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Automatic Smart Kitchen System Using Microcontroller

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Abstract: *This project is related to the Automatic Smart Kitchen System by using Microcontroller. The system is designed is to discharge heat and smoke in the kitchen by controlling the speed of air blower. Hence, the speed of air blower can be controlled using PMW (Pulse Width Modulation) waves generated by a PIC 16F877A microcontroller based on temperature sensor. It is also part of the smart home application where the air blower will gradually increase the speed if the temperature in the surrounding kitchen is increasing. Besides that, the component that made up the temperature sensor is known as LM35 and photoelectric detector is installed to encounter the presence of smoke. This method shows significant improvement in temperature control as the process is functioning without needing support from the human to control all the process. The result obtains from the process shows the temperature is controlled effectively and more accurate. In addition, this finding makes human works become easy and system that automatically controlled and function will be developed. These projects are implemented PIC 16F877A microcontroller circuit and direct current motor to create the process of removing heat and smoke. Furthermore, these projects provide safety purpose for a household because the alarm would be installed as a warning alert to avoid a fire accident.*

Keywords: *Pulse Width Modulation, Photoelectric Detector, PIC16F877A, Temperature Sensor.*

1. INTRODUCTION

Nowadays, in globalization era, there is always the foundation of the new technology features every year. The automatic temperature control system becomes the most popular features which rapidly gaining its popularity due to its importance to certain applications. Therefore, automatic smart kitchen system is an upgrading system using existence product in market by applying automation system concepts. Automation can be defined as a system is the technology by which a process or procedure is accomplished without human assistance. Besides, automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and service due to the improvements of technology things are becoming simpler and easier for us. Therefore, automatic smart system is advancements system form air ventilation to discharge heat and smoke at kitchen by using LM35 and smoke detector that controlled by PIC 16F877A [1]. Moreover, automatic smart kitchen system installed safety precaution element to alert people because due to some research from U.S. Fire Administration state that every year the Fire and Rescue Service is called to over 600,000 fires which result in over 800 deaths and over 17,000 injuries[2] . These problems occurred because there is no warning while the temperature in kitchen increases rapidly and reach maximum temperature. Therefore, the buzzer was installed to alert people when the temperature reaches the maximum value[3].

2. METHODOLOGY

Figure 1 below shows the block diagram of the whole system.

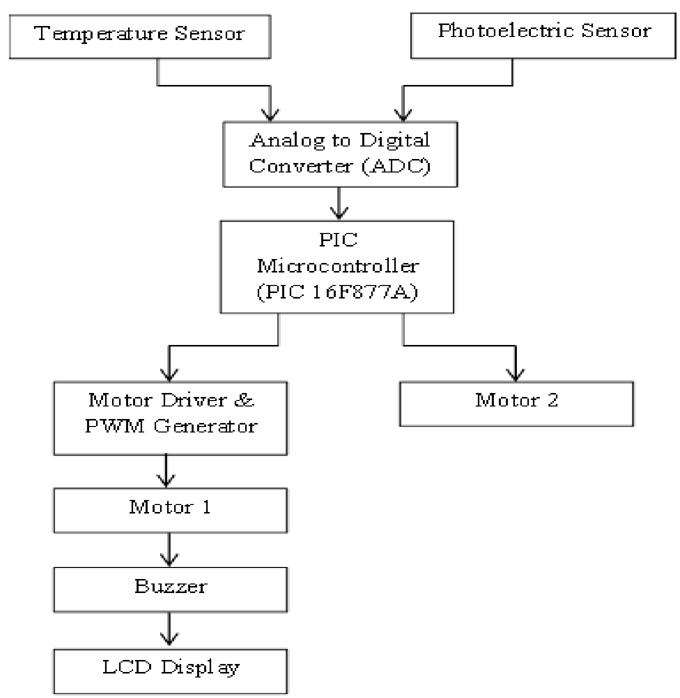

Figure 1: Block Diagram for Overview Project

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LM35 is a precision IC temperature sensor, whose output voltage is proportional to the temperature in Celsius. LM35 sensor is interfaced with the microcontroller to discharge heat using with motor 1 and the RPM of the motor increases with temperature and vice versa. Photoelectric sensor is installed inside the smoke detector to discharges smoke using motor 2. Photoelectric sensor gives an on and off output, which the RPM of fan blower will rotate in 100% speed without using a PWM generator [4]. Motor driver IC is used to control motor 1 and motor 2 through a microcontroller. L293D IC is used as a motor driver IC. It provides different logic to control the direction of the motor. It is assembled in a 16 pin lead, plastic package, which has 4 center pins connected together. The buzzer is a signaling device that used to detect and alert people when maximum heat is exceeded. The LCD display is a dot matrix liquid crystal display that displays alphanumeric characters and symbols. 16X2 LCD digital display has been used in the system to show the current temperature and speed of motor rotation[5].

