Design and Implementation of RF Remote temperature speed controlled Fan

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Abstract— this paper presents the design and implementation of RF remote temperature speed controlled Fan. Most of the fans installed at home and offices are operated manually and physically challenged persons find it stressful to control the fan operating at a distance around them. Also, at night people find it difficult to wake up to reduce the speed or to switch ON/OFF the fan while they lie on the bed. This issue has called for serious concern and Radio Frequency (RF) remote temperature speed controlled fan is considered and developed. The system will enable the physically challenged persons or individual at night/day to control the speed of fan operating around them without moving close. The system has transmitter and receiver units. The transmitter unit is the RF remote device which enables the operator to adjust the speed of the fan. The receiver unit attached to the body of the fan receives the RF signal and controls the fan speed as selected by the user. When installed, the temperature sensor in the receiver unit reads the room temperature automatically and regulates the speed of the fan. If the room temperature increases, the speed of the fan will also increase. The fan operates in two modes namely manual and automatic. In the manual mode, the speed of the fan is regulated by the user by using the RF remote device whereas, in the automatic mode, the receiver control unit controls the speed of the fan with respect to the current room temperature sensed. The fan is designed to switch off when temperature drops below a set-point, in order to conserve energy

Index Terms— RF Remote, Fan, temperature controlled, Microcontroller (PIC), Manual & Automatic modes, Transmitter, Receiver

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1 INTRODUCTION

Today, electric Fan is used for various purposes, especially in Africa. It is used to control the room temperature. The activities of an electric fan –usually the ceiling fan- can be controlled by using centrifugal switch. The user can select the required speed by selecting the appropriate level in the normal centrifugal switch. Normally, a conventional electric fan operates with six speeds switches: speed 0, speed 1, speed 2, speed 3, speed 4 and speed 5, where speed 0 is especially for switching off the fan. Depending on the manufacturer's choice, speed 1 gives the slowest rotational speed while speed 5 produces the fastest speed or vice versa.

Over time, the cooling requirement of our body varies, and this usually involves the tedious task of adjusting/regulating the speed of the Fan. Many people, especially the physically challenged are affected most because of the inconveniences associated in changing the Fan speed level manually. This could force them at times, to let the fan rotate at a speed that does not reflect their current need [1]. Usually, the fan is left to run continuously at a very fast rate than needed. Hence, an efficient and reliable closed loop control system that automatically changes the Fan speed level according to the change in room temperature is built to solve the problems and shortcomings associated with manual method of Fan speed control.

It is a stressful process to get up (usually at night) to adjust the Fan speed level manually when the room temperature changes. As stated earlier, the disabled/physically challenged persons are most affected. However, there are two perspectives to this problem: more electrical energy is being spent than required and inconveniencies are suffered with regularly manually adjusting fan speed with varying room temperature. A smart Fan that automatically changes its speed level, according to varying environmental temperature is developed.

2 LITERATURE REVIEW

Hossam et al, in 2014 designed an electronic circuit in which a microcontroller was used to control the fan according to temperature variation. A temperature sensor, LM35 measured the changes of temperature of the surroundings. All the operations were controlled by the PIC to produce the output. The fan was however the only output device [2]. The system lacked an LCD to display the current system condition. The speed of the fan was similarly controlled by using PWM technique according to the room temperature change.

Surabhi et al, in 2015 presented a paper on the speed control of a DC fan based on room temperature [3]. To get rid of the problem of improper temperature control in homes and industries, a microcontroller based controller was proposed. A temperature sensor was used to measure the temperature of the process and the speed of the fan varied according to the room temperature using pulse width modulation technique. Controller was used to control the speed of DC Fan. The duty cycle was varied from 0 to 100% to control the fan speed depending on the room temperature. Duty cycle values between 25% and 95% allowed smooth control of the fan. It was a very bogus system and little was done to eliminate hysteresis which affected the system's accuracy.

Zairi et al, in 2013 produced a Peripheral Interface Controller (PIC) based automatic fan system and attempted to upgrade the functionality to embed an automation feature. The electric fan will automatically switch on according to the environmental temperature changes [4]. The circuit adapted a microcontroller to control the fan according to the temperature variation. The system measured the temperature from the Integrated Circuit (IC) LM35, and operates the fan according to the setting values in the programming. The temperature then is compared with the setting value. If the room temperature goes beyond the preset temperature, then the fan will turn on.

