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A IMPLEMENTATION PAPER ON ROBOTIC ARM ANGULAR MOTOR DRIVING APPLICATION

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ABSTRACT

The "Robot Arm angular motor application" represents a pioneering project at the forefront of robotics and automation. In today's dynamic industrial landscape, robotic arms play a pivotal role in various sectors, from manufacturing to healthcare. However, the intricacies of programming and coordinating these robotic arms have often posed challenges. This project introduces an innovative software application specifically designed for robotic arms. The primary goal is to create a user-friendly interface that simplifies the programming and control of robotic arms, enabling users to define, manage, and optimize operation sequences effortlessly. Advanced control algorithms ensure real-time monitoring and coordination, enhancing precision and adaptability in diverse applications. The expected outcomes include a powerful tool that revolutionizes the way robotic arms are operated. Industries such as manufacturing, logistics, healthcare, and agriculture will benefit from increased efficiency, reduced complexity, and improved automation. As robotics technology continues to advance, the Robot Operation Sequencer Application for Robotic Arm emerges as a catalyst for transformative change, promising a future where robotic arms are more accessible, versatile, and indispensable in various domains.

Keywords: Motor Drivers , Robotic Arm, Microcontroller, Power Supply, Programming Environment.

I. INTRODUCTION

A robotic arm is a mechanical device that mimics the functionality of a human arm. It consists of several segments (links) joined by joints, allowing it to move with precision in a controlled manner. These arms are commonly used in industrial settings for various applications ranging from assembly lines to hazardous material handling. Here's a detailed description of robotic arms and their usefulness in industry.

A robotic arm is a sophisticated mechanical apparatus designed to replicate the intricate movements and dexterity of a human arm. Comprising an interconnected series of segments, or links, joined together by joints, this engineering marvel enables precise and controlled motion across multiple axes. These segments are meticulously crafted from lightweight yet durable materials, ensuring optimal performance and manoeuvrability while maintaining structural integrity.

In industrial contexts, robotic arms are indispensable assets, revolutionizing production processes across diverse sectors. Their versatility extends from the seamless automation of assembly lines to the meticulous handling of hazardous materials, safeguarding human workers from potential risks. These robotic arms function as the backbone of modern manufacturing, orchestrating a symphony of movements with unparalleled accuracy and efficiency.

II. LITERATURE REVIEW

Advancements in Robotic Arm Development

The development of robotic arms has been a focal point in the realm of robotics, witnessing significant advancements over the years. This literature review aims to explore and analyze recent research papers focusing on various aspects of robotic arm design, control, and applications.

Gesture-Controlled Robotic Arm

Saleheen et al. (2023) present a novel approach to robotic arm control through gestures. Their work, showcased at the International Conference on Computer Science, Information Technology and Engineering (ICCoSITE) in

2023, highlights the integration of gesture recognition technology with robotic arms, enabling intuitive and user-friendly interaction. This innovative control mechanism opens new avenues for human-robot collaboration, offering enhanced flexibility and ease of operation in diverse industrial and domestic settings.

Design and Development of a Robotic Arm

Kruthika et al. (2016) delve into the fundamental aspects of robotic arm design and development. Their research, presented at the International Conference on Circuits, Controls, Communications and Computing (I4C) in 2016, provides insights into the structural components, kinematics, and actuation systems of robotic arms. By addressing key design considerations and implementation challenges, the study contributes to the foundational knowledge base essential for creating robust and efficient robotic arm systems.

Robotic Arm Control Based on Internet of Things (IoT)

Fu and Bhavsar (2019) explore the integration of robotic arm control with the Internet of Things (IoT), a paradigm that enables seamless connectivity and data exchange between devices. Their research, showcased at the IEEE Long Island Systems, Applications and Technology Conference (LISAT) in 2019, demonstrates the potential of IoT-enabled robotic arms in smart manufacturing and automation. By leveraging real-time data insights and remote monitoring capabilities, IoT-driven control systems enhance operational efficiency and adaptability in dynamic industrial environments.

