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Robotic arm to pick and place

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ABSTRACT

Robotics has emerged as a more important area in the current technological era. When compared to human labor, robots are more precise. This study presents a method for replicating a human arm by using a smartphone to operate it. A robotic arm is a mechanical device that has been programmed to carry out certain activities. This paper describes the creation of a robotic arm that can pick and place objects and is controlled through Bluetooth. The Android application serves as a transmitter, sending commands to the receiver to control the robotic arm's movement. The Bluetooth module establishes a connection between the phone and the robotic arm. After linking the robotic arm with the smart phone's Bluetooth, different moments of the robotic arm may be controlled with a single tap on the android application.

Keywords: *3D printing, Bluetooth, Degrees of Freedom, End-Effector, Robotic Arm.*

1. INTRODUCTION

Robots are self-operated robots that take the place of humans in some tasks, particularly those that are repetitive. Robots are increasingly being utilized in a variety of industries and have a wide range of applications, including military operations, medical operations, hazardous environments, and many more. Robotic arms can be employed in a variety of challenging conditions where human touch is impossible and their operation of picking and placing can injure people. For example, in a science lab dealing with hazardous chemicals or in military operations dispersing a bomb, robotic arms can be employed in a variety of circumstances. We have developed a robotic arm which can be controlled by using android smart phone through Bluetooth.

The robotic arm may be self-contained or operated manually, and it can perform a wide range of activities with excellent precision. The robotic arm may be customized for either industrial or household application. End effectors are designed to accomplish certain activities such as welding, rotating gripping, and a variety of other operations, depending on the application. Wireless mobile robots have progressed throughout time as well.

2. LITERATURE SURVEY

In [1], it is proposed to construct a robot arm that is controlled by a natural human arm movement, the data for which was gathered using accelerometers. The arm's development was based on the ATmega32 and ATmega640 platforms, plus a personal computer signal processor. Finally, this arm should be able to solve problems like picking up and depositing hazardous or non-hazardous goods objects that are too far away from the user.

In [2], the design and development of a robotic arm is done utilizing an AT mega microcontroller is described. The robotic arm reacts to gestures and is designed to follow a predetermined course. The robotic arm imitates the supplied input gesture based on the user's arm movement. Potentiometers detect the motions. The potentiometer moves the servo motors that control the moments of the robotic arm.

In [3], Two people (Gourab Sen Gupta,S. C. Mukhopadhyay and Matthew Finnie) suggested developing anthropomorphic robotic arm control through the Internet or LAN in the year 2009. The robot arm can be controlled remotely, and its sensory feedback signals may be accessed by the user. Images are captured by a robotic arm camera and transmitted to the control station. A master-slave control system is used to operate this robotic arm.

In [4], The Raspberry Pi acquires and analyses data from a database. This program was created based on an algorithm that was designed to lift the item. After then, internet users may operate the robots' arms from anywhere and at any time by utilizing a web-based user interface. The AT-mega platform was used to create and develop this robot.

3. TECHNICAL DESCRIPTION

A Robotic Arm was created utilizing 3D printing technology and an Arduino UNO microcontroller board with Bluetooth technology, which is operated via a smartphone application. The program is made up of button controls that may be used to execute a variety of tasks. This action regulates the movements of the base, shoulder, elbow, hand, wrist, and gripper. The application and the robotic arm have established

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communication using Bluetooth. The Mobile Application offers a Bluetooth connectivity option, which is connected to the Bluetooth module in the Robotic Arm.

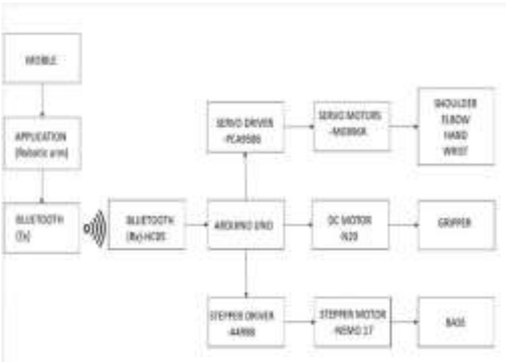

Fig 1: Block Diagram of Robotic arm

3D modelling software (Autodesk Fusion 360) was used to create the robotic arm. Drawings are exported after they have been designed in software. Our goal is to build actual pieces of the robotic arm and combine them as we designed them in Autodesk software, and then use a 3D printer to create a model of the robotic arm. The servo motors are assembled with the 3D printed components. The arm operates in five axes and can be controlled by five servo motors, a stepper motor, and a DC motor. End-effectors, which are situated at the end of the arm, are utilised to interact with the external environment. The application of the robotic arm influences the end-effector selection. Because our goal is to pick and position, we chose a four-fingered end effector as our gripper. End-effectors play an essential and intricate function in selecting and positioning objects since they must hold the grasp of any object.

