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Design and Implementation of Remotely Controlled Curtain System

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Abstract—*We have designed remotely controlled curtain system for wide applications. The mechanical parts are used to fabricate and mount the curtain at appropriate place. The electrical and electronics components are used to fabricate the circuit for controlling its operation remotely. The control circuit consists of three sections, the transmitter section associated with open and close switch followed by encoder and the next sections consist of receiver and controller. The Radio Frequency signal is used to communicate between receiver and transmitter section. In this paper we present the design, development and testing result of the system.*

1. INTRODUCTION

In today's life we try to maximize our tasks within an allotted time. Without Electronics, it is not possible to accomplish our daily tasks and we are also not able to do our work with efficiency. Every Electronic device is meant for providing comfort and flexibility to our lifestyle. Our work is also being done with a view to enhance people's lifestyle. Electrically driven and remotely control curtain system can be widely used for homes, hospitals, cinema hall theatre curtain and hotels. The curtains are also used for covering the wall magazines, painting and exhibition hall. Rather than closing manually one by one after reaching its installation place, all the curtains or particular one will be closed far from their mounting place. Again, for physical disabled or elderly person, those are suffered from movement disorder find difficult to close each window curtain manually [1-5].

In designing a remote controlled electrically driven curtain system, emphasize has been given in building up a reliable and flexible system that can be easily operated and adapted for a closed or open environment. Therefore, for the purpose of this work some specific deliberate choices were made on the type of platforms, hardware components and mode of operation of the curtain system.

2. IMPLEMENTATION SETUP

The electrically driven curtain assembly comprises a c-channel aluminium track which is to be mounted over a window, a curtain rod, stationary pulleys, drapery cord housed in the track, a curtain, wound up to a varying degree on the curtain shaft, a driving device which is a Geared DC motor. At one end of the track, the driving motor will be mounted inside an enclosure box to hold the motors and control circuitry. A drapery cord will cover the wooden pulleys of the driving motor fitted on its shaft and over stationary pulleys on both ends of the track and this drapery cord will move the curtain to and fro as per direction of rotation of the driving motor. The direction and the speed of the driving motors are controlled by a micro-controller AT89C52 which is interfaced with an Amplitude Shift Keying (ASK) Radio Frequency (RF) receiver for its wireless operation. Most of the DC motors have power requirements well out of the reach of a microcontroller and more over the voltage spikes produced while reversing the direction of rotation could easily damage the microcontroller. So it is not wise to connect a DC motor directly to the microcontroller. Hence L293D IC has been used for running the geared DC motor. The AT89C52 microcontroller will take input from the push button switches of the remote through transmitter and receiver and will run the motor as per the program set. **Fig.1** shows the schematic block diagram of the remotely controlled curtain system.

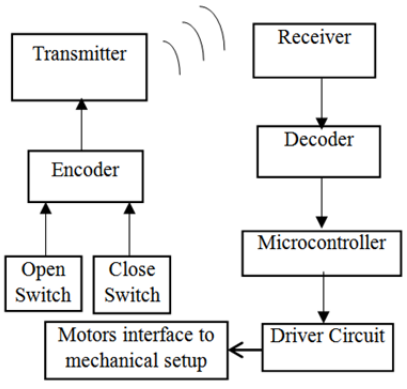

Fig. 1: Schematic block diagram of the remotely controlled curtain system.

The complete implementation setup consists of Hardware setup, mechanical setup and software programme.

