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Robotic Arm Using Arduino Uno

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Abstract
The applications & advantages of remote controlled robots are plenty, especially in specific areas where people cannot go there to perform specific tasks, these robots are playing a major role. The system designed here can be used for picking any small object from the hazardous place. The technology implemented in the system offers many latest expectations. The advancement of technology has made possible the implementation of embedded systems in each and every field. This project presents a possible solution whereby the user controls the robot for picking and placing the goods by a mobile phone through its android interface. This results in a simple, cost effective and flexible system, making it an excellent feature for future smart robotic operations.

To prove the concept practically a prototype module is constructed with electro-mechanical equipment that is guided by android device and electronic programming. Many robots have been built for manufacturing purposes and can be found in factories around the world. Here we are developing the remote buttons in the android app by which we can control the robot motion with them in which we use Bluetooth/WiFi communication to interface the controller and android. Controller can be interfaced to the Bluetooth/WiFi module through the UART protocol. According to commands received from android mobile, the robot motion can be controlled. The pick and place robot (robotic arm) designed with a microcontroller unit, functions according to the command signals generated and transmitted from the android device. Based on this information the robot will be moved in all directions. This robot is equipped with a gripper mechanism at its front side for picking the object and after holding the object it will be lifted up to a certain height and then can be carried to the required place. DC servo motors are used to control robotic arm including functions like controlling the gripper mechanism is performed. The robotic arm designed here has four degrees of freedom just like a human hand (shoulder, elbow and fingers as gripper).

1-INTRODUCTION

Industrial robots can easily automate picking a part up and placing it into a new location. Pick and place robots not only speed up the process, which increases production rates, but they are also more accurate and do not fatigue. Most of the movements that pick and place robots perform are back-breaking and are hard to maneuver for humans. The consistent output of a robotic system along with quality and repeatability are unmatched. Pick and place robots can be reprogrammable and tooling can be interchanged to provide for multiple applications.

There are long term savings associated with a pick and place robotic work cell. An increase in output with a material handling robotic system has saved factories money. With the advancements in technology and affordability of robots, more pick and place robotic cells are being installed for automation applications. In this highly developing society; time and manpower are critical constraints

for completion of tasks on large scales. Automation is playing an important role to save human efforts in most of the regular and frequently carried works e.g. most of the industrial jobs like welding, painting, assembly, container filling etc. one of the major and most commonly performed work is picking and placing of jobs from source to destination. For this purpose, 'pick and place robots 'may be used.

The pick and place robot is a microcontroller based mechatronic system that detects the object, picks that object from source location and places it at desired location. For detection of an object, infrared sensors are used which detect the presence of an object as the transmitter to receiver path for the infrared sensor is interrupted by a placed object. As soon as the robot senses the presence of an object, it moves towards the object, picks it with end effects, and moves along the gantry and finally places it on its destination. If another object causes an interrupt, it again does the same job. Whole process is controlled by a microcontroller.

But here in our project work for detecting the object infrared sensors are not used but by visualizing, the robot is controlled through a remote sitting at a place. In the manufacturing industry and nuclear industry, a large fraction of the work is repetitive and judicious application of automation will most certainly result in optimum utilization of machine and manpower. A pneumatic `Pick and Place' Robot has been developed to achieve automation in applications where great sophistication is not needed and simple tasks like picking up small parts at one location and placing them at another location can be done with great ease.

The machine provides motion to the end effector in the theta and Z directions. The end effector can be a pair of pneumatic grippers, a set of multiple grippers, magnetic pick-up, vacuum pick- up etc. The device has its own in-built logic and all the movements of the device are controlled by the combination of control valve and reversible valve which form the vital part of the machine or can be controlled through remote. A single pulse of air given to the control valve activates the reversible valve and admits air alternately to the two pneumatic cylinders during one cycle. This causes to and fro linear motion of the common rack which is converted into the rotary motion of the pinion and ultimately imparts angular sweep (theta) and vertical motion (Z) at the end of each stroke to the head carrying the pick up arm with the end effector. Angular sweep (theta) as well as the vertical motion (Z) is adjustable by means of mechanical stoppers. The operating speed of the pick up arm can be varied to suit the requirement by operating the flow control valves provided on the two cylinder heads. During one operating cycle the pick up arm carrying the end effector starts from its home position, goes to the other end, picks up the part and returns to its original home position. The picked up part is delivered to the home position when the next cycle is triggered.

