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An Analysis Of Automatic Function Smoke Detection Tools Based On Arduino Uno

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ABSTRACT
In the era of the industrial revolution, the use of technology to increase safety and efficiency in various fields is increasingly growing. One important application is an automatic smoke detection system that can prevent fires effectively. This paper described an analyze the performance of an Arduino Uno-based automatic smoke detection tool which can turn the system on and off automatically. This tool is designed to detect the presence of smoke using the MQ-2 sensor and provide a response in the form of activating the alarm and fire extinguishing system.This system consists of several main components: an MQ-2 sensor to detect smoke, an Arduino Uno microcontroller as the main controller, a relay module to control external devices, and a buzzer alarm as a fire indication. When the sensor detects smoke, the data is sent to the Arduino Uno which then processes the signal and activates the alarm and fire extinguishing system via the relay module, also evaluates the effectiveness and reliability of the smoke detection system by conducting a series of trials in various environmental conditions. The test results show that this tool is able to detect smoke quickly and accurately, and provide a timely response in activating the security system. The system can be set to turn devices on and off automatically, increasing efficiency and reducing the risk of human error.

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INTRODUCTION

The increasingly rapid development of technology has now helped humans to complete work that was initially difficult to do more effectively and efficiently. Technological developments are divided into several types, namely technology in the fields of Economics, Food, Transportation, Information, Communication, Medical and Education. Technological developments in recent years have created artificial intelligence technology.

This artificial intelligence has several branches of science, namely Natural Language Processing (NLP), Expert System (ES), Pattern Recognition (PR), and Robotics. The branch of robotics science is now quite popular in various countries around the world. Robotics is a branch of technology related to the design, construction, operation, structural disposition, manufacture and application of robots. Robotics is a science that has many connections

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with other fields of science, such as electronics, machines, mechanics and computer software.

The robotics branch of science also has algorithms for creating programs to run a robot that will be created. One of the algorithms from this branch of robotics is Fuzzy Logic. Fuzzy Logic is an improvement on Boolean logic that deals with the concept of partial truth. While classical logic states that everything can be expressed in binary terms (0 or 1), black or white, yes or no), fuzzy logic replaces boolean truths with degrees of truth. This logic is related to fuzzy sets and probability theory. Fuzzy logic has set operations, which function to combine and modify fuzzy sets. The membership value as a result of the operation of two sets is often known as fire strength or a-cut. There are three basic operators created by Zadeh, namely AND, OR, and NOT. This fuzzy logic has the ability to predict, make decisions and control in a robotic system. In the real world, fuzzy logic is usually used as a detector, for example in detecting smoke in a room, detecting indoor temperature, detecting light and determining production quantities.

Robotica technology is basically created to make every job and human affairs easier in various aspects of life. One of them can be applied in indoor smoke detectors to prevent people from inhaling smoke in air-conditioned rooms. Although the development of AC has increased to date. However, conditions in public rooms that are full of smoke or forest fires occur, the AC cannot turn ON/OFF automatically in its electrical system, so this can cause the air produced in the AC to damage the clean air in the room so that people Those who are in a room where there is smoke will inhale the smoke. Efforts that can be made to prevent smoke from spreading throughout the room is to create an automatic ON/OFF control system for the AC.

By creating this automatic control system, it can prevent the room from being contaminated by cigarette smoke or other smoke so that it can provide fresher air to the people in the air-conditioned room. And in this way, it can indirectly prohibit people from smoking carelessly in certain places.

One way to prevent smoke from spreading further into a room is to make a device that can detect whether the air contains smoke or not. However, before the process of making a tool, it is necessary to carry out design and simulation in making the tool to minimize system errors and also serve as a reference for making the tool. One method that can be used to detect smoke is the Fuzzy Logic method. By using fuzzy logic in the tool to detect whether the air contains smoke or not.

Literature Review

Arduino Uno R3.

Arduino Uno is a microcontroller-based board on the ATMega 328. The Arduino Uno board has 14 digital input / output pins (of which 6 pins can be used as PWM output), 6 analog inputs, 16 MHz crystal oscillator, USB connection, power jack and reset button. The pins on the Arduino Uno board contain everything needed to support the microcontroller, just connect it to a computer with a USB cable or a pressure source can be obtained from an AC – DC adapter or battery to use it (Arduino, Inc., 2009).

