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Intelligent Integrated RF Remote Control for Fan, Light and Heater

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Abstract

This paper proposes asmart remote control system which is capable of controlling the light intensity, temperature and humidity of the room as per the requirement of the user in both autonomous and semiautonomous (remote control).In semiautonomous mode, the parameters are controlled through the smart remote. In autonomous mode the parameters are controlled by the receiver board itself. The remote controlcomprises of light dependent register,humidity sensor, temperature sensor, switch array,microcontroller,LCD display and RF modem. The receiver board comprises of dimmer for light, dimmer for fan, dimmer for heater, one ice cube relay, microcontroller, LCD display, Fan, Bulb, heater, exhaust fan and RF modem. The user can set the parameters by pressing the corresponding button in the remote control where the corresponding sensor will send the appropriate sensory signal to the receiver board for controlling the respective dimmer. The communication between and the receiver board will be done wirelessly through the 2.4 GHz RF modem with 9600 baud rate. Remote switch array is capable of setting thedesired user input.The sensor on remote will provide the corresponding feedback signal to receiver board. The difference in the user defined data and the feedback signal from remote will generate the error signal in closed loop. The PID controllerwill tuned its parameters Kp, Ki and Kd in accordance with this error signal and generate the corresponding control signal for dimming of the respective parameters. This system is capable to reduce the overall energy consumption of house. The system can be upgraded for centralized heating and cooling of larger building byautonomous and semiautonomous (remote control) method.

Keywords-Closed loop system ,Dimmer, Fan, Heater, Light, Remote control, Receiver board, RF modem,Sensor.

I. Introduction

The home appliances like Ceiling fan, exhaust fan, bulb, and heater have become a necessity in everyday life. Because of its extensive use at all home, the energy consumption becomes a very important issue. The literature available shows that although ON/OFF control of home appliances have been implemented but in order to save more power more control of these appliances are necessary. Zhen-ya Liu et al. discuss intelligent home environment based on zigbee and GSM networkto monitor the parameters like temperature, humidity, infrared, smoke, gas, fire, theft alarm, home appliances such as home environment, through the wireless networking of multiple monitoring devices[1].Sunghoi Parkaet al. propose a ZigBee wireless communication based Smart Energy Management System (SEMS) which is control the motion sensor and setting time of power usage to reduce power consumption [2].Lili Liang et. al propose ZigBee and PSTN remote control based system using PIC18LF4620 SCM and 2.4G RF transceiver module for smart home. [3].Chunlong Zhanget. Al discuss the Internet of Things and ZigBee wireless sensor network technology based network through which system users can know the environment parameters like temperature, humidity, meter readings, light, and control the home electronic equipment, such as light, air-conditioner, heater, in the home[4].David Keysonet. Al describe the design a smart home management toolkit system has three components like smart plug, gateway and a mobile application [5].WoongHee Kimet. al propose an energy management system based on wireless sensor networks has two main components like a wireless sensor network and an intelligent home gateway for sensing and transmitting electricity data and remote monitoring and control of home appliances [6].Jer-Vui Leeet. al discuss a smart elderly home monitoring system (SEHMS) monitor using 3-axial accelerometer with Android-based smart phone application to monitor fall, heat attack[7].Wei LIUet. Al reviewed and compared current technologies in the wireless home networking area and proposes ahardware design of ZigBee wireless sensor network based on CC2430 chip and embedded home gateway for smart home system [8].Firdouskausaret. al propose a “Intelligent Home Security Monitoring System” (IHMS) using RSSI in Wireless Sensor Networks enabled smart home environments to create pervasive and ubiquitous applications, which give scalable services and context-aware to the end users[9].DipakSurieet. aldiscuss a ZigBee wireless sensor networking of 42 everyday objectsin the smart home environment the information processing [10].

The above study shows that the controlling of home appliances has been reported by controlling it through ON/OFF mechanism. However, more energy can be conserved by dimming the intensity of these parameters. This paper illustrates a method for controlling these parameters by dimming and thereby conserving much more energy in comparison to what has been reported earlier.

II. Hardware Development

The whole system comprises two type of boards one is remote section and other is receiver board.

