Development of Automatic Mini Fan with Human Detector by Using PIR Sensor

N.A.A Talib*1,a, Farhah Kamarudin1,b S.S. Shema1,c Azri A. Aziz1,d

1Department of Electrical Engineering Technology, Faculty of Engineering Technology Universiti Malaysia Perlis, 02600 Padang Besar Perlis, Malaysia

*a, *anidatalib@unimap.edu.my

Abstract – This project will present the design, construction, development, control and evaluation of an automatic function of electric fan. Fan is the important thing for circulation of air. The development of Automatic Mini Fan with Human Detector System by Using PIR Sensor presented in this project is required to fulfill the requirement of technologies today and it had been fabricate with new design. The automatic mini fan with two types of power supply which is Alternating Current (AC) and Direct Current (DC) can continuously function if one of the power supplies cannot be used. The human detection systems by using PIR sensor are implemented in this project and the detection range is up to 13 feet. The temperature sensors which maximum 70°C that are used in this project can automatically control the speed of fan up to 225 rpm. This automatic mini fan with human detection system contains combination of sensor, controller, motor and two types of power supply that controlled by Arduino UNO as the main controller. This project also presents the expected performance of the automatic mini fan with human detector system which the fan can rotate 0° to 180° and the construction of hardware and software development to gather the performance data. Finally, this project can give many benefits to people because it is portable and can save electricity. The result of this project becomes useful in the future.

Keywords: Arduino, Mini Fan, Sensor

1. Introduction

The living rooms and other places are normally not well arranged with air circulation. So, the fan is a fundamental method that is used for cooling down and being used in most of the houses. But when it is desired to change the direction and the speed of the fan, it does not have any automatic or efficient features. Besides, most fans that are used nowadays are inconvenient due to the large size of the fan and other factors.

Current technologies require something that can work or function automatically and efficiently. Thus, many types of fan were produced since many problems had occurred. Automatic mini fan will automatically function when the sensor detects human surroundings. Human detection system is applied in this project to make it different from the previous project.

This mini fan uses two power supplies that consist of two energy sources which are Alternating Current (AC) and Direct Current (DC) power supplies. Other than that, the Passive Infrared Sensor (PIR) sensor is used to detect the human presence and is automatically off when there is no presence of the human. The automatic person detection system using PIR sensor is the reliable circuit that
tracks a person accurately and controls the speed of the motor by using Arduino. The hardware and software have been integrated and installed correctly and completely. The Automatic Mini Fan with Human Detector by Using PIR Sensor works when the fan is switched on. Then the system of the fan automatically functions based on the coding of the Arduino and when the PIR sensor detects the presence of human crossing it. The speed motor of the fan is controlled by the temperature sensor and it will rotate in 180 degrees if more than one person in the room. The result is verified by simulation and hardware result to prove the prototype is fully functional.

2. Chapter Overview

2.1 Preliminary idea

The content of the chapter for this project focuses more on the material, component and operation of the Automatic Mini Fan with Human Detection by Using PIR Sensor. The problems need to be identified based on the objective that needs to be achieved. The information to solve the problem is based on the observation. The analysis is the examination and evaluation of data and information to make the understanding of the project.

2.2 Automatic Human Detector

The automatic human detector is the system that is used to detect human motion by using PIR sensor because it is very low on power and consumption [2] compared to ultrasonic sensor that high in cost and do not have the gaps in the covering zone [3]. The automatic system focused more on a function of the fan when there is a presence of the human in the room. The fan function based on the presence of human surrounding. Temperature sensor controls the speed of the motor when the PIR sensor detects human movement [4]. The motor driver IC is used because the controller cannot give sufficient current to drive the DC motors. In this project, L239D was chosen to control the speed of the motor based on temperature sensor [5] and 5V single relay to switching ON the power supply [6].

2.3 System of the Automatic Mini Fan

Based on block diagram in Figure 1, the main part of this project is Arduino UNO R3. The Arduino Uno is a microcontroller board that consists of 20 digital inputs/outputs pins that connect to the automatic mini fan. It controls the operation of the mini fan. The power supplies that are used for this project are AC power supply and DC power supply. The AC voltage is the power from the main power supply. The DC voltage is the current of the rechargeable battery. Previous project by Mustafa Saad (2014) has using DC power supply that has range between 9 V to 12 V [1].