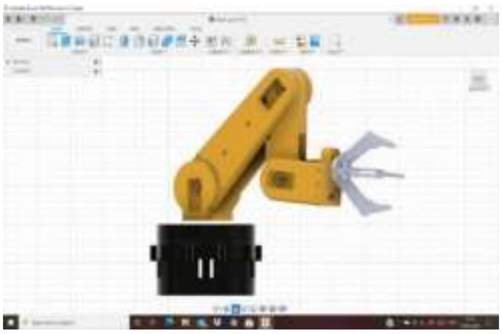

Fig 2: Robotic arm mechanical design

The following components has been used in the project

3.1 Arduino Uno
The Arduino Uno microcontroller was utilized in this project. It's an AT mega series microcontroller on an open source board. Arduino cc is the company that created the board. The Arduino microcontroller is an 8-bit microcontroller with 14 digital pins and 6 analog pins. Using an open source software called Arduino IDE (Integrated Development Environment) and a type B USB connector, the code is uploaded to the board. It can be powered by a USB cable or by an external battery through a power jack.

3.2 Bluetooth Module
The HC-05 Bluetooth Module was utilized in this project, and it has a range of 10 meters in open space. It's a serial port protocol module that makes serial communication quick. In the ISM band, it employs UHF radio waves between 2.402GHz and 2.48GHz. It's a two-way (full duplex) wireless communication. USART at 9600 baud rate is used to communicate with the module. Data mode and At-command mode are the two modes available. Bluetooth can receive data in data mode. Bluetooth may transfer data in At-command mode. Bluetooth is set to data mode in this project. Vcc, gnd, Tx, and Rx are the four pins. Vcc is for power, gnd is for ground, Tx is for data transmission, and Rx is for data reception through Bluetooth. The Bluetooth module's Tx and Rx are linked to the Arduino Uno's Rx and Tx.

3.3 Servo motors
Servo Motors control the motion of the arms and end-effector. This project makes use of Mg996 servo motors, which have a torque of 11kg/cm and only require a 5V power source. It's a rotatory motor with exact and precise angle, velocity, and acceleration control. It is controlled via a closed loop system. It may rotate from 0 to 180 degrees. It can identify a malfunction in the mechanism's operation, offer feedback, and fix the problem. These are extremely accurate motors that can run at both high and low speeds. The power wire is red, the ground cable is black, and the signal cable is yellow. PWM signals are used to drive servo motors. As a result, the signal line must be linked to the controller's PWM pin.

3.4 PCA8695 servo driver
The PCA8695 servo driver was utilized to operate the servo motors. It's a 16-channel servo motor driver with the ability to operate 16 servos at once. It only has two input pins, which the PCA8695 with I2C demultiplexes. Vin, Vcc, Gnd, SDA, SCL, and OE are the six pins. Vcc is the power supply pin, gnd is connected to the board's gnd, SDA is the data pin, SCL is the clock pin, and OE is the output enable pin. Vin is an optional 5V power output connector. One of the most significant advantages of the PCA8695 is that it can cascade 62 drivers to operate 992 servo motors using the same two pins.

3.5 Stepper motor
A brushless DC motor that transforms one full cycle revolution into an equivalent number of steps is known as a stepper motor. It's a 200-step-per-revolution hybrid stepping motor with a 1.8-degree step angle. The motor has a torque of 3.2kg-cm. It's a control system with an open loop. The base of the robotic arm is controlled by a stepper motor. The project uses a nema 17 stepper motor. There are no feedback loops in place to control the motor's steps. It is entirely controlled by the motor's internal structure.