Robotic Arm with Proximity and Color Detection

Wali-ur-Rahman et al. (2018) propose a robotic arm system equipped with proximity and color detection capabilities. Their study, presented at the IEEE International Conference on Power and Energy (PECon) in 2018, focuses on enhancing robotic perception and object recognition capabilities for improved manipulation tasks. By integrating sensor technologies and image processing algorithms, the robotic arm demonstrates enhanced adaptability and versatility in industrial automation scenarios.

Teaching and Learning Robotic Arm Model

Jahnavi and Siv raj (2017) present an educational approach to robotic arm modeling, focusing on teaching and learning methodologies. Their work, showcased at the International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT) in 2017, emphasizes the importance of hands-on experience and interactive learning in understanding robotic arm principles. By providing students with access to robotic arm models and simulation tools, the study fosters a deeper comprehension of robotics concepts and promotes skill development in STEM education.

Development of Robotic Arm Prototype

Chaudhari et al. (2023) introduce a prototype of a robotic arm system designed for specific industrial applications. Presented at the International Conference on Sustainable Computing and Data Communication Systems (ICSCDS) in 2023, their research focuses on practical implementation aspects, including mechanical design, control algorithms, and integration with industrial automation systems. The developed prototype serves as a proof-of-concept for potential deployment in manufacturing environments, showcasing the feasibility and scalability of robotic arm technology for real-world applications.

Robotic Arm Control with Hand Movement Gestures

Bularka et al. (2018) explore the use of hand movement gestures for robotic arm control, leveraging motion sensing technologies and machine learning algorithms. Their research, presented at the International Conference on Telecommunications and Signal Processing (TSP) in 2018, demonstrates the intuitive and natural interaction between users and robotic arms. By mapping hand gestures to specific robotic commands, the proposed control interface enhances user experience and accessibility, opening up new possibilities for human-robot collaboration in diverse domains.

Implementation of Pick & Place Robotic Arm for Warehouse Products Management

Sobhan and Shaikat (2021) focus on the implementation of pick & place robotic arm systems for warehouse automation and product management. Presented at the IEEE International Conference on Smart Instrumentation, Measurement and Applications (ICSIMA) in 2021, their research addresses the challenges of logistics and inventory management through robotic automation solutions. By streamlining warehouse operations and optimizing material handling processes, pick & place robotic arms offer increased efficiency, accuracy, and scalability in modern supply chain management.

III. METHODOLOGY

Proposed Work

The primary objective of this project is to develop a cutting-edge software application, aptly named the "Robot Operation Sequencer," tailored specifically for robotic arms. This application is envisioned to achieve several key objectives:

- **User-Friendly Interface**: Create an intuitive graphical user interface (GUI) that simplifies the process of defining, managing, and optimizing robotic arm operation sequences. The GUI will enable users to interact with robotic arms in a manner that is akin to orchestrating a symphony.
- **Advanced Control Algorithms:** Implement advanced control algorithms that enable real-time monitoring and coordination of multiple robotic arms. These algorithms will provide precision, adaptability, and efficiency to robotic arm operations, ensuring that they can respond dynamically to changing conditions and requirements.
- **Broad Applicability:** Ensure that the Robot Operation Sequencer is compatible with a wide range of robotic arm platforms and control systems. The application should be designed with flexibility in mind, allowing it to seamlessly integrate with diverse robotic hardware.

IV. MODELING AND ANALYSIS

4.1 Stepper Motors working principle

A stepper motor is a type of electric motor that converts electrical pulses into precise mechanical motion. It operates based on the principle of electromagnetism and utilizes a unique design that allows it to move in discrete steps, making it ideal for applications requiring accurate positioning and control. Here's a detailed explanation of the working principle of a stepper motor and how it operates:

Basic Construction: A stepper motor consists of a rotor (or shaft) and a stator, both of which contain multiple sets of electromagnetic coils and poles. The rotor is the movable part of the motor, while the stator is the stationary part.

Electromagnetic Coils: The stator of a stepper motor typically contains multiple sets of coils arranged in a circular or linear pattern. These coils are energized in sequence to generate magnetic fields that interact with the rotor.

