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ROBOTIC ARM AND ARDUINO CONTROLLED SMART MACHINE

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Abstract— **Today, artificial arms are increasingly required in a range of dehumanising contexts were establishing and maintaining human connection is difficult at best. Some examples of such tasks include taking readings from an active volcano or defusing a bomb. In this paper, we propose the creation of a robotic arm that mimics the natural movements of a human arm, with the use of accelerometers or human observers. This arm was built using the ATmega32 and ATmega640 platforms, an Arduino UNO or MEGA board, and a personal computer for signal processing. A serial connection will be used to link these gadgets together. Last but not least, this prototype arm may be used to reach out and grab items that are too far away to set down safely. Its use is not limited to the automation of certain sectors but may also be put to use when extremely massive commodities need to be transported between places.**

Keywords-Robotic arm, Arduino UNO, MEGA board, Using ATmea32, Using ATmega640.

I. Introduction

As a result, robots are increasingly being deployed in the workplace to do mundane tasks that humans used to do. The two most prominent branches of robotics are the industrial and service varieties. With the exception of industrial operations, According to the IFR (International Federation of Robotics), a "service robot" is one that can function independently or in a limited capacity under human supervision in order to aid in the care of people and other machines [2]. These robots are increasingly useful in a variety of settings, including the factory floor, the hospital, the field, and the battlefield. Humans may struggle or be put in risk when doing some jobs, such as those requiring them to pick up hazardous chemicals, defuse bombs, or worst case scenario, pick up the bomb itself and move it somewhere safe for containment. As a result, it's possible that a robot will replace human labourers. [4]

It is becoming more common to utilise robots to do mundane tasks that humans would otherwise have to do. The two most prominent branches of robotics are the industrial and service varieties. Service robots, as defined by the International Federation of Robotics (IFR), are robots that perform semi- or fully-autonomous activities for the benefit of humans and other machines. [7]

However, the internet is rapidly becoming the focal point of contemporary culture. People would rather spend time online than do chores around the house. The internet is now accessible from everywhere there is a device with an internet connection, in contrast to the prior decades when it was exclusively wired and users had to be in front of a computer. Including robots in domestic life has this advantage. The robot's body was wired and equipped to make it work as a robotic arm. [9]

Fig 1. A Robotic Arm

An Arduino Uno serves as the robot's central processing unit. Arduino is a free and open-source electronics prototyping platform that features flexible and intuitive hardware and software. The needed motion of the robotic arm may be set by inputting the desired degree of motion, and the robotic arm will then move accordingly. Pressing a button might cause the robotic arm to follow a predetermined path.

II. LITERATURE RIVIEW

Robotic Arm Development using Arduino UNO by Priyambada Mishra, Rik Patel, Trushit Upadhyaya, and Arpan Desai [9]

In this study, a robotic arm with four servo motors at its joints will be controlled by a potentiometer. In this case, an Arduino UNO serves as the brains. It is the Potentiometer that the Arduinos use to read their analogue input signals. The arm's components are secured to their respective servo motors after having been constructed out of cardboard. Lightweight objects are ideal for the arm to pick up and place down. Consequently, servos with low torque and rotational angles between 0 and 180 have been used. Arduino 1.6.10 is utilised for the coding process. Therefore, the primary focus of the research is on developing an inefficient robotic arm for limited applications.

Conceptualization of a Spot-Welding Robot Arm, Including a Gripper and an End Effector authored by Puran Singh, Anil Kumar, and Mahesh Vashishth [10]

The research recommends using a robotic arm equipped with a gripper and two degrees of freedom for spot welding. An AC motor, several threaded shafts, and some spur gears make up the end effector. Design considerations for the robotic arm included the following:

1.To have a rigid structure.
2.Movement of parts to defined angles.
3.To attain consumption of power at optimum level.
4.To perform spot welding operation with the help of end effectors.

The plywood used in the construction of the robotic arm's base has the following dimensions.
Length-48 cm,
Breadth-28 cm,
Thickness-2 cm.

Arm manipulator will be made up of plastic and has the following description-

- Weight=(30)2=60 g for big arm
and (10)2=20 g for small arm.
- Length=25 cm for big arm
And 5cm for small arm.

