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ROBOTIC ARM USING ESP32 MICROCONTROLLER WITH BROWSER CONTROL

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Abstract - The purpose of this project is to design and build a control system with microcontroller to control the movements of arm. The whole system is composed of the Controller System and the drive circuits, one driver circuit for each motor on the arm. Here we used servo motor software driver in the ARM and it is connected to AC supply with the presence of power Module. The controller System is implemented on the ESP32 Microcontroller using Arduino programming. And a Webpage is created to control the ARM which can be access by the phone/computer.

Key Words: Robotics, ESP32 Microcontroller, Servo motor, power Module, Webpage

1.INTRODUCTION

A Robot is a virtually intelligent agent capable of carrying out tasks robotically with the help of some supervision. Practically, a robot is basically an electro-mechanical machine that is guided by means of computer and electronic programming. Robots can be classified as autonomous, semiautonomous and remotely controlled. A robotic arm is a robotic manipulator, usually programmable, with similar functions to a human arm.

This Robotic arm is programmable in nature and it can be manipulated. The robotic arm is also sometimes referred to as anthropomorphic as it is very similar to that of a human hand. Humans today do all the tasks involved in the manufacturing industry by themselves. However, a Robotic arm can be used for various tasks such as welding, drilling, spraying and many more. A self-sufficient robotic arm is fabricated by using components like micro-controllers and motors. This increases their speed of operation and reduces the complexity. It also brings about an increase in productivity which makes it easy to shift to hazardous materials. The main part of the design is ESP32 micro-controller which coordinates and controls the product's action. This specific micro controller is used in various types of embedded applications. Robotics involves elements of mechanical and electrical engineering, as well as control theory, computing and now artificial intelligence.

Robotic ARM Architecture:

There are many different types of Robotic ARM. To reach the desired point, robots use different co-ordinate systems. Some of them are given below.

1. Cartesian robot: This type of robot is made up of three linear joints. It is the easiest to control, has the highest repeatability and has a good payload capability.
2. Cylindrical robot: This robot has a rotational joint at the bottom in addition to two linear joints. This makes the robot work envelope cylindrically shaped.
3. Spherical robots: This robot have one linear joint combined with two rotational joints. They are suitable for heavy lifting, small spaces and have a good reach.
4. Revolute robot: This robot has all rotational joints and makes it the most flexible. Because of this, it's the most used robot.

2. Purpose work

Robotic arm is a copy of human arm which can do rotational motion and translation motion as human arm can do. This block diagram is representing all the component connecting with each other.[2]Here, four servo motors are connected to the ESP32 Microcontroller and power module is used to supply the power of input 5v to the microcontroller and Servo motor.

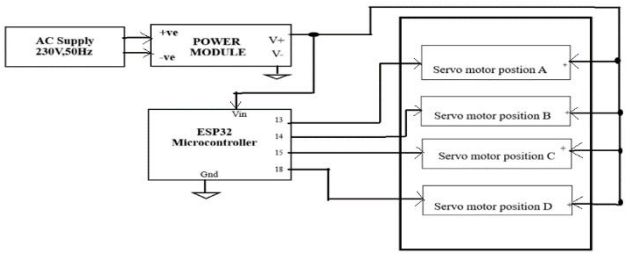


Fig 1: Block Diagram of Robotic ARM

3. ESP32 Microcontroller

The ESP32 is dual core, this means it has 2 processors. It has Wi-Fi and Bluetooth built-in. It runs 32-bit programs. The clock frequency can go up to 240MHz and it has a 512 kB RAM. This particular board has 40 pins, 20 in each row. It also has wide variety of peripherals available, like: capacitive touch, ADCs, DACs, UART, SPI, I2C and much more. It comes with built-in hall effect sensor and built-in temperature sensor.

ESP32 is a highly-integrated solution for Wi-Fi-and-Bluetooth IoT applications, with around 20 external components. ESP32 integrates an antenna switch, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. As such, the entire solution occupies minimal Printed Circuit Board (PCB)area.

ESP32 has 34 GPIO pins which can be assigned various functions by programming the appropriate registers. There are several kinds of GPIOs: digital-only, analog-enabled, capacitive-touch-enabled, etc.

