INTELLIGENT POWER SAVING SYSTEM

CS09-608 B.Tech Mini Project 2012

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ABSTRACT

Intelligent Energy Saving System can be used in places like where lighting is very important. The libraries will be well illuminated with many lamps. When people are not present at a reading place the lighting can be made OFF and when they are present, the lighting made ON. All these can be done through by Dimming circuit and PIR sensor.

If a person entering to the monitored area, the Infrared energy emitted from the living body is focused by a Fresnel lens segment and the PIR sensors activates, senses the person, gives it to the micro controller. After sensing the person LDR checks the light intensity of the monitored area, whether it is bright or dark. Depending on the LDR output, the lamp may be ON / OFF by using Dimmer circuit.

By using this system we can adjust the speed of Fan according to the room temperature measured by Thermostat, which is connected to the micro controller.

To display the room temperature and PIR mode operation we are using the LCD display.

ACKNOWLEDGEMENT

We are very thankful to everyone who all supported us. We are equally grateful to Ajay James(Asst. Professor) for guiding and correcting various documents with attention and care. He has taken pain to go through the project and make necessary correction as and when needed. He gave us moral support and guided us in different matters regarding the topic.He had been very kind and patient while suggesting us the outlines of this project and correcting our doubts. We thank him for his overall support.

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Nomenclature

LCD	Liquid Crystal Display
LDR	Light Dependent Resister
PCB	Printed Circuit Board
PIR	Passive Infra Red Sensor
PWM	Pulse Width Modulation

Chapter 1

Introduction

Intelligent Energy Saving System, the aim of the project is to save the energy. In this project we are using various sensors, controlling and display.

However, in this project work the basic signal processing of various parameters which are temperature, LDR, Smoke sensor. For measuring various parameters values, various sensors are used and the output of these sensors are converted to control the parameters. The control circuit is designed using micro-controller. The outputs of all the three parameters are fed to micro-controller. The output of the micro-controller is used to drive the LCD display, so that the value of each parameter can be displayed. In addition to the LCD display micro-controller outputs are also used to driver a relay independently. This relay energizes and de-energizes automatically according to the condition of the parameter.

1.1 Objective of the project

The aim of the project is to save the energy or power, used in places like libraries where lighting is very important for the people who come to read books. So, the libraries will be well illuminated with many lamps. At the same time when people are not present at a particular reading place the lighting can be made off by using Dimmer and when people come to that area, according to the LDR lighting can be made sufficiently brighter.

By using this system, we can also adjust the speed of the Fan according to the room temperature using Thermostat and Dimmer.

1.2 Principle of operation

Consider a particular table in the library, which is connected with our experimental kit .When a person entering into that place the PIR sensor absorbs the black body radiation emitted by that person and activates it. The LCD display will display PIR ON.

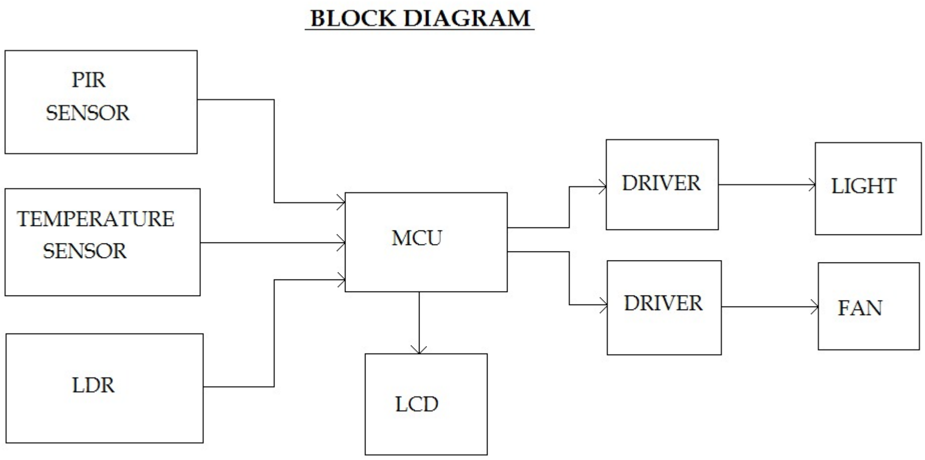
After some time delay the light will glow for some time by using the Dimmer circuit and with the help of LDR sensor that checks the room lightening

,and it takes the condition when the light is sufficient the lamp will be in OFF state and when light is insufficient the lamp will be in ON state.

With the help of Thermostat sensor the room temperature is measured and the speed of the Fan varies according to the room temperature. The LCD display will display the room temperature in degree centigrade.

When a person leavs that place, the PIR sensor will activate again and the Fan and the Lamp will made OFF. Now the LCD display is in stand by mode. And the main power supply will be switched OFF.

