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Arduino in agriculture and the teaching of mathematics

Abstract

Arduino is an open-source electronics platform designed for creating interactive projects. Arduino agriculture refers to the practice of using Arduino microcontrollers in the field of agriculture. In agriculture, Arduino is commonly used for various applications such as automated irrigation systems, soil moisture monitoring, temperature and humidity control, plant health monitoring, and more. By the other hand using Arduino in mathematics teaching can be an innovative and engaging way to enhance students' understanding and practical application of mathematical concepts. Teaching mathematics through Arduino in agriculture offers several benefits: The aim of this work is to show that the applications of the Arduino board are very varied, and that it can be used efficiently in the teaching of mathematics, relating both disciplines agriculture and mathematics. From the unsystematic and elementary literature review, it can be concluded that there are enough research options, in which application projects in agriculture and livestock are implemented using the Arduino board and that can also be used for teaching mathematics, thus fulfilling the objective of this work is to highlight the possibility of the aforementioned. Therefore, it is suggested to follow this line of research that promises to be very productive.

Keywords: arduino, agriculture, precision agriculture, mathematics, education

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Jaime Cuauhtémoc Negrete
Professor of mechanization and agricultural machines, Autonomous Agrarian, Antonio Narro University, Mexico

Correspondence: Jaime Cuauhtemoc Negrete, Professor of mechanization and agricultural machines, Autonomous Agrarian, Antonio Narro University, Mexico, Email temone@gmail.com

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Introduction

Arduino is an open-source electronics platform designed for creating interactive projects. It consists of a microcontroller board, development environment, and a supportive community. Arduino boards are programmable using the Arduino programming language, which is a simplified version of C++. Arduino boards can interact with sensors, motors, displays, and other electronic components, making them versatile for prototyping and creating interactive projects. These boards are widely used in various applications, in this work some applications to agriculture and the teaching of mathematics are described.

Arduino agriculture refers to the practice of using Arduino microcontrollers in the field of agriculture. In agriculture, Arduino is commonly used for various applications such as automated irrigation systems, soil moisture monitoring, temperature and humidity control, plant health monitoring, and more. By integrating Arduino boards with sensors, farmers can collect real-time data on essential environmental parameters for their crops. This data can be used to make informed decisions regarding irrigation scheduling, fertilizer application, pest control, and overall crop management. Arduino-based systems provide farmers with the ability to automate and optimize their agricultural processes, leading to better efficiency, improved yields, and reduced resource consumption. With Arduino's versatility and compatibility with various sensors, it has become a popular choice for small-scale and urban farmers as well as researchers exploring innovative agricultural practices. The platform's open-source nature allows for easy customization and collaboration within the agricultural community. Overall, Arduino agriculture offers a cost-effective and accessible solution for implementing smart farming techniques, promoting sustainable practices, and maximizing agricultural productivity.

By the other hand using Arduino in mathematics teaching can be an innovative and engaging way to enhance students' understanding and practical application of mathematical concepts. Here are a few ways Arduino can be incorporated into mathematics lessons: **1.** Data Collection and Analysis: **2.** Programming and Algorithm Development: **3.** Geometry and Spatial Reasoning. **4.** Mathematical Puzzles and Challenges: **5.** Interdisciplinary Projects: Arduino projects can integrate mathematics with other subjects like agriculture.

Incorporating Arduino into mathematics teaching encourages students to think creatively, apply mathematical principles in real-life situations, and develop critical thinking skills. The aim of this work is to show that the applications of the Arduino board are very varied, and that it can be used efficiently in the teaching of mathematics, relating both disciplines agriculture and mathematics.

Materials and methods

A semi-systematic review of the literature was carried out, that is, a mixture of narrative review and systematic review whose definitions are exemplified by Reyna,[1] and Moreno,[2] since some steps of the systematic review and others were omitted because the main objective is to highlight the importance of mechatronics in the teaching of mathematics, the steps that were followed from the systematic review were; define the research questions, review the search for evidence, extract the data and present the results, the omitted steps were; specify the inclusion and exclusion criteria of the results and evaluate the quality of the studies. The search was conducted in academic Google, and the questions were Arduino for Teaching Mathematics and Arduino for agriculture.

