Design of Robotic Arm Control Model for Industrial Applications

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Abstract: *The paper designs the device to support in industrial applications. Therefore, we present the research and development on the design of a robotic arm on 4-wheel robot that assists in picking up objects and moving them to a safe place in this paper. We divided it into parts ,first one is manually identify the location of object. Second, the robot arm is placed on 4 wheel robot and it approach object using joystick control. The device with the goal of picking up and drop an object at any position . The paper consists of the block diagram design, the operating principle of the device, the results, and the development analysis.*

Keywords:

I. INTRODUCTION

In response to the burgeoning demands of industrial applications, there has been a noticeable surge in the need for robotic solutions that are not only efficient but also versatile in tackling complex tasks within industrial environments. Traditional methods often struggle to cope with the intricacies involved in tasks such as debris removal, pick-and-place operations, and obstacle manipulation. As industries continually strive for heightened productivity and safety standards, there arises an urgent requirement for innovative technologies capable of streamlining operations and augmenting overall efficiency. It is against this backdrop that this project endeavors to make its mark, presenting a sophisticated robotic arm meticulously engineered for industrial applications.

At the heart of this endeavor lies the Arduino UNO, a microcontroller renowned for its versatility and power-efficient performance. Leveraging the capabilities of this compact yet potent microcontroller, our project aims to realize a real-time wireless controlled robotic arm that seamlessly integrates into industrial workflows. By harnessing wireless communication protocols, such as Bluetooth or Wi-Fi, operators can remotely command and supervise the robotic arm's movements with precision and ease.

Moreover, the integration of real-time control mechanisms empowers operators with instantaneous feedback and response capabilities, ensuring optimal efficiency and safety during operation. With the ability to adapt to dynamic environments and unforeseen challenges on the fly, the real-time wireless controlled robotic arm represents a paradigm shift in industrial automation, ushering in a new era of agility and productivity.

In essence, this project represents a culmination of technological innovation and industrial pragmatism, aimed at revolutionizing the way tasks are executed within industrial settings. By harnessing the capabilities of the Arduino UNO and cutting-edge wireless communication technologies, our endeavor seeks to empower industries with a versatile and efficient robotic solution tailored to their unique operational requirements.

II. RELATED WORK

Currently, robotic devices for rescue are considering and developing for many applications [10]–[18]. In [10], the authors designed to develop a prototype of robotic vehicle using mobile devices as controller by using Bluetooth transmission. It can transmit from 10 m to 100 m depending on the type of Bluetooth module. In [11], the authors designed a hybrid robotic arm using soft and inflatable bladders for actuation. It is derived based on system identification and used to derive a linear quadratic Gaussian controller. The authors [12] designed an experimental lightweight robot arm and controller. It uses a two-degree of freedom robot, driven by two electric motors, and is controlled by three Intel 80286/80287 microprocessor/coprocessor pairs. The authors [13] designed an ARM vehicle robot based on a STM32F103ZET6 microcontroller.

Existed System Block Diagram: In a robotic arm system without Adafruit shield and wireless joystick controller, the central control unit is a microcontroller (MCU) responsible for orchestrating the arm's movements. Serving as the brain of the system, the MCU receives input signals from a user interface, which can be a combination of physical controls like buttons or switches, or a digital interface such as a computer or smartphone app. These input signals are interpreted by the MCU to determine the desired motion of the robotic arm.

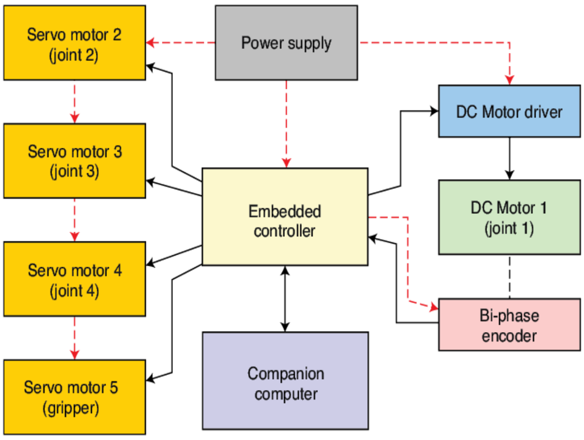

Fig 1:Existing system block diagram of robotic arm

In a robotic arm system without Adafruit shield and wireless joystick controller, the central control unit is a microcontroller(MCU)responsible for orchestrating the arm's movements. Serving as the brain of the system, the MCU receives input signals from a user interface, which can be a combination of physical controls like buttons or switches, or a digital interface such as a computer or smartphone app. These input signals are interpreted by the MCU to determine the desired motion of the robotic arm.

To translate these commands into physical movement, the MCU interfaces with a motor driver circuit. This circuit acts as a bridge between the MCU and the servo motors that drive the robotic arm's joints. It amplifies the control signals from the MCU and ensures proper power distribution and voltage regulation to the motors. The servo motors themselves are the actuators responsible for moving the various joints of the 12 robotic arm. Each servo motor corresponds to a specific joint and is controlled by the MCU using Pulse Width Modulation (PWM) signals. This allows for precise angular control over the arm's movements, enabling it to perform tasks with accuracy and repeatability.