It also included a security characteristic, in which a buzzer will instantly produce an alarm when it detects an extremely high temperature; for example, when the room is on fire, which the sound to alert people of the danger.

Gavish et al, in 2012 presented a paper on the design and simulation of a novel fan speed control system based on room temperature using Pulse Width Modulation Technique. The duty cycle was made to vary according to the room temperature and the fan speed is controlled accordingly [5]. This paper simplified how the autonomous speed control of fan is done based on data from the temperature sensor. This was a direct system which gave a linear analog output for the appropriate temperature input.

Katole et al, in 2013 proposed a Smart Device Controller capable of activating and controlling most of the electronic devices such as TV, Fan, AC, Lights, etc. The SDC was supposed to be a user friendly device that can be a replacement for many other remote controls of various electronic devices such as TV, audio/video player, etc. It could also handle various devices that had no remote control [6]. The remote controls of the electronic devices are usually complex and hard to quickly learn and adapt to, given that each appliance would naturally have its own specific means of control. The SDC aimed to replace this problem with simple hand gestures which are easier to master.

Kaphungkui, in 2015 presented a work to control independent home electrical appliances through RF based remote system. The controlling circuit was built around RF transmitter and RF Receiver modules which operated at 434 MHz along with encoder IC HT12E and decoder ICHT12D with few passive components [7]. The four different channels at the encoder were used as input switches and the four channels at the decoder output were connected to the appliances through a relay. Here the transmission technique is amplitude shift keying (ASK) and the circuit powered by a 9V supply. The main objective of this work was to build the circuit without any programming skill and to make it work without the usual line of sight requirement of the RF technology.

Sriskanthan et al, in 2002 introduced a Bluetooth-based automated appliance system, consisting of a primary controller and a number of Bluetooth sub-controllers. Each home device is physically connected to a local Bluetooth sub-controller. The home devices communicate with their respective sub-controller using wired communications [8]. From the sub-controller all communications are sent to the primary controller using Wireless communications. It is desirable for each home device to have a dedicated Bluetooth module. However, due to the fiscal expense of Bluetooth technology, a single module is shared amongst several devices. This architecture reduced the amount of physical wiring required and hence the intrusiveness of the installation, through the use of wireless technology. However, the architecture did not completely alleviate the intrusiveness incurring an access delay.

Scaradozzi et al, in 2003 viewed automated systems as multiple agent systems (MAS). In the paper, automated systems were proposed that include home appliances and devices that are controlled and maintained for home management. The control element for each device was based on a particular physical variable such as temperature, light intensity etc. The major aim was to improve overall performance.

3 SYSTEM DESIGN APPROACH

The system comprises of hardware and software.The hardware has transmitter and receiver and software written in Micro C-language to control the entire system. The system block diagram is shown in Figure 1.
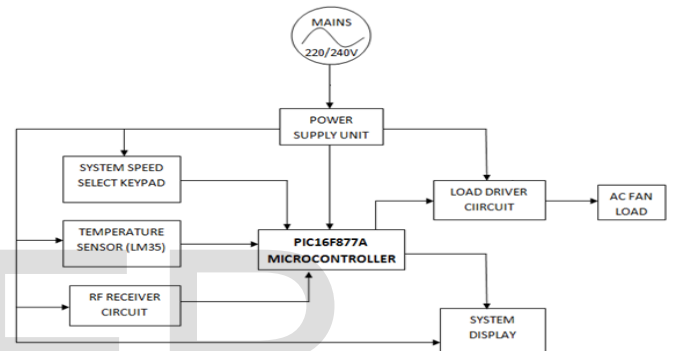

Figure 1: Block Diagram of the System

3.1 Power Supply Unit (PSU)

Power supply unit generates +5V D.C required for the system operation. This +5V D.C is captured using step down transformer of 220V A.C, 50/60Hz. The output of the transformer is rectified using bridged diodes, filtered with capacitors and finally regulated with IC 7805 voltage regulator. The regulated power supply circuit diagram is shown in Figure 2.
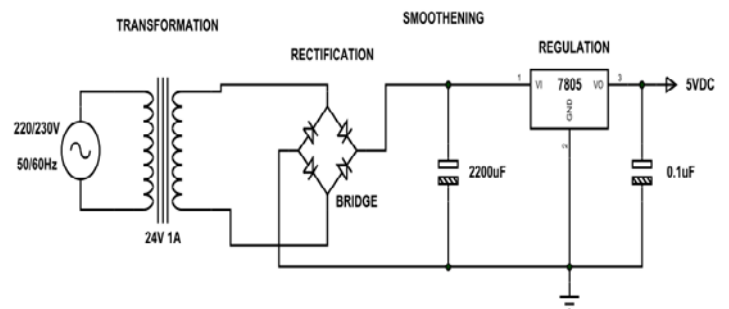

