Automated Smart Curtains Using IOT

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***Abstract* – In the field of IOT home automation is a wild spread fire that has got a lot of attention all over the world. It's been always a vast field when the word automation is used mankind wants to finish every work with a press of a button. It's been a trillion-dollar industry where vast advancements and break throughs are seen over a period of time. Today we concentrate on an aspect of home automation that is the smart curtains. Automatic Electronic Curtain Control System is a simple and powerful concept, which uses TB6600 stepper motor driver, to Open and close the Electronic Curtain automatically. By using this system manual works are removed. It is operated using a mobile application that allows multiple users to control the curtain system whether to open it or close it or partially open or close. This curtain system is connected to the main server that helps multiple users to operate the system. It can also be operated based on a particular point of time in a day by adding time domain into the code. In sunny and rainy days, ON time and OFF time differ significantly which is one of the major disadvantages of using timer circuits or manual operation.**

Keywords— Internet of things, smart curtains, ESP32, NEMA-17 stepper motor driver.

I. INTRODUCTION

One of the most exciting development in the field of information and communications is the start of the Internet of things (IOT). And smart homes are one of the field where IOT is being used vastly and is improving every time. Smart home applications can improve the lives of the residents by providing comfort easiness and practicality. Currently as technology plays a very important role in the lives of people ,they are also preferring smart home applications as it makes the working of things better and simple. Here the devices are built to be autonomous according to the users preferences.

An embedded system is a computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. Embedded systems are controlled by a main processing core that is typically either a microcontroller or a digital signal processor (DSP).

Since the embedded system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product, or increasing the reliability and performance. Some embedded systems are mass-produced, benefiting from economies of scale. Physically, embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure.

In general, embedded system is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected. Here in this world that has a wide area of applications in IOT it's our responsibility to contribute to the same so we plan to design a smart curtain which makes the usual human work easier and helps him or her to save the time.

When we talk about smart homes the main perspective of people is that they are expensive and overrated but at the same time because of this attitude the country lags behind in the wild spread fire of technologies. It's very hard to move this mentality out and make it available to each and every citizen of the country keeping in mind the economic efficiency and here we have an idea of doing the same reducing the expenses by the use of proper devices so that the system can be put to work at the right time rather than wasting power. Also, we plan to make it more faster in processing so that it responds to the user's needs immediately by reducing unwanted calculations and figuring out the constant terms and calculating the out comes with high speeds.

So here we have a the application that takes user inputs and passes it to the system where the micro controller directs the curtains to open in a proper amount. And also, a mobile application that can listen to the user commands and operate based on his requirements. Making the human life simpler and more advanced is the main goal of this project at the same time cutting out the extra expenses and installing them in the IOT labs is our main goal. This system is a combination of small devices with effective planning and plotting that helps the users to make their environment more

automatic and helps them to carry out all their wishes at one point using a small mobile application.

So here the ideology is to run the system by using the application and also in-case of power failure it can be operated manually. So, we build a system that can work automatically as well as on human commands this will make it more user friendly and the curtains can be a perfect fit for their name that is the smart curtains. We also have to make sure that all the risks and constraints of this device are minimized and it can be utilized for the best of human intentions.

II. Background And Related Work

A. Position Switches

It has all the other system as mentioned earlier but here we have a reed switch that is used to calibrate the last position of the curtains and then adjust them automatically from their last position so there will be a track of the moments of the curtain using the magnets that are attached to the curtains and the switches that are stationary. So this paper is mainly based on calibration of the curtains position.

B. PIR Sensors

For detecting whether people are in the room or not they have proposed the concept of PIR sensors that is the passive infrared sensor which is used to detect the motion in the room using the infrared light but here we have to face a drawback if someone is already sleeping in the room then the motion won't be detected and it might cause problems in the proper working of the system

In this design they have concentrated on the low power consumption and also the calibration but it does not give more accurate picture on how to detect the presence of humans and also it talks about the LDR that we are using here to capture the intensity of light.

C. PID controlled fuzzy algorithm

The fuzzy control algorithm basically has real number values between zero and one both included and these values speaks about the partial truth which is useful for our design where we get options to open curtains partially if needed it processes all the input data and gives us the best result required to operate the curtains.

