ISSN (Online):3048-5088

International Journal of Advancement and Innovation in Technology and Research (IJAITR)

Volume 1, Issue 2, (Jul-Dec) 2024

Ardu Arm: The User-Friendly Wireless Robotic Arm

Param Gupta[1], P. Anitha Rajkumari[2]
1-Student, Department of CSE, 2-Assistant Professor, Department of CSE
SRMIST Delhi NCR Campus
Modinagar, Ghaziabad

***Abstract*— In today's world there is an increasing need to create artificial arms for different inhuman situations where human interaction is difficult or impossible. They may involve taking readings from an active volcano to diffusing a bomb. This work proposes to build a robotic arm (prototype) . The main focus is to design, and program a robotic arm with five degrees of freedom and talented to accomplish accurately simple tasks, such as light material handling. The robot arm is equipped with several servo 40 motors which do links between arms and perform arm movements. A microcontroller enabled arm with servo motors has the capability of modifying position. Initially the work focuses on the foundational aspect, utilizing an Arduino UNO microcontroller and a basic arm structure. It lays the groundwork for subsequent developments, enabling precise control and manipulation of the arm's movements. Next phase introduces a wireless element by incorporating an HC-05 Bluetooth module. This addition enhances the arm's mobility and opens opportunities for remote control. The final phase, involves the development of an Android app for wireless control of the robotic arm. This user-friendly interface makes it easier for users to interact with the arm, demonstrating the integration of hardware and software skills.**

The future prospects of the work is promising, with potential applications in industries such as manufacturing, healthcare, and education. The wireless control feature offers increased flexibility and efficiency, while the Android app expands accessibility and usability.

Index Terms: artificial, robotics, IoT, arm, wireless, microcontroller, mobility, degree, sensor.

I. INTRODUCTION

A robotic arm is very similar to human arm. It is a kind of mechanical arm that can be programmed. After programming it can act like a human arm.

The arm can be designed with various segments. Segments are lookalike a shoulder, elbow, and wrist. These segments are joined with the help of motors, which makes its movement in every possible direction. In its deployment area each and every arm has to work precisely and accurately.

Any robotic arm is generally having 5 major parts viz: Input / Output, Controller (brain of arm), joints and actuators (for movements), sensors (internal sensors), links (to connect joints) and end of arm tool.

Any robotic arm is designed with primary goal to perform recurring tasks that need a perfect precision. Sometime work may be risky in nature. It can be used for assembling of products, segregation, transferring material, wielding etc.[1] [2]

Robotic arm is an industrial revolution that not only make task easier but it enhance the working capability. Some common benefits are: simplification of task, improved safety, increased productivity, fine precision, less time consumption, higher flexibility, decrease errors, wastage of material etc.[3][4]. The robotic arms, in industry, were initially used to move objects from one place to another [5].

For automation purpose it becomes essential to have a programmed robotic arm. To develop such an arm the best possible way to use microcontroller that controls the mechanism of an arm. The work uses arduino microcontroller. Arduino is an open-source hardware and software platform that enables enthusiasts, hobbyists, and professionals to create interactive electronic projects. [6][7]. It was developed in 2005.Thework aims at creating an arduino powered robotic arm which will have 5 DOF (Degree of Freedom).The work prioritizes user experience by incorporating intuitive control methods and exploring the potential of mobile app integration. The core functionalities are established in the initial phase, followed by the introduction of wireless control via Bluetooth in the subsequent stage. Finally, the project culminates in the development of a dedicated mobile application for enhanced user interaction.

Throughout the development process, the work emphasizes the potential for scalability and diverse connectivity options. By exploring modifications to the hardware design and control code, the work demonstrates how the robotic arm can be adapted to perform tasks requiring varying degrees of power, precision, and autonomy. This work not only contributes to the development of user-friendly robotics but

also lays the groundwork for future advancements in control systems, sensor integration, and potential applications across a wide range of fields.

II. Literature Review

Robotic arm innovation helps industry for making task easier and cost effective with safety measures. In its infant stage a robotic arm was controlled by many other means like computer terminals, Joysticks, even interfacing them with the internet [1] [8]. Generally any robotic arm is controlled by a central controller which makes uses of Human Arm Movement Sensors, Microcontroller Processing Unit Microcontroller Robotic Arm Actuators (Servo Motor Controller).