Figure 2: Regulated +5V DC Power Supply Circuit

3.2 Ra
An RF   a
12-bit generated data from an encoder when any key is pressed on the remote. The remote circuit configuration is shown in Figure 3. The circuit is powered by a 9V battery and comprises mainly of an encoder IC and an RF transmitter module. The manual push button switches are used to switch between the two modes of operation of the fan speed.The

HT12E encoder used is a low-power Complementary Meta Oxide Semiconductor technology for remote control system applications which encodes information that consists of N address bits and 12^{12} N data bits. Each address/data input can be set to one of the two logic states high or low. The programmed addresses/data are transmitted via an RF transmission medium upon receipt of a trigger at transmit enable pin
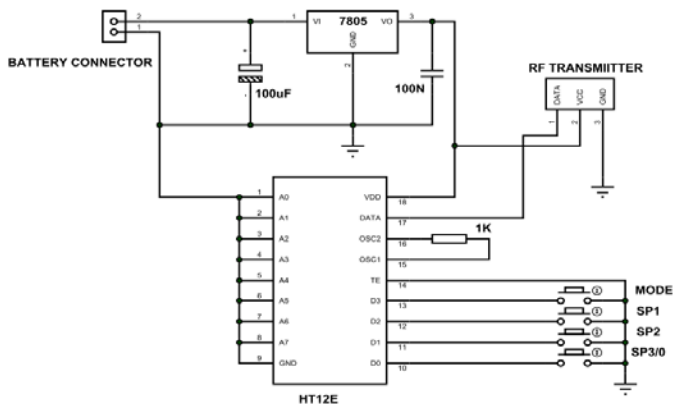

Figure 3: Transmitter System remote circuit

The manual push button key has four distinct keys for increasing/decreasing the speed of the fan, and also for selecting manual or automatic mode of the fan. The push button key sends a momentary electrical signal to the control unit when pressed. Each of the keys represents a special function to be executed by the control unit and is configured as:

MODE: To switch between Automatic and Manual operation modes. *SP1*: This key sets the fan rotating at Minimum speed. *SP2*: This key switches the rotation speed of the fan to Medium. *SP3/0FF*: This key sets the fan speed to Maximum. When pressed again, it turns the fan OFF and vice- versa.

3.3 System Control Unit

The control unit controls all the activities of the system. Microcontroller (PIC16F877A) is used to carry out control action. It receives input signals from the transmitter unit, then processes it and control the fan speed and display information to the user on Liquid Crystal Display. The microcontroller selected has the following properties: 386MB of RAM, 8KB of ROM, 32 number of programmable I/O lines, programmable serial channel (USART), and high data precision and processing time. A pin configuration of the PIC16F877A Microcontroller is shown in Figure 4.
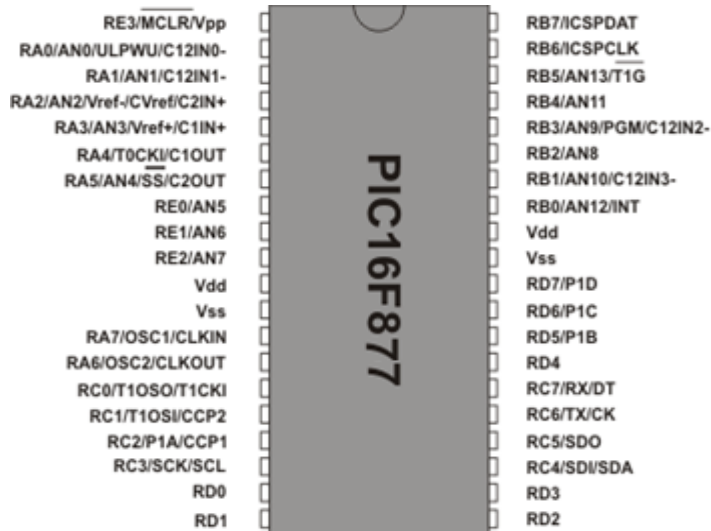

Figure 4: Pin Configuration of PIC16F877A Microcontroller

The microcontroller is 8-bits wide with five (5) unique programmable ports (Port A, Port B, Port C, Port D and Port E). Ports A and E are 8-bits wide having both analog and digital features. Ports B, C and D are also 8-bits wide input/output port but with only digital features.