3.6 A4988 stepper motor driver
A4988 driver has been utilized to operate the stepper, make operation easier, and achieve micro stepping. It can control a bipolar stepper in five different resolutions: full, half, quarter, eighth, and sixteenth steps. A4988 can only control one motor at a time. It has 16 pins namely Vcc, gnd-1, Vmot, gnd-2, 1A, 1B, 2A, 2B, step, dir, sleep, reset, MS1, MS2, and MS3. Vcc and gnd-1 are connected to 5V and gnd of micro controller, Vmot and gnd-2 are connected to external motor power supply (8V-30V), stepper motor four wires are connect to 1A, 1B, 2A, and 2B respectively, step pin is used to control the number of steps and dir pin is used to determine the direction of motor rotation. Sleep pin is put to high on the break out and the pin is an active low which make board not to sleep. Reset is also an active low pin. Sleep is connected to reset. The five step resolutions are achieved through MS1, MS2, and MS3.

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4. SPECIFICATIONS

Our robotic arm is having following features and specification.

1. Degree of Freedom: 5
2. Payload Capacity (Fully Extended): 300gm
3. Maximum Reach (Fully Extended): 45cm
4. Rated speed (Adjustable): 0-0.3 m/s
5. Joint speed (Adjustable): 0-60 rpm
6. Hardware interface: USB
7. Control Software: computer interface (GUI)
8. Shoulder Base Spin: 180°
9. Shoulder Pitch: 180°
10. Elbow Pitch: 180°
11. Wrist Pitch: 180°
12. Wrist spin: 180°
13. Gripper Opening (Max): 8cm

5. WORKING

The robotic arm basically has 2 sections: transmitter and receiver section. Transmitter consists control buttons of mobile application with Bluetooth connectivity. Receiver contains four levels of computing: receiver module (HC-05), microcontroller (Arduino UNO), motor driver level, and motors level.

Fig 3: Robotic arm application

Android Application contains buttons to control the base and wrist to move left and right; shoulder, elbow, and hand to move up and down; gripper to open and close. It also contains a connect robot button which is used to connect the receiver section of robotic arm via Bluetooth. User have to activate Bluetooth in the mobile and start connecting the receiver. Remember that the receiver must be power on and ready to be connect. If Bluetooth is in deactivated mode, then it promotes the user to activate it. Once activated user can scan for the Bluetooth network that is provided to robotic arm and connect to it. After connecting user can operate the robotic arm as required.

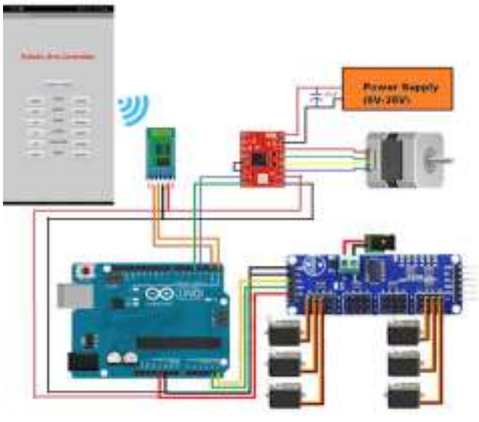

Fig 4: Circuit Diagram of Robotic Arm

Robotic arm connected with the user via Bluetooth to a Bluetooth module installed in the robotic arm control system. When the user taps each button on the app, the input signal or control signal is supplied from the paired Android smart phone and sent via Bluetooth to the robotic arm. Each button stores a specific identifying data. That data from the smart phone is sent in ASCII format to be adopted by the Bluetooth module and then transferred to Arduino for continuous operation which will be decoded by the Bluetooth module. The received input signal to the Arduino is decoded and converts into a command. Robotic Arm scans the command with its pre-defined commands and operation is performed as the command of the user. If the command received to operate the base then signal is sent to the A4988 stepper driver which controls the stepper motor. If command received from shoulder, elbow, hand, or wrist then signal is sent to the PCA8695 which controls servo motors. If the command received from grip then it is sent to the N20 motor present in the gripper which opens and closes the end-effector.

6. RESULTS AND CONCLUSION

Fig 5: Robotic Arm

From this paper it can be concluded that one-way communication is established between the android application and the robotic arm. The main objectives of developing robotic arm and implementing pick and place operation with faster completion time with lowest errors has been achieved. Robotic arm movements are accurate, easy to control, precise and user friendly. Anyone with non-experienced can also control the robotic arm with ease and in an efficient manner**.** Robotic Arm is controlled using Bluetooth via mobile application. The purpose of this project is to pick and place the objects and gain control of a robotic arm with 5 degrees of freedom using a microcontroller and Bluetooth module with android application is achieved. As Bluetooth is a short ranged communication it can be replaced with Wi-Fi or Zig-bee module for long range communication. Through this design Complex and repetitive work can be easily achieved.

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