Remote Section and Receiver board :

Fig.1.a shows the remote section which comprises of temperature(TS), Humidity(HS) and Light dependent resistors(LS1&LS2), atmega16, RF modem,LCD 16*2 display unit,switchesand battery. The temperature sensor provides temperature information as feedback signal and also provides preset temperature using switches to receiver node. Receiver node generate error signal and then provide the signal to PID controller to control the intensity of heater. The humidity sensor provides humidity information as feedback signal to receiver node and corresponding to it, it will control the speed of ceiling fan and ON the exhaust fan to reduce the humidity level. The two light dependent resistors provide the information of light intensity of room and according to that control the light intensity of bulb.

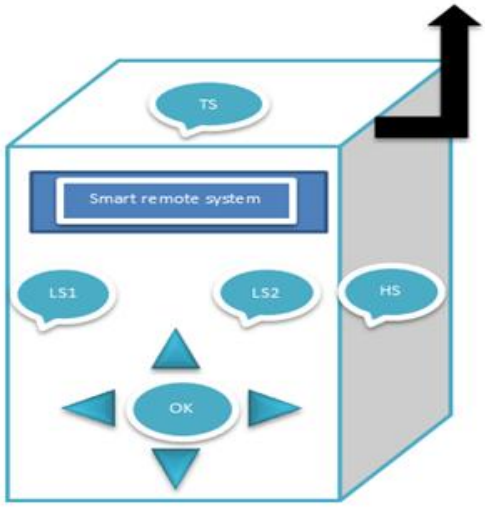

Fig.1.a View of remote control

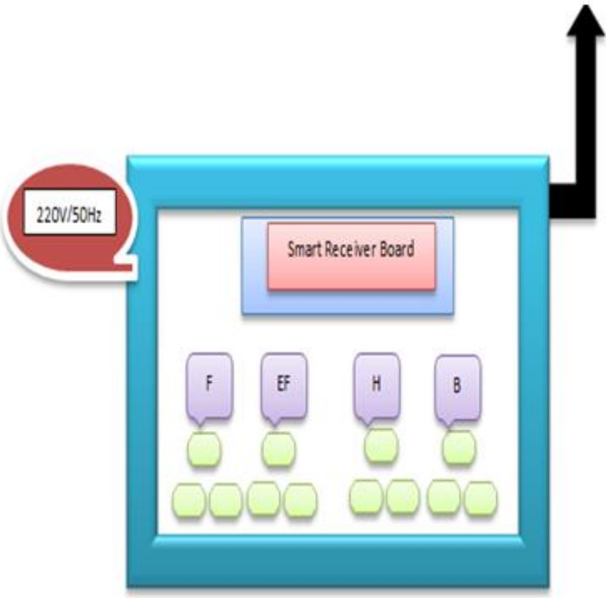

Fig.1.b View of Receiver board

Fig.1.b shows the receiver board comprises of Three dimmer circuit, One ON/OFF relay, atmega16 microcontroller, RF modem, LCD 16*2 display unit, power supply, ceiling fan(F),exhaust fan(EF), heater(H) and bulb(B).Dimming circuits are useful to control the dimming levels ofceiling fan, heater and bulb. PID controller is also implemented with dimmer in receiver board to control dimming of room appliances.