3.4 Liquid Crystal Display (LCD)

The Liquid Crystal Display is used to display the operational mode of the fan (whether manual or auto), the temperature of the environment and the current speed level of the fan. The interfacing of the device with the microcontroller unit is shown in the system circuit diagram. Data is sent from the microcontroller to the LCD in a 4-bits mode to minimize I/O port usage. Hence, there are four lines connecting the LCD to the controller in the other of RD0-D4, RD1-D5, RD2-D6, and RD3-D7. The other two lines are the Command (RS) and Enable lines (E) of the LCD respectively. RS is connected to RD5 and E is connected to RD7.

3.5 System Software Design Flow Chart

The step-by-step system software flow chart works following conditions stated below and the diagram is as shown in fig. 5.
If temperature is below 28°C, the fan goes OFF.
If temperature is greater than 28°C, fan comes ON according to temperature of the environment as measured by the sensor.
The device switches operation mode from Automatic to manual and vice versa when the Mode button is pressed.
The speed of the fan can be manually controlled when the fan is in manual operation mode.
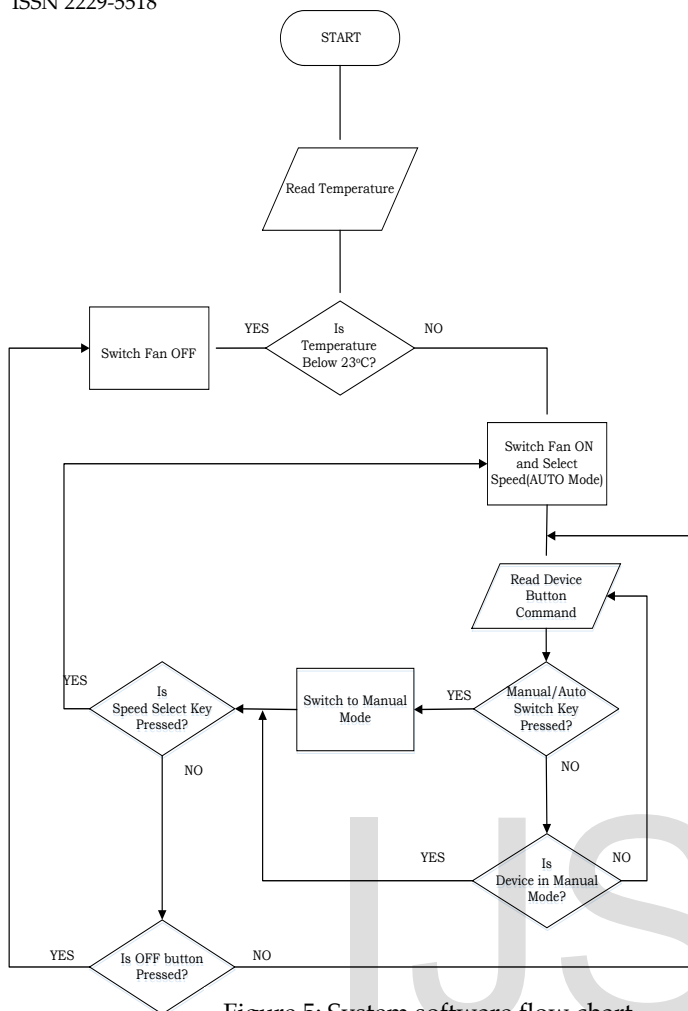
fan's speed by selecting Speed1 through Speed3 labelled on the RF remote device. The OFF command is sent either when the operator presses the Speed3 button second time in the manual mode; or when the temperature of the room falls below 23°C. The system circuit diagram is shown in figure 6.
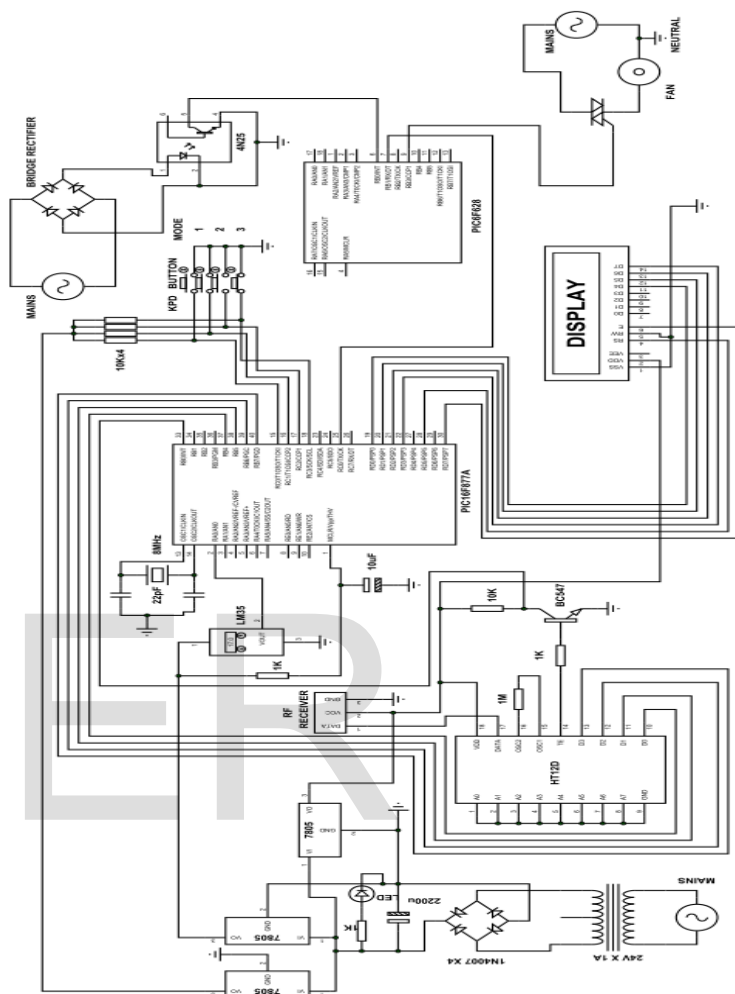