At the point of assembly between the wrist and the end effector, two different kinds of end effectors are used: one is fixed, while the other may be moved. Spur and worm gears that mesh are attached to a 9 V stepper motor in the end effector assembly. There are 100 revolutions per minute from the stepper motor, and its step angle is 1.8 degrees. An evaluation of the forces acting on each joint is carried out. This robotic arm's lifting function is carried out by its two degrees of freedom (dof), the centre of mass of each of which is located at the arm's midpoint. Each joint of the robotic arm may rotate up to 180 degrees to accommodate its many possible configurations. All of the End Effector's locations must be known in order to calculate the required workspace. Using this technique on robotic arms might boost the efficiency of spot welding processes. The material was easy to work with since it only involved picking up the necessary piece and placing it where it belonged. The robot arms may be built in a variety of ways, and they can rotate at a number of different angles.

A Color-Based Review of the Object-Moving Robot Arm by Areepen Sengsalonga and Nuryono Satya Widodo [11]

Using the motors and photodiode sensors included in this finding together with an Arduino Mega series microcontroller, one may create a manipulator that can sort objects depending on colour. The photodiode detector of light may be used to differentiate between the RGB colour channels. In this setup, the observed colour is shown on an LCD screen in the form of the output from the Arduino Mega 2560. Locating an item's RGB colour is the first step in the relocation process. The robotic arm's gripper may be programmed to choose objects based on colour using data from a photodiode sensor. The Arduino Mega 2560, a microcontroller based on the Atmega2564, is installed in a robotic arm and has 54 digital I/O ports. Additionally, a colour sensor test is performed to evaluate the performance of photodiode sensors in identifying colours. The photodiode's output voltage will be sent to an ADC for analysis before being displayed on the onboard LCD.

Researchers V. K. Banga, Jasjit Kaur, R. Kumar, and Y. Singh used soft computing to model and simulate the motion of a robotic arm [12]

Researchers in this work successfully built a four-axis robotic arm using just soft computing. Genetic Algorithms (GAs) and fuzzy logic have been used to create methods for the guided motion of robotic arms and trajectory planning (FL). Autonomous robots can only function effectively with efficient movement. This architectural layout is used in robotic arms to lessen issues with component motion, friction, and settling time. The optimal joint angles for this four-dimensional robotic system are found by means of genetic optimization. Inverse kinematics for robotic arm movement supports a wide variety of possible joint angle configurations, and this kind of optimization eliminates the need for time-consuming trial and error in order to find the optimal one. Fuzzy logic was used to create these models of joint motion, friction, and lowest settling time.

This article presents the work of Kemal Oltun Evliyaolu1, Meltem Elitaş, and his team as they design and develop a self-adaptive, reconfigurable, and inexpensive robotic arm [13]

The authors of this study used soft computing to develop a 4-DOF robotic arm. Fuzzy logic and genetic algorithms (GAs) have been used to develop techniques for the controlled motion and predetermined path of a robotic arm (FL). Inasmuch as high-performing autonomous robots are continually moving. It is intended to reduce the amount of time it takes for the various components of a robotic arm to stop moving, rubbing against one another, and finally come to rest. In order to find the best possible joint angles for this four-dimensional robotic system, genetic optimization is applied. Optimization of this kind may replace the time-consuming iteration required to find the optimal set of joint angles for inverse kinematics-based robotic arm motion. Joint motion, friction, and least settling time features were used to inform the development of these fuzzy logic models.

Anughna N, Ranjitha V, and Tanuja G., "Design and Implementation of Wireless Robotic Arm Model utilising Flex and Gyro Sensor," [14]

As can be observed from the research, the author collects data with the use of accelerometers. The used controller is Arduino's Atmega328. The fingers on a human arm are detected by flex and gyro sensors, and the data from these sensors is sent to an Arduino ATmega328, which then controls the servo motors. The Arduino was written in C, one of its included programming languages. Fingertip access to the Flex and Gyro Sensors was a welcome feature.If a change is detected, the controller evaluates the information from both sensors. The impending the article covers the usage of five Flex Sensors near to the fingers and additional Gyros for convenience.