The Pulse Width Modulation (PWM) controller can be used for driving digital motors and smart lights. The controller consists of PWM timers, the PWM operator and a dedicated capture sub-module. Each timer provides timing in synchronous or independent form, and each PWM operator generates a waveform for one PWM channel. The dedicated capture sub-module can accurately capture events with external timing.

The LED PWM controller can generate 16 independent channels of digital waveforms with configurable periods and duties.

The 16 channels of digital waveforms operate with an APB clock of 80 MHz Eight of these channels have the option of using the 8 MHz oscillator clock. Each channel can select a 20-bit timer with configurable counting range, while its accuracy of duty can be up to 16 bits within a 1 msec period. The software can change the duty immediately.

Moreover, each channel automatically supports step-by-step duty increase or decrease, which is useful for the LED RGB color-gradient generator.

4. Servo Motor

Most of the hobby Servo motors operates from 4.8V to 6.5V, the higher the voltage higher the torque we can achieve, but most commonly they are operated at +5V. Almost all hobby servo motors can rotate only from 0° to 180° due to their gear arrangement so to make sure our project can live with the half circle. If no, we can prefer for a 0° to 360° motor or modify the motor to make a full circle.

To make the motor rotate, we have to power the motor with +5V using the Red and Brown wire and send PWM signals to the orange color wire. Hence, we need something that could generate PWM signals to make this motor work, this something could be Microcontroller,555 Timers and many more

Wire Number	Wire Color	Description
1	Brown	Ground wire connected to the ground of system
2	Red	Powers the motor typically +5V is used
3	Orange	PWM signal is given in through this wire to drive the motor

Table 1: Wiring Description

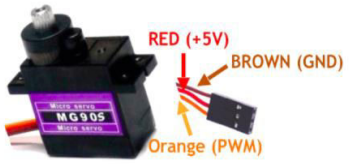


Fig 2:Servo Motor Wiring's

5.Power Module(HLK-PM01)

The **HLK-PM01** is commonly used in places where a microcontroller circuit has to be powered directly from AC mains. Most digital circuits operate at a voltage of 5V, this module can **convert the AC mains to 5V** with an efficiency of 70%.

The **HLK-PM01** is a small size low-cost **AC to DC converter** which can take in 110V/220V AC at 50/60 Hz and give 5V,3W output.

Table 2: Pin description of PM01

Pin Number	Pin Name	Description
1	AC	Connect to the Phase/Live terminal
2	AC	Connect to the Neutral terminal
3	-Vo	Output negative voltage here ground
4	+Vo	Outputs +5V regulated voltage

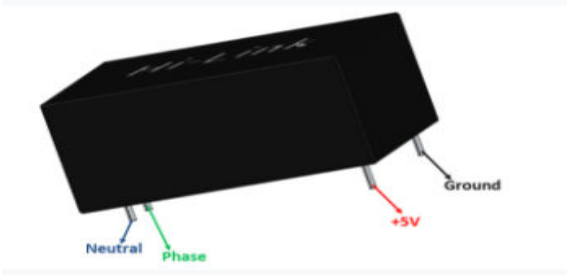


Figure 3: Pin layout of PM01

6. Design & Results

The main control unit of the controller system is controlling ESP32 Microcontroller. As an intelligent hardware control board, Arduino software has many open technical resources and can be easily redeveloped.[1]To access the ESP32 Microcontroller in the software. We need to add the preferences of ESP32 Microcontroller. As, ESP32 Microcontroller is a wi-fi module. The Wi-Fi module communicates with the control board through Arduino's soft serial port, using the library already developed in Arduino to realize the Wi-Fi connection and the topic subscription of the server.[1]The callback function captures the data information sent by the server, extracting the angle values from the message. Then the function will assign angle values to the angled array and send control information to the servo through pins. The specific control process is as Fig. 4.[1]