Pole Arrangement: The rotor of a stepper motor is typically magnetized with alternating poles, such as north (N) and south (S) poles, arranged in a pattern that corresponds to the coils in the stator. The number of poles on the rotor determines the resolution or step size of the motor.

Step Sequence: Stepper motors operate by stepping through a sequence of discrete positions or steps, with each step corresponding to a specific angular or linear displacement.

The sequence of steps is determined by energizing the coils in the stator in a specific pattern, causing the rotor to move incrementally in response to each pulse of electrical current.

Arduino Connection Application Example:

In this section, we'll show you how to use TB6600 with Arduino to drive stepper motor quickly. Wiring up the TB6600 driver to Arduino Uno controller board as shown below:

TB6600 upgraded one is a kind two-phase hybrid stepping motor driver which suitable for 57/42 phase current below 4.0A. Through 6-digit DIP switch, set 7 subdivisions (1/2A/2B/4/8/16/32) and 8 level output current (0.5A/ 1.0A/ 1.5A/ 2.0A/ 2.5A/ 2.8A/ 3.0A/ 3.5A). It is widely used in a variety of small automation equipment and hardware, such as engraving machine, marking machine, cutting machine, laser phototypesetting, plotter, CNC machine, crystal grinding machine, automatic assembly equipment. The best application target torque is 1.8N.m and below 57 stepping motor, 42 stepping motor.

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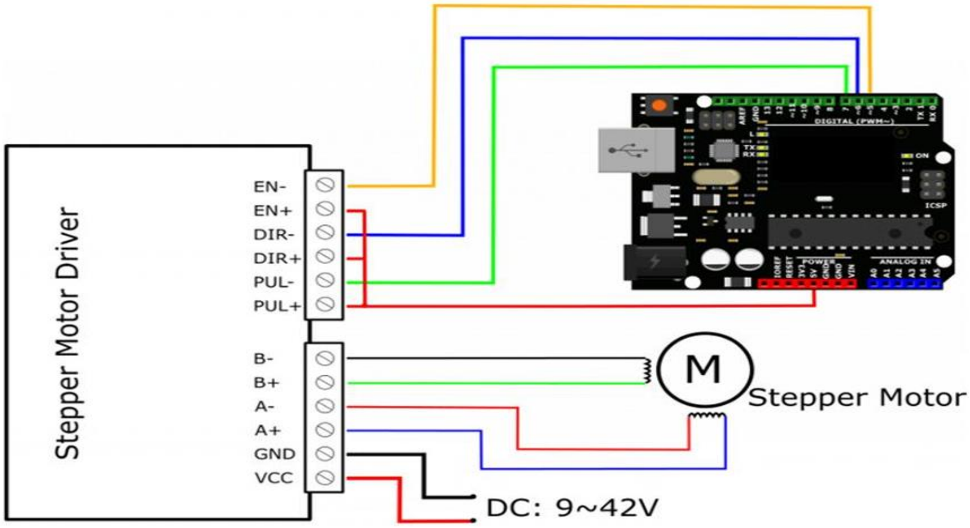

Figure 1: Arduino Connection Application

4.2 Modules

In addition to the programming process, the successful operation of a robotic arm also relies on several key components and subsystems that work together seamlessly to execute the programmed instructions. These components play crucial roles in controlling the motion, positioning, and interaction of the robotic arm with its environment. Here's an extended description of these components:

