest in the IDC community. During last year's IDC conference, multiple tools and projects focused on teaching subjects like mathematics [4, 6, 7] or chemistry [5], stimulating the development of computational thinking [3, 16, 19, 27], approaching learning and literacy in a novel way [10, 15, 17, 26] or supporting learning and social inclusion of neurodiverse children [8, 9, 11, 14, 18] were presented in the form of articles, posters, and live demonstrations to communicate the existing developments.

Technology can be a creative tool, a means of expression, support for solving repetitive tasks, a communication medium, and so forth. As it is present in diverse areas of our lives, it is considered important and beneficial to help children understand that they can use it to create innovative solutions to their problems or express themselves using technology. Computational thinking involves in part the ability to formulate solutions that can be performed by computers [25] that children should acquire and develop. Robotito was developed to provide a free software and open hardware tool to introduce concepts related to programming and computational thinking to young children [12, 22]. It is part of an educational robotics project that is constantly growing, trying to provide meaningful tools in the educational trajectory of children of diverse ages, backgrounds, and interests. Our idea is to create a tool that can be used with a wide range of users by providing different interfaces to program the robot's behavior.

Contrary to commercial products designed for individual use, Robotito was designed for classroom use. It facilitates the perception of input (program), output (robot's actions), and program state for groups of children [3]. Hence it facilitates collaboration and group work. This emphasis on group activities can help children rediscover a very important part of childhood in learning together with friends as opposed to individually.

We believe the opportunity to interact with it during IDC will help the attendees discover and get to know by direct interaction a novel free software and open hardware tool that can be a platform for research and education. It is an alternative that, contrary to commercially available products, can be adapted to researchers' and teachers' needs.

2 DESCRIPTION

Robotito is a circular-shaped omnidirectional floor robot. It has 16.5 cm of diameter and 7.5 cm of height.

2.1 Hardware and software

Robotito computation platform is a Sparkfun ESP32 Thing [20] microcontroller unit (MCU) board. It is connected to sensors and actuators (see Figure 2).

The robot has six VL53L0X distance sensors [21] mounted around the robot that measure distances to objects from a few millimeters to about a meter. It also has an APDS-9960 sensor [1] that is a combined color, distance, and gesture unit placed under the robot to sense color patches placed on the floor and disable the motors when the robot is picked up.

Among the actuators, it has three omnidirectional wheels that allow the robot to move freely in all directions. It can provide luminous feedback using NeoPixel Ring [2], an array of 24 RGB LEDs placed in a circle. Robitito can also emit simple sounds using an active Buzzer [13]

The robot's firmware [23] is derived from the Lua RTOS project [24], which consists of a Lua Virtual Machine and a set of bindings that allow users to write Lua scripts to access MCU functionalities. Additional bindings were implemented to support Robotito's specific functionalities like omnidirectional movements or detection of preconfigured colors.

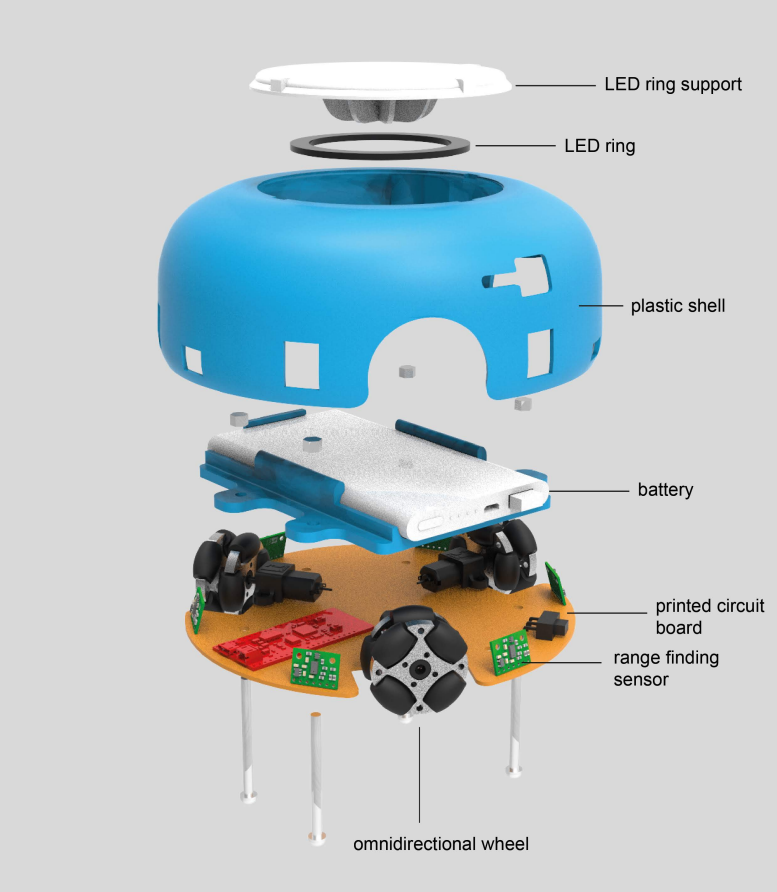

Fig. 2. Robotito's components.

2.2 Tangible programming interface

The tangible user interface was designed to be used by young pre-literate children. Five colors are preconfigured to be detected by the robot; four are associated with directions (yellow - forward, red - left, blue - backward, and green - right), and purple is used to make the robot spin in place (see Figure 3). Children place color patches on the floor to design the robot's trajectory.