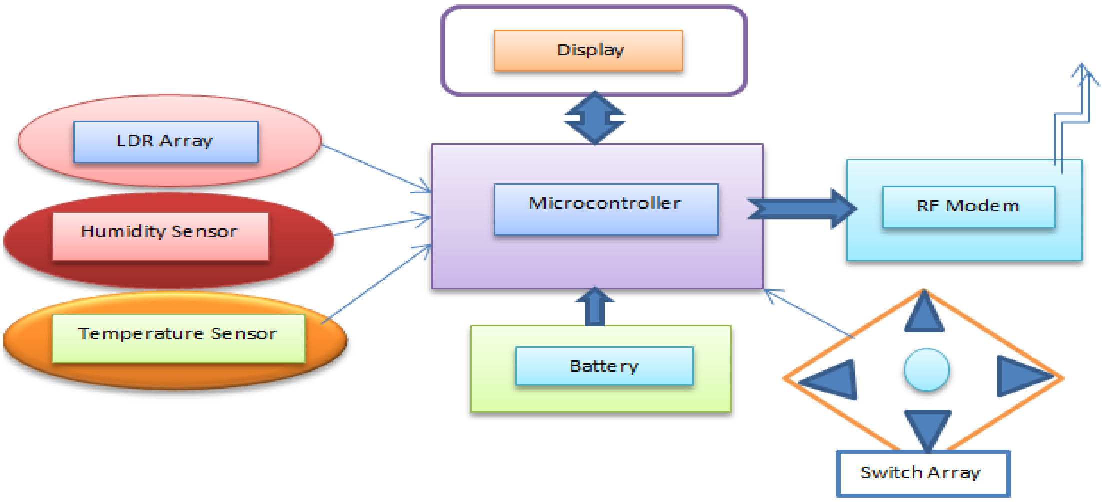

Fig.2 Block diagram of remote control

Fig.2 shows the block diagram of remote control. Fig.3 shows the block diagram of receiver board. The developed system has radio frequency modem, which ensures that signals be transmitted and received form remote control and receiver board. Both the modem in form remote control and receiver board is powered and operate effectively in the frequency of 2.4 GHz within the distance constraints below 30 meters.

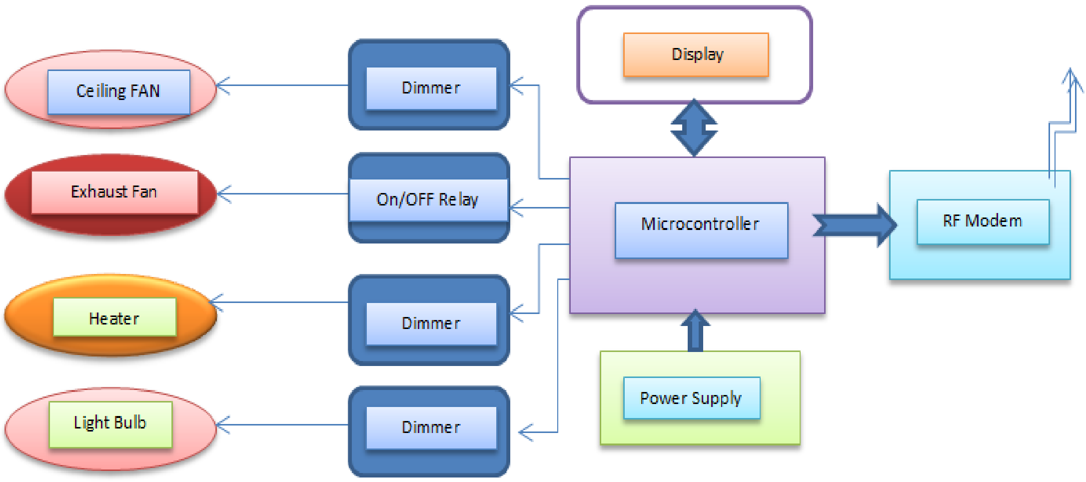

Fig.3 Block diagram of Receiver board

The description of components of cluster node, cluster head and main server are given in table-1.

Table-1

S.No.	Device/Module	Specifications and working
1.	Atmega16	Atmega8 is used. It is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture.
2.	RF modem	RF data modem working at 2.4 GHz frequency. Receives and Transmits serial data of adjustable baud rate of 9600/4800/2400/19200 bps at 5V or 3V level for direct interfacing to microcontrollers.
3.	LDR	Light dependent resistor
4.	LM35	Temperature sensor and Linear scale factor is + 10.0 mV/ C
5.	Humidity sensor	It uses a humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin
6.	Dimmer	The input can be simple 3 bit binary signal which is isolated with the use of opto-isolator. Output can switch on AC Load upto 12 Amp. Input and output are optically isolated
7.	2N2222	NPN transistor which is used as switch
8.	Relay	12V/1A ice cube relay as switch to operate hooter
9.	LCD	16*2 LCD to display the information for user and connected in remote section and receiver section
10.	Crystal	14.7456MHz frequency to set the baud rate of microcontroller to 9600 and connected with cluster head and cluster node
11.	Switch array	DPDT switches are used
12.	battery	9V/500mA battery to operate the remote section
13.	Power supply	12/1A supply to operate the Receiver section bulb
14.	AC Source	12V AC source to operate the Fan, Exhaust fan, heater and
15.	Capacitor	22pF to connect crystal in microcontroller atmega16

III. Circuit and Simulation

Fig.4show thecircuit diagram of remote control and receiver board.The connection of remote control and receiver boardare as follows-

1. LCD 1, 3, 16 pins to ground and 2, 15 pins should be connected to Vcc.
2. Control pins of LCD are to be Connected RS, RW and E pin of LCD to PD6, PD5 and PD7 respectively of remote section and receiver board.
3. The data pins of LCD (D4 to D7) are connected to Atmega16 (PC0 to PC3) of remote section and receiver board.
4. The TX pin of Atmega16 to RX pin of RF modem, The RXD pin of Atmega16 to TX pin of RF modemof remote section and receiver board.
5. Modem, Ground & +5V Power Supply between RF modem and Atmega16 should be connected.
6. RF modem works on TTL logic so can be directly connected to Atmega16. Configure ATMEGA16 at 9600 baud rate to communicate with RF modem.

