

The Versatile World of Arduino Boards: A Comprehensive Review



Ibraheem Redhwi¹ and Ahmad Fallatah^{2*}

¹Advance Materials Institute, King Abdulaziz City for Science and Technology, Saudi Arabia

²Future Mobility Institute, King Abdulaziz City for Science and Technology, Saudi Arabia

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*Corresponding author: Ahmad Fallatah, Future Mobility Institute, King Abdulaziz City for Science and Technology, Riyadh 11442, Saudi Arabia

Abstract

Arduino boards involve single-board microcontrollers and microcontroller kits that are essential for building digital tools. The following is a discussion that reviews Arduino boards, focusing on their structure, applications, merits, demerits, and future expectations. From the analysis, the architecture of Arduino boards is made up of four components: microprocessor, digital and analog pins, programming interface, and power supply. The paper finds that Arduino boards are applied in education, prototyping, smart wearables, and artistic field. It also observes that Arduino boards are advantageous because they have open-source software infrastructure, they are easy to use, they are affordable, and they have a big interactive community. However, Arduino boards are prone to insecurities, have limited power and low storage capacity. In future, Arduino boards are expected to improve on power capacity, be embedded with better communication networks, and continue to drive STEM education.

Keywords: Microcontrollers; Microprocessor; Digital; Analog pins; Power supply; Smart wearables

Introduction

Arduino boards have been among the top game-changers in the field of electronics and programming, improving the accessibility of these tools to many users across the world. Arduino boards involve single-board microcontrollers and microcontroller kits that are essential for building digital tools. Their open-source microcontroller platform empowers customers to create interactive projects and prototypes without complications. The following is a discussion that reviews Arduino boards, focusing on their structure, applications, merits, demerits, and future expectations.

Overview of Arduino Boards

Arduino boards are tools that allow users to write a set of instructions and send them to a microcontroller attached to the board to perform a function such as activating a motor and publishing a message. The most commonly used Arduino models are Arduino Uno, Arduino Mega, Arduino Nano, and Arduino Student Kit. Arduino boards are designed using different models to allow them to achieve specific objectives. These boards are integrated with digital and analog input and output systems that will enable them to link with various sensors and other electronic interfaces [1,2].

Architecture of Arduino Boards

Micro Controller

To start with, the microcontroller serves as the backbone of the Arduino board because it is useful for executing a set of instructions or code that has been sent by the user. This part also plays an integral role in controlling the peripherals connected to the board. The majority of the Arduino boards employ Atmel AVR microcontrollers due to their effectiveness and efficiency [3]. For instance, Arduino Uno uses ATmega328 while Arduino Mega uses ATmega 2560.

Digital and analog pins

Secondly, digital and analog pins are key components that enable the board to interpret input signals from linked sensors and pass outputs to actuating devices such as LEDs and motors. In other words, these pins allow the board to interact with external devices for responsive and manageable coordination [4].

Power supply

Third, the power supply is another structure that involves how the board is powered. Arduino boards use USB or external power

sources that mainly accommodate 5V. However, there are some Arduino products that can manage higher voltages [5].

Programming interface

Fourth, programming interface is a key structure that dictates the language used between the user and the board. These boards allow user to use C/C++ programming language on Arduino Integrated Development Environment (IDE) [6].

Applications of Arduino Boards

Education

Arduino boards are employed for a wide range of activities across various domains. In education, Arduino boards are crucial for teaching robotics technology because learners can create simple robots. Arduino's user-friendly interface and big community base develop a pool of users who share ideas and essential projects [7].

Prototyping

Arduino boards are also used in prototyping, where engineers and designers apply these gadgets to develop prototypes for new products that bring a better experience to the market [8]. In addition, Arduino boards are used for home automation because they can be easily linked to home technology solutions to manage lighting, heat, and security systems [9].

Wearable technology

Also, Arduino boards are essential in wearable technology because they are applied by smart wearables to control basic functionalities like heart beat rate and physical exercise tracking

[10]. Moreover, Arduino board plays a significant role in artistic field because it helps artists to install interactive arts that react to instructions coded by the user [11].

