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AUTOMATIC CONTROLLING SYSTEM OF THE BLOWER'S SPEED FOR SMOKING AREA

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ABSTRACT

Nowadays, almost in every public room there is particularly a spot for smokers and it is commonly called as smoking area. In order to keep the condition of smoking area comfortable, it is installed blowers that exhaust the smoke out of the room. However, the blower rotation is usually in constant speed whitout considering the amount of smoke. Blower that rotates in constant speed will waste of electricity because the smoking area is not all of the time full of smoke. This paper presents a blower system using exhaust fan that rotation speed depents on the volume of smoke in the room. If the smoke increase then blower's speed automatically increase, and vice versa if the level of smoke decrease then the blower speed automatically decrease. The rotation speed is controlled by implementing gas sensor MQ2 and, Zero Crossing Detector, and Microcontroller Atmega8 technologies. The blower system has three different speed levels, in which the speed is proportionately linier with the smoke level in the area. Based on the tests, it is found that the system has triggering delay time. The longer the triggering delay occurs, the lower the rotation speed.

Keyword: speed controlling, zero crossing detector, driver triac.

INTRODUCTION

Nowadays almost all rooms are equipped with air condition. In the rooms with air condition is prohibited to smoke. Smoking in the rooms is not good for the healthy. However not all people stops smoking. Even the number of smoker is increasing. Therefore almost every public room is equipped with a spot for smoker that is usually called smoking area. By having this room the smoker people will not contaminate the unsmoker people with the smoke.

In order to keep the smoking area condition is comfortable for smokers; the air circulation is overseen by installing the blower using exhaust fan. However, based on the observation on several places, the air circulation in the smoking area has not been proper yet, because the exhaust fan rotates slowly although the smoking area is full of smoke. Besides, the room is not quite efficient in term of electricity because the exhaust fan (blower) rotates in constant speed whole the time although when it is less smoke

Based on this condition, it is necessary to build a system that automatically able to control the smoking area with the air circulation runs well, and also to keep the electricity be used efficiently. However, the problem is how to create that kind of system.

This paper presents blower system using exhaust fan that rotation speed depends on the volume of smoke in the room. If the smoke increase then blower's speed automatically increase, and vice versa if the level of smoke decrease then the blower speed automatically decrease. The rotation speed is controlled by implementing gas sensor MQ2 and Atmega8 Microcontroller technologies. The unit testing of the system is smoking area with dimension (2.9 x 2.9 x 2.8) meter.

LITERATURE REVIEW

Exhaust fan is a fan for ventilating an interior by drawing air from the interior and expelling it outside [1]. There many type of speed controller of exhaust fan [2-5]. However no one using microcontroller Atmega8 together with MQ-2 Gas Sensor and Zero Crossing Detector for controlling the speed.

MQ-2 Gas sensor composed by micro AL2O3 ceramic tube, Tin Dixide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work for sensitive componnets. The enveloped MQ-2 have 6 pin, 4 of them are used to fetch signals, an other 2 are used for providing heating current. The sensor are used in gas leakage detecting equipments in family and industry, are suitable for detecting of LPG, i-butane, propane, methane, alcohol, Hydrogen, smoke [6]. Figure-1 shows the sensitivity characteristic of MQ-2 for various gas.

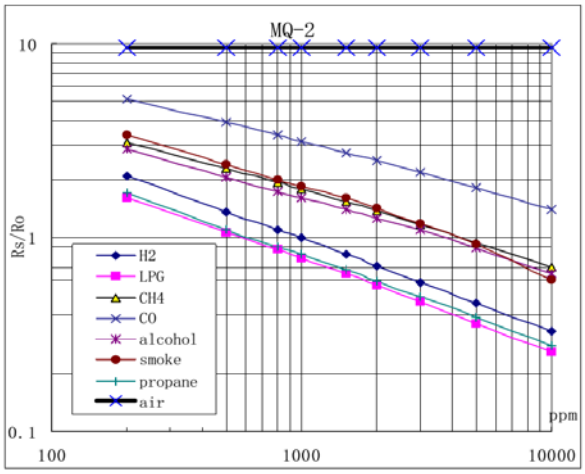

Figure-1. Sensitivity characteristic of the MQ-2[6].

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ATmega8 Microcontroller is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. The device is manufactured using Atmel's high density non-volatile memory technology.

The ATmega8 provides the following features: 8Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1 Kbyte of SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a seri al programmable USART, a byte oriented Two wire Serial Interface, a 6-channel ADC (eight channels in TQFP and QFN/MLF packages) with 10-bit accuracy, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Powerdown mode saves the register contents but freezesthe Oscillator, disabling all other chip functions until the next Interrupt or Hardware Reset.