1.3 Block diagram



Block Diagram

Chapter 2

Requirement Analysis

2.1 Hardware and Software Requirements

2.1.1 Hardware Requirements

- Printed Circuit Board
- Micro controller:- PIC 16F877A
- DC Power supply
- IR sensor:-Passive Infrared Sensor
- LDR:-Light Dependent Resistor
- Temperature Sensor
- LCD:-Optrax, 2 line by 16 characters
- Microcontroller burner

2.1.2 Software Requirements

- Micro C Compiler

2.2 Detailed Functionalities

2.2.1 Functional Requirments

Here we capture the intended behaviour of the system. This behavior can be expressed as tasks, functions and services that the system required to perform.

- Sense the entry of a person in the monitered area: We use a PIR senser to sense the presence of a human being. PIR senser with the help of Fresnel lens senses the human bodys black body radiation.The entry of a human being activates the entire system.

- Measure the intensity of light in the area: We measure the intensity of light using a LDR. According to the output of LDR, the system will control the intensity of the bulb.
- Switch ON/OFF the light: The bulb is switched ON/OFF according to the intensity of light in the room after the entry of the person.
- Measure temperature: We measure the temperature using a temperature sensor, according to the output of which the speed of the fan is adjusted.
- Deactivtes the senser after the person leaving the palce: The whole system should be deactivated when the person moves out of the moniterd area. This is done by the PIR sensor. When the intensity of the blackbody radiation decreases, the PIR sensor detects it and deactivates the entire system.

2.2.2 Nonfunctional requirements

- Accuracy : The application should be accurate with its output. The algorithms which are to be used should adhere to required accuracy constraints
- Ease of use :The application should be user friendly so that any user can assemble easily.
- Speed : The speed of response by PIR sensor is a major concern.
- Availability :The items required for the system is easily available in market. And can be installed without any difficulties.
- Reliability : The PIR sensor should be placed within the range, where the human presence can be detected.
- Expected product life span : Since DC current is using, there will not be any fluctuation. Hence high life span can expected.
- Testability : The system should be properly tested in order to assure its reliability.

2.3 Scope of the project

Our project aims to reduce the wastage or conservation of electricity. Energy conservation is the practice of limiting or reducing energy use in your home and workplace. Conserving energy can be practiced by turning off light switches in unused rooms and turning off power switches that are not needed. Saving electricity or energy conservation is not only frugal and economically smart but also reduces carbon output. Conserving energy also improves the local economy and prevents higher energy rates.

Chapter 3

Design And Implementation

3.1 System Design

The UML use case diagram is used to represent the user perspective.The system can be divided into three modules.
1.PIR sensor, LDR and Thermostat(Input).
2.The microcontroller and dimmers(processing the input signal and storing the programs for the working of the system).
3.The LCD display, fan and bulb(Output).

The flow of data through different modules of the system are represented by the Data Flow Diagrams(DFD).An integrated DFD is used to represent the overall system.

3.1.1 User perspective

The user perspective is represented by UML Use Case Diagram.
The functions related to each modules are given below.

1. Input: When a person enters into the monitered area an interrupt is produced at the PIR sensor module kept at its entrance. At the same time, thermostat an LDR become active. As a result, a difference in the output voltage levels of the sensors is produced, and is given to the input ports of microcontroller.These signals are used by the microcontroller to detect the presence of a person, temperature level and intensity in the room.

2. Signal Processing:The modulated analog signals from the sensors are demodulated and digitized by the microcontroller.

3. Output: The microcontroller outputs signals to the dimmer circuits so that they can control the intensity of bulb and speed of the fan.

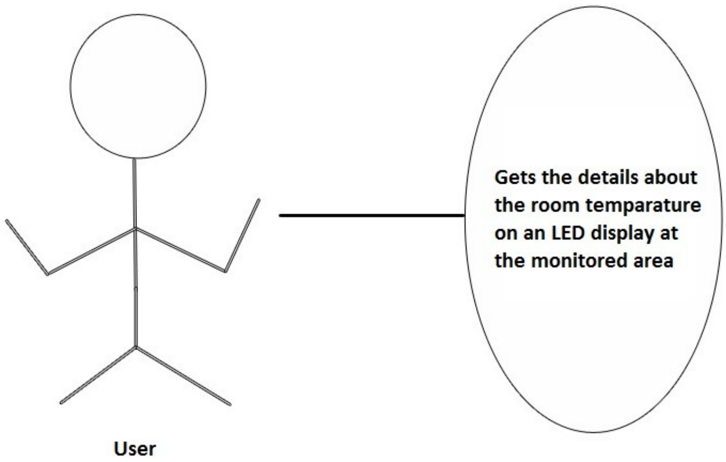


Figure 3.1: Use case Diagram

3.2 Data flow through modules

The data flow through various modules of the system are shown below.