Advantages of Arduino Boards

Open-source

First, Arduino board is welcomed by the market thanks to its open-source feature that allows users or developers to tailor projects to their particular needs. This feature also encourages team work and innovation among developers because they can limitlessly access schematics and codes for enhancing their creativity [12].

Community support

Secondly, Arduino provides community support because it has an extensive user who available essential resources such as tutorials and platforms for discussing common issues such as troubleshooting projects [13].

Affordable

Third, Arduino boards are relatively affordable, allowing them to gain a competitive edge over their competitors [14]. Their cheaper prices allows many consumers to order them across the globe.

Attractive IDE

Fourth, Arduino has created its unique Integrated Development Environment (IDE), which is easier for beginners and experts to use. Users with little coding experience can easily learn how to code Arduino boards [15].

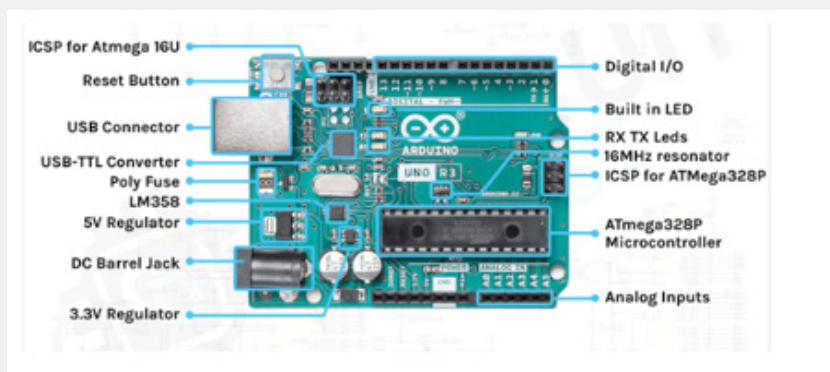


Figure 1: Arduino Uno hardware board.

Disadvantages

Despite the successful penetration in the innovative market, Arduino boards come with some drawbacks. Arduino boards are constrained by their low processing power that makes them show poor performance in big projects [16]. Also, Arduino boards have

limited memory capacity that reduces their speed, efficiency, input and output data storage [17]. In addition, Arduino boards have been found unfavorable for real-time applications because they depend on an operating system that does not support real-time monitoring figure 1.

Security Concerns

With the advancement of the Internet of Things, Arduino boards are easily accessing a wide range of interconnections with devices, a move that is becoming threatened by security issues. The three main potential vulnerabilities are unauthorized access, malware risks, and data privacy concerns.

Hackers and unauthorized users are easily accessing poorly secured Arduino board systems and collecting data, a problem that is leading to data leakage. This problem can be twinned with data privacy concerns, where people claim that the transmission of data across Arduino systems exposes private data to users who might misuse the data and risk the owners of such data. Since Arduino boards can be connected to the internet, they can

be attacked by malicious viruses that can ruin their functionality, data storage, and software components [1].

Future Prospects

Arduino has a promising future because it has a growing community that is improving its hardware and software systems figure 2. Future Arduinos are expected to come with better processing power to handle complex projects [2]. Also, future Arduino boards will be linked with advanced communication techniques such as LoRa, which have the potential to double Arduino's IoT applications [3]. Furthermore, Arduino is expected to be a key contributor to STEM education, which will continue to empower upcoming engineers and programmers [4].