Kurt E. Clothier and Ying Shang's A Geometric Approach for Robotic Arm Kinematics Includes Hardware Design, Electrical Design, and Implementation [15]

The robotic arm was placed in an autonomous fashion thanks to the author's usage of geometry in this work. The iRobot command model serves as the main controller for the robot. The Atmega 168 microcontroller acts as the design's hub, and its four expansion ports allow for the connection of other gear. iRobot Make makes use of three external sensors. Two SharpGP2D12 rangefinders and one GP2D120 are used. These sensors emit an infrared beam, the angles of which are then used to determine how far apart the detected objects are. Both GP2D12 and GP2D120 can identify things from a distance of 10 to 80 cm, whereas the former can detect objects as close as 4 to 30 cm. The Element Direct, Inc. screen used here was built for compatibility with a command module and had a four-character display. The robot's front is equipped with two infrared range finders for scanning. We can utilise the millimeter-scale distance measured when an item blocks these sensors' line of sight to pinpoint its position.

Gurudu Rishank Reddy and Venkata Krishna Prashanth Eranki, "Design and Structural Analysis of a Robotic Arm," [16]

The researchers in this work built a robot arm with four degrees of freedom to move metal sheets down a conveyor. Getting fewer people to move sheets from a stack to a shearing machine was a major factor in the development of this pick and place robotic arm. A robotic arm and two pneumatic cylinders were developed for the feeding mechanism to ensure the safety of the workers. The RCC is installed in the robotic arm and combines the position sensor for the manipulator and the brains of the robot. With RCC control, robots can really have meaningful interactions with their environments. The manipulator has an option for automatic optimization based on the current configuration. Safety in the workplace may be assured thanks to the robot's built-in self-awareness system. A vacuum is created by the end effector's vacuum cup, which draws the object into the cup. Features including speed regulation, repeatability, and high resolution were prioritised while designing the manipulator.

By Dr. Bindu A. Thomas, Stafford Michahial, Shreeraksha.P, Vijayashri B. Nagvi, and Suresh M. [17]

An autonomous robotic arm, tailored specifically for use in manufacturing settings, is among the topics covered by this research. The prototype functioned well. Humans would find it less difficult to maintain a safe distance from potentially hazardous objects in the workplace if this structure were in place. It is strongly recommended that businesses adopt the usage of robots, particularly for safety and cost savings. In their design, they included a 5-degrees-of-freedom (DoF) manipulator. The microcontroller sends instructions to the many channels that make up the network interface. A microprocessor controls the electric motor's speed, direction, and motion in response to orders. The microcontroller has programmed the robot's obstacle sensor to alert it to potential danger within a 10-centimeter radius of the robot's working area. If an impediment is encountered for the first time, operation is halted. If the problem persists after another attempt at resolution, a notification system (like a buzzer) is triggered to inform the appropriate people that the item has to be taken out of circulation.

Recognition and grasping of natural objects by robots, by A Hui Wei and B Yang Chen [18]

In this research, the authors suggested a method for real-time image-based contour detection and matching to pinpoint the exact location of an item to be gripped. Using this technique, a single monocular camera may be utilised for closed-loop robotic grasping. This approach required far less work than current methods, especially no-prerequisite-training deep learning algorithms based on visual data. New approaches to form matching, superpixel segmentation, and edge identification have been implemented. The visual servoing methods the authors used here did not need perfect camera positioning or calibration for use in varying conditions. The experimental results demonstrated the method's superior reliability, performance, and resilience under various testing scenarios.

III. ROBOTIC ARM

A robotic arm is a mechanism that functions similarly to a human hand; it consists of a series or parallel network of connections. In certain cases, it may be programmed to carry out a specific task.