Figure 2 below describes the overall project's flow from understanding the problem statement until then result analysis.

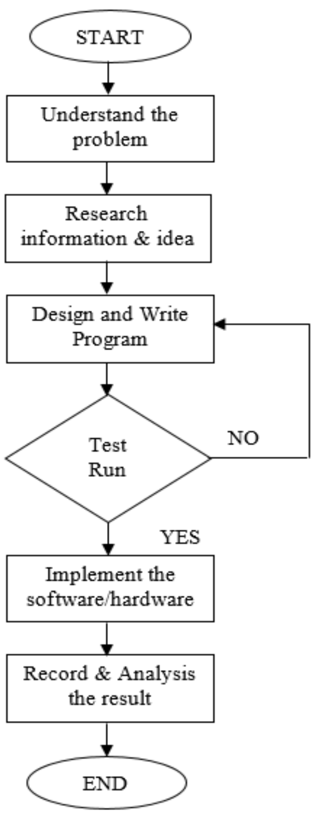

Figure 2: Flow Chart of the Overall Project

2.1 Circuit Design

The simulation of the system has been done on Proteus Professional Software v8.0. PIC16F877A microcontroller is used in the system as a control element[6]. Coding of the system has been done in MPLAB Software. 16X2 LCD display has been used which is connected to PORT B of the microcontroller. The simulation of the circuit is shown in Figure 3.

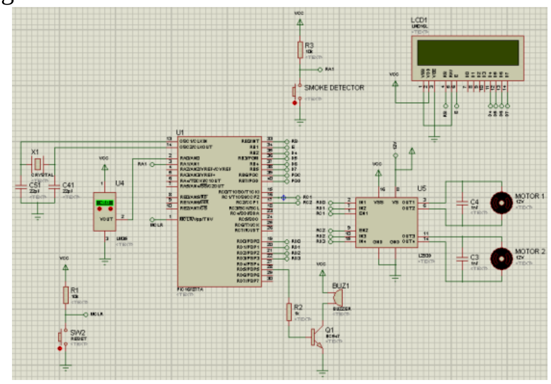

Figure 3: Simulation of the circuit

Pin 2 and pin 3 are used for input element in this system which is LM35 and smoke detector. For an output element PORT D used for motor driver trigger a signal to rotate both motors. At the same port buzzer also being an output element as temperature exceeding maximum value [7-8]. While giving a pulse signal to control the speed of the motor pin 16 and pin 17 used. Other than that, PORT B is also being used to display the speed and temperature value as a reference for the user.

2.2 Software implementation

For software implementation, the MPLAB software is used to program the PIC 16F877A [9]-[15]. The program is the brain of the system such as to control the movement of the motor by triggering the value of LM35 and get the signal from smoke detector. Other than that Proteus software also being used to design the circuit before PCB board constructs. Figure 4 below shows the MPLAB software where user designs program of the system.

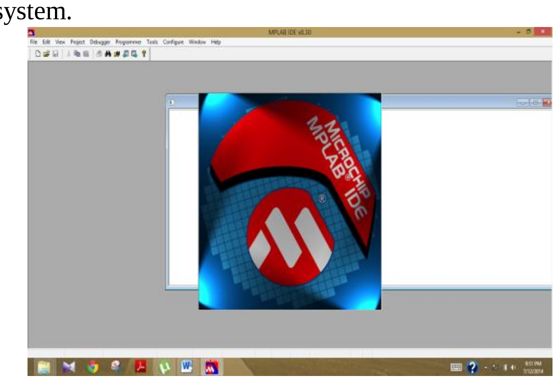

Figure 4: MPLAB Software

3. RESULT AND ANALYSIS

The temperature sensor senses the surrounding temperature and it is displayed on the LCD. The speed of the motor is controlled by using PWM technique according to the surrounding temperature. For processing analog signals, the microcontroller has analog to digital converter which converts analog signals to digital ones. The temperature sensor LM35 interfaced to the analog port acquires the surrounding

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temperature and converts it into a digital voltage signal. Figure 5 shows the relationship between voltage and the temperature.