2.1 Hardware Setup Description

The hardware setup consists of the following components:-

i. **Microcontroller AT89C52: The AT89C52** is a low power 8-bit microcontroller and belongs to Atmel's 8051 family. AT89C52 has 8KB of Flash programmable and erasable read only memory (PEROM) and 256 bytes of RAM [6-7].

ii. **ASK Transmitter-Receiver Module:** TWS-BS transmitter and RWS-434N receiver has been used in pair which operates at a frequency of **434MHz**. The RF transmitter receives serial data and transmits it wirelessly through the antenna pin over radio frequency. The transmission occurs at the rate of 1Kbps to 10Kbps.The transmitted data is received by the receiver module operating at the same frequency as that of the transmitter. The RF module is often used along with a pair of encoder and decoder. The encoder is used for encoding parallel data into serial for transmission feed while reception is decoded by a decoder. This 434MHz Transmitter is an ASK Hybrid transmitter module. It uses saw resonator for frequency stability. The receiver is an ASK super heterodyne receiver with PLL synthesizer and crystal oscillator. This transmitter and receiver module along with encoder HT12E and decoder HT12D has been used to build a remote control. Few features of the transmitter and receiver module that has made the two module suitable for the design are Low power consumption, Easy for application, On-Chip VCO with integrated PLL using crystal oscillator reference, Operating temperature range of -40 to 80 °C and Operating voltage of 5 Volts [8-9].

iii. **HT12D Decoder and HT12E Encoder:** The HT12E Encoder and HT12D decoder are two pair of IC of CMOS LSI series used for Remote Control system applications. By using the paired HT12E encoder and HT12D decoder we can transmit and receive 12 bits of parallel data serially of which 8 bits are for address. The decoder receive the serial address and data from its corresponding encoder, transmitted over radio frequency wave and gives the available output to the output pins of the decoder after processing the data. The key features of the HT12E encoder and HT12D decoder ICs are as follows:- It is capable of operating in a wide voltage range from 2.4V to 12V, low power and high noise immunity CMOS technology, low standby current and minimum transmission word, built-in oscillator needs only 5% resistor, easy interface with and RF or an infrared transmission medium, minimal external components and accuracy [10-11].

iv. **L293D motor driver IC:** L293D is a popular motor driver IC which allows the motor to drive in clockwise and anti-clockwise direction. L293D is a 16-pin IC which can control rotation of two DC motors independently and simultaneously in any direction [12].

v. **DC geared motor:** Almost all the electro-mechanical movements around us are achieved either by an A.C. or a **DC motor**. This is a device that converts electrical energy into mechanical energy. Motors with high torque are designed with the addition of some gear mechanism. The DC motors with gear mechanism are quiet powerful and becomes useful for several automation and industrial application. High torque and low rpm DC motors are ideal for our project, though the size of the motor is a matter of concern because it is a bit large in size due to additional gear box but still it would save the trouble and cost of adding external gears to the assembly where just the regular DC motors wouldn't do well.

The design of this project involved associating several hardware components & developing software programme to serve its purpose and testing at the different stages of the implementation. The development of the complete setup is described as below:-

- **Transmitter Unit:** The transmitter unit which will serve as remote control has been built up with following components-TWS-BS RF module, HT12E Encoder IC, LM7805 Regulator IC, Push button switches and few connecting wires. Fig.2 shows the circuit diagram of the transmitter section [13].