3.2.1 Level zero Data Flow Diagram

The level zero DFD given below represents the system in the most outer layer.

3.2.2 Level 1 Data Flow Diagrams

The level-1(High level) Data Flow Diagrams of each modules are given below.

- **Input**

  Input:When a person enters into the monitered area, PIR sensor detects the presence of the person by interrupting the sensor signals.

  When a person is present in the monitered area, the system will be switched ON and thermostat and LDR become active and give inputs to the microcontroller.This inputs are used to control the intensity of bulb and speed of the fan.

- **Signal Processing**

  The signals from the sensor modules are processed by the microcontroller module to detect the presence of person as well as to control the intensity of bulb and speed of the fan.

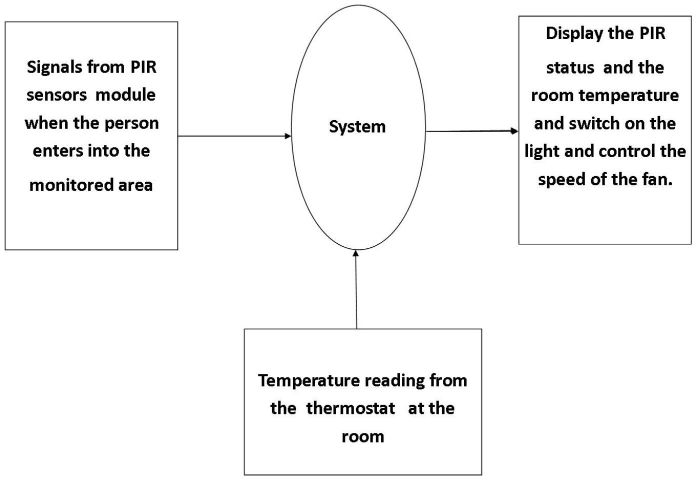


Figure 3.2: Data Flow Diagram-Level zero

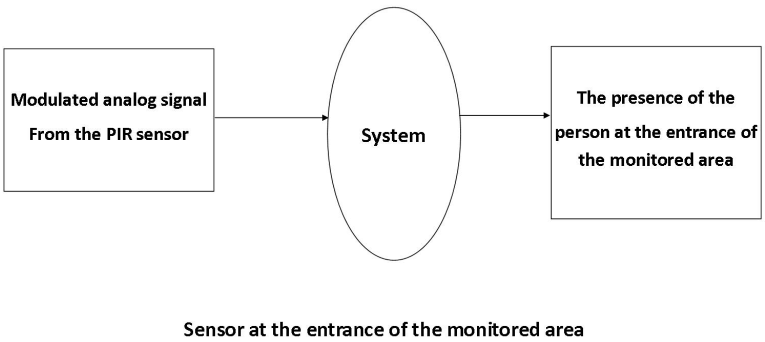


Figure 3.3: Data Flow Diagram-Level 1-input 1

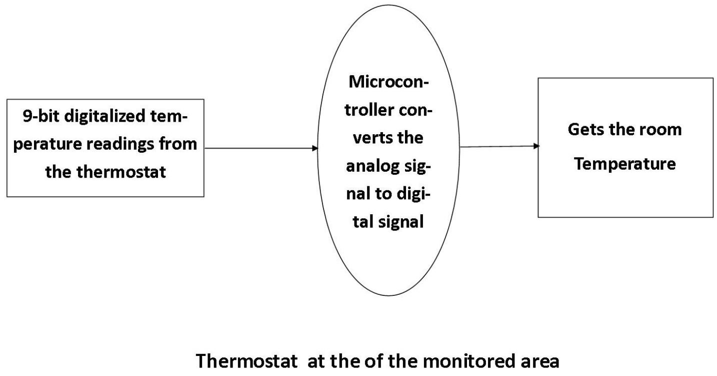


Figure 3.4: Data Flow Diagram-Level 1-Input 2

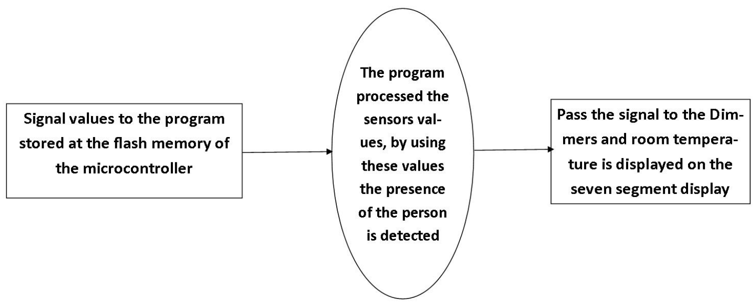


Figure 3.5: Data Flow Diagram-Level 1-signal processing 1

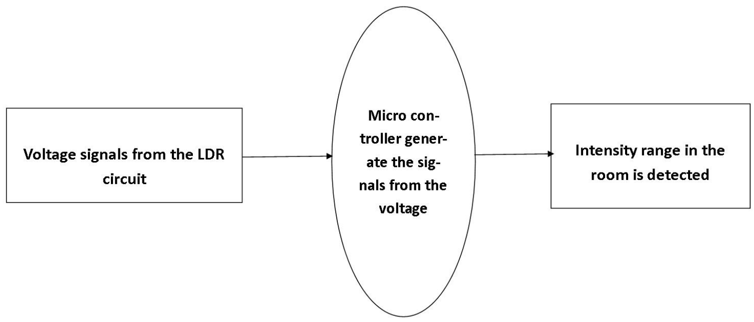


Figure 3.6: Data Flow Diagram-Level 1-signal processing 2

- **Output**

  The C program burned into the flash memory of the microcontroller receives the input signals from the sensors and based on this input it find outs the presence of the person, temperature and intensity in the monitered area.The temperature is displayed into a seven segment display system.And the intensity of bulb and speed of the fan will be adjusted.

3.2.3 Level 2 Data Flow Diagrams

The Level 2 Data Flow Diagrams which describes the internal working of each modules(ie.input section,signal processing section and the output section) are given below.

3.3 Overall System Design

Integrated Data Flow Diagram

The system is divided into three logical modules:-

1. Sensor modules:PIR sensor, thermostat and LDR sensor are used to give inputs to the microcontroller.The sensor modules are kept at the monitered area.The outputs of the sensors are analog signals.These signals are modulated and given to the microcontroller module.

2. Microcontroller module:- The microcontroller module(PIC 16F72) demodulates,lowpass filters and digitizes the signal.The voltage level difference from sensors help to identify the presence of the person , intensitity level and temperature level in the monitered area.The C program burned to the