Results

Arduino for teaching mathematics

Arduino can be used as educational tools for teaching mathematics. For instance, Arduino is used to teach concepts like algebra and trigonometry through coding projects that involve controlled movements and sensor measurements. Overall, incorporating Arduino into math lessons can make for engaging and interactive learning experiences. However, it's important to consider the level of technical knowledge required and provide necessary guidance to

ensure students can fully benefit from these tools. By using Google Scholar, was obtained 20,900 search results for "Arduino for Teaching Mathematics "in June 2023. some articles are described in the following table 1.

Table 1 Arduino for teaching mathematics

Author	Description	Year
Sobota[3]	Describes an extremely inexpensive, straightforward and surprisingly powerful platform for implementation of real-time control algorithms. The platform consists of an Arduino board and a Raspberry Pi running the REX Control System. The Arduino board is used for interaction with the physical world via its inputs and outputs.	2013
Serrano[4]	Presents an educational tool for teaching the numerical methods of bisection and secant through its hardware implementation with a card based on Arduino Due. It is an accessible practice for the university level in which students who are not familiar with programming languages can simultaneously learn numerical methods and the Arduino language given its accessibility and simplicity.	2021
Morón[5]	Propose the incorporation of Arduino technology within the Primary Education classrooms as a tool for teaching mathematics. More specifically, an easy-to-program system has been implemented for teachers that allows performing arithmetic operations of positive integers and representing their results visually	2019
Mollo[6]	Development of new tangible game tools for learning basic mathematic concepts. The prototypes can be easily implemented by exploiting new open source electronic hardware technologies, such as Arduino and related sensors and actuators, combing simplicity, wide diffusion and low cost.	2016
Herceg[7]	Present several exercises in numerical mathematics which are based on experiments in electrical engineering with Arduino, and show how to turn them into motivational examples	2019
Negrete[8]	Made a literature review and concludes that Arduino is a microcontroller board used for the teaching of mathematics should be interrelated with agricultural projects so that students learning a positive way with contributions to the community.	2023

Arduino in agriculture

By using Google Scholar, we obtained search results for "Arduino agriculture "in June 2023. These results indicate that many researchers and practitioners center their attention on this topic. Only articles from 2018 to date were analyzed.

Author	Description	Year
Negrete[9]	From the review of literature made highlights the amount of research work and design proposals for systems based on the Arduino board with application in Indian agriculture, over the other countries in which it is used. Likewise it was found that the Arduino board is used in the different fields of agriculture in Mexico; Irrigation, Livestock Production, Agricultural Machines, Photovoltaic Energy, Biotechnology, Agricultural Education, Agrometeorological, Greenhouses.	2018
Negrete[10]	Made a literature review on the use of Arduino in the irrigation of agriculture in Mexico.	2019
Murugan[11]	Proposes a Smart TMHG Measurement System, to measure the values of Temperature, Moisture, Humidity and Gas. Initially soil moisture sensor, humidity sensors, gas sensor and water pump which is connected to Arduino. These measured values are displayed in Liquid Crystal Display (LCD). After detecting soil moisture and Humidity level, dc pump will be on or off based on the measured value	2021
Prasojo[12]	Design a programmed microcontroller chip to control watering automatically based on soil moisture detected using a domestic soil moisture sensor. This device detects whether the soil is dry or not. The farmers do not need to do watering manually. In addition to helping farmers, the device can also be installed on plantations, seedbed nurseries, urban parks, hotels, offices, and in homes that have parks or plants that need regular watering.	2020
Toai[13]	Proposed the Markov Decision Process (MDP) with a reward function for efficient water use. Based on the prediction of soil humidity soon, the MDP decides for watering. By doing so, the water can be supplied to plants in well-time for expected water demand. Compared to the threshold level-based decision, the MDP can save more than 63% water and energy consumption. Moreover, the commercial Arduino board is used to implement this MDP with low cost.	2019
Kulmány[14]	Developed an automated Arduino-based low-cost capacitive soil moisture sensor for data acquisition. A sensor- and soil-specific calibration was performed for the soil moisture sensors (SKU: SEN0193 - DFROBOT, Shanghai, China).	2022
Kumar[15]	Proposing an effective moisture control based Modern Irrigation System (MIS) using Arduino Nano with various adjustments to the plantation. The main purpose of this project is to reduce the excess water usage, thereby saving crops from damage. There were numerous projects and prototypes for automatic irrigation using Arduino, but these projects are effective only for only one crop. The proposed system can be applied to various crops, as those crops have different moisture conditions for its growth.	2019