The amount of current used for this project depends on the amount of voltage because it has the differences between battery voltage and charger adapter voltage from main power supply. The fan uses two types of power sources for current supplied to make the rotation of the fan. For the motor of the fan, servo motor and Dc motor are important to make the movement and control the speed [7, 8, 9]. Khan Masom Raza (2016) states that the speed of DC motor can be control by PWM method to avoid higher frequency. In many applications that are use DC motor, there is lots of power loss on control system at normal voltage control. So when PWM technique is applied in control system it can avoid the higher frequency because at the higher frequency it will not perform well [10, 11].

For the rotation speed of the fan, it depends on the PWM speed control function that externally controls the rotation of the fan by changing the duty of the input pulse signal between the control terminal and GND.

The controller gives the command for the detection of human presence by the sensor to make the fan automatically function. Furthermore, the temperature sensors control the speed of the motor. The whole function of the automatic mini fan will stop function when there is no presence of the human in the room.
Figure 2 shows the flowchart for the function of the prototype of the Automatic Mini Fan with Human Detector by Using PIR Sensor. Mini fan depends on two power source to make it function which are AC and DC power supply. When the DC power supply is turned ON, both PIR sensor detects the human surrounding. If PIR 1 detects the motion of the human, servo motor rotates from the 0 to 90 degree based on the position of the human in the room. And the blade of the fan start function. When PIR 2 detects the motion of the human, it rotates from 90 degrees to 180 degrees. After the fan start function, the temperature sensor detects temperature surrounding and it changes the speed of the motor. The speed of the blade of the fan depends on the temperature sensor. the fan stop function when the power source is turned OFF.

Figure 1. Block Diagram

Figure 2. The flow chart for the function of prototype
3. Result and Discussion

The project starts with circuit design by using Proteus. Simulation part was done before process to hardware development. All the components that used are choosing in the library to make the connections of the circuit. Next the coding program is run by using Arduino software to test and compiles to export into Proteus circuit. Arduino is an open source platform used for building electronics projects [13]. For the hardware development, first step is to design the mechanical part by using Solidwork such as blade, stand and base [12]. Then, the circuit connections of all the components are transferred into the PCB board. Soldering process were implement of this part to connect the components to the PCB board. After all the mechanical part was prepared, the parts were assembly one by one to make sure the fan is function well in the development process.

Figure 3 show an Automatic Mini Fan with Human detector Using PIR Sensor is developed. The operation and function of the fan based on the motion of the human in the room. The stand of the fan rotates to the direction of the human that cross in front of the fan. Two PIR sensors detect human accurately based on the sensitivity that is set on PIR sensor.

![Figure 3. Automatic Mini Fan with Human Detector by using PIR Sensor](image)

Servo motors that have been attaching at the base of stand fan control the movement stand of the fan. If right PIR detects the motion of the human in the room the servo motor rotates in 0 to a 90-degree rotation. When left PIR sensor detects the human it rotates from 90 to 180 degree. The dc motor attaches to a blade of the fan to function. When more than one person in the room means both PIR detect the motion. It stops when there is no human in the room or places.

Figure 4 shows the design which is the position of AC and DC power sources for the prototype. AC power supply which is charger adapter are placed with DC power supply which is battery 9 V.
Table 1 shows the data that are obtained based on the experiment of the sensitivity of PIR for transverse movement of the human. The purpose of this experiment is to obtain the accurate result for the range sensitivity of the PIR sensor. The experiment is conducted is real-time and continuously through time with variation of distance during the time of experiment. The first and second column of Table 1 show the time taken at motion detects and motion ended. At distance 14 and 16 feet, there is no motion detected by PIR sensor. It shows that the maximum distance that the PIR can detect the human distance is 13 feet. The maximum duration of time taken off the fan to function is 23 sec and the minimum is 12 sec. For the maximum duration of time taken at 2 feet distance. For the minimum duration of time taken at 11 feet distance. So the surrounding effect the sensitivity of PIR sensor. The duration of time taken is the time taken for the fan to function. Time taken can be adjusted at PIR sensor. The average duration of time taken are obtained which are 13.6 second approximately to 14 seconds. So, the fan can function in the range of 14 seconds.