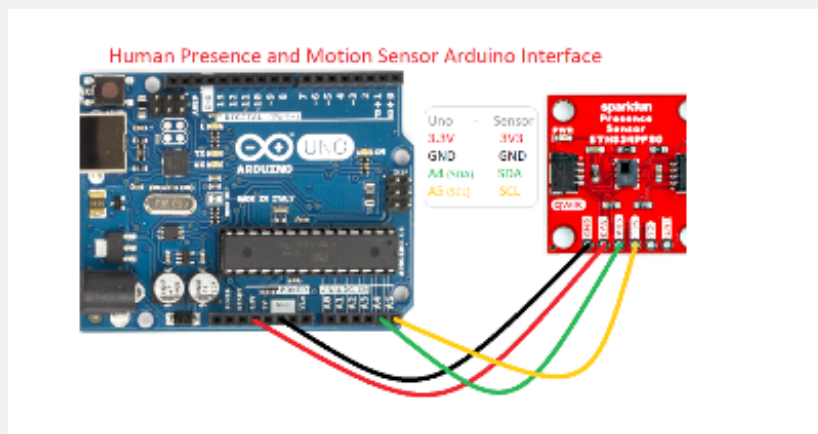


Figure 2: Human presence and motion sensor Arduino interface.

Conclusion

Arduino boards have created an enabling environment for advancing prototyping and the creation of embedded systems for innovation activities. These facilities have transformed automation, robotics, and the Internet of Things while still boosting a growing network of engineers and developers who can share ideas and solve problems through a social forum. While challenges persist, the future of Arduino boards is promising due to constant research and innovations.

References

1. Park SH, Kim WH, Seo SH (2015) Development of the educational Arduino module using the helium gas airship. *Modern Physics Letters B* 29: 1540050.
2. Subekti S, Pranoto H, Rukasah Salmon B, Qomarudin Yusuf S, Suyadiyanto S, et al. (2020) Preventive maintenance of taper bearing using Arduino in the application of industry 4.0. *International Research Journal of Engineering, IT & Scientific Research* 6(4): 1-14.
3. Rosly MA, Shaari MF, Samad Z. (2015) Feasibility Study of Arduino Microcontroller Usage for IPMC Actuator Control. *Applied Mechanics and Materials* 793: 625-629.
4. Purwaningsih S, Pebralia J, Rustan R (2022) Development of Smart Trash Cans Using Arduino Uno-Based Ultrasonic Sensors for Mask Waste. *Journal of Physics Coil* 5(1): 1-6.
5. Gheorghe AC, Stoica CI (2021) Wireless Weather Station Using Arduino Mega and Arduino Nano. *Scientific Bulletin of Electrical Engineering Faculty* 21(1): 35-38.
6. Murthy MN, Ravinder G, Sreelatha CJ (2022) Designing Low-Cost Arduino Powered Spin Coater for Thin Film Deposition. *Advanced Materials Research* 1169: 49-55.
7. Canto R, Bufalari I, D'Ausilio A (2011) Timing accuracy in behavioral experiments: A comparison of different hardware solutions. *Behavior Research Methods* 43(3): 763-770.
8. Chambers CD, Brown J (2003) The role of timing in behavioral research: A review of the literature. *Psychological Bulletin* 129(5): 681-703.
9. Plant J, Turner R (2009) Real-time control in behavioral experiments: A review of hardware and software solutions. *Journal of Experimental Psychology: General* 138(3): 345-360.
10. Groerer T, Adenew M, Williams E (2022) Sunny with a Chance of Servos: Solar-Powered Arduinos. *Physics Teacher* 60(9): 724-726.
11. Roumen GJ, Fernaeus Y (2021) Envisioning Arduino Action. *International Journal of Child-Computer Interaction* 29: 100277.

12. Hossameldin A, Kravchuk O (2021) Prosthetic hand using ARDUINO. Thesis XHYPE.
13. Jyrkkä J (2016) Solar panel measurement system for Arduino development platform. Bachelor's thesis, University of Oulu.
14. Mustakangas A (2016) Solar panel measurement system for Arduino development platform. Bachelor's thesis, University of Oulu.
15. Rukmana STE, Mayub A, Medriati R (2019) Prototype Rat Detection and Repellent in Oil Palm Nursery Based on Arduino. Journal of Physics Coil 2(1): 9-16.
16. Roumen GJ, Fernaeus Y (2021) Envisioning Arduino Action: A collaborative tool for physical computing in educational settings. International Journal of Child-Computer Interaction 29: 100277.
17. Dolinay J, Dostalek P, Vasek V (2016) Arduino Debugger. IEEE Embedded Systems Letters 8(4): 85-88.



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