Cui[16]	Design a smart agricultural greenhouse control system that can collect, display and control the temperature, humidity and light environment in the greenhouse in real time. The system is based on the Arduino mainboard, using temperature and humidity sensor DHT11, light sensor GY-30, relay and LCD display to realize the real-time collection, display and control of temperature, humidity, and light intensity in the greenhouse.	2020
Revathy[17]	Design an autonomous watering system. Continuous sensing and looking of crops through the convergence of sensors, an Arduino and thus the web of Things (IoT), allowing farmers to recollect of crop growth and harvest on a daily basis, resulting in high agricultural yield and correct product delivery to end users.	2022
Titovskaya[18]	Discusses the problems of agriculture digitization, shows the reasons for its appearance. One of the ways to solve these problems is proposed based on the modern Arduino microcontroller platform implementation. A brief review of its capabilities for building distributed systems for collecting and processing information has been carried out.	2019
Banerjee[19]	Developed an Arduino based Automatic Irrigation System backed up by cloud/server that serves two major purposes. Firstly, it reduces the workforce needed in the fields as the water supply will be automatic.	2019
Risaldi[20]	Making a system so using the Arduino Uno microcontroller, SIM-800L V2 Module, Piezoelectric Sensor, Soil Moisture Sensor, Buzzer and LCD. The designed system will be able to display information on the spot and can send via SMS. In pre-erosion conditions, there are two variables used, namely soil moisture and soil vibration.	2023
Rios[21]	Design of a Prototype System for Electromagnetic Treatment of Agricultural Seeds using Arduino	2019
Winkler[22]	Describe the MeteoMex project aims to build simple hardware kits and their integration into current Internet-of-Things (IoT) platforms. Shows the use of low-end Wemos D1 mini boards to connect environmental sensors to the open-source platform Things Board. Two printed circuit boards (PCB) were designed for mounting components. Analog, digital and I^2C sensors are supported. The Wemos ESP8266 microchip provides WiFi capability and can be programed with the Arduino IDE.	2021
Sousa[23]	Describe a work for automate the processes that are still manual, focusing on increasing the production success rate through a simple and effective system that aims to increase productivity and reduce waste. The method used consists of bibliographic research on the subject and prototype creation with reduced implementation cost that uses Arduino, sensors and actuators for automation. By reading the data collected by the sensors, measures will be taken to intervene in the internal parameters, such as irrigation, artificial lighting or nutrient injection, in order to maintain the ideal environment for the best plant development.	2020
Rodrigues[24]	Made a research was the objective is to test the germination of two lettuce cultivars in coconut fiber and to propose a system for the production of lettuce seedlings in a low-cost germination table automated with Arduino. For that, curly lettuce cultivars Rafaela and Moana were used. In the production of seedlings, the nutritional formulation proposed by Furlani (1998) was used. The automation system was developed with Arduino Uno R3 and the germination table for irrigation by capillary rise. From the results obtained, it was found to be possible to use the automation system with Arduino Uno in the production of lettuce seedlings in a low-cost germination table with irrigation by capillary rise.	2022
Kumar[25]	Proposed a system to increase the efficiency of the seeding process without affecting the nature of soil. The proposed system is equipped with Arduino MEGA and Arduino UNO which acts as the main control unit while ultrasonic and soil moisture sensors are used to detect the obstacles and soil moisture level, respectively.	2022

Discussion

Teaching mathematics through Arduino in agriculture offers several advantages:

I. Enhanced learning experience: Arduino enables firsthand, experiential learning in both agriculture and mathematics. Students can apply theoretical knowledge to real-world scenarios, fostering a deeper understanding of concepts.