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The Arduino Uno R3 is different from all previous boards because the Arduino Uno R3 does not use an FTDI USB-to-serial driver chip. Instead, it uses the features of the ATMega 16U2 which is programmed as a USB-to-serial converter. Arduino Uno R3 is a microcontroller development board based on the ATmega328P chip. Arduino Uno has 14 digital input / output pins (or usually written I/O, of which 14 pins can be used as PWM output, including pins 0 to 13), 6 analog input pins, using a 16 MHz crystal, including pins A0 to A5, USB connection, power jack, ICSP header and reset button. This is all that is needed to support a microcontroller circuit. The specifications for the Arduino Uno R3 can be seen in table 2.1 and the Arduino Uno R3 can be seen in Figure 1.

Table 1. Arduino Uno R3 Specifications

Microcontroller	ATmega328
Voltage Operation	5 Volt
Voltage Input	7-12 Volt
Digital I/O Pins	14
And Analogue	6
DC current per I/O pin	50 mA
DC current when 3.3V	50mA
Flash memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Clock speed	16 MHz

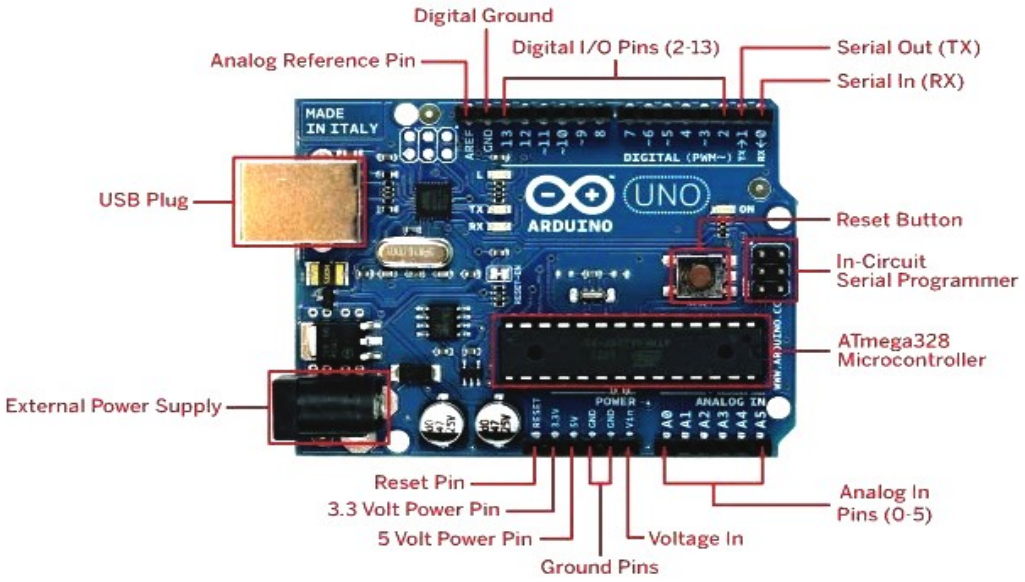

Figure 1. Arduino Uno R3

The Arduino Uno R3 has a number of facilities for communicating with a computer, another Arduino, or another microcontroller. The ATmega328 provides UART TTL (5V) serial communication, available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on this

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board serial communications via USB and appears as a virtual com port for software on the computer. The '16U2 firmware uses the standard USB COM driver, and no external drivers are required. However, on Windows, the . Info required.

The Arduino software includes a serial monitor that allows simple data to be sent to the Arduino board. The RX and TX on board LEDs will flash when data is being sent via the chip's USB-to-serial and USB connections to the computer (but not for serial communications on pins 0 and 1). This function is used to carry out interface communications on the system. The ATmega328 also supports I2C (TWI) and SPI communications.

Fuzzy Logic

Fuzzy Logic was first developed by Lotfi A. Zadeh in 1965. This theory is widely applied in various fields, including the representation of human thoughts into a system. There are many reasons why fuzzy logic is often used, including the concept of fuzzy logic which is similar to the concept of human thinking. Fuzzy systems can represent human knowledge in mathematical form that more closely resembles human thinking.