The work prioritizes user experience by incorporating intuitive control methods and exploring the potential of mobile app integration [8] [9]. The core functionalities are established in the initial phase, followed by the introduction of wireless control via Bluetooth in the subsequent stage. Finally, the project culminates in the development of a dedicated mobile application for enhanced user interaction.

Throughout the development process, the work concentrates on the potential for scalability and diverse connectivity options. By exploring modifications to the hardware design and control code, the project demonstrates how the robotic arm can be adapted to perform tasks requiring varying degrees of power, precision, and autonomy.

This research not only contributes to the development of user-friendly robotics but also lays the groundwork for future advancements in control systems, sensor integration, and potential applications across a wide range of fields [8] present the design and development of an Android app for controlling a robotic arm. Integrating user-friendly interfaces with robotic arms can enhance control and accessibility, particularly in scenarios requiring real-time adjustments. However, app functionality may depend on specific hardware configurations [9]. The field of robotic arms for inhuman situations is constantly evolving. Soft robotics offers potential for safe interaction and manipulation in confined spaces [10]. Additionally, the usage of low powered Bluetooth module HC-05 [4] [11]. A robotic arm is beneficial in industrial tasks. It can be designed with a capability of learning different movements and reproduces them as required. These advancements can further enhance the effectiveness of robotic arms in various inhuman tasks. The design controlled by the Arduino platform receives orders from the user's mobile application through wireless controlling signals, that is Bluetooth [12] [13]. The application of such robotic arm can be helpful to the patient with disability of body part. These devices can be used in rehabilitation process. Arms designed for specific work may get interruption during working. Robotic manipulators are electronically controlled mechanical devices with several links, which are used to perform any specific task under certain circumstances [14] [15].

III. Problem Statement

Current robotic arm learning experiences often lack a structured approach for beginners, particularly focusing on affordability and user-friendliness. This can present several challenges:

Complexity: Many existing projects require advanced programming skills or expensive equipment, making them inaccessible to those new to robotics.

Limited Functionality: Introductory projects might offer basic arm movement but lack functionalities like wireless control or user-friendly interfaces, hindering the learning experience.

Disjointed Learning: Learning resources might not provide a well-defined path that progressively builds upon concepts, making it difficult to grasp the underlying principles of robotic arm control.

This work aims to address these limitations by developing a robotic arm in phases using an Arduino UNO and readily available components. The focus is on creating a user-friendly and affordable system that progressively introduces functionalities like wireless control and mobile app integration. This phased approach caters to users with varying skill levels while providing a structured learning experience in robotics and control systems.

IV. Methodology

The methodology employed in developing a user-friendly, programmable and controllable robotic arm across three distinct phases. Each phase builds upon the previous, progressively introducing functionalities and enhancing user experience

A. Materials and Tools

1. Hardware:
   a. Arduino UNO microcontroller board
   b. Servo motors (quantity and specifications based on arm design)
   c. Building materials for the arm structure (wood, 3D-printed parts, etc.)
   d. HC-05 Bluetooth module (Phase 2)
   e. Android mobile device (Phase 2)

Fig.-1: Structure of the Arm

2. Software:
a. Arduino IDE (Integrated Development Environment)
b. Android development tools (e.g., Android Studio) (Phase 3)

B. Phase 1: Building the Foundation

1. Arm Structure Selection:
   a. Option 1: Pre-made Arm Structure
   b. Option 2: 3D-Printed Arm Design
2. Arduino Code Development