II. Practical application in agriculture: Arduino allows students to design and develop automated systems for agricultural purposes, such as monitoring soil moisture, controlling irrigation systems, or creating precision farming techniques. This practical application bridges the gap between theoretical knowledge and agricultural practices.

III. Interdisciplinary approach: Integrating Arduino in both agriculture and mathematics teaching promotes an interdisciplinary approach to learning. Students can explore and gain insights into mathematical concepts, such as data analysis, statistics, programming, and problem-solving, while simultaneously understanding their practical implications in agriculture. Also students can explore connections between math, technology, and agriculture, fostering a deeper appreciation for the subject.

IV. Engagement and motivation: The firsthand nature of Arduino projects in agriculture and mathematics captures students' interest and enhances their engagement. It supplies tangible results and encourages creativity in finding innovative solutions to agricultural challenges or mathematical problems.

V. Firsthand Learning: Using Arduino in agriculture allows students to engage in practical, hands-on learning experiences. They can apply mathematical concepts in a real-world context, enhancing their understanding of mathematical principles.

VI. Critical Thinking Skills: Arduino projects in agriculture often require students to analyze data, measure variables, and find solutions to specific challenges. This cultivates their critical thinking skills, critical thinking, and mathematical reasoning abilities.

VII. Data Analysis: Agriculture involves collecting and analyzing data related to crop yields, soil moisture, weather patterns, etc. Through Arduino-based projects, students can learn data analysis techniques, statistical concepts, and mathematical modeling, which are crucial skills in modern agriculture.

VIII. Practical Applications: Arduino's versatility allows students to design and build automated systems for monitoring and controlling various agricultural processes. By incorporating mathematics, students can optimize resources, make informed decisions, and develop innovative solutions to improve efficiency and sustainability in agriculture.

IX. Career Opportunities: Teaching mathematics through Arduino in agriculture introduces students to the practical applications of math in a rapidly advancing field. It can inspire them to pursue careers in agricultural engineering, data analysis, precision farming, agricultural mechatronics, or other related areas.

X. Generally, combining Arduino and mathematics in agriculture empowers students with practical skills, fosters an immersed understanding of mathematical concepts, and prepares them for a technology-driven future in agriculture.

Conclusion

From the unsystematic and elementary literature review, it can be concluded that there are enough research options, in which application projects in agriculture and livestock are implemented using the Arduino board and that can also be used for teaching mathematics, thus fulfilling the objective of this work is to highlight the possibility of the aforementioned. Therefore, it is suggested to follow this line of research that promises to be very productive.

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None.

Conflicts of interest

The authors declare that there is no conflicts of interest.