Proportional integral derivative control algorithm takes a feedback value and sends it to process the calculation and produce the desired results it has wide range of applications in the industrial areas. Here the last location of the curtain is obtained and the curtain is adjusted to the desired position by taking the last location of the system.

As we all know there are many external factors that affect the working of this system as the system is highly non-linear and has a lot of uncertainties, we need to handle them all as we know the motors uniform rotation will be affected by unstable voltage and current. The sensitivity of the sensors may be affected by the external factors like dust and other tiny things. So the traditional PID control system will not perform well in this case because of the non linearity in the curtain system this algorithm becomes unstable so here we have the fuzzy self-tuning PID control algorithm is applied to the actual curtain control of smart home system.

It is useful in solving the bigger system error and less than ideal dynamic characteristics of the past curtain controller system, and it contributes greatly to raising the reliability and precision of the control system. This will help us generate the values we actually need for the system. The results show the correctness and feasibility of the algorithm design, and it greatly improves the dynamic and static performance of the system and automation.

D. Time Control

This feature helps the user to open the curtain at a particular time of the day for example 8 AM and also there is one more clock that gives the delay in the sense open the curtain after several hours. This will also help us to save power by reducing the system activities. These time control activities can be reset by the mobile application if the user wishes to do so.

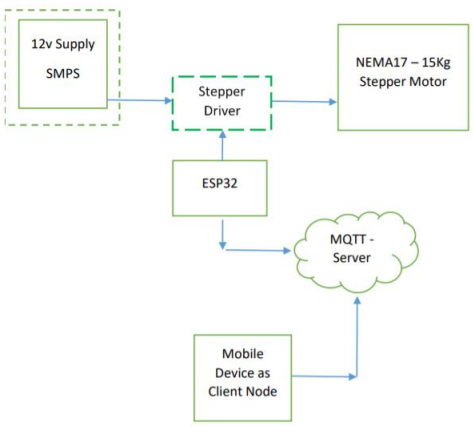
III. Proposal And Construction of the Curtain System

Currently people are using normal curtains which need human intervention for opening and closing. Smart curtains can be programmed to change position based on temperature, time of the day and other factors. In case of an indoor scenario, it can be controlled using a mobile application. So, we can reduce human interaction and create more of AI systems so that it fits into the smart home environment.

A. Design Ideas

We aim to build a smart curtain for home automation that allows users to close or open the curtains automatically by a mobile application. This next generation of technology opens up possibilities for sleek style, easy living and home comfort. Currently people are using normal curtains which need human intervention for opening and closing. Smart curtains can be programmed to change position based on user commands that are given through the application or the time factor.

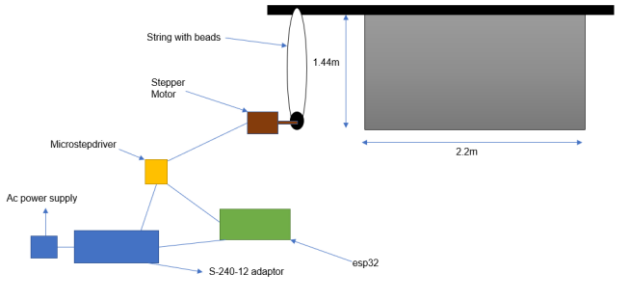
Block Diagram



The entire system is controlled by the ESP32 that provides the user with the Wi-Fi communication capabilities. Thus, this micro controller will be connected to the main server. There is a mobile application that is the MQTT app that helps the user to pass the commands over the Wi-Fi which also is connected to the main server. Multiple mobile devices with the key code can act as nodes to the MQTT server.

It has the Mosquito that is the broker application that is run on the local server to establish a medium of communication. There is a direct power supply from the house voltage to the power adapter that runs the TB6600 stepper motor driver which in turn runs the stepper motor that does the physical work. The motor driver is connected to the ESP32 which passes the command to the driver based on the user's requirements.