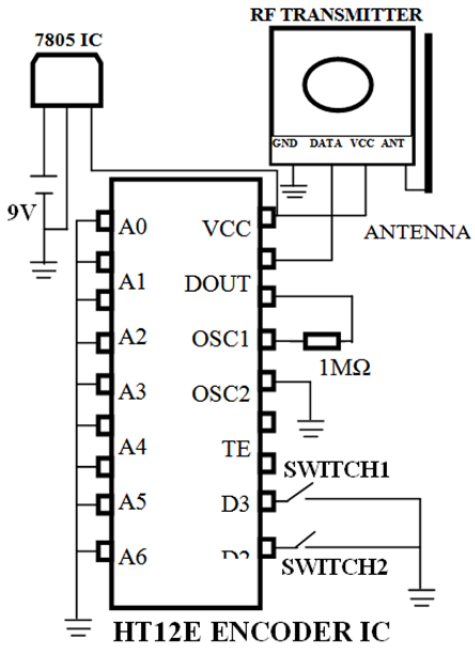

Fig. 2: Circuit diagram of transmitter section

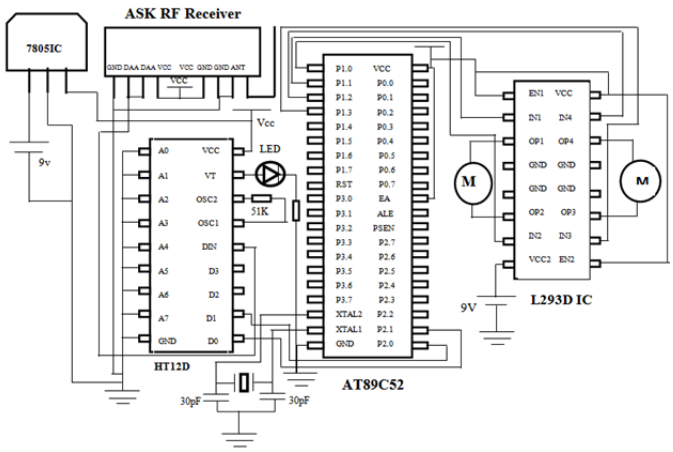

Fig. 3: Circuit Diagram of Receiver and Controller Unit of the system

- **Receiver and controller Circuit:** The entire control unit comprises of several section: – power supply section, receiver section and controller section. In building up the receiver section and the controller section following components has been used:- RWS-434N Receiver module, HT12D Decoder IC, LED indicator, AT89C52 Microcontroller, 12.0 MHz Crystal Oscillator, Push button switches, 0.33 pF Capacitors, L293D Motor driver IC and few resistors. **Fig.3** shows the circuit diagram of the receiver and controller unit.

2.2 Mechanical Setup Description

The mechanical setup of the curtain system consists of the following parts:-

i. **C-Channel Curtain track:** There are a wide range of Curtain Tracks available such as P-channel, C-channel, M-channel, and smooth line for curtains. These window curtain tracks are smooth gliding channels & are available in variety of finishes and are available at industry leading prices. We have used C-channel curtain track for our purpose. Some of the key features of C-Channel aluminium curtain track are: corrosion resistant, sturdy in construct, easy to install, available in variety of finish and most importantly customization can be done.

ii. **Runners:** Runners are designed and manufactured to fit specific curtain tracks. They come in various shapes as well as sizes and can be made of metal or plastic, some gliders are silicone impregnated for a smoother gliding action. They are sold in packs with the quantities supplied varying depending on the make and model of each curtain track.

2.3 Wooden Pulley: This pulley is made of wood. It has been used to wound the curtain cord. It will offer the movement of the curtain. This pulley is 4cm long and the diameter of the hole of the pulley is 6mm.

2.4 Software Description

The software programme is written and compile in Keil C compiler and generated .hex file is used to burn the microcontroller. The programme is written in C language. The flowchart of the programme is shown in **Fig.4.**

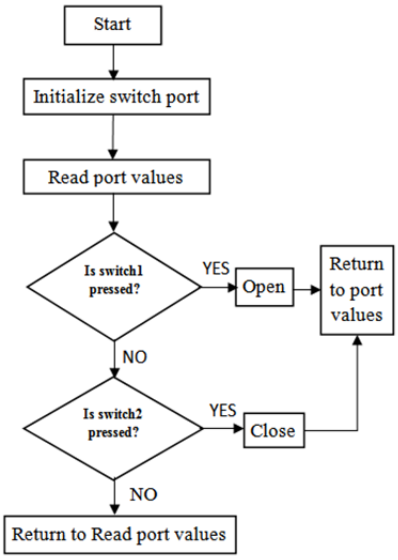

Fig. 4: Flowchart of programme.