References

1. Reyna MVS, del Toro AV, Vincent NAM, et al. Revisión sistemática: el más alto nivel de evidencia. *Orthotips AMOT.* 2021; 17(4):217-221.
2. Moreno B, Muñoz M, Cuellar J, et al. Revisiones Sistemáticas: definición y nociones básicas. Revista clínica de periodoncia, implantología y rehabilitación oral. 2018;11(3):184-186.
3. Sobota J, PiŜl R, Balda P, et al. Raspberry Pi and Arduino boards in control education. *IFAC Proceedings Volumes.* 2013;46(17).
4. Serrano-Perez E. Enseñanza de Métodos Numéricos a través de una Herramienta Didáctica Basada En Arduino. El Mecanismo de las 4 Barras. *Rev Cubana Fis.* 2021. 3817.
5. Morón, C, Yedra, E, Ferrández, D, et al. Application of arduino for the teaching of mathematics in primary education. In ICERI2019 Proceedings. 2019. pp. 6316-6321. IATED.
6. Mollo, L, Bellotti, F, Berta, R, et al. Building arduino-based tangible serious games for elementary mathematics and physics. In Games and Learning Alliance: 5th International Conference, GALA 2016, Utrecht, The Netherlands, December 5–7, Proceedings 5. 2016. p. 60-69.
7. Herceg Đ, Herceg D. Arduino and numerical mathematics. In Proceedings of the 9th Balkan Conference on Informatics. 2019. pp. 1-6.
8. Negrete JC. Mechatronics in agriculture and the teaching of mathematics. *Research and Advances in Education.* 2023;2(7):6-11.
9. Negrete JC, Romantchik EK, Lopez GDJC, et al. Arduino board in the automation of agriculture in Mexico, a review. *International Journal of Horticulture.* 2018;8(6):52-68.
10. Negrete JC. Arduino board in the automation of agricultural irrigation in mexico. a Review. *EC Agriculture*. 2019;5(9):550-554.
11. Murugan K, Alaguselvi, R. Arduino based wireless sensor network systems for agriculture. 3C Tecnología. *Glosas de innovación aplicadas a la pyme, Edición Especial.* 2021;87-97.
12. Prasojo I, Maseleno A, Shahu N. Design of automatic watering system based on Arduino. *Journal of Robotics and Control*. 2020;1(2):59-63.
13. Toai TK, Huan VM. Implementing the markov decision process for efficient water utilization with arduino board in agriculture. In 2019 International Conference on System Science and Engineering (ICSSE). IEEE. 2019. Pp. 335-340.
14. Kulmány IM, Bede-Fazekas Á, Beslin A, et al. Calibration of an Arduino-based low-cost capacitive soil moisture sensor for smart agriculture. *Journal of Hydrology and Hydromechanics.* 2022;70(3):330-340.
15. Kumar NK, Vigneswari D, Rogith C. An effective moisture control based modern irrigation system (MIS) with Arduino Nano. In 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS*)*. IEEE. 2019. p. 70-72.
16. Cui, X, Kou, Z, Shi, Y, et al. Design and experiment of control system for intelligent agriculture based on arduino. In 2020 IEEE 9th Joint International Information Technology and Artificial Intelligence Conference (ITAIC). IEEE. 2020. Vol 9. pp. 2297-2300.
17. Revathy N, Guhan T, Nandhini S, et al. IOT based Agriculture Monitoring System using Arduino UNO. In 2022 International Conference on Computer Communication and Informatics (ICCCI). IEEE. 2022. p. 01-05.
18. Titovskaya NV, Titovskaya TS, Titovskii SN. The prospects of microcontroller application in the agriculture digitalization. In IOP Conference Series: Earth and Environmental Science. IOP Publishing. 2019;315(3).
19. Banerjee I, Tribady S, Mukherjee S, et al. Automated irrigation system using arduino and cloud. In 2019 international conference on opto-electronics and applied optics (Optronix). IEEE. 2019. p. 1-4.
20. Risaldi MU, Baswara ARC. Design of a soil erosion warning system in watersheds based on arduino uno. *Buletin Ilmiah Sarjana Teknik Elektro.* 2023;5(1):167-179.
21. Rios GAA, Rico MR, Rodriguez PL, et al. Prototipo de sistema para el tratamiento Electomagnético de semillas agrícolas. 2019.
22. Winkler R. MeteoMex: open infrastructure for networked environmental monitoring and agriculture 4.0. *Peer J Computer Science*. 2021;7:e343.
23. Sousa AVD, Rocha RVD. The use of automation to improve the agricultural production of small farmer. *Revista Eletrônica Competências Digitais para Agricultura Familiar.* 2020;20(6).
24. Rodrigues GL, Meireles ACM, Oliveira CW, et al. Mesa de germinação e produção de mudas de alface em sistema automatizado com Arduino Uno R3. *Revista Eletrônica Competências Digitais para Agricultura Familiar.* 2022;8(1).
25. Kumar A, Heshalini Rajagopal H. Automated seeding and irrigation system using arduino journal of robotics. *Networking and Artificial Life.* 2022;8(4):259-262.