2-HARDWARE AND SOFTWARE REQUIREMENTS

Hardware Requirements

Robotic arms designed with Arduino Uno integrate multiple hardware components to achieve precision, flexibility, and automation in various applications. The Arduino Uno acts as the central controller, interfacing with essential components such as servo motors for movement, sensors for feedback, and power modules to supply consistent energy. Additionally, structural elements like the arm frame, grippers, and joints provide the mechanical foundation, while electronic modules such as motor drivers ensure efficient control of movements. Together, these components form a

cohesive system, enabling the robotic arm to perform tasks with high accuracy and adaptability in fields like manufacturing, education, and research.

2.2.1 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.

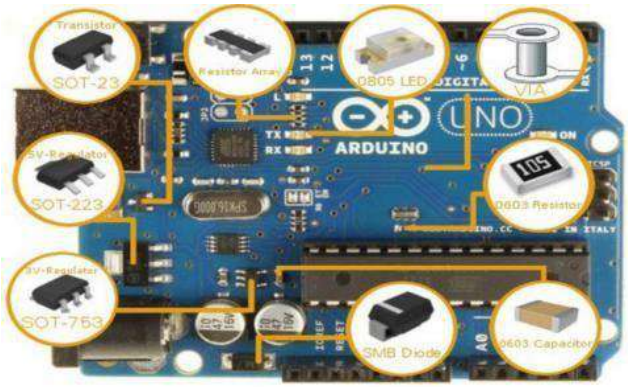


Fig 2.2.1: Arduino Uno board

Software Requirements

The Arduino Integrated Development Environment - or Arduino Software (IDE) - connects to the Arduino boards to upload programs and communicate with them.

The program or code written in the Arduino IDE is often called sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino'

Arduino Ide Installation:

In this we will get know of the process of installation of Arduino IDE and connecting Arduino uno to Arduino IDE.

Step 1-

First we must have our Arduino board (we can choose our favorite board) and a USB cable. In case we use Adriana UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, we will need a standard USB cable (A plug to B plug), t In case we use Arduino Nano, we will need an A to Mini-B cable.

Step 2 - Download Arduino IDE Software.

We can get different versions of Arduino IDE from

the Download page on the Arduino Official website. We must select wer software, which is compatible with wear operating system (Windows, IOS, or Linux).

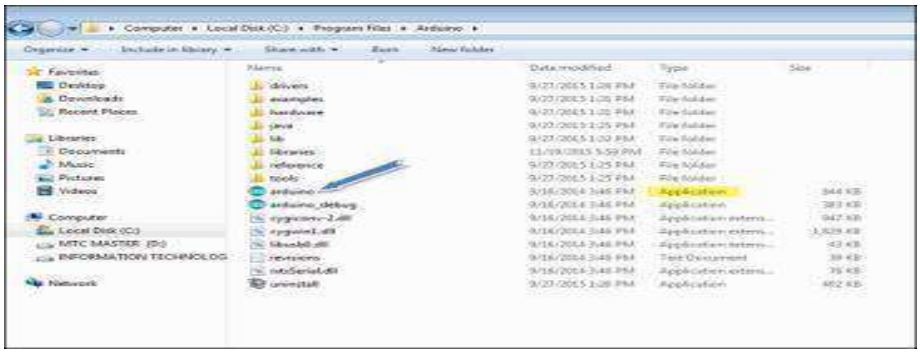
After the file download is complete, unzip the file.

Step 3 - Power up our board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either the USB connection to the computer or an external power supply. If we are using an Arduino Diecimila, we have to make sure that the board is configured to draw power from the USB connection. The power source is selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB and power jacks. Check that it is on the two pins closest to the USB port.

Connect the Arduino board to the computer using the USB cable. The green power LED (labeled PWR) should glow.

Step 4 - Launch Arduino IDE.