In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. The Flash Program memory can be reprogrammed In-System through an SPI serial interface, by a conventional non-volatile memory programmer, or by an On-chip boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash Section will continue to run while the Application Flash Section is updated, providing true Read-While-Write operation [7].

The TRIAC is a three terminal semiconductor device for controlling current. It gains its name from the term TRIode for **A**lternating **C**urrent. The TRIAC is a component that is effectively based on the thyristor. It provides AC switching for electrical systems. They find particular use for circuits in light dimmers, etc., where they enable both halves of the AC cycle to be used. This makes them more efficient in terms of the usage of the power available. While it is possible to use two thyristors back to back, this is not always cost effective for low cost and relatively low power applications [8].

DESIGN AND CONSTRUCTION

The design of the controlling system of Blower's rotation speed is shown in Figure 2. The system consists of hardware and software. The hardware sonsists of eight subsystems included power supply of the system. The main subsystems are MQ-2 gas sensor, Atmega8 microcontroller, driver Triac, and exhaust fan.

MQ-2 Gas sensor function as the smoke level detector in the smoking area. The output of the MQ-2 is analog voltage and is passed through ADC of the Atmega8 to Atmega8 microcontroller input. The higher the smoke levels in the smoking area, the higher the voltage output. The output value of ADC compared to the smoke level in the room is set as follows:

0-74 : no smoke in the room
75-109 : low smoke level
110-129 : average smoke level
130-1023 : high smoke level.

The output value of ADC will be used as a reference to determine the duration of triggering delay which can be seen on Table-1.

Table-1. Triggering delay.

ADC Output value	**Triggering delay** (ms)
75-109	4,5
110-129	3,5
130-1023	0

The output of ADC becomes the input of microcontroller. The microcontroller also obtains input from zero crossing detector devices. The input from the zero crossing detector devices will be used in conducting the interruption command on the microcontroller. This interruption command functions as a zero point of the microcontroller to do the triggering delay by driver triac. Duration of triggering delay will affect the trigger angle of the AC signal, so it is affecting on the average of the output voltage from the driver. Triggering delay of the microcontroller will depend on how huge the output value of ADC is.

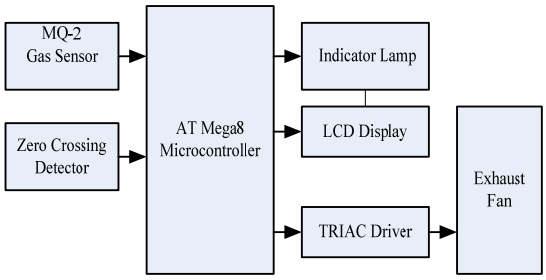

Figure-2. Diagram block of the controlling system of the blower's rotation speed.

The zero detectors is a circuit which is function in detecting the crossing of zero volts from the input of AC signal. The circuit of zero crossing detectors will send a voltage functioning in running the external interruption command from the microcontroller when conversion from high level to low level occurs.

The driver triac is a circuit which functions in activating the triac so that the triac transfers the flow of current to the load.

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The exhaust fan willl rotate based on the amount current flow form the TRIAC. LCD functions in displaying the output value of ADC and also smoke level in the smoking area. The indicator lamp functions as smoke level indicator in the smoking area. If it is low smoke level, the lamp turns green, if it is average smoke level, the lamp turns blue, if it is high smoke level, the lamp turns red.

The C programming language is used in the design of software, by the compiler's assisting of the Arduino program. This kind of programming aims to procure data input from the sensor gas and also routine interruption from the circuit of zero detectors, then the microcontroller can transmit the output signal to the triac driver. Flowchart of the system that describes the logic of thinking and working overall system is shown in Figure-3.

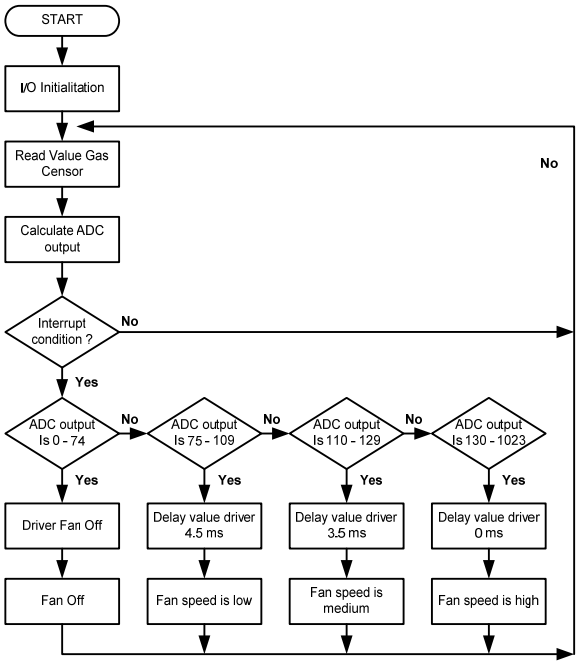

Figure-3. The flow chart of the system.