Controllers with fuzzy logic have the advantage of being able to control complex, non-linear systems, or systems that are difficult to represent in mathematical form. Apart from that, information in the form of knowledge and experience has an important role in recognizing system behavior in the real world.

Fuzzy logic is one of the appropriate ways to map an input space into an output space (Kusumadewi, 2004:1). Fuzzy logic is different from ordinary digital logic, where ordinary digital logic only recognizes two states, namely: Yes and No or ON and OFF or High and Low or "1" and "0". Meanwhile, Fuzzy Logic imitates human thinking by using the concept of the vague nature of a value. With fuzzy sets, an object can be a member of many sets with different degrees of membership in each set (Wulandari, 2010). Fuzzy logic is an alternative to various existing systems in decision making because fuzzy logic has the following advantages:

a. Fuzzy logic has a very simple concept so it is easy to understand.
b. Fuzzy logic is very flexible, meaning it is able to adapt to changes and uncertainty.
c. Fuzzy logic has tolerance for imprecise data.
d. Fuzzy logic is able to systemize very complex non-linear functions.
e. Fuzzy logic can apply experience or knowledge from experts.
f. Fuzzy logic is based on everyday language so it is easy to understand.

Fuzzy logic has several components that must be understood, such as fuzzy sets, membership functions, operators on fuzzy sets, fuzzy inference and defuzzification.

Fuzzy Sets

In fuzzy logic theory, fuzzy sets are known, which are groupings of things based on linguistic variables, which are expressed in membership functions. In the universe of discourse, the membership function of a fuzzy set has a value of 0 to 1. Examples of language variable sets include: A set of temperatures or temperatures can be expressed as cold, cool, normal, warm and hot. The graph of this set of temperatures is shown in figure 2.

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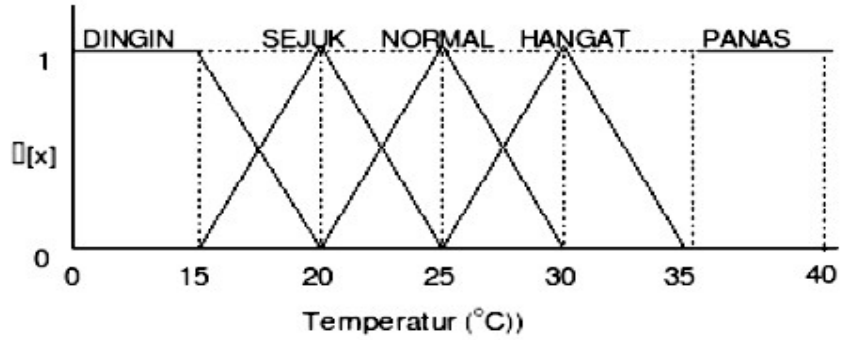

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Figure 2. Example of temperature or temperature set membership

$$\mu[x] = \begin{cases} 0; & x \le a \text{ atau } x \ge c \\ (x-a)/(b-a); & a \le x \le b \\ (c-x)/(c-b); & b \le x \le c \end{cases}$$

Smoke Detection Device in Air Conditioner (AC)

This smoke detector is made to be able to anticipate the prevention of smoke in an air-conditioned room. This tool will cut off the electric current connection with the AC, where if someone smokes in an air-conditioned room, this tool will detect the smoke as quickly as possible to prevent the smoke from being swirled around in a room for too long, so that it can prevent someone from inhaling air contaminated with smoke. cigarette. Because the AC cannot remove the air that has been produced, the AC can only enter new air, so the AC can only recycle the air that was there before. As has been explained, smoke is the main thing that will be explained, why smoke can be very dangerous if someone smokes in an air-conditioned room.

Smoke is combustion residue which is actually in solid or liquid form, but its size and weight are very light, so it looks as if it is mixed with air and has air-like properties. This kind of mixture is called a colloid. The solid substance contained in smoke is usually called soot, most of which is carbon. Smoke may contain trace amounts of metal compounds, depending on the combustion source. One example of a metal compound contained in smoke is TEL (tetraethyl lead) - a compound of lead metal which comes from motor vehicle exhaust. This substance is very dangerous because it can cause brain damage.