Figure 5: System software flow chart

Figure 6: System Circuit diagram

3.6 System RF Receive Unit

The RF receiver unit installed on the AC Fan body uses RF module to receive signal from the transmitter. The receiver receives 12-bit data transmitted from the RF remote control unit and fed to HT12D decoder to confirm channel integrity (address synchronization). If confirmed, data is presented at the output pins of the HT12D decoder unit which controls the rotational speed of the Fan. The receiver circuit is integrated in the system circuit diagram as shown in Figure 6.

3.7 System operation & Circuit Diagram

When the Fan power source is switched ON, system by default goes into automatic operation mode. The operator can change the operation mode using the RF remote. The control unit reads the temperature of the environment and switches the fan ON if the temperature is above 23°C. Otherwise, it remains OFF. The control unit is always alert to receive any command from the operator either to switch the system to automatic or manual modes. When the manual/auto button is pressed, the system goes into manual operational mode and hence, the operator decides at what speed the Fan should rotate. While in the manual mode, the operator can change the

3.8 Fan Power Control Unit

The load power control unit controls the power delivered to the load (Fan). This is known as "phase control" which involves varying the firing angle or the turn on and turn off time of the AC line voltage after the zero crossing of the AC wave. Phase control is achieved using the following components:

i. **4N25 IC -** This is a 6 pin optical isolator IC used for detecting the zero crossing of the AC mains voltage. The circuit operation of the zero crossing detectors is designed in such that at every time the mains voltage crosses the zero point on the wave, the output collector of the optical isolator turns a 0V.

ii. **628A IC** – This module is a serial communication protocol used to relay the speed value of the fan as determined by the main system controller to the load

driver IC (628A IC). This IC controls the power delivered to the load through the help of the ZCD which notifies the IC every time the mains voltage crosses the zero point through the interrupt line. After the zero point, delaying the turn on time of the triac reduces the power delivered to load which indirectly reduces the speed of the fan.

iii. **BT 136 IC -** This 3-pin triac is used for switching the output load in accordance with the speed variations. The interfacing of the 4N25, 628A and BT136 ICs with the PIC are shown in Figure 6.