2.3 Digital programming interface

The digital programming interface is an Android application that allows users to define connections between what the robot is sensing and its actions (see Figure 4). The programming language is block-based and has seven block categories: the first category is "sensors". The blocks from this category allow Robotito to respond to events caused by six distance sensors and by the color sensors. The second category is "movements", which contain blocks to move the robot forward, backward, left, right, spin in place, change its velocity, and detain the robot. The next category is "time". It is used to define the duration of time between different actions. The fourth category is "lights." It contains blocks to turn all

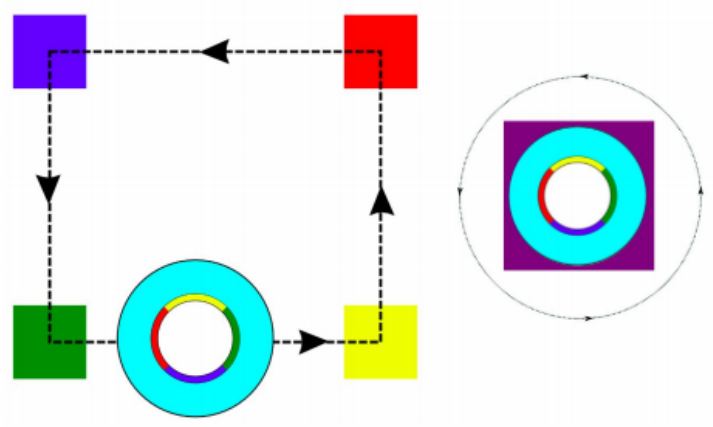

Fig. 3. An example of tangible program for Robotito. Color cards placed on the floor indicate robot in which direction it should move.

lights on/off and control four light arcs. The "sound" category contains four preconfigured sounds. The "logic" category contains blocks AND, OR, and NOT that allow defining more complex conditions, such as "if the robot senses a red color card and has detected an object close to the first sensor." The last category is "states" and it allows the user to respond to events differently, depending on the state the robot is in.

3 CONCLUSION

Robotito is a robot that can be (re)discovered at various stages of education as it allows the user to define rules that define its behavior. It uses low-cost materials, free software, and open hardware so it can be (re)designed and (re)programmed to adapt it to various scenarios of use. It can support both research and educational activities.

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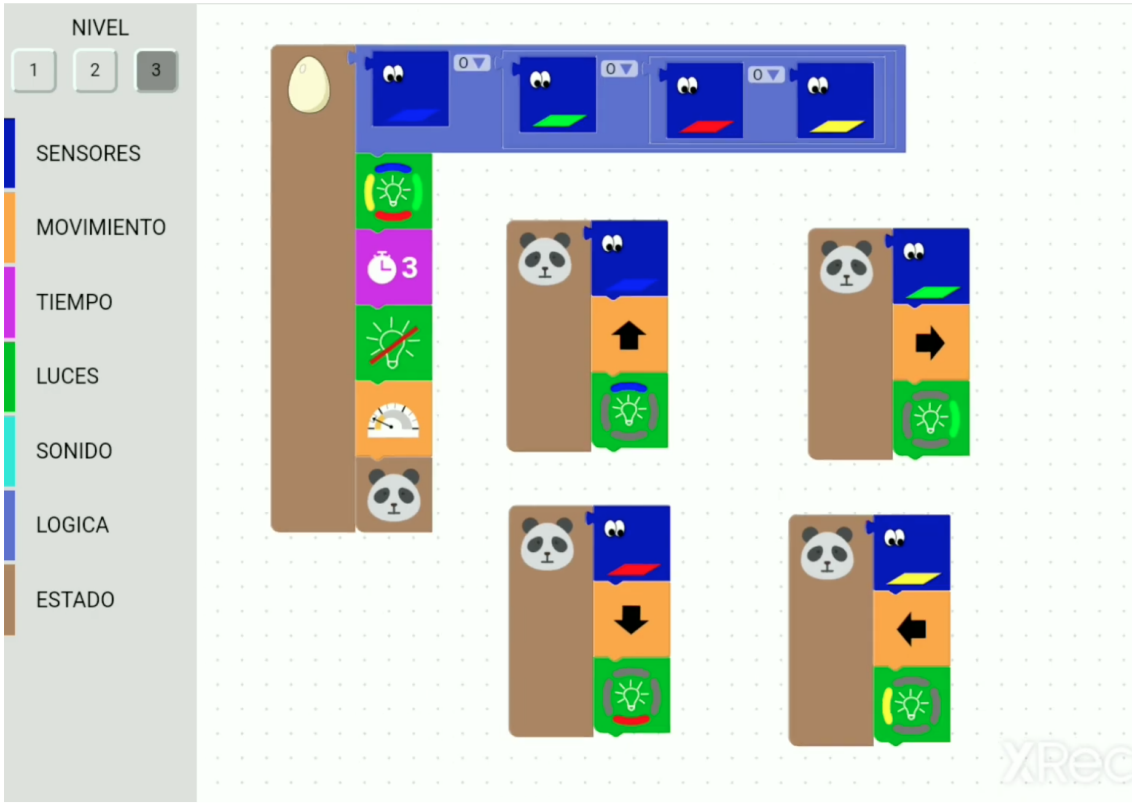

Fig. 4. An example of digital program for Robotito.

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