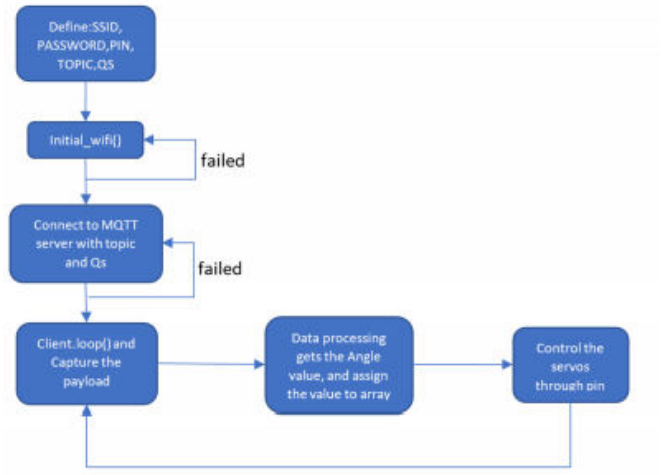
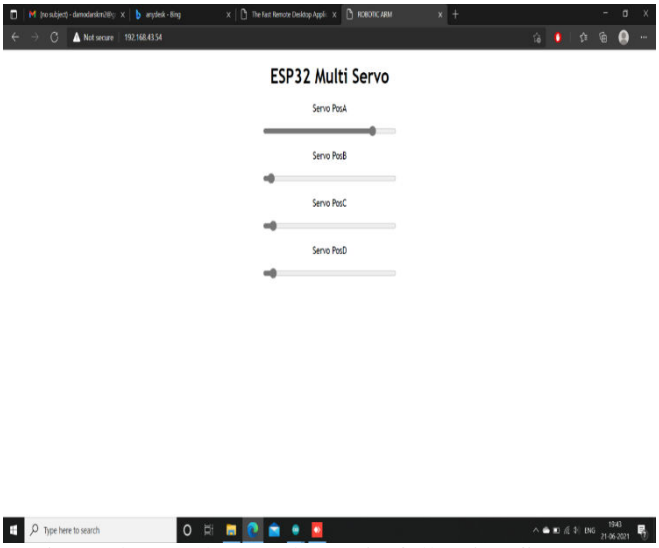


Figure 4:Function Design[1]

After the connection between each client and server is established, it is a session. There is an interaction between the client and the server, and the session exists between a network.[1] When the manipulator client acts as another client of MQTT, it subscribes to the broker server and provides a topic.[1]

The control of the manipulator is realized through the web page, so the web page needs to be opened through the browser first. It can browse web pages on computers, laptops, iPad and other platforms. The website is shown in the Fig. 5.[1]

The Webpage is composed of 4 sliders. Where each slider represents each motor. The slider has a Minimum value and Maximum value of the servo motor to control the Robotic ARM. When the user moves the slider, the angle of the servo motor changes. By this, the four-servo motor is controlled by the webpage. The webpage of the ARM is access by using IP address of the ESP32 Microcontroller. The IP address is generated in the serial



monitor. The results are shown in following figures.

Figure 5:Result of webpage

Press the ESP32 "Enable" button to restart the board, and copy the ESP32 IP address that shows up on the Serial Monitor.

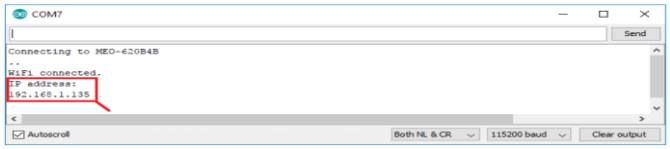


Figure 6:IP address of the Microcontroller

Advantages:

- Increase productivity
- Use equipment effectively
- Reduce working costs
- Flexibility at work
- Get the job done in the shortest time
- Provide good returns on investment

Disadvantages:

- Cause unemployment for manual workers
- High initial cost
- Designed Arm to perform specific tasks and not comparable to the human hand

- Difficulty programmed to perform Accurate task

7. CONCLUSIONS

Robotic arms, many areas are developable. Thanks to the robotic arms, many tasks are made easier and the resulting error level has been reduced to a minimum. For example; some pharmacy-based drug-giving robots and a projected robot arm have been developed. In addition to this, the ability to move the robot arm is further increased, and when the camera is placed in the finger area and the sensitivity is increased, it can be used in a wide range of applications from the medical sector to the automation systems. With the robotic arms developed in this way, the risk of infecting the patient in the medical sector is minimized, while the human errors are minimized during the surgical intervention. Despite the fact that the robotic arm made by this project is of prototype quality, it has a quality that can be improved for more robotic systems. Besides these, robotic arm sector, which is open to development, will keep its importance in the future.

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