5 SYSTEM PERFORMANCE

Various tests were conducted on the system section by section and finally integrated to ensure efficient throughput. This approach helps in tracing any unforeseen fault in every section of the system. The power supply unit was checked for proper voltage level from its output pins with a multi-meter. The system program written in C language and simulation carried out using PROTEUS software. The codes checked for errors and burned into microcontroller chip. The various components level tests conducted are:

A. **Transformer Test:** When tested with a digital multi-meter, the transformer had primary voltage 220 V_{AC} and 12 V_{AC}-0 V_{AC}-12 V_{AC} secondary voltages.
It was connected to the AC mains outlet where the output voltage was checked and found to be within the voltage ratings of the transformer as specified.

B. **Relay Test:** The resulting resistance gave 69 ohms as stated by the manufacturer and suitable for the work.

C. **Capacitor Test:** When tested, the capacitor gave readings in the range of 2100μF to 2200μF considering tolerance as stated by the manufacturer.

D. **Resistor Test:** Considering tolerance, the resistance values obtained during tests were within range of the stated values.

E. **LM35 Temperature Sensor Test:** For every degree rise in temperature, the sensor output pin produced a 10mV output during test. This result was satisfactorily in line with stated accuracy of the sensor given by the manufacturer.

F. **LCD Test:** when tested, the lower line of the 16×2 LCD lits up that shows good working condition of the component.

G. **PIC Microcontroller:** The device was tested and confirmed ok.

The overall device test is described in Table 1. It also illustrates the results obtained from the system work.

TABLE 1

Test Result description of completed System

S/N	Process	Output Device	Action and description
1.	Power is turned ON using power switch	Blue LED indicator	LED flashes times, indicating device good working condition. Device operates in Auto Mode upon start up.
2.	Press Mode button (Remote or Local) to switch system mode of operation.	LCD Display	Mode changed. System mode of operation changed from Auto to Manual
3.	Press Mode button (Remote or Local) to switch system mode of operation.	LCD Display	Mode changed. System mode of operation changed from Manual to auto Mode
4.	Temperature below 23°	Fan	The fan is switched off
5.	Temperature above 23° but be-	Fan	Fan is switched to speed 1

	low 25°		
6.	Temperature above 25° but below 28°	Fan	Fan is switched to speed 2
7.	Temperature above 28°	Fan	Fan switched to Speed 3
8.	Mode button pressed (Remote and Local)	Fan	Operation mode changed from Auto to Manual mode
9.	SP1 button pressed (Remote and Local)	Fan	Fan switched to Speed 1
10.	SP2 button pressed (Remote and Local)	Fan	Fan is switched to Speed 2
11.	SP3/OFF button pressed (Remote and Local)	Fan	Fan is switched to Speed 3
12.	SP3/OFF button pressed (Remote and Local) when Fan is operating at Speed 3	Fan	Fan is switched OFF

5.1 System RF Receive Unit

The completed system circuit for the Smart fan regulator and the remote control unit were packaged in suitable Fibre-glass cases.

A. Remote Control Unit (Transmitter)

The remote control unit measures 12cm in length, 7cm in width and 3.5cm in depth as shown in figure 7.

Figure 7: The packaged Remote Control unit (Transmitter)

B. Fan Regulator Unit (Receiver)

The dimensions of the Fan regulator packaging are given as 15cm length, 10cm breadth and 5cm depth. The fan regulator device is also packaged in a PVC case shown in Figure 8.

The Receiver Fan Regulator packaged in PVC

C. System Transmitter & Receiver Units

The Micro-controller-based Temperature-controlled Fan with associated RF remote control unit is shown in Figure 9.

Figure 9: The complete Temperature-controlled Smart Fan System with Remote Control Unit