This displacement, which may be either translational or rotational, is caused by the connections between the manipulator's joints. The arm's joints form a kinematic chain. The End Effector is the terminal link in this kinematic chain, and it may be thought of as analogous to a human hand. [10]

Types-

- **Cartesian robot:-** Cartesian robots consist of three prismatic joints with axes that are perpendicular to the coordinate system. Useful in fields such as arc welding, pick-and-place assembly, and other applications that need pinpoint accuracy.
- **Cylindrical robot:-** One definition of a cylindrical robot is one having a cylindrical coordinate system provided by its axes. It may be used for a wide variety of tasks, such as operating spot welding and diecasting machines. [12]
- **Spherical robot: -** Robots having axes that form a polar coordinate system are known as spherical robots. It is used in a wide variety of manufacturing processes, from arc welding and spot welding to diecasting and fettling.
- **Scara Robot: -** Scara is a plane-compliant robot with two parallel rotary joints. Among its many applications are pick-and-place work, sealant, assembly procedures, and machinery management.
- **Articulated robot: -** When a robot's arm has more than two fixed joints, we call it "articulated." Uses for this product include arc welding, gas welding, fettling machines, spray painting, and assembling. [14]
- **Parallel Robot: -** Concurrent prismatic or rotational joints characterise the arms of a The Robotic Parallel. One example is a mobile platform used to manage flight simulators housed in a cockpit environment.
- **Anthropomorphic robot:-** Arms on anthropomorphic robots are designed to seem like human hands, complete with fingers and thumbs.

IV. OBJECTIVES

There are many major goals that may be accomplished with robotic system installations in factories.

1) Saving of manpower.
2) Improved quality and efficiency.
3) Save human’s life.
4) Ability to work in any hostile environment.

V. BLOCK DIAGRAM

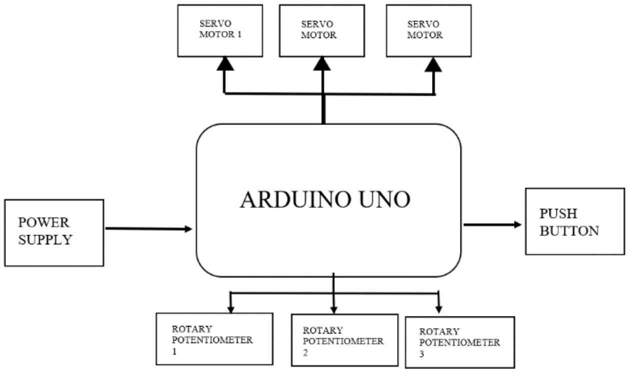


Fig 2. Arduino-based robotic arm block diagram

VI. METHODOLOGY

We tried to model the robot's motions like those of a human arm as closely as possible. This section will summarise the robot's components in detail, separating them into the mechanical and electrical categories.

Mechanical Design: The robot stood on a spherical base that was 22 cm in diameter and 15 cm in height. Servo motors are used to directly power the robot's degree of freedom mechanism. Acrylic is used as the robot's base because it meets all of the requirements for this application: it is light, cheap, robust, and able to sustain the weight and movement of the motors. Lightweight and stiff enough to mimic the bone structure of a human arm, aluminium servo brackets are utilised to construct the robotic arm. The aluminium used for the robot arm's primary structure is also used for the gripper. [18]

Electrical Design: The block diagram is unchanged as before. This robot can essentially be broken down into three parts: the base, the shoulder, and the elbow.
Robots have found widespread application in modern society, from the domestic sphere to the industrial sphere to the realms of security and entertainment. The number of robots available to serve as human companions, helpers around the home, and service workers is growing rapidly. Because robots are so commonplace now, we must use them to address pressing problems. The pandemic has caused widespread problems with hygiene and sanitation. Robotic vacuum cleaners that can be set to run autonomously will fix this problem. [19]

Automation

"Automation" manufacturing and distribution processes where few or no human workers are involved. The use of automated tools, processes, and systems has made it possible to execute many formerly human-only tasks with greater efficiency, reliability, and speed. The two possible modes of operation for autonomous models are:

1) In an open-loop control system, the "process output" does not affect the controller's control action in any way.