Table 1. The Sensitivity of PIR for transverse Movement of Human.

| Motion detected (second) | Motion ended (second) | Distance (feet) | Duration of detection (second) | Result |
|--------------------------|-----------------------|-----------------|-------------------------------|--------|
| 37                       | 55                    | 1               | 18                            | Detect |
| 65                       | 88                    | 2               | 23                            | Detect |
| 95                       | 115                   | 3               | 20                            | Detect |
| 123                      | 144                   | 5               | 21                            | Detect |
| 161                      | 177                   | 6               | 16                            | Detect |
| 188                      | 207                   | 7               | 19                            | Detect |
| 222                      | 226                   | 9               | 17                            | Detect |
| 251                      | 253                   | 10              | 14                            | Detect |
Table 2 shows the temperature and speed of the fans, the maximum temperature sensor is 70 and the minimum temperature is 20. The experiment was conducted by using thermocouple as temperature measurement and tachometer to measure the fan speed. Based on the data that have been collected the temperature of surrounding affects the speed of the motor. Temperature is increasing linearly with the speed of a motor. The maximum fan speed is 225 rpm.

**Table 2.** Temperature and speed of motor.

| Temperature ($^\circ$C) | Fan Speed (rpm) |
|-------------------------|-----------------|
| 21                      | 32              |
| 30                      | 106             |
| 31                      | 113             |
| 32                      | 121             |
| 33                      | 128             |
| 34                      | 136             |
| 36                      | 150             |
| 37                      | 158             |
| 39                      | 173             |
| 52                      | 185             |
| 57                      | 194             |
| 66                      | 200             |
| 70                      | 225             |

4. Conclusion

This paper presents the development of automatic mini fan. The proposes of this project was to fabricate an automatic mini fan with human detector by using the PIR sensor. It was the new design for the fan. It was the portable mini fan that can carry everywhere. The design is based on the available on the market today with some improvement.

The project is focused to develop the mini fan with two power supply which is AC and DC power supply. By using two power supply the mini fan can function depends to either AC or DC power supply. The dual power system is applied by using two different power sources. The fan can automatically function when the sensor detects the presence of a human in the living room. The maximum range of detection is 13 feet. It is very useful for human and has a potential to be commercialized.
5. References

[1] M. Saad, H. Abdoalgader, and M. Mohamed, “Automatic Fan Speed Control System Using,” *Iceece*, vol. 6, no. 1, p. 86, 87, 88, 89, 2014.

[2] A. Note, S. Applications, and E. Summary, “A Guide to IR/PIR Sensor Set-Up and Testing,” pp. 1–10.

[3] T. Ishrat, M. A. Rahaman, and A. Ahammad, “Smart fan for human tracking,” *2014 9th Int. Forum Strateg. Technol. IFOST 2014*, vol. 30, no. 1, pp. 124–127, 2014.

[4] D. Information, “LM35 Precision Centigrade Temperature Sensors,” 2016.

[5] K. N. Gupta, P. Agrawal, and M. Agarwal, “IC L239D,” *Mot. Driv. L239D*, 2011.

[6] A. N. Vaghela, B. D. Gajjar, and S. J. Patel, “Automatic Switch using PIR Sensor,” vol. 5, no. 1, pp. 696–698, 2017.

[7] Future Electronic, “Servo Motors Control & Arduino,” *DATA SHEET SERVO Mot.*, vol. 5, no. 3, p. 6, 2015.

[8] Agilent Technologies, “DC Power Supply handbook,” *Appl. Note 90B*, p. 126, 2000.

[9] J. Dubois, T. Borgwarner, and F. Clutch, “Design a simple DC power supply,” *DC POWER SUPPLY*, 2009.

[10] Intel, “4-Wire Pulse Width Modulation (PWM) Controlled Fans,” no. July, p. 23, 2004.

[11] F. Description, “Intelligent Temperature Monitor and PWM Fan Controller,” pp. 1–30, 2007.

[12] Christopher The Boon Sung, “3, 4, or 5 fan blades,” *Do Ceiling fans with more Bl. give more airflow? Sci. behind your Ceiling fan Des.*, vol. 90, no. 5, pp. 1–58.

[13] B. Earl, “Adafruit 16-Channel Servo Driver with Arduino,” 2014.