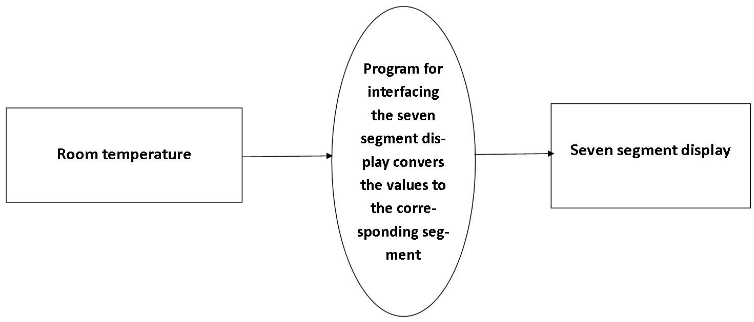


Figure 3.7: Data Flow Diagram-Level 1-Output 1

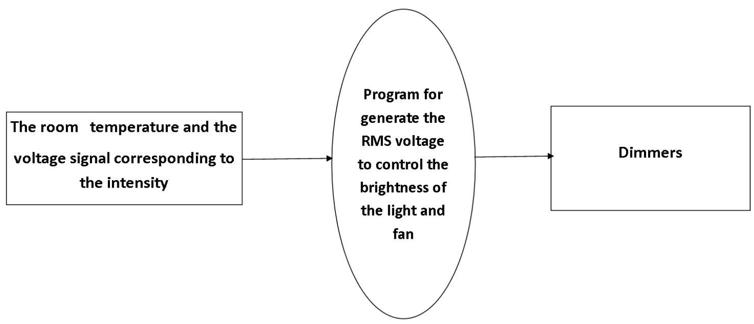


Figure 3.8: Data Flow Diagram-Level 1-Output 2

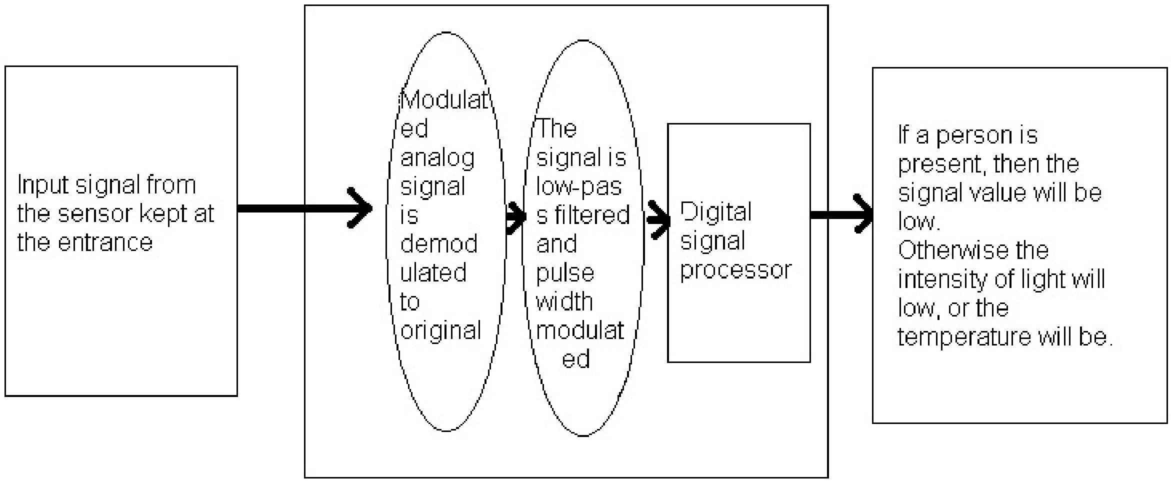