C. Phase 2: Introducing Wireless Control

1. HC-05 Bluetooth Module Integration
2. Modified Arduino Code

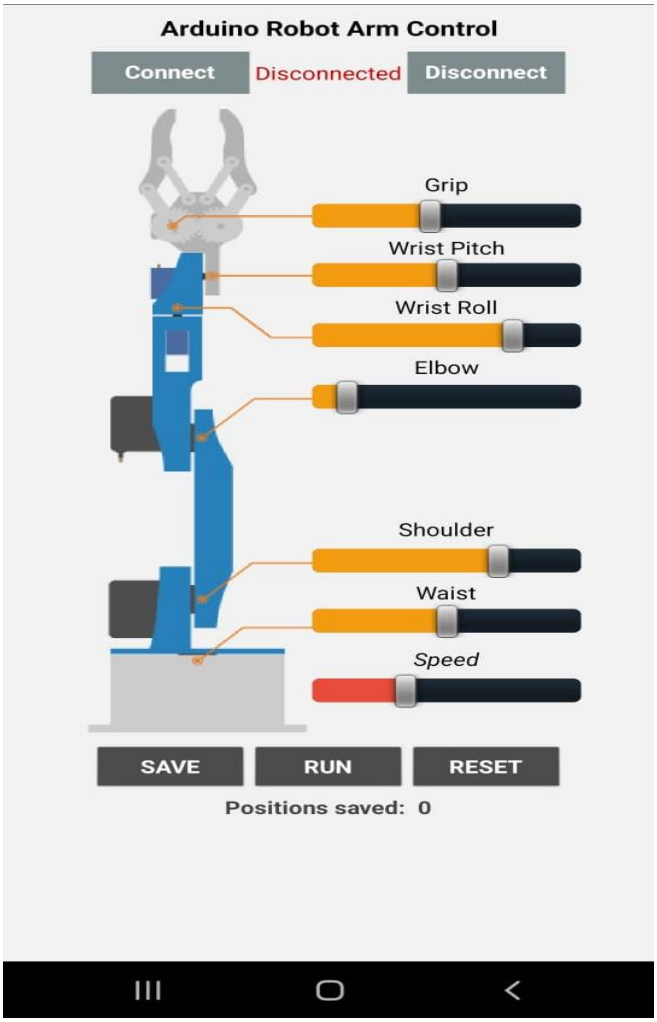

Fig 2: Proposed UI For the App

D. Phase 3: Mobile App Integration

V. Future Prospects

This project's strength lies in its adaptability. By making minor modifications to the core functionalities established in the previous phases, the robotic arm can be transformed into a powerful tool for diverse tasks.

A. Scalability through Hardware Adjustments

1.Heavy Machinery Operation
2. Precision Tasks
3.Specialized End-Effectors

B. Connectivity Options for Diverse Applications

1.Remote Operations by adding Wi-Fi control
2.Sensor Integration

Hence, Just by making minor changes to the hardware or software we can easily make this project into anything that fits within the use case from precession tasks such as operations to heavy usage like mining, we can also add specialized sensors for very specific tasks such as collecting materials from hazardous locations.

VI. Conclusion

The work has explored the development of a user-friendly robotic arm in a phased approach. By utilizing an Arduino UNO as the central processing unit and readily available components, the project prioritizes accessibility and user experience.

The initial phase focuses on the core mechanics, establishing basic functionalities through a pre-made arm structure or a 3D-printed design. This initial stage allows users to familiarize themselves with Arduino programming for controlling servo motors and lays the groundwork for further exploration. As the project progresses, wireless control is introduced via an HC-05 Bluetooth module. This empowers users to control the arm remotely using a smart phone or tablet, offering greater flexibility and user convenience. The final phase elevates user interaction by integrating a dedicated Android application for control. This app provides an intuitive interface with controls that map directly to the desired movements of the arm. The seamless communication between app and Arduino through Bluetooth allows for precise and user-friendly control of the robotic arm.

The true strength of work lies in its scalability and connectivity potential. Minor modifications to the core design and code can transform the arm into a versatile tool for diverse applications. By utilizing sturdier materials and high-torque servo motors, the arm can be scaled to handle heavier objects, opening doors to industrial applications. Alternatively, increased degrees of freedom and specialized end-effectors can cater to tasks requiring high precision, such as intricate surgeries or delicate electronics assembly. Furthermore, integrating Wi-Fi modules and sensors expands the arm's reach and capabilities. Imagine remote operations like bomb disposal or sample collection from

hazardous environments, all controlled from a safe distance through a secure internet connection. Sensor integration further enhances the arm's functionality, allowing it to adapt to changing conditions and perform tasks with greater autonomy in search and rescue operations, hazardous material handling, or even autonomous exploration. In conclusion, this project serves as a stepping stone for exploring the world of robotics. It offers a user-friendly platform for beginners to gain practical experience in building, programming, and controlling robotic arms. The project's inherent scalability and diverse connectivity options lay the groundwork for future development, sparking innovation and exploration in various fields. With continued development, this project's core principles can be adapted and expanded upon, pushing the boundaries of robotic capabilities and contributing to advancements in automation, remote manipulation, and precision work across various industries and scientific endeavors.