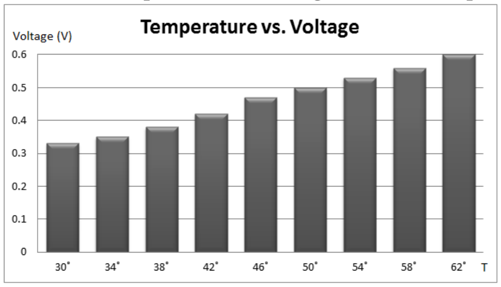

Figure 5: Relationship between voltage and the temperature

The microcontroller used in this system has inbuilt PWM module which is used to control the speed of the motor by varying the duty cycle. According to the readings from the temperature sensor duty cycle is varied to automatically thus control motor speed. Table 1 shows the duty cycles, varying with the temperature.

Table 1: Duty cycle varying with the temperature

No.	Temperature (ºC)	Duty Cycle (%)	Speed
1.	Less than 30º	0	Zero
2.	30-35	5	Slow
3.	36-40	20	Slow
4.	41-45	45	Medium
5.	46-50	62	Fast
6.	51-55	83	Fast
7.	56-60	100	Very Fast
8.	Greater than 60	100	Very Fast

Variation of duty cycle with temperature (in Celsius) has also been shown in Figure 6. The duty cycle is varied according to the surrounding temperature and speed is controlled accordingly.

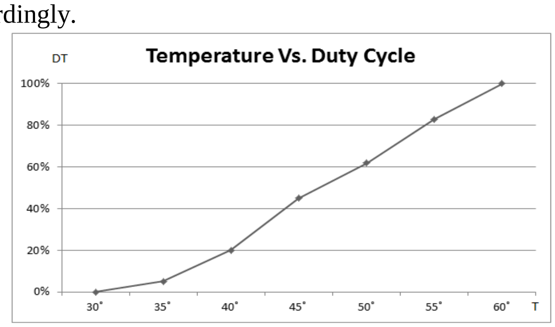

Figure 6: Duty cycle with temperature

In order to control the speed of motor, PWM technique is applied in this system. Pulse Width Modulation (PWM) is a technique in which the width of the periodic sequence pulses is varied in accordance with the baseband signal. In PWM, the pulse width is proportional to the amplitude of the signal. By varying the duty cycle of the pulse, the speed of the motor can be controlled. Duty cycle may be defined as the amount of time in a particular period during which the pulse is active or high. Figure 7 until Figure 10 below shows the duty cycle range from 0% to 100% by changing the value of temperature using oscilloscope in Proteus Software.