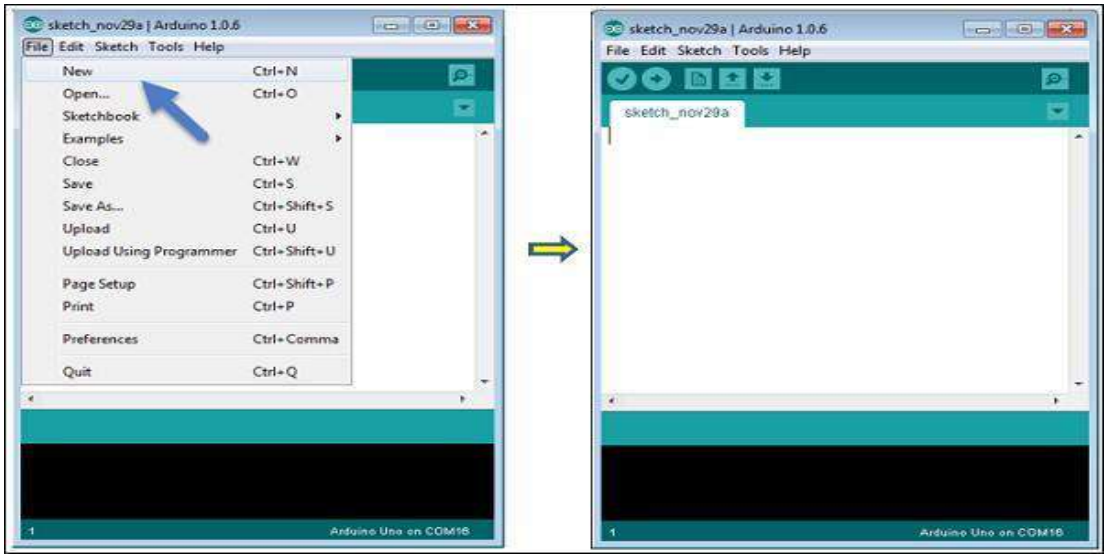


After our Arduino IDE software is downloaded, we need to unzip the folder. Inside the folder, we can find the application icon with an infinity label (application.exe).

Double click the icon to start the IDE. Step 5 - Open our first project.

Once the software starts, we have two options

- Create a new project



- Open an existing project example.

To create a new project, select File → New.

3-ROBOTIC ARM USING ARDUINO UNO

In this chapter we will discuss the Existing/Proposed System, block diagram and methodology for Robotic Arm using Arduino UNO.

Existing System

There are multiple designs of pick and place robots, based on the specific application for which they are used. The existing system was designed using DC gear motors which had the following limitations:Lack of flexibility and adaptability in the robotic arms.

- Lack of flexibility and adaptability in the robotic arms.
- Limited speed control.
- DC gear motors produce noise and vibration during operation.

A robotic arm using DC gear motors is a cost-effective and easy-to-assemble solution for simple automation tasks. It utilizes DC gear motors for movement, controlled by a microcontroller unit (MCU) and powered by a suitable power supply. While affordable and compact, these arms have limitations, including lower precision (±1-5°), restricted payload capacity (100-500g), and reduced speed (100-300°/s).

4.3 Proposed System

The Robotic Arm Using Arduino Uno is a Cost-Effective and Customizable Solution. The robotic arm using Arduino Uno and 4 servo motors is an innovative and affordable solution for automation and robotics enthusiasts. This compact and easy-to-assemble system offers a range of benefits, making it an ideal choice for education, research, and hobby projects.

One of the primary advantages of this robotic arm is its cost-effectiveness. The Arduino Uno microcontroller and servo motors are widely available and relatively inexpensive, making it easy to source components. The robotic arm's compact design and 4 degrees of freedom (DOF) enable precise movement and flexibility. The servo motors provide accurate positioning, with a precision of ±1°, making it suitable for tasks requiring delicate handling. The payload capacity of 100-500g is sufficient for small-scale applications, such as pick-and-place tasks.