Figure 3.9: Data Flow Diagram- Level 2(1)

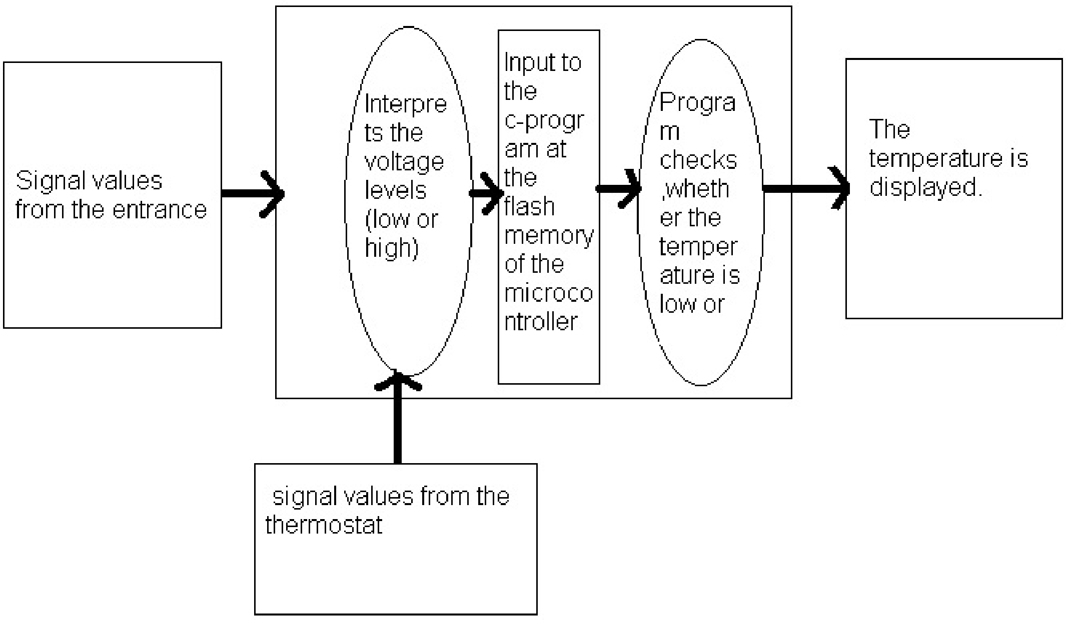


Figure 3.10: Data Flow Diagram- Level 2(2)

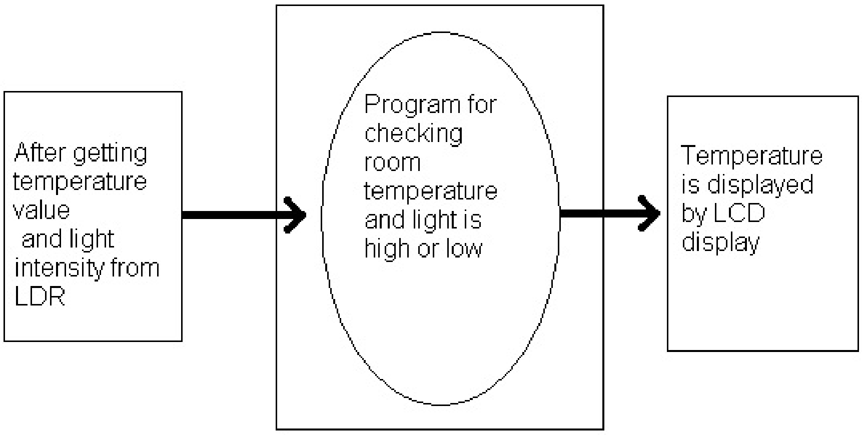


Figure 3.11: Data Flow Diagram- Level 2(3)