1. **Main System:** The main computer system serves as the brain of the robotic arm, housing the controller software that orchestrates all the necessary tasks to control the robot. This system interfaces with the operator or external programming devices and translates high-level commands into low-level instructions that the robotic arm can understand and execute.
2. **Motor Control Unit:** The motor control unit comprises a collection of motor driver circuits responsible for controlling the rotation of individual motors within the robotic arm. These motor drivers regulate the electrical signals sent to the motors, ensuring precise speed, torque, and direction control for each motorized joint or actuator.
3. **Stepper Motor Set:** The stepper motor set consists of the actual motors responsible for performing the rotational and movement actions of the robotic arm. Stepper motors are commonly used in robotic applications due to their ability to move in precise increments, allowing for accurate positioning and control. Each stepper motor is connected to its respective motor driver within the motor control unit, receiving commands to rotate to specific angles or move along predefined trajectories.
4. **End-Effector:** The end-effector is the tool or attachment mounted at the end of the robotic arm, which interacts with objects in the environment to perform tasks. The design of the end-effector varies depending on the specific application,
5. ranging from grippers and suction cups for picking and placing objects to specialized tools for welding, painting, or assembly tasks.
6. **Sensors:** Sensors play a vital role in providing feedback to the robotic arm system, enabling it to perceive and respond to changes in its environment. These sensors may include proximity sensors, vision systems, force/torque sensors, and encoders, among others. Proximity sensors detect the presence or absence of objects in the robot's vicinity, while vision systems capture visual information for object detection, recognition, and localization. Force/torque sensors measure the forces and torques exerted on the robotic arm during interactions with objects, providing feedback for precise control and manipulation. Encoders track the position and orientation of each motorized joint, enabling closed-loop control and feedback-based motion planning.
7. **Safety Systems:** Safety systems are essential for ensuring the safe operation of the robotic arm in industrial environments. These systems may include emergency stop buttons, protective barriers, safety interlocks, and collision detection sensors. Emergency stop buttons allow operators to immediately halt the robot's

movements in case of emergencies, while protective barriers and safety interlocks restrict access to hazardous areas.

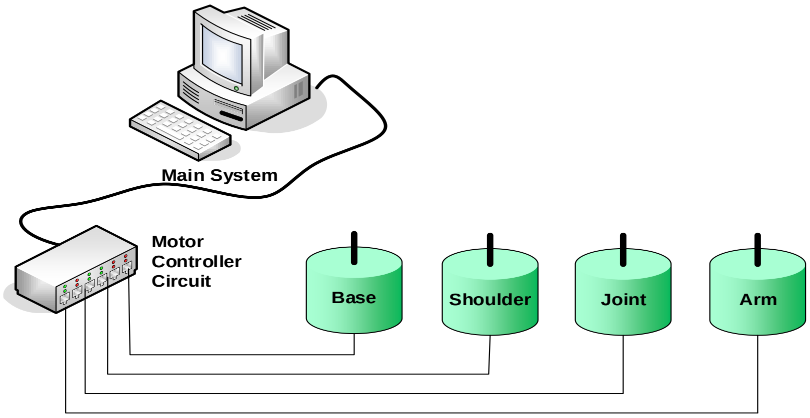

Figure 2: Proposed system hardware working block diagram

V. RESULT AND DISCUSSION

Figure 3: Proposed System Hardware Front View

Figure 4:

The Robotic Arm base connected to DC motors make the Robot to move forward, backward, right and left turn, including forward right, forward left, backwards right, backward left and stay using the joystick controller in the The Robotic Arm is controlled using a slider widget in the Mekabot Software by changing the angular movements. The Robotic Arm picks an object from one place using the angular movement of the servo motors and successfully drops the object.

VI. CONCLUSION

In conclusion, the development of industrial robotic arms offers numerous advantages that significantly impact manufacturing processes and industrial operations. It presents a transformative opportunity for manufacturing industries worldwide. These sophisticated machines offer a myriad of advantages, including increased efficiency, improved quality, enhanced safety, and flexibility in adapting to changing production needs. By automating repetitive and hazardous tasks, robotic arms not only boost productivity but also reduce the risk of workplace accidents and injuries. Furthermore, their ability to operate continuously, optimize resource utilization, and improve ergonomics contributes to cost savings and sustainability in manufacturing operations. As technology continues to advance, the future of industrial robotic arms holds immense potential for driving innovation, increasing competitiveness, and shaping the factories of tomorrow. With ongoing research and development efforts, the integration of robotic arms into industrial processes will continue to evolve, further revolutionizing the way products are designed, produced, and delivered. Overall, the development of industrial robotic arms revolutionizes manufacturing by increasing efficiency, improving quality, enhancing safety, and driving innovation. As technology continues to advance, the potential for further optimization and integration of robotic arms into industrial processes will only continue to grow, unlocking new possibilities for increased productivity, competitiveness, and sustainability in manufacturing industries.

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