Block Diagram

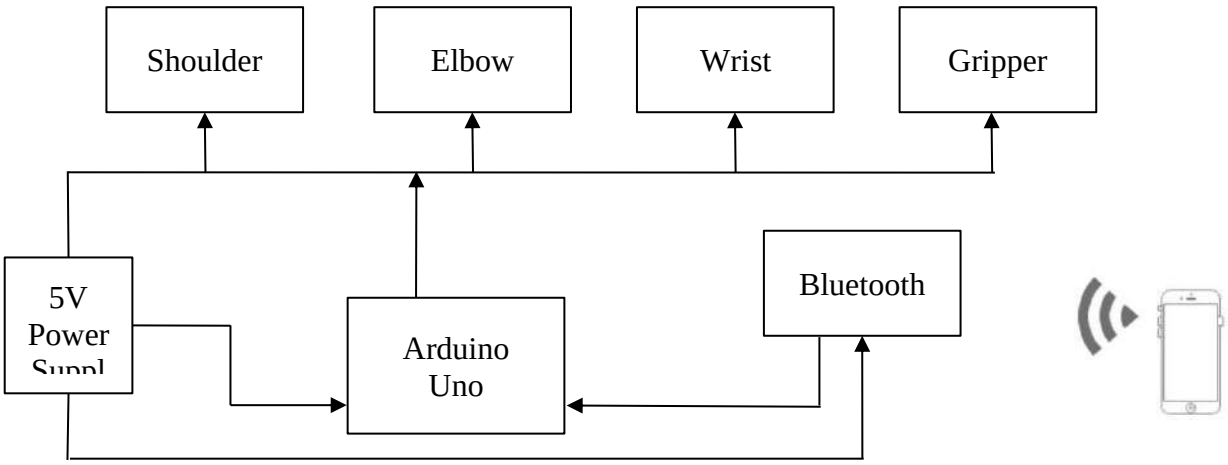


Fig: Block Diagram

- Initialization: The Arduino Uno initializes the 4 servo motors, Bluetooth module, and sets their initial positions.
- Bluetooth Connection: The Arduino Uno establishes a Bluetooth connection with the controller (smartphone or tablet).
- Receiving Commands: The Arduino Uno receives commands from the controller via

Bluetooth.

- Calculating Joint Angles: The Arduino Uno calculates the joint angles required to move the arm to a specific position using kinematics and inverse kinematics algorithms.
- Sending Signals: The Arduino Uno sends signals to the servo motor drivers, which control the servo motors.
- Moving Joints: The servo motors move the robotic arm's joints to the calculated positions.
- End Effector Action: The end effector performs tasks (e.g., gripping, releasing, drawing).

Methodology

The robot has been designed to mimic the movement of a human arm. The connection is made to distribute the 5V voltage from the supply source to the servo motors. In doing so, servo motor inputs, Arduino pin inputs, and communication circuit elements are used.

The mechanical part of the robot arm is designed by combining the pre-selected parts appropriately. In order to move the arm properly, the software has been implemented with the appropriate Arduino microcontroller selected so that the robot arm can be moved appropriately for the intended purpose.

Electrical Design: The block diagram is as shown above. Basically, this robot has 4 outputs which consists of the robot shoulder, the robot elbow, the robot wrist, and the robot gripper.

4-ADVANTAGES, DISADVANTAGES AND APPLICATIONS

Advantages

- Easy to install and work
- With 4 DOF precision is increased.
- Android controlled.
- Can be controlled from distance.
- Consume less power
- .Low cost for control achieved
- Simplicity of construction

Disadvantages

- Physical presence of man is required to control the arm.
- Cannot pick heavy loads.
- As it is Bluetooth operated, the robotic arm cannot be controlled from far distance.

Applications

- The machine will be of great use to perform repetitive tasks of picking and placing of small parts in an industrial production line.
- Its use can be extended and exploited by few modifications to do difficult and hazardous tasks for nuclear applications.
- As a basic tool for automation.

5-RESULTS

Fig 6.3.1: Off State

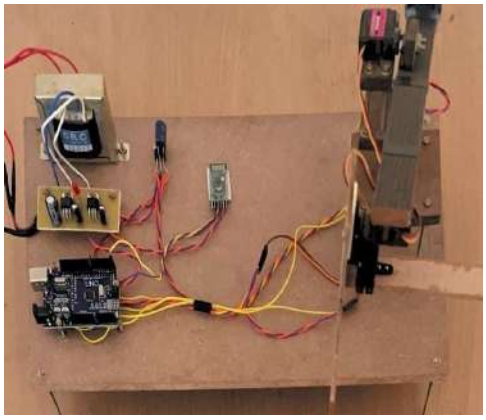
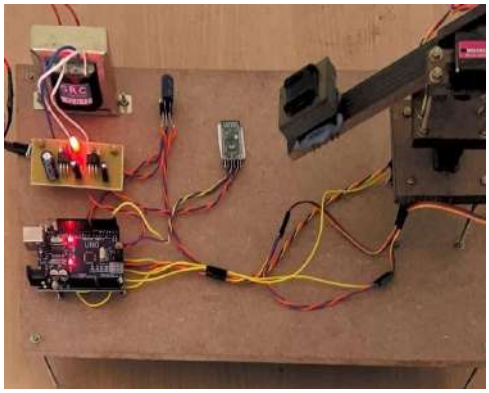