THE RESULT AND DISCUSSIONS

In order to know the performance of the system constructed, series of measurements and testing have been done. The results are as follows:

Table-2 shows the voltage output of gas sensor and the output value of ADC related to the voltage output gas sensor. These data show that when the output voltages of gas sensor increase then the ADC output value also increases.

Table-2. The voltage of output sensor and the ADC output value.

Output of gas sensor (Volt)	ADC output value
0,341	69
0,430	86
0,502	99
0,553	114
0,563	117
0,631	125
0,659	135
0,725	142
0,737	150
0,871	179
0,907	191
0,958	199

The input and output signals of the zero crossing detectors are measured using digital osciloscope and the result are shown in Figures 4 and 5. The testing on zero crossing detectors is aimed to find out whether the output of the circuit is on the right position while the AC signal is on zero value. This result of testing is used to interrupt the microcontroller.

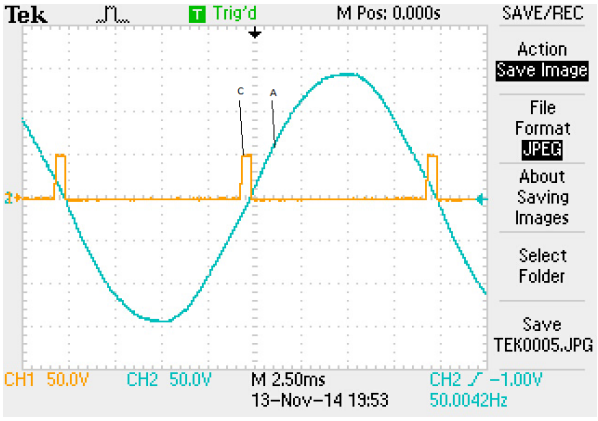

Figure-4. Input signal and zero crossing detectors.

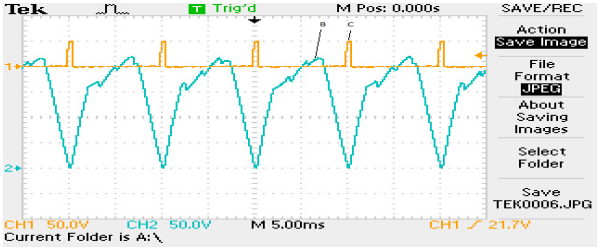

Figure-5. Output signal of zero crossing detectors

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The driver circuit to control triac connecting the voltage in state electricity company (PLN) to the exhaust fan has been conducted and shown in Figure-10. This will

Table-3 shows the testing and measuring of the exhaust fan speed according to the the smoke level. This measurement is conducted to find out the relation between the smoke level, triggering delay, the current flow, and the speed of the exhaust fan.

Table-3. The relation between triggering delays and the exhaust fan speed.

Triggering delay (ms)	**Current** (mA)	**Speed of exhaust fan** (rpm)
4,5	90	630
3,5	120	870
0	140	1080

From the Table-4, it can be seen that triggering delay affect to current flow and the exhaust fan speed. The longer the triggering delay, the slower the speed of the exhaust fan and the less the current flows. Meanwhile, from the Table-1, the triggering delay reflects the ADC output value and the smoke level in the smoke area. So, from the Table-1 and Table-4 can be concluded that the higher the smoke level then higher current flow to the exhaust fan and the higher the exhaust fan speed. This fact is reflecting the function of the system designed.

What will be the power used by the exhaust fan? The amount of power being used can be calculated using equation 1, in which V is output voltage of Triac driver:

$$P = V \times I \quad (1)$$

Using the equation (1), it can be found that the powers being used in each speed level are shown in Table-4.

Table-4. The exhaust speed and power used. when V= 225,3 Volt.

Current (mA)	**Speed** (rpm)	**Power** (watt)
90	630	20,227
120	870	27,036
140	1080	31,542

5. CONCLUSIONS

The prototype of system of rotation control of motor blower own designed have functioned as the objective design. The speed of exhaust fan is automatically increase according to the smoke level in the smoke area, while the smoke level decrease then the exhaust fan speed is also automatically decrease. Also, due to speed of exhaust fan depend on the smoke level then the power consumed by the exhaust fan is not constant anymore, but decrease when the smoke level decrease and increase when the smoke level increase. This will results efficient energy consumption.

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