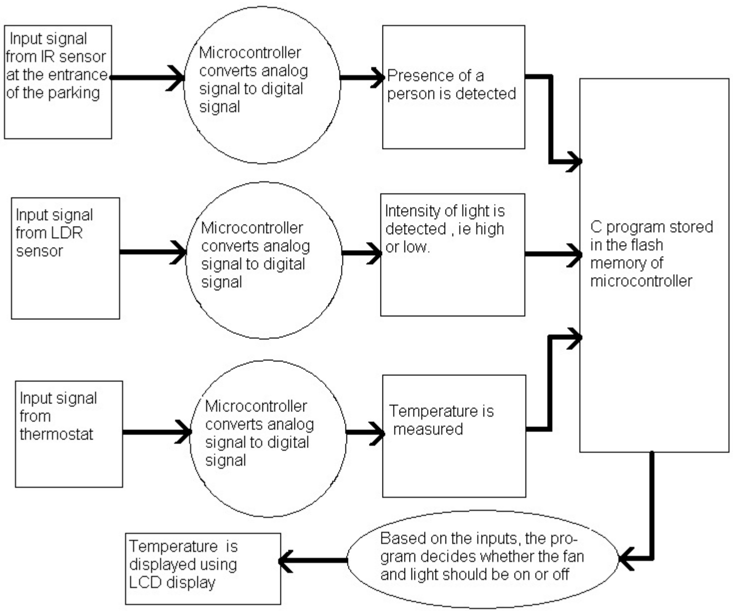


Figure 3.12: Integrated DataFlow Diagram

flash memory of microcontroller controls the intensity of bulb and speed of the fan based on the sensor signals.

3. Output module:-The display section is a seven segment display kept in the monitered area.The microcontroller outputs the temperature of the room the display section.The speed of the fan and intensity of the bulb varies according to the microcontroller output. A C program is burned to the microcontroller for interfacing the output module.

Chapter 4

Coding

4.1 Pseudo code

interrupt()
Interrupt service routine that services timer overflow and input interrupts.

```
Incase of counter overflow
        increment COUNT by 1
        ie; COUNT = COUNT+1
        And then reset the counter

if accidentinterrupt
        reset the counter
        reset interrupt flag

main()
```

Initially configure the ports of microcontroller and then give commands to LCD to clear,off the cursor and to print the WELCOME
Then wait till the warmup time of PIR sensor is over(2 minutes)
initialize the PWM duty cycle
initialize x to 250

```
if time = 10 seconds
        Then deactivate the output ports

else
        human presence detected
        read temperature and intensity to temp and light respectively
        display temperature

if temp > 20 and temp < 35
        for 100 times,
            output 5V to fan for 300 microseconds
            output 0V to fan for 700 microseconds
```

```
if temp > 35 and temp < 45
    for 100 times,
        output 5V to fan for 450 microseconds
        output 0V to fan for 550 microseconds

if temp > 45 and temp < 55
    for 100 times,
        output 5V to fan for 550 microseconds
        output 0V to fan for 450 microseconds

if temp > 55 and temp < 65
    for 100 times,
        output 5V to fan for 700 microseconds
        output 0V to fan for 300 microseconds

if temp < 65
    for 100 times,
        output 0V to fan

if light < 650
    change duty cylce to x250

if light ≥ 500 and light < 650
    change duty cylce to x5

if light ≥ 350 and light < 500
    change duty cylce to x2

if light ≥ 200 and light < 350
    change duty cylce to x

if light < 200
    change duty cylce to x
```

Chapter 5

Testing and Implementation

5.1 Testcases

NO	ACTION	INPUT	OUTPUT
1	POWER ON	Power	Idle(Checks for human presence)
2	Human detection in low heat illuminated room	IR radiation, Light, Low temperature	Human presence detected, But fan and light in off state.
3	Human detection in low heat non-illuminated room	IR radiation, Low temperature, No light	Human presence detected, But fan in off state and light ON with adjusted intensity.
4	Human detection in high heat illuminated room	IR radiation, Light high temperature	Human presence detected, But light in off state and fan ON with adjusted speed.
5	Human detection in high heat non-illuminated room	IR radiation, high temperature, no light	Human presence detected, but light and fan On with controlled intensity and speed.
6	No human presence	Light, Low temperature	Idle
7	No human presence	Low temperature, No light	Idle
8	No human presence	Light high temperature	Idle
9	No human presence	high temperature, no light	Idle

5.2 Testing methods

All the possible testing methods done for the project are described below.

5.2.1 Black Box Testing

Black-box testing is a method of software testing that tests the functionality of an application as opposed to its internal structures or workings (see white-box testing). Specific knowledge of the application's code/internal structure and

Table 5.1: Testcases

Table 5.2: Black Box Testing

programming knowledge in general is not required. The tester is only aware of what the software is supposed to do, but not how i.e. when he enters a certain input, he gets a certain output; without being aware of how the output was produced in the first places. Test cases are built around specifications and requirements, i.e., what the application is supposed to do. It uses external descriptions of the software, including specifications, requirements, and designs to derive test cases. These tests can be functional or non-functional, though usually functional. The test designer selects valid and invalid inputs and determines the correct output. There is no knowledge of the test object's internal structure.