7. 14.7456MHz crystal is connected with Atmega16 to set the baud rate 9600 of remote section and receiver board.
8. The data out pins of Temperature sensor LM35, Humidity sensor and LDR are connected to PA0 (40),PA1 (39) and PA2 (38) pins of Atmega16 of remote section. These pins are act as ADC pins of Atmega16.
9. Fan dimmer is connected with lower B port pins of Atmega16 of receiver board.
10. Heater dimmer is connected with upper B port pins of Atmega16 of receiver board.
11. Light bulb dimmer is connected with upper A port pins of Atmega16 of receiver board.

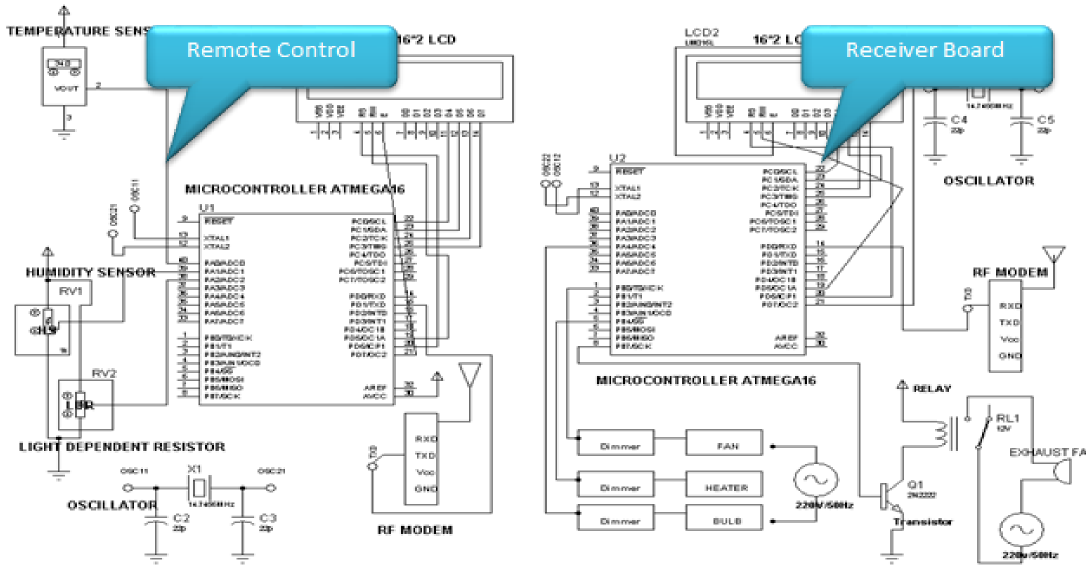

Fig.4 circuit diagram of remote control and receiver board

Fig.5 shows Proteus simulation model for the system. The simulation is done before hardware implementation to check accuracy and feasibility. The above circuit diagram is realized using proteus software and tested by writing the code in AVR studio 4. The C code is written for remote control and receiver board separately.