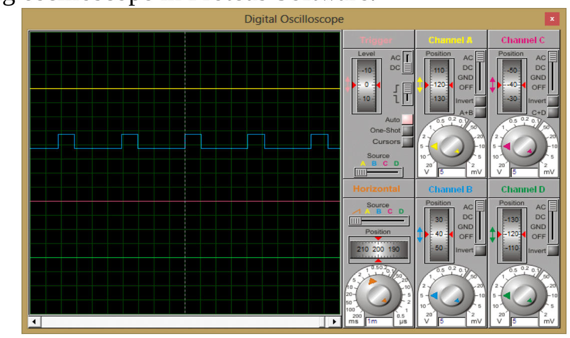

Figure 7: Duty Cycle = 25%

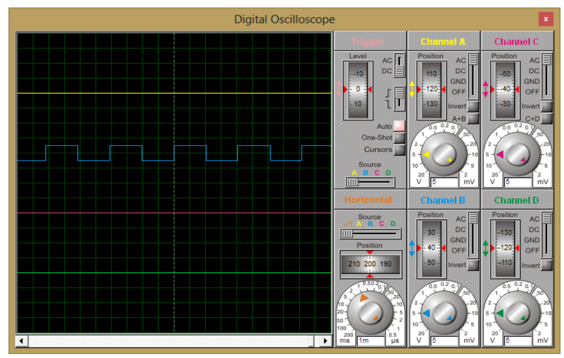

Figure 8: Duty Cycle = 50%

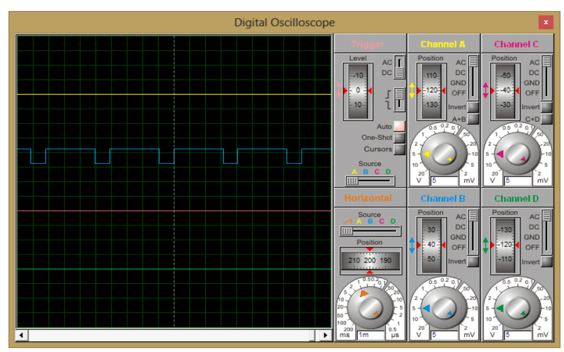

Figure 9: Duty Cycle = 75%

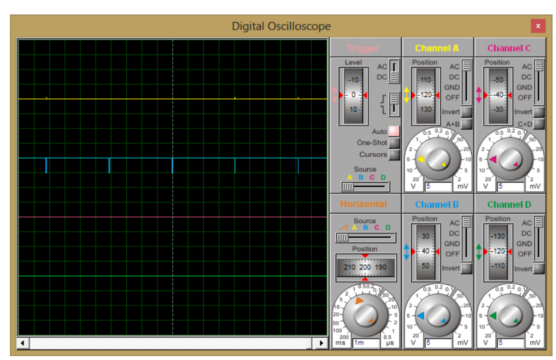

Figure 10: Duty Cycle = 100%

Secondly, the photoelectric sensor is installed in smoke detector to discharge smoke. Therefore, Table 2 below shows the status of smoke detector and the output will transmit to PIC 16F877A and rotated motor 1 at full speed. While, in the circuit smoke detector is constructed in pull-up connection and 1 is indicated as an output or high for the microcontroller. The different with pull-down connection, it will initialize 0 as an output.

Table 2: Smoke Detector Status

Smoke Detector Status	Output
Smoke present	1
Smoke non-present	0

Since smoke detector is on-off system, the motor will rotate at full speed. Once its trigger, the duty cycle will send signals and rotated 100% for motor 1. Figure 11 below shows the oscilloscope result for smoke detector output:

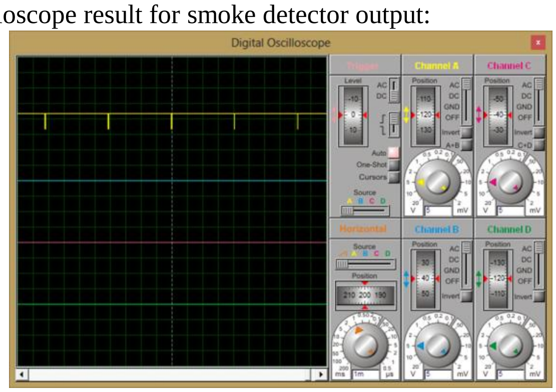

Figure 11: Full Duty Cycle for Smoke Detector

The ambient temperature collected while tested in this system is 29˚ until 32˚ Celsius. The data were collected within different time, so that, accurate temperature could choose for motor 2 starts rotate. Table 3 below shows the data collected in different time.

Table 3: Ambient Temperature in Different Time

Time	Ambient Temperature
7:00am - 10:00am	28º
11:00pm - 1:00pm	32º
2:00pm – 4:00pm	31
5:00pm – 7:00pm	30
9:00pm – 11:00pm	29

From this data, 34˚Celcius is selected as a starting point of motor 2 starts rotate. LM35 will send digital voltage to the microcontroller. Then, PWM generates the PWM resolution and enable H-bridge motor driver to rotate. The input signal is received from the program of the system and the user can control the movement of motor by declaring the input in the program. As Automatic Smart Kitchen System only uses forward rotation and stop, so that we only use two conditions within four conditions that motor driver would rotate. Table 4 below shows the input signal for motor rotation.

Table 4: Input for Motor Rotation

Rotation	Input 1	Input 2
Forward	1	0
Reverse	0	1
Braking	1	1
Stop	0	0

The overall performance test is the most important test among all the experiments. The experiment is to control the input power flow to the fan blower motor 1, which affects the speed of the fan blower. This test was carried out by embedding the system into a real fan blower. Different temperatures were applied to the temperature sensor. Furthermore the input voltage and input current to the fan blower motor were measured by a digital multi-meter for calculating the input power proposes. Table 5 shows the result of the system performance.

Table 5: Overall Performance Result

Surrounding Temperature(°C)	Voltage to the fan (V)	Ampere(I)	Power to the fan (W)
34º	1.24	0	0
38º	2.76	0.01	0.0276
42º	4.75	0.02	0.095
46º	5.98	0.06	0.3588
50º	7.03	0.08	0.5624
54º	8.14	0.14	1.1396
58º	9.04	0.18	1.6272
62º	9.46	0.20	1.892

From the result, the power required to run at high speed is more than running in the low speed. Therefore, motor speed controlled according to the ambient temperature.

4. CONCLUSION

A design of speed control of the motor based on room temperature using PWM technique is proposed in this paper. The simulation of the system is working properly and the design is appropriate according to the modern needs and technology. The simulation of the system has been done on Proteus Professional v 8.0 software packages and it is run in good agreement. The speed of motor depends on the room temperature and there is no need for regulating the speed manually. Various graphs have been plotted to show the varying relationships between different parameters. PWM technique is found to be appropriate for controlling motor speed according to the surrounding temperature. This design can be further extended in terms of area and power of layout and characteristic level by using Advanced VLSI applications.

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