III. METHODOLOGY

The real-time wireless controlled Robotic Arm project utilizing Arduino UNO presents an innovative solution for remote manipulation and control of robotic mechanisms. The proposed system operates via Bluetooth technology, employing.HC-12 modules for wireless communication.The project integrates two microcontrollers, namely the Arduino Nano and Arduino UNO, to orchestrate the functionality of the robotic arm. The robotic arm assembly includes servo motors, specifically SG90 and MG996R, which facilitate precise and coordinated movements in response to user input.

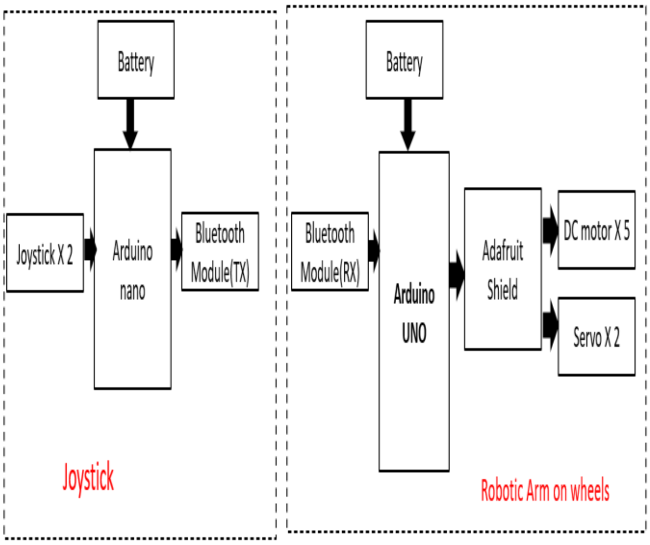

Fig 2. Modeling the robotic arm.

System Integration and Hardware Setup: Begin by integrating the Arduino UNO as the central controller and Arduino Nano for secondary tasks. Connect the Adafruit Motor Shield to the UNO for motor control, including servo motors (MG996R) on the robotic arm chassis and DC motors on the four-wheel chassis. Ensure proper mounting of all components and establish connections with batteries, voltage regulator, and HC-12 module for wireless communication.

Wireless Communication Configuration: Set up the HC-12 modules to enable wireless communication between the joystick modules and the robotic arm. Develop communication protocols to transmit joystick inputs to the Arduino UNO wirelessly, allowing users to control the robotic arm's movements remotely.

Control Logic Implementation:Program the Arduino UNO to interpret joystick commands and translate them into precise movements of the robotic arm's servo motors and the four-wheel chassis' DC motors. Develop control algorithms to coordinate servo motor articulation for the arm's movement and implement logic for navigating the wheeled chassis.

Power Management and Regulation:Install batteries and battery holders to power the system and incorporate a voltage regulator for stable power distribution. Ensure adequate power supply to all components to prevent performance issues or damage due to voltage fluctuations.

Testing and Optimization:Conduct comprehensive testing to verify the functionality and performance of the integrated system. Fine-tune control algorithms and parameters to optimize responsiveness, accuracy, and efficiency. Perform field tests to evaluate the system's suitability for rescue applications and make necessary adjustments based on real-world scenarios and requirements.

In educational institutions and research laboratories, the robotic arm system can serve as a valuable tool for teaching robotics concepts,conducting experiments, and exploring innovative applications.

It fosters hands-on learning experiences and promotes interdisciplinary collaboration in fields such as engineering, computer science, and robotics. Overall, the robotic arm system offers versatile applications across various industries and domains, empowering organizations to optimize processes, improve efficiency, and achieve better outcomes in their respective fields.

IV. RESULTS AND DISCUSSIONS

Incorporated a 4-wheel chassis into the hardware setup to provide mobility to the robotic arm. Mounted DC motors on the chassis and connect them to the Adafruit Motor Shield for control & proper alignment and balance of the chassis to support the weight and movement of the robotic arm.

Fig 3: 4-wheel Arm model

Expanded the control logic to include commands for maneuvering the 4-wheel chassis along with the robotic arm. Developed algorithms to coordinate the movement of the chassis with the articulation of the arm, enabling seamless navigation in various directions.

Fig 4: Joystick

V. CONCLUSION

In this paper, we perform to detect and track objects by using an arm robot with an accuracy of 90%. The results can be used to solve many practice problems such as earthquakes, tsunamis, fire, and flood disasters. We find that the error result depends greatly on the sensor value so it is easy to be affected by external factors. In the future, we will therefore focus on minimizing errors, providing methods to help the system stabilize and operate effectively to improve the accuracy and speed of the system to apply to practice systems

VI. ACKNOWLEDGEMENT

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