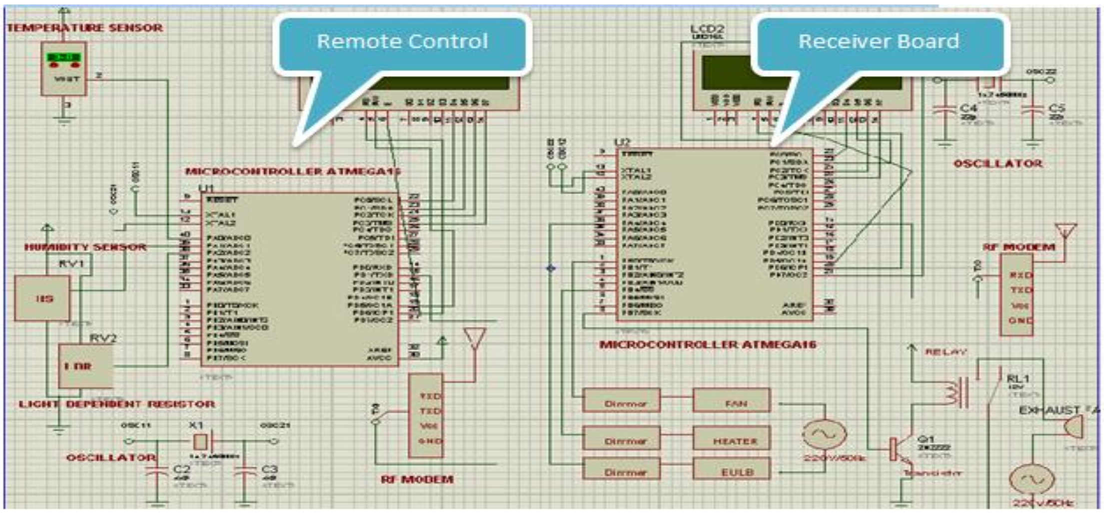

Fig.5Proteus simulation of remote control and receiver board

IV. Implementation of PID control

The processor employed for implementation of PID is the Atmega16. It is 8 bit microcontroller based on enhanced RISC architecture with 131 powerful instructions. It can work on a maximum frequency of 16MHz. ATmega16 has flash memory of 16 KB, static RAM of 1 KB and EEPROM of 512 Bytes. It has 32 I/O (input/output) lines.It is supported by USART, ADC, Analog Comparator, SPI, JTAG etc. The following command set have been used for implementation of the PID-

-#define Prop_GAIN2.2821/*all GAIN values have been computed by PID tuner*/
#define Int_GAIN 0.0230
#define Der_GAIN -21.285
#define dt_ 0.5
intset_**X**= 0 , previous_error = 0; // **X** may be temperature/light intensity/humidity
int error, feedback_**X**, output;
intD_error = 0, I_error = 0;
previous_error = set_**X** - feedback_**X**;
error = set_**X** - feedback_**X**;
Integral_error += (error)*dt;
Derivative_error = (error - previous_error)/dt;
output = (Prop_GAIN * error) + (Int_GAIN * Integral_error) + (Der_GAIN * Derivative_error);
previous_error = error;

Fig.6 shows the PID controller realization using scilab. By selecting the appropriate values of Kp, Ki and Kdin accordance with the response time. The transient response and steady state response have been taken into account while selecting the Kp, Ki and Kd. The Kp, Ki and Kd values are computed by the Scilab simulation. These computed values have beenapplied to the PID control algorithm.

The parameters in algorithm will drive the dimming circuitry present in the receiver board in order to control the corresponding physical parameters.

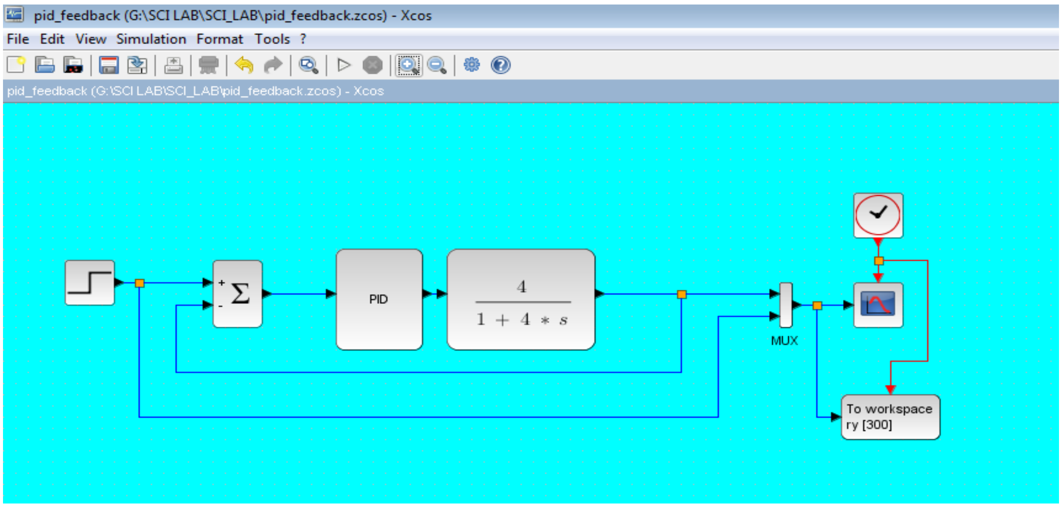

Fig.6 shows the PID controller realization using SCILab.