VI. REFERENCES

[1] C. S. Chen, S. K. Chen, C. C. Lai, and C. T. Lin, "Sequential motion primitives recognition of robotic arm task via human demonstration using hierarchical BiLSTM classifier," IEEE Robotics and Automation Letters, vol. 6, no. 2, pp. 502–509, Apr. 2021, doi: 10.1109/LRA.2020.3047772.

[2] X. Chen, X. Huang, Y. Wang, and X. Gao, "Combination of augmented reality based brain- computer interface and computer vision for high-level control of a robotic arm," IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 28, no. 12, pp. 3140–3147, Dec. 2020, doi: 10.1109/TNSRE.2020.3038209.

[3] P. Sutyasadi and M. B. Wicaksono, "Joint control of a robotic arm using particle swarm optimization based H2/H∞ robust control on arduino," TELKOMNIKA (Telecommunication Computing Electronics and Control), vol. 18, no. 2, Apr. 2020, Art. no. 1021, doi: 10.12928/telkomnika.v18i2.14749.

[4] A. H. Basori, "End-effector wheeled robotic arm gaming prototype for upper limb coordination control in home-based therapy," TELKOMNIKA (Telecommunication Computing Electronics and Control), vol. 18, no. 4, Aug. 2020, Art. no. 2080, doi: 10.12928/telkomnika.v18i4.3775.

[5] T. T. Nguyen, "Sliding mode control-based system for the two-link robot arm," International Journal of Electrical and Computer Engineering, vol. 9, no. 4, pp. 2771–2778, Aug. 2019, doi: 10.11591/ijece.v9i4.pp2771-2778.

[6] R. Jain, M. Nayab Zafar, and J. C. Mohanta, "Modeling and analysis of articulated robotic arm for material handling applications," IOP Conference Series: Materials Science and Engineering, vol. 691, no. 1, Dec. 2019, Art. no. 12010, doi: 10.1088/1757- 899X/691/1/012010.

[7] M Alblaihess, William Farrar, Fernando Gonzalez and Yifan Shao "Designing a robotic arm for moving and sorting scraps at Pacific Can, Beijing, China,", Worcester Polytechnic Institute, Beijing, 2015.

[8] Rupali R. Nimje, P. R. Indurkar , D. M. Khatri "Design and Development of an Android App for Controlling a Robotic Arm", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 10, Issue V, May 2022

[9] Nguyen, H. Q., & Dang, T. T. An Android Application for Remote Control of a Robotic Arm using Bluetooth Low Energy (2022)

[10] Yang, S., & Li, X. Development of an Android App for Intuitive Control of a Robotic Arm for Educational Purposes (2021).

[11] Theint Win Lai, Zaw Lin Oo, Maung Maung Than "Bluetooth Based Home Automation System Using Android and Arduino", The 2nd Conference on Computer application and Research (CCAR 2018), https://doi.org/10.5281/zenodo.5503596

[12] Arpitha H V, K M Shweta, Nikhil S Pattar, Rahul Kuntoji, Chetan B V, "Arduino Based Trainable Robotic Arm" International Journal for Research Trends and Innovation, vol 2 , issue: 5, pp.337-339, 2017. doi: 10.6084/m9.doione.IJRTI1705064

[13] Hussein Mohammed Ali, Yasir Hashim, Ghadah Alaadden Al-Sakkal "Design and implementation of Arduino based robotic arm" in International Journal of Electrical and Computer Engineering (IJECE), Vol. 12, No. 2, April 2022, pp. 1411~1418, DOI: 10.1159 1/ijece.v1212.

[14] Iris Jakob, Alexander Kollreider, Marco Germanotta, Arianna Crucian i, Luca Padua, Irene Aprile "Robotic and Sensor Technology for Upper Limb Rehabilitation" Innovations Influencing Physical Medicine and Rehabilitation, Volume 10, Issue 9, pages 189-197, 2018, https://doi.org/10.1016/j.pmrj.2018.07.011

[15] Venkata Satya, Durga Manohar Sahu, Padarbinda Samal, Chinmoy Kumar Panigrahi "Modelling, and control techniques of robotic manipulators: A review" 3rd International Conference on Contemporary Advances in Mechanical Engineering, Volume 56, Part 5, pages- 2758-2766, 2022, https://doi.org/10.1016/j.matpr.2021.10.009