AIR4Children: Artificial Intelligence and Robotics for Children

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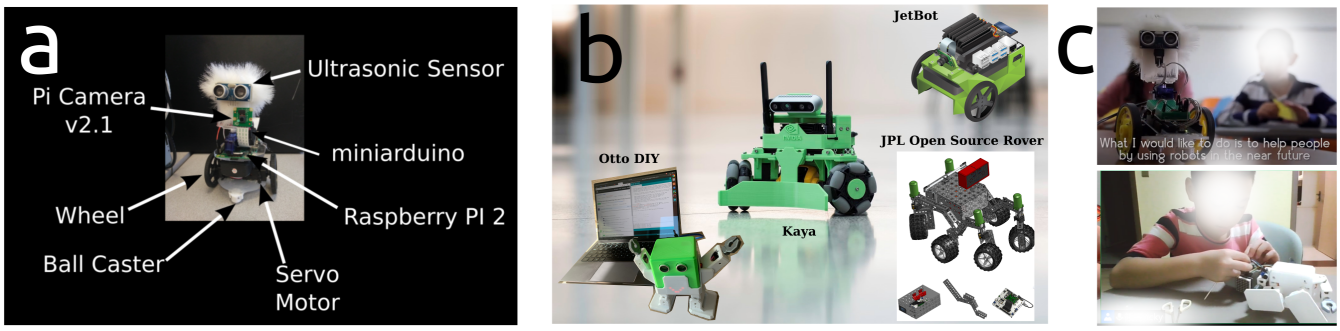

Figure 1: (a) Robot prototype (b) open-source robots for ai and robotics, (c) piloting teaching materials with children.

ABSTRACT

In this work, we proposed AIR4Children, artificial intelligence for children, as a way to (a) tackle aspects for inclusion, accessibility, transparency, equity, fairness and participation and (b) to create affordable child-centred materials in AI and robotics. We present current challenges and opportunities for a child-centred approaches for AI and robotics (AIR). Similarly, we touch on open-sourced software and hardware technologies to make a more inclusive, transparent and fair participation of children in areas of AIR. Then, we describe the avenues that AIR4Children can take with the development of open-sourced software and hardware. Similarly, we propose to follow the philosophy of Montessori education to help children to not only develop matematical thinking but also to internalise new concepts and learning skills through activities of movement and repetition with open source robots. Finally, we add conclusions and mainly we pose the future work to go of AIR4children to putting in practice what is proposed here and measure the impact on AI and robotics of children.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Accessibility systems and tools**; • **Applied computing** → *Interactive learning environments*; • **Social and professional topics** → **Children**; • **Computing methodologies** → *Cognitive robotics.*

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KEYWORDS

Child-centred AI, Educational Robotics, Child-robot interaction

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1 INTRODUCTION

The scientific and technological progress in the fields of Artificial Intelligence and Robotics (AIR) has been rapidly moving forward over the past decade with special focus in countries such as United States, China and Europe where support of such fields is part of their agenda [11]. However, such progress also brings other challenges such as the little to none focus on a centred AIR for children as well as the challenge of making the fields of AIR available to under-represented communities. With regard to child-centered AIR, there is few materials and resources with poor accessble and not appropriately affortable. In terms of affortability, such technologies are unreachable to young audiences from under-represented communities as recently pointed out by United Nations Children's Fund (UNICEF) [18]. Therefore, this work is proposing Artificial Intelligence and Robotics for Children (AIR4Children) as a way to make AIR available to young audiences with perhaps limited resources and to creation and design tools based on open-sourced projects to address fairness and accessibility. Additionally, AIR4Children is aiming to design curriculums with an non-traditional education approach for children of different socio economical backgrounds, developmental stages or learning abilities.

For this work, as a way to minimise cost for hardware and software, section 2 review open source project as the basis of the material for AIR4Children. In section 3, it is presented three stages of AIR4Children including open source materials and teaching materials based on Montessori education. We then conclude this work with current status of AIR for children, open source materials for

Project	Established	Cost
JPL Open Source Rover [8]	April 2018	USD 2500.00
JetBot AI Robot [12]	March 2019	EUROS 212.00
Otto DIY robots [13]	2016	EUROS 100.00
Robot at AIR4Children	2021	EUROS 100.00

Table 1: Open source projects for educational AI and Robotics

hardware, software and teaching and add few words on the future work as a way to mitigate few of the challenges cited above.

2 OPEN SOURCE SOFTWARE AND HARDWARE FOR AI AND ROBOTICS

In 1978 Donald Knuth designed TEX, typesetting system, which is a role model for open source projects where organisational phases of its development and the relative and simple accessibility to users were crucial to its success [6]. Then, in 1983 Richard Stallman, with the frustration to not freely inspect, modify or share software, founded the GNU project to then create a GNU manifesto [16]. Such projects were the corner stone of what is known as the Open Software Initiative, founded by Bruce Perens and Eric S. Raymond in 1998, stating that projects must be free redistributable, code must be available and distributable, modification must be allowed, etc [4]. Following a similar spirit that software can be used, studied, copied, modified, and redistributed without restriction, projects of open source hardware started to emerge in mid 2000s emerged (e.g., OpenCores, RepRap (3D printing), Arduino, Adafruit and SparkFun) [14].