3. WORKING MECHANISM

The complete working mechanism of the system can be described as follows:-

3.1 Working Mechanism of Transmitter

The switches of the remote are directly connected to the data pins of HT12E encoder. When the data pins of the encoder are in open state, the status of the pin is “high” and when connected to the ground, the status is “low”. Thus by pressing the switches, a connection to ground is allowed to individual pins making the status “low”. If a transmission-enable signal is applied, the encoder scans and transmits the status of the 12 bits of address/data (8 bits address and 4 bits data) serially in the order A0 to AD11 (refer to figure 3.8). During information transmission these bits are transmitted with a preceding synchronization bit. If the trigger signal is not applied, the chip enters the standby mode and consumes a reduced current of less than 1mA for a supply voltage of 5V. The encoders begin a 4-word transmission cycle upon receipt of a transmission enable and this cycle will repeat itself as long as the transmission enable (TE) is held low. Once the transmissions enable returns high the encoder output completes its final cycle and then stops. The serial data available at DOUT pin is fed to the data in pin of the wireless high power transmitter TWS-BS RF module (refer to figure 3.4). The transmitter modulate the signal in ASK mode and

sends out the data as electromagnetic waves at a frequency of 433.92MHz.

3.2 Working Mechanism of Receiver and controller

The transmitted signal is received by RWS-434N which is a high sensitivity OOK receiver module which has built-in automatic gain control with receiver sensitivity of -116dBm. After the signal is received, the receiver will output TTL signal to external decoder IC for decoding. Thus the decoder receives data that are transmitted by an encoder and interpret the first 8 bits of code period as addresses and the last 4 bits as data. A signal on the DIN pin activates the oscillator which in turn decodes the incoming address and data. The decoders will then check the received address three times continuously. If the received address codes all match the contents of the decoder's local address, the 4 bits of data are decoded to activate the output pins and the VT pin is set high to indicate a valid transmission. This will last unless the address code is incorrect or no signal is received. The output of the VT pin is high only when the transmission is valid. Otherwise it is always low. The data pins of the decoder are interfaced with a port of AT89S52 microcontroller. According to the program loaded on the microcontroller, the microcontroller will instruct the L293D motor driver IC to rotate the motor in required direction as demanded by the data coming from the remote switches. The motor driver offer bidirectional rotation of the connected motor which in turn move the runners on which curtain is hanged.

Working Mechanism of Mechanical Setup

The mechanical assembly is what that is responsible for serving the main purpose of our work. If the mechanical setup fails, there is nothing to take part of the other units in the design.

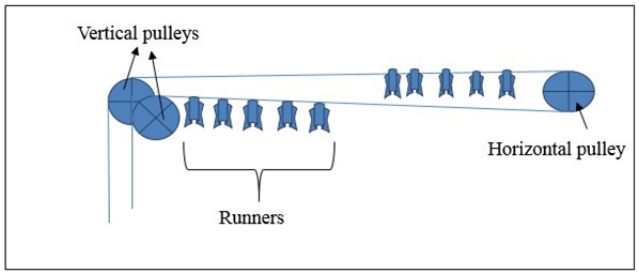

Fig. 5: View of mechanical construction of the curtain.

In building the complete mechanical setup following raw parts have been used- 140 cm C-Channel aluminium track, Drapery cord, Drapery pin, Curtain brackets, Curtain rod, Wooden pulley, Curtain runners & Curtain. While installing the curtain system drywall screw, sheet metal screw, Security head screw, hex cap screw and bolts have been used to secure the system. The concept behind the mechanical working is shown in the **Fig.5.** Two vertical pulleys at one end and one horizontal pulley is placed at the other end of the C-channel track. Then threaded the drapery cord through the back left pulley, across the curtain rod, through the right-hand pulley, back to the left side of the rod and through the front pulley on the left leaving few meters excess cord. Ensure that the pulleys are level with the drapery carrier. Runners are directly attached to the drapery chord. Since our curtain is a Centre Split Curtains, half of the runners are attached in opposite drapery cord. Now, if the forward cord is pulled, it will drag all the runners to the end on both sides leading to the opening of the curtain. If the backward cord is pulled, it will also take out the runners to the centre position on both sides, thus by closing the curtain. It is to be noticed that on pulling down one cord, other cord automatically pulled up and vice-versa. Hence if we connect this two ends of the cord to two motors, when one motor rotates in clockwise direction, other motor has to be rotate in anti-clockwise direction. This is how the curtain will operate.