Fig 6.3.2: Connection established



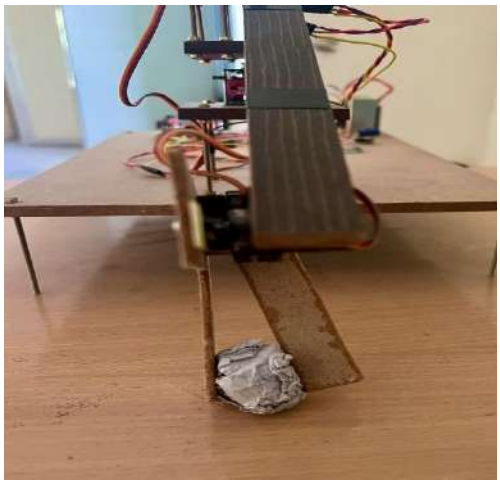


Fig 6.3.3: Arm Holding the object

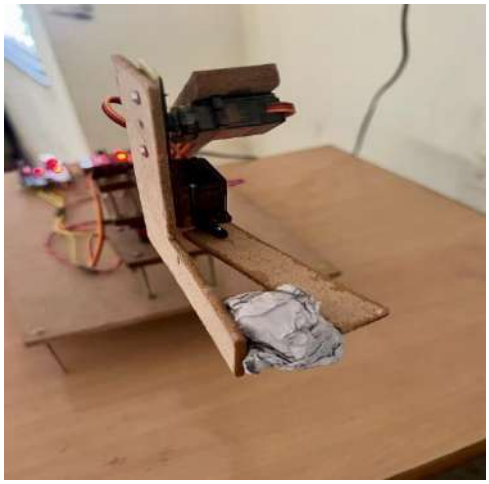


Fig 6.3.4: Arm Picking the object

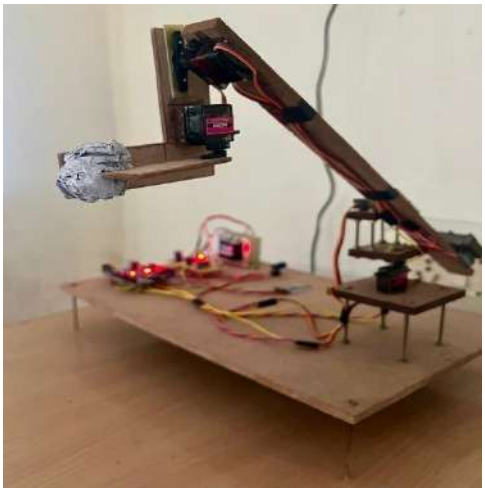


Fig 6.3.5: Movement of Arm

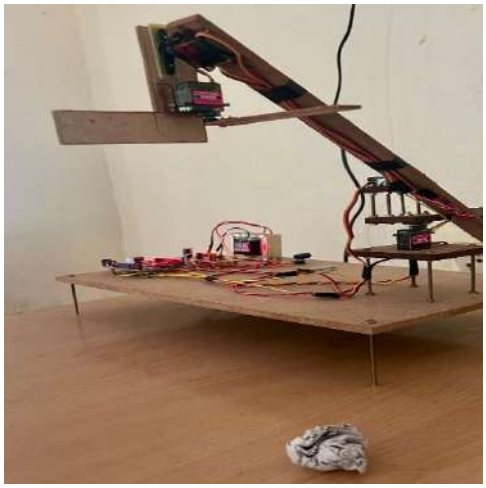


Fig 6.3.6: Arm placing the object

6-CONCLUSION

This report presents the design and the development of robotic arm, which has the ability to perform simple tasks, such as light material handling. The robotic arm is designed and built where servo motors were used to perform arm movements. The design of the robotic arm is limited to the four degrees of freedom The design of a Robotic arm has been completed. A prototype was built and confirmed functional. This system would make it easier for man to unrivalled the risk of handling suspicious objects which could be hazardous in its present environment and workplace. Complex and complicated duties would be achieved faster and more accurately with this design.

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.

2. Ranjan, R, Jindal, N. & Singh,A.K. The identities of n-dimensional s-transforms and applications. Multimed Tools Appl 81,16661-16677 (2022).

3. P. Sutyasadi and M. B Wickson, "Joint control of a robotic arm using particle swarm optimization based H2/Ho robust control on Arduino, " TELKOMNIKA (Telecommunication computing electronics and control), vol. 18, no. 2, Apr. 2020

4. Introduction to Robotics - By: Saeed B. Niku

5. R. Smith, E. Cucco, and C. Fairbairn, "Robotic development for the nuclear environment: challenges and strategy," Robotics, vol.9, no. 4, pp. 1-16, Nov. 2020.

6. Elfasakhany A, Yanez E, Design and development of a competitive low cost Robot Arm with four degrees of freedom, MME, Nov 2021.

7. Nisha, Kumar D, Sekar, Vision assisted pick and place robotic arm, AVCIJ, Sept 2020, Volume 2.

8. Patel H, Verma P, Ranka S, Design and Development of coordinate based Autonomous robotic arm, IEEE, Oct 2020.