This method of test can be applied to all levels of software testing: unit, integration, system and acceptance. It typically comprises most if not all testing at higher levels, but can also dominate unit testing as well.

In our project we applied decision table technique to do black box testing and the outcome is shown below.

Condition Stub		Condition Entry			
IF	Human presence is detected	Y	N	N	N
	PIR Sensor is on	N	Y	N	N
	Intensity of light is low	N	N	Y	N
	Temperature is high	N	N	N	Y
THEN	PIR sensor is activated	X	.	.	.
	Checks temperature & intensity of light	.	X	.	.
	Glows bulb	.	.	X	.
	Fan speed increases	.	.	.	X

5.2.2 White Box Testing

White-box testing (also known as clear box testing, glass box testing, transparent box testing, and structural testing) is a method of testing software that tests internal structures or workings of an application, as opposed to its functionality (i.e. black-box testing). In white-box testing an internal perspective of the system, as well as programming skills, are used to design test cases. The tester chooses inputs to exercise paths through the code and determine the appropriate outputs. This is analogous to testing nodes in a circuit, e.g. in-circuit testing (ICT).

While white-box testing can be applied at the unit, integration and system levels of the software testing process, it is usually done at the unit level. It can test paths within a unit, paths between units during integration, and between subsystems during a systemlevel test. Though this method of test design can uncover many errors or problems, it might not detect unimplemented parts of the specification or missing requirements.

In our project we applied control flow testing technique to do white box testing and the outcome is shown below.

As part of white box testing, assessment of code coverage was tested and verified. The test cases executed to ensure maximum code coverage. Code coverage is a measure used in software testing. It describes the degree to which the source code of a program has been tested. It is a form of testing that inspects the code directly and is therefore a form of white box testing.

Divided the whole code into several segments.

Code segment	Code

A	if(temp>20&&temp<35)
	for(i=0;i<100;i++)
	{
	portb.f4=1;
	delay_us(300);
	portb.f4=0;
	delay_us(700);
	}

B	if(temp>=35&&temp<45)
	for(i=0;i<100;i++)
	{
	portb.f4=1;
	delay_us(450);
	portb.f4=0;
	delay_us(550);
	}

Table 5.3: Code Segments

C	if(temp>=45&&temp<55)
	for(i=0;i<100;i++)
	{
	portb.f4=1;
	delay_us(550);
	portb.f4=0;
	delay_us(450);
	}

D	if(temp>=55&&temp<65)
	for(i=0;i<100;i++)
	{
	portb.f4=1;
	delay_us(700);
	portb.f4=0;
	delay_us(300);
	}

E	if(temp>=65)
	{
	por15tb.f4=1;
	delay_ms(100);
	}

F	if(light>=650) pwm_change_duty(x/250);
G	if(light>=500&&light<650) pwm_change_duty(x/5);
H	if(light>=350&&light<500) pwm_change_duty(x/2);
I	if(light>=200&&light<350) pwm_change_duty(x);
J	if(light<200) pwm_change_duty(x);

K	if(COUNT>150)
	{
	
	lcd_cmd(lcd_clear);
	lcd_out(1,1,"ABSENCE OF HUMAN");
	lcd_out(2,1,"S/M DEACTIVATED ");
	delay_ms(500);
	portb=0;
	pwm_change_duty(x/250);
	porte.f0=0;
	
	} else
	{
	porte.f0=1;
	lcd_cmd(lcd_clear);
	lcd_out(1,1,"HUMAN PRESENCE ");
	temp=adc_read(2)/2;
	inttostr(temp,txt);
	lcd_out(2,1,"TEMP:");
	lcd_out(2,7,txt);
	light=1024-adc_read(0);

As part of white box testing, assessment of code coverage was tested and verified. The test cases executed to ensure maximum code coverage. In our project we applied control flow testing technique to do white box testing and the outcome is shown below.

TC ID	TC Name	Code segment	TC description	TC precondition	Steps	Expected result	Tc result	Remarks
TCA01	Decision coverage	A	Check the pulse width to the portb.f4 and speed of fan	Closed room with a thermostat and gas stove.	Set the room temperature at 25°C,observe the speed of fan.	Fan on, with normal speed	Fan on, with normal speed	Working code segment A
TCA02	Decision coverage	B	Check the pulse width to the portb.f4 and speed of fan	Closed room with a thermostat and gas stove.	Set the room temperature at 38°C,observe the speed of fan.	Fan on, Increase the speed of fan than TCA01	Fan on, Increase the speed of fan than TCA01	Working code segment B
TCA03	Decision coverage	C	Check the pulse width to the portb.f4 and speed of fan	Closed room with a thermostat and gas stove.	Set the room temperature at 50°C,observe the speed of fan.	Fan on, Increase the speed of fan than TCA01 and TCA02	Fan on, Increase the speed of fan than TCA01 and TCA02	Working code segment C
TCA04	Decision coverage	D	Check the pulse width to the portb.f4 and speed of fan	Closed room with a thermostat and gas stove.	Set the room temperature at 50°C,observe the speed of fan.	Fan on, Increase the speed of fan than TCA01 , TCA02 and TCA03	Fan on, Increase the speed of fan than TCA01 , TCA02 ans TCA03	Working code segment D