4. INSTALLATION AND TESTING

At the very beginning, it is mentioned that it's a multipurpose curtain system. The curtain system has been for experimental purpose installed at a wall magazine. The c-channel curtain track along with the pulley and cord system housed inside is mounted with the help of the curtain brackets in their designated place on the wall which is depicted in the **Fig.6.** A curtain rod is used to hold the runners inside the track and each runner are attached to the cord. Drapery pins are used to hold the curtain cloth and to bind the curtain with the runners. For pull down and pull up operation of the curtain cord, the two excess cord ends are connected to the two wooden pulleys. The two wooden pulleys are in turn affixed to the shaft of the two motors so that rotation can occur with the rotation of the motors.

A project enclosure box is used which will contain the two dc motors, two wooden pulleys mounted on the shaft of the motors and the receiver & control circuit. The enclosure box is installed aside on the left hand side so that the excess cord of the left hand side of the track can be wounded on the wooden pulley.

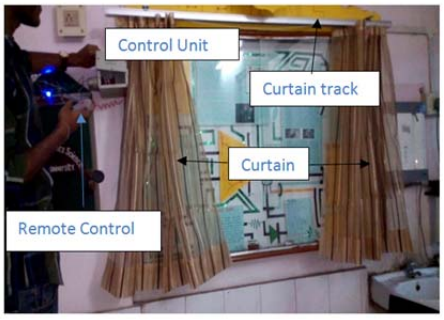

Fig. 6: Curtain System Installation at Wall Magazine

5. RESULTS AND DISCUSSIONS

After installing the mechanical assembly, the control unit is powered up from the mains ac power supply. After inserting 9V battery in the remote, system is ready for its operation and following results were found. As soon as the remote is powered up, the led connected to the VT pin of the decoder IC starts blinking, indicating that communication between the remote and the control section has been successfully established. With a 15cm coiled antenna on the both transmitter and receiver side, up to 2.5 m wireless distance is achieved. On pressing the OPEN switch and CLOSE switch, the curtain successfully open and close from the centre respectively. As per the program, the curtain stops at any position when the push button switch is stop pressing. Thus the design and building of the working model of the remotely controlled curtain system has been successfully completed. Every components and parts of the window curtain system is well installed and secured with screws and brackets. Table 1 shows the status of the data pins in the transmitter section and the receiver section. From the observation it is found that correct set of bit is transmitted from the receiver to transmitter.

Table1: Transmitted and received bit for remote operation of the curtain system.

Remote switch status				**Status of decoder data pin**			
Open Switch		**Close Switch**		**Data Pin 1 (Pin no. 10)**		**Data Pin 1 (Pin no. 10)**	
State	Logic	State	Logic	Logic	Voltage Level in V	Logic	Voltage Level in V
OFF	1	OFF	1	1	4.98	1	4.88
ON	0	OFF	1	0	0.198	1	4.92
OFF	1	ON	0	1	4.99	0	0.213
ON	0	ON	0	0	0.188	0	0.210

6. CONCLUSION

It is evident that remotely controlled curtain system for wide applications can be made at very low-cost locally. And can be installed at closed environment as well as open environment. Particularly, due to its simple mode of operation it is highly useful for the elderly people and people having joint problems. The components required are so small and few that they can be packaged into a small inconspicuous container. Project is less complicated and hence analysis and replacement of components is easy. With the use SMD devices the space for the control unit can be reduced to a much smaller dimension.

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