Then, in the last decade, another wave of scientific innovation has been emerging in the field of AI due to open source software frameworks (e.g. pytorch, tensorflow, etc.) and places to distribute these (e.g. GitHub, gitlab, bitbucket) [9]. However, little has been done for child-centred AI and Robotics. For instance, Otto DIY is an educational open source robot founded in 2016 by Camilo Parra, where the community of OTTO has more than 20,000 users from 20 countries and more than 100 re-designs of the robot [13]. Another example is the JPL Open Source Rover, created by engineers at NASA and initially released in April 2018, which it is designed with detailed instructions for constructions for mainly high school students, and open source technical specifications, 3D models and assembly instructions [8]. Recently, engineers at NVIDIA in 2019, released nano JetBot as a affordable, education and fun platform "to give the hands on experience needed to create entirely new AI projects" [12].

That said, there is opportunity to create educational resources to teach AI and robotics to children aiming to be, as pointed by JetBot, affordable, educational and fun [12], where our prototype, explained in next section, is starting to tackle few of them. Table 1 summarises open source projects with year of establishment and cost.

2.1 Open source hardware and software

Adopting the philosophy of open source, AIR4Children is aiming to tackle the need of accessible and affordable resources for AI and Robotics to young audiences [18]. For instance, as a way to mitigate the hight prices of educational robots, our initial prototypes of AIR4Children are in the range of 100.00 EUROS. Such prototype, based on raspberry pi, arduino uno board and few actuators, is able to recognise voice commands in English language to move the robot in different directions (Fig 1(a)). Similarly, we have identified Otto robot, a DIY educational robot, which is based on arduino, servomotors and a scratch as interface to program the robot with various routines for sensors and actuators with a price of EURO 100.00 (Fig 2 (b)).

3 AIR4CHILDREN AS A OPEN SOURCE PROJECT

Having known the benefits of not only the lower price of open source projects but the increase of customisation and control of these, AIR4Children is therefore intending to adopt a similar journey along the lines of open source principles with the aim of making affordable, customisable and accessible tools for a child-centred AIR.

That said, in a first phase, AIR4Children project will be piloting teaching materials with our open source robots and otto, a well known open source educational robot [13]. Then in a second phase, and with feedback of the pilots, teaching materials as well as the customisation of open source robots will be improved to polish a more child-centred curriculum of AIR. On a third phase, children and adolescents in a range of age between 6 to 14 years old will be invited to enroll on workshops to be free of charge to all the participants. In this regard, this initial phases of the project will help us to provide evidence of the impact of AIR in a children of different backgrounds and evaluate children's perception on the fields of AI and Robotics.

3.1 Open teaching materials

Considering teaching materials of AI and Robotics to be child-like oriented, AIR4Children is then adopting Montessori's education with philosophy orbited around the quote "the hand is the instrument of the mind." [10]. In that way, materials for AIR4Children are based on Montessori education with the aim to help children to internalise new concepts and to develop concentration of their learning skills through activities of movement and repetition. One potential way to develop such skills is by designing activities in AI and robotics that are appropriately introduced in development stages [1, 2, 7] as well as the development of grasping and understanding mathematical concepts (e.g. numbers, size, and shapes) [3, 15]. Similarly, as Elkin et al. (2014) [5] explained, air4children can provide a way to engage children in problem-solving activities based on Montessori education as well as design activities that allow children to participate in creative explorations, develop fine motor skills, hand-eye coordination, engage in collaborative and teamwork activities.

That said, figure 2(a) illustrates the spiral learning technique adopted for AIR4Children to reinforce the above Montessori skills [17].

4 CONCLUSIONS AND FUTURE WORK

We introduced the term air4project as a project with the aim to tackle aspects for inclusion, accessibility, transparency, equity, fairness and participation of children in the fields of AI and Robotics

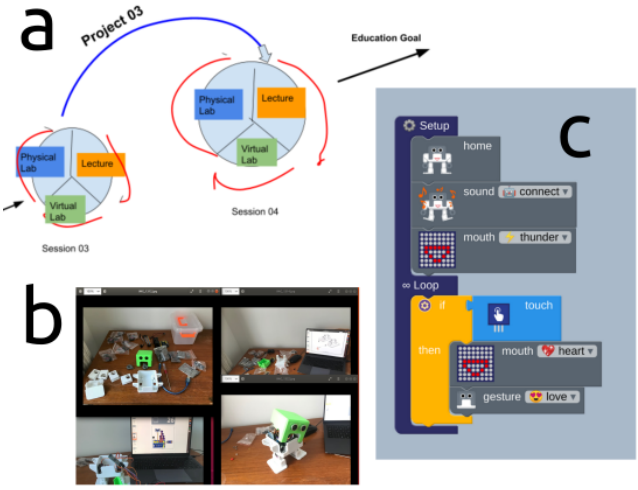

Figure 2: (a) Spiral learning divided into lecture, virtual and physical laboratory and connected via project to next session [17] (b) robot assembly and (c) block-like programming style.

as well as to create teaching materials with a more child-centre approach for AI and Robotics. We also touched on the open source projects in AI and Robotics as a corner stone for AIR4Children with the aim of minimise cost of the materials and made customised educational materials. Similarly, it has been presented the initial phases of AIR4Children that include piloting, implementing and refining workshops for children in the age range between 6 to 14 to be implemented in Xicohtzinco, a town from Tlaxcala, México. We also touched on the creation of curriculums with Montessori education, a non-traditional educational approach to help young audiences to develop skills to think creatively with curiosity and open-minded as well as to develop a sense of wonder and joy in learning.

As a future work, air4children aims to run workshops by the end of 2021 to put in practice educational material of child-centre AI and robotics and to evaluate the impact on these fields to children and to the community.

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