2) When the controller's reaction is determined by the process's output, the process is said to be "closed-loop controlled." [21]

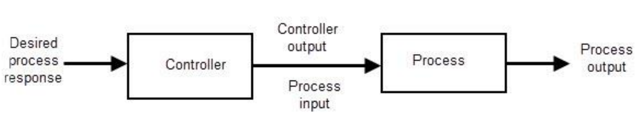


Fig 3. Open Loop Control System

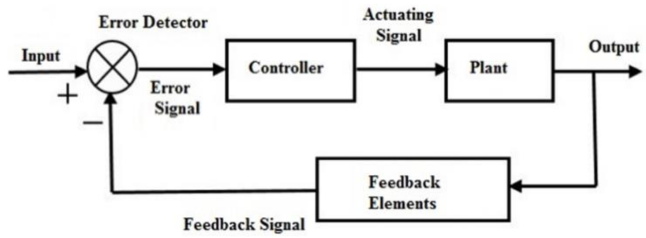


Fig 4. Closed Loop Control System

Robotics

Robotics is the interdisciplinary field that investigates and develops mechanical tools capable of doing manual labour. Robotics is the study of all aspects of robots, including their construction, upkeep, use, and management. Robotics' end game is to develop tools that help and sustain human life. Robotics is a broad discipline that incorporates Engineering fields include but are not limited to: mechatronics; electronics; bioengineering; computer; control; and software engineering.It's not out of the question that human workers may be replaced by robots in the future. There are many practical applications for robots, from domestic automation to hazardous industrial operations and even potentially life-threatening environments like those involving radioactivity or bomb detection and deactivation (Such as in space exploration, deep sea exploration, high temperature environments, and the removal of biohazard wastes and highly polluted waste). Though robots may assume many shapes, those designed to look like humans tend to be the most popular. This increases public acceptance of robots in general and robots that mimic human behaviour in particular. Humans conduct several behaviours that can be repeated, including walking, lifting, talking, and thinking. Since robots can successfully imitate human behaviour, they help society make up for a scarcity of skilled labourers. [25]

VII. CIRCUIT DIAGRAM

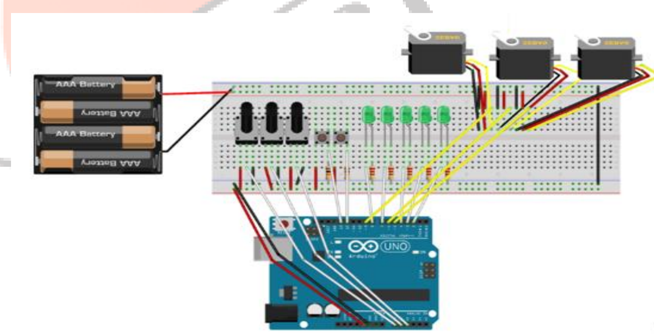


Fig 5. The connection circuitry

1.Robotic arm: Robotic arms are a sort of mechanical arm that can be controlled by a computer and perform a variety of tasks analogous to those performed by a human arm. Joints between the links of such a manipulator make it possible to rotate and move it in other directions. One may think of the manipulator's joints as forming a kinematic chain. End-effecter refers to the last link in the manipulator's kinematic chain and functions like a human hand. Depending on the job at hand, the end-effecter, or robotic hand, may be customised to execute a wide variety of actions. [24]

2.Arduino Uno: The Arduino Uno's central processing unit is an ATmega328. The device has 20 digital I/O pins, 6 PWM outputs, 6 analogue inputs, a USB connector, a 16 MHz resonator, a power connection, an ICSP header, a reset button, and a resetting pin. The microcontroller may be powered and programmed via a USB cable, an AC-to-DC converter, or batteries (not provided). In contrast to its forerunners, the Uno does not use the FTDI USB-to-serial driver chip. Instead, we employ a USB-to-serial converter based on the ATmega16U2 chip. This extra microcontroller has a USB bootloader, making it reprogrammable by anybody with a little bit of technical know-how. [22]

Fig 6. Arduino UNO

3.Standard servo motor (180-degree rotation): A servo motor's output shaft may be steered to a certain angle through a coded signal. While the encoded signal is being sent, the servo motor will keep the shaft in its current position. The angle of the shaft changes in response to the encoded signal.