TCA05		E	Check the pulse width to the portb.f4 and speed of fan	Closed room with a thermostat and gas stove.	Set the room temperature at 70°C, observe the speed of fan.	Fan on, Increase the speed of fan than TCA01 , TCA02 , TCA03 and TCA04	Fan on, Increase the speed of fan than TCA01 , TCA02 , TCA03 and TCA04	Working code segment E
TCB01	Decision coverage	F	Check the intensity of bulbs	Closed room with laptop for change the brightens .	Adjust the brightness of laptop at 85% and face it on LDR sensor. Read the current on output bulb circuit.	Light on. Current 5V	Light on. Current 5V	Working code segment F
TCB02	Decision coverage	G	Check the intensity of bulbs	Closed room with laptop for change the brightens .	Adjust the brightness of laptop at 75% and face it on LDR sensor. Read the current on output bulb circuit.	Light on. Current 3.5V	Light on. Current 3.5V	Working code segment G

TCB03	Decision coverage	H	Check the intensity of bulbs	Closed room with laptop for change the brightens.	Adjust the brightness of laptop at 55% and face it on LDR sensor. Read the current on output bulb circuit.	Light on. Current 2.75V	Light on. Current 2.75V	Working code segment H
TCB04	Decision coverage	I	Check the intensity of bulbs	Closed room with laptop for change the brightens.	Adjust the brightness of laptop at 35% and face it on LDR sensor. Read the current on output bulb circuit.	Light on. Current 1.75V	Light on. Current 1.75V	Working code segment I
TCB05	Decision coverage	J	Check the intensity of bulbs	Closed room with laptop for change the brightens.	Adjust the brightness of laptop at 15% and face it on LDR sensor. Read the current on output bulb circuit.	Light on. Current . 0.75V	Light on. Current . 0.75V	Working code segment J
TCC01	Statement coverage , Decision coverage	K	Detect the human presence	Closed room with living human body	a)Move the human body in front of PIR sensor	Whole circuit activated	Whole circuit activated	Check the TCC02 to complete the human presence testing
TCC02	Statement coverage , Decision coverage	K	Detect the human presence	Closed room	b)don't move the human body in front of PIR	Whole circuit deactivated	Whole circuit deactivated	Working code segment K

Table 5.4: White Box Testing

5.3 Advantages and limitations

5.3.1 Advantages

- The aim and main advantage of using this system is to save energy.
- There is no need of switches for each fan and bulb, which reduces the hardware cost.
- The power consumption of the system is negligible compared to the enery that can be saved by using the system.
- Size and cost of the system is considerably less.

5.3.2 Limitations

- The system entirely depends on a timer because of which the system will be deactivated after a fixed time interval after the person leaving the room.
- The PIR sensor needs a warm up time of 2 minutes, only after which the system will start working.
- PIR sensor cannot detect a stationary or very slowly moving body - if the sensor was set to the required sensitivity, it would be activated by the cooling of a nearby wall in the evening, or by very small animals. Similarly, if someone walks straight towards a PIR sensor, it will not detect them until they are very close by.
- PIR sensors are temperature sensitive - they work optimally at ambient air temperatures of around 15-20 degrees Celcius. If the temperature is over 30 degrees, the field of view narrows and the sensor will be less sensitive. Alternatively, if the temperature is below 15 degrees, the field of view widens and smaller or more distant objects will activate the sensor.

5.4 Future extensions if possible

- We except that our next generation will develop this energy saving system with wire less network. In our project we connected all the sensors to micro controller with the wires. This can be developed with wire less such that we can place different sensors in different places. This sensor will activate the micro controller with the signals instead of using wires.
- Another increment possible is including an air conditioner to the system. The air conditioner can set the temperature in the room as needed.

- Another increment we are planning to form a PC interface which will be more users friendly. It can display the details about the temperature and lighting status of the room and the user can interactively adjust the temperature and intensity ranges.
- Another one is to implement the system successfully in any shopping malls or factories. It will help to save large amount of energy by reducing wastage.

Chapter 6

Conclusion

When selecting this topic our aim was to study about embedded systems and its characteristics.This project was very helpful for us to understand the practical aspects of theory of the embedded systems.The interfacing of different peripherals to microcontroller was done successfully in this project.This project helped us to pass through all the phases of system designing.

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