Real time diagram



B. Work Flow of the system

- The stepper motor selected is of 15kg NEMA 17 two phase motor. As per specification, it can take a current of 2A per phase when the maximum torque value reaches.
- In order to have a minimum current requirement from the supply, A 5A rated current SMPS is minimum required to carry out full load operation of a motor.
- In this project 12V 20A SMPS for seamless full load operation with higher marginal current supply value is selected.
- TB6600 stepper driver is used to drive a stepper motor. The main use case of driver is to send pulses for stepper motor in each phase of rotation (motor is 2phase). The driver can be configured for current limitation feature and the step angle of motor. Once these two configurations are pre-set then a gate pulse, direction and enable signal is triggered from controller. These signals will be generated from ESP32 microcontroller.
- An MQTT protocol is used to have seamless wireless communication published or subscribed over MQTT server. It's a light weight protocol which works top over TCP/IP protocol. In order to publish messages, Syntax: MQTT-pub broker_IP_address Topic Message. In order to subscribe messages, Syntax: MQTT-sub broker_IP_adrress Topic.
- To run MQT server/broker, create a local server by simply running a mosquito broker application file on windows OS.
- Note down the IP address in which the system is running the broker application. (IP config)
- Connect any mobile to Same Wi-Fi access point and give MQTT credential (IP address and port:1883)
- Now a successful full duplex communication is established for publish/subscribing messages over MQTT.

C. Architecture Choices

The entire system is built, on a step-by-step procedure initially we had a model prepared for the same and later using various combination of motors and different trials were taken and the best fit for the situation was chosen. Based on the size and material of the curtain system choosing the essential components becomes more important. At the same time the design should be handy and not a bunch of wires and devices that would be difficult and won't give a neat look to it.

Restrictions and Dependencies

- Interoperability requirements

Since the commands are passed by the user, we need to make sure that no two users pass command to the same system at a time and there must be a proper way to receive them from multiple users and execute each command one after the other without losing any packets.

- Interface/protocol requirements

We have an interface for the user that is the application interface which allows the curtains to be operated on the smart phones. Here the user has our MQTT application that allows them to operate the curtain system using a key that lets only the authenticated users to use it.

- Data repository and distribution requirements

For the device to work perfectly, it should be provided with the right inputs when the curtain should close and when it should open and when there are inputs from users how to handle those and process accordingly also aim on tracking all the inputs so that the device can work more efficiently according to the user's needs.

- Discuss the performance related issues as relevant

The security of the device is very important; therefore, authenticity plays a major role as the device will be connected to main wi-fi in college for networking there are chances of other people getting the access and tampering it. So, we have to make sure we provide authenticity to the device.

- End User Environment

From the perspective of a user, the requirements are a device that would support the application to control the device and that connects to the internet so that it can connect to the device and give commands.

- Hardware or software environment

The device can be accessed through an application so the user needs stable internet connection, it is expected to be the only software limitation and the hardware limitations could be the device to work automatically it needs constant supply of electricity so it can be one of the limitations.

Implementation Work

It has various microcontrollers that help the user to operate this system but the tubular ones can only be applied to small curtains but not the bigger ones most of them can be run either vertically or horizontally based on the environment we are working on and the curtain designs that have been used it can also be made more automatic using the sensors if it's an outdoor scenario and also it can be made more secure by using radio frequency identification.

All these techniques can be used to make the curtain system more advanced and efficient that have been already proposed in the market these systems should also concentrate on the power consumption factors as too many advancements can lead to situation where the power consumption may exceed way over the limits that can cause some serious issues when it comes to the case of efficiency so we bring a system that is detachable that can be used when required and that runs with minimum power.

In this we have a mobile interface that is the MQTT application that takes input from the user and it sends it to the main server which then transfers the messages to the ESP32 our micro controller that acts as the heart of the entire curtain system. We use MQTT domain for this purpose it is a protocol that is more advanced than the TCP/IP which helps us to transfer light weight messages in a faster manner.

So here it establishes a medium for communication between the interface and the micro controller that runs the stepper motor. In this scenario we have a TB6600 stepper motor driver that controls the current flow to the stepper motor that allows us to set the speed of rotation and also the direction. The best methodology is the tubular motor that is not currently available in the market and these motors are of smaller sizes that cannot be used to run the entire curtain of size two meters so we need to install multiple motors of the same kind to run the entire system.

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