V. Result and discussion

Fig.7 shows the snapshot of the prototype. In this system there are four sockets on the board. Each socket corresponds to different appliances like Bulb, Heater, ceiling fan and exhaust fan. Second port is non- dimmable and is used for only for switching ON/OFF of the exhaust fan. The other three ports are dimmable ports and is used for controlling the light intensity, temperature of room and air flow by dimming the bulb, heater and ceiling fan. The system has been executed for one 100Watt bulb, 1Kw room heater and 50 watt ceiling fan for 4 hours. The dimming was performed by the smart remote and was running successfully for all types of sensors. The similar experiment also performed without using dimming facility and the results were compared in terms of percentage saving of power.

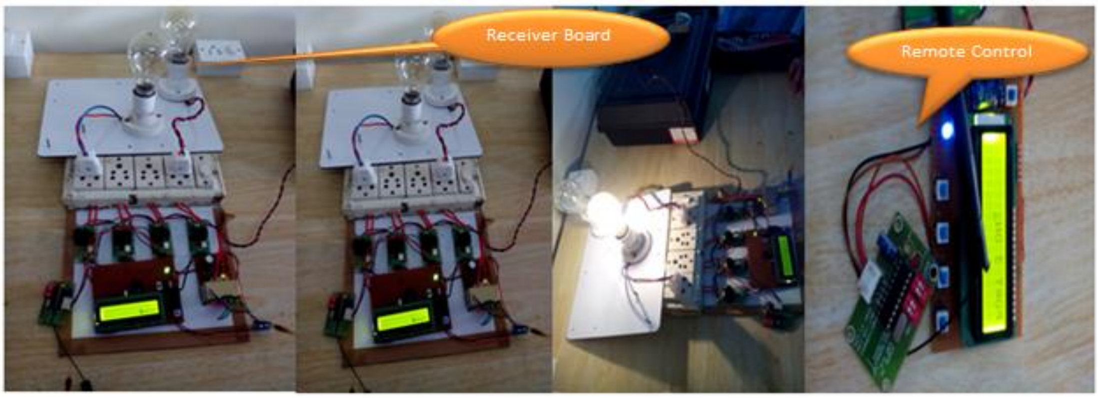

Fig.7 Snapshot of the experimental set of the system

Table-2 (Power consumption chart for heater)

S. No.	Timeduration (Month of Nov-Dec 2014)	Room Temperature(to maintain constantat 16^0C)	Power Consumption Remote control Heating System(inkWh)	Power Consumption of Conventional Heater(inkWh)
1	5:30 AMto 7:30 AM	6^0Cto 11^0C	4.00	4.00
2	7:31 AMto 8:00 AM	11^0Cto 12^0C	1.00	1.00
3	8:01 AMto 8:15 AM	12^0C	.420	.500
4	8:16 AMto 8:30 AM	12^0C	.400	.500
5	8:31 AMto 8:45 AM	12^0C	.450	.500
6	8:46 AMto 9:00AM	12^0C	.450	.500
7	9:01AM9:30AM	12^0C	.500	1.00
			7.22kW	8kW

Similar experiment has been performed for bulb and fans. The intensity of bulb was made to change in accordance with background light intensity of the room. The speed of rotation of ceiling fan was controlled in accordance with the humidity and temperature of the room. The percentage power saving for the dimming of 2K heateras per the above table is found to be 9.75 %. Since dimming was executed for bulb and fan, the overall percentage power saving will be higher than 12%.

VI. Conclusion and future scope

The primary focusof the developed system isto solve the problem of energy wastage due to human laziness and lethargy. The developed systemwill enable the user to use the equipment safely and easily.The system is very user friendly and hence will solve the problem of energy wastagedue to laziness. The device is equipped with the mechanism to control the intensity of bulb, heater wattage and fan speed by the use of feedback from sensors which is connected in remote control. The system can be used in big apartments, shopping mall, waiting rooms in railway station etc.

In future more number of devices can be interfaced for dimming of more number of appliances like CFL, florescent lampand LED bulb. Since the system is modular so more number of modules can easily be interfaced in order to upgrade the system.

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