Servos are often used for position control. An electric motor is used to create mechanical force in most servos, making them electrical or electronic devices. Besides the magnetic and pneumatic/hydraulic systems, additional types of servos also exist. [26]

Fig 7. Standard Servo Motor

4. Rotatory Potentiometer: In electronics, a rotary potentiometer is a variable electrical resistor that can be turned. This paves the way for the incorporation of regulation techniques in a variety of electrical or electronic systems, such as the volume control of multi-media gadgets.

A rotary potentiometer has three terminals, a carrier, and a circular resistor material. The resistor is connected to the two permanent terminals on the exterior. The third contact may be adjusted and is sometimes called a slider. In conventional designs, this may be rotated by an axis by up to 300 degrees. Adjusting the slider will change the integrated resistance. This allows for a wide range of voltage regulation in a circuit as well as the production of unique resistances. [28]

Fig 8. Rotatory Potentiometer

5.Push Button Switch: Push-button switches are mechanical devices that employ external pressure to trigger an internal switching mechanism and thereby control an electrical circuit.

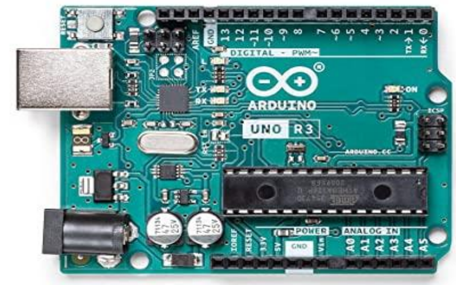
It's possible to get them in a wide variety of shapes, sizes, and configurations to meet the design's specific requirements. Push buttons employ a simple actuation mechanism that involves pushing in and pulling out. They may turn something on or off, or they can break a circuit. Alternatively, they may initiate or terminate a certain function or provide input for the equipment's user interface. [29]

Push button switches may be broken down into two groups.

Fig 9. Push Button Switch

VIII. RESULTS

The Experimental Results of Robotic Arm are recorded as firstly the positioning accuracy of the arm is ±0.8 mm, the maximum payload is 0.6 kg and the weight of the whole model is 8.5 kg.



The Actual and Target position of the arm were recorded, which

are displayed in the table below.

Table 1: Experimental Results of Robotic Arm

Joint	Actual Position Angle	Target Position Angle
Body	220°	105°
Shoulder	-60°	-55°
Elbow	-20°	-25°
Wrist	30°	30°
Hand	25mm	25mm

IX. CONCLUSION

This project reviews the history of robotic arms. The project successfully developed the necessary hardware and software to operate a robotic arm.

- Our primary goal is to create a grasping robotic arm.
- In spite of the research done, robotic arms still have few applications outside of the manufacturing industry, and even there, their primary purpose is to increase output. These arms have matured to a point where they can make precise movements. Underutilized are the many general and domestic applications for robotic arms. The robotic arms may be used to provide a "helping hand" wherever they are installed. [30]
- Preliminary testing has shown that its motion is precise, accurate, highly configurable, and a pleasure to use.
- The progress of the robotic arm is aided by the fact that its movements may be accurately controlled.
- Picking up and putting things at a convenient distance from the user is a common problem, and a robotic arm is widely recognised as a viable solution.

X. FUTURE SCOPE

Those who are unable to use their hands due to an injury or illness may find this to be a great boon. An individual might instruct the arm to do the desired task. It is also feasible to develop a system that is controlled by precise gestures. The arm's actions and instructions might be delivered via a wearable computer. [32]

The opportunity might be a huge boon for those who are unable to work because they are paralysed or have lost the use of their hands in an accident. It's possible to instruct the arm to carry out a certain task when given directions by a person. Also possible is a system that can be controlled with precise gestures. Some kind of wearable technology might be used to provide instructions and guide the arm's movements.

Research into BCIs (brain-computer interfaces) is on the rise. It is possible to use a BCI to read brain impulses and then use those signals to move the arm. The technology can function as a human arm would. A person who has lost a hand in an accident may continue living normally with the help of one of these artificial arms. It's possible to do many different things with a robotic arm because of its flexibility. [33]

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