5.2 Part of System Program in C Language

* RF Temperature-controlled Smart Fan
* Test configuration:
* MCU: PIC18F877A

```
 *   Oscillator:     HS-PLL, 32.00000 MHz
extern const char lcd_string[112];
char beg,col,count,T1,T2,T3,T4,T5;
long time_var,temp;
unsigned                short               modeBut-
ton=0,speedSelected=0,speed1,speed2,speed3,remotePress=0;
unsigned int speed;
unsigned char remoteData=0X00;
void lcd_reset(){
PORTD = 0XFF;
delay_ms(20);                    //0.02s
PORTD = (0X03 + 0X80);
PORTD = 0X03;
delay_ms(10);              //0.01s
PORTD = (0X03 + 0X80);
PORTD = 0X03;
delay_ms(1);            //0.001s
PORTD = (0X02 + 0X80);
PORTD = 0X02;                //0.001s
delay_ms(1);
}
void lcd_cmmand(unsigned char cmmd){
PORTD = ((cmmd >> 4) & 0X0F | (0X80));
PORTD = ((cmmd >> 4) & 0X0F);
PORTD = ((cmmd & 0X0F) | 0X80);
PORTD = (cmmd & 0X0F);
delay_us(900);
}
void lcd_initia(){
lcd_reset();
lcd_cmmand(0X28);
lcd_cmmand(0X0C);
lcd_cmmand(0X06);
lcd_cmmand(0X80);
}
void lcd_display(char row,char col,char start,char stop){
if(row==1){
row = (0X7F + col);
lcd_cmmand(row);
}
if(row==2){
row = (0XBF + col);
lcd_cmmand(row);
}
if(row==3){
row = (0X8F + col);
lcd_cmmand(row);
}
if(row==4){
lcd_cmmand(row);
}
for(beg=start;beg<stop;beg++){
PORTD = (((Lcd_string[beg] >> 4) & 0X0F) | (0XA0));
RD7_BIT=0;
PORTD = (((Lcd_string[beg]) & 0x0F) | 0XA0);
RD7_BIT=0;
}
}
//MODE Display
if(modeButton==0){lcd_display(1,13,100,104);}
//display "AUTO"
else        {lcd_display2(1,13,32);lcd_display(1,14,104,107);}
//display "MAN"
//SPEED Display
if(speed==1){lcd_display2(2,16,49);}                 //display
"1"(speed 1)
else if(speed==2){lcd_display2(2,16,50);}             //display
"2" (speed 2)
else {lcd_display2(2,16,51);}                //display "3"
(speed 3)
}
void interrupt(){
//TIMER0 INTERRUPT
if(T0IF_BIT == 1){
T0IF_BIT=0;
TMR0=0;
}
if(INTF_BIT==1){
INTE_BIT=0;
delay_ms(20);
//RECEPTION INDICATOR
RC4_BIT=1;
DELAY_MS(100);                       //0.1s
RC4_BIT=0;
//MODE
if(RC0_BIT==0   &&   RC1_BIT==1   &&   RC2_BIT==1   &&
RC3_BIT==1){
if(modeButton == 0){modeButton = 1;}         //Switch
to MANUAL Mode
else {modeButton = 0;}               //Switch to AU-
TO Mode
}
if(modeButton==1){
//SPEED ONE
if(RC0_BIT==1   &&   RC1_BIT==0   &&   RC2_BIT==1   &&
RC3_BIT==1){
remoteData = 0X31;
remotePress=1;                    //If Sp1 key is
pressed
speed = 1;                            //Enter
Speed 1
speed1=1;speed2=0;speed3=0;            //Only speed
1 selected
}
//End Speed 1 program
//SPEED TWO
```

```
if(RC0_BIT==1  &&  RC1_BIT==1  &&  RC2_BIT==0  &&
RC3_BIT==1){
remoteData = 0X32;
remotePress=1;                              //If  Sp2
key is pressed
speed = 2;                                  //Enter
Speed 2
speed1=0;speed2=1;speed3=0;                 //Only speed
2 selected
}
//End Speed 2 program
//SPPED THREE
if(RC0_BIT==1  &&  RC1_BIT==1  &&  RC2_BIT==1  &&
RC3_BIT==0){
remoteData = 0X33;
remotePress=1;                              //If Sp3 key is
pressed
speed = 3;                                  //Enter
Speed 3
speed1=0;speed2=0;speed3=1;                 //Only speed
3 selected
}
}
INTF_BIT=0;
INTE_BIT=1;
}
}
//End Speed 3 program
void main() {
delay_ms(100);
TRISD5_BIT=0;
TRISD7_BIT=0;
TRISD0_BIT=0;
TRISD1_BIT=0;
TRISD2_BIT=0;
TRISD3_BIT=0;
INTCON=0XB0;
OPTION_REG = 0X07;
```

6 CONCLUSION

The RF Remote temperature speed controlled Fan is designed based on its important in homes/industries. This was implemented in order to make life easy for home/industry Fan users' to switch ON/OFF of their standing fans within a distance using designed RF remote device. With this system, users can comfortably increase the speed of the Fan, change from manual mode to Automatic mode, and switch ON/OFF Fan via RF remote without going close to the Fan. The physically challenged persons would also benefit from it. The system has been tested with accurate result and hereby recommended to everybody for use in their respective places.

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