The liquid contained in smoke is usually water, which is also a product of combustion. The more water the smoke contains, the whiter the color of the smoke. Smoke can contain carbon monoxide or carbon dioxide gas, depending on the amount of oxygen when combustion occurs. If oxygen is abundant, carbon dioxide will form, for example in campfires in open fields and stoves that are still in good condition. However, if there is little oxygen, carbon monoxide will form which is very toxic, such as in motor vehicle exhaust and cigarette smoke. Sometimes smoke contains sweet-smelling gases, for example in incense smoke.

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METHOD

The AC on/off automation system model for detecting smoke in a room is designed using Arduino Uno R3 which has been integrated with a relay module. It's time for the Arduino Uno to control the device connected to it, the device must be turned on or off at a certain sensor reading value. Apart from that, the Arduino Uno also collects sensor reading data and the status of each device. If the sensor detects smoke in a room, the sensor will send it to the Arduino Uno to cut off the electric current in the AC. And after the AC power is turned off, the sensor will continue to detect smoke in the room. If the sensor no longer detects smoke, the electric current in the AC will turn back on.

Research plan or design in the narrow sense is interpreted as a process of collecting and analyzing research data. In a broad sense, research design includes the process of planning and implementing research. Preparation steps in making an AC on/off automation tool to detect smoke in a room:

1. Literature Study
   The author examines references obtained from several scientific works such as thesis journals and books.
2. Literature Study
   Library method, namely collecting data and information by reading references, e-books, websites, documents which include previous research, books, articles and journals related to the research object. For example, the author uses an electronic book (ebook) with the title practical guide to Arduino for beginners and electronics and Android instrumentation.
3. Consultation
   Done in consultation with the supervisor to resolve problems encountered during software creation and hardware creation.
4. Tool Testing
   This is done by conducting experiments, testing modules and integrating the modules with programs to control the system so that it becomes a complete unit and obtains maximum results.

The supporting equipment used to create an early detection tool for fire hotspots in peatlands is:

1. USB aims to provide a voltage and electric current source of 5 volts to the Arduino Uno R3 device
2. The drill is used to make holes in the acrylic board.
3. Solder to melt the tin.
4. Solder attractor as a tin sucker.
5. Ruler for measuring acrylic
6. Cutter knife to cut the acrylic plate to the desired size.
7. Pliers are used to cut or strip cables and cut component legs.

This chapter discusses the working principles of the circuit designed to realize the device system, namely Arduino Uno R3, smoke sensor. So that the tool can detect smoke around the tool in the room.

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The tool system is created and designed according to the block diagram below. The discussion focuses on the design of tools which are based on the author's thoughts referring to reference sources related to tools. The hardware design using a block diagram of the system being designed is as shown in Figure 3.

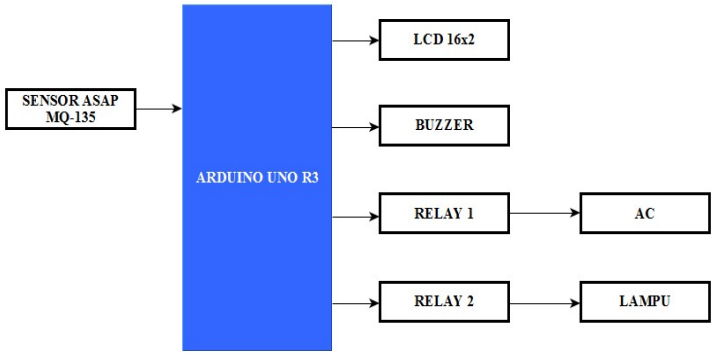

Figure 3. Block diagram of the AC on/off automation system when detecting smoke

The explanation and function of each block is as follows:

1. Arduino Uno R3 functions as the control center of the circuit working system used to control the entire circuit starting from sensor input to output used in making AC on/off automation tools.
2. Smoke sensors are used to detect the presence of smoke content in indoor air to prevent someone from breathing indoor air contaminated with dangerous smoke.
3. The buzzer functions as a sound indicator or as a warning alarm from the device due to detected smoke.
4. LCD 16x2 (liquid crystal display) functions to display the ADC from the sensor.
5. This relay module can be used as a switch to run various electronic equipment. For example, electric lights, electric motors, and various other electronic equipment. The on/off control of the switch (relay), is completely determined by the sensor output value, which after being processed by the Arduino Uno R3 will produce a command to the relay to carry out the on/off function.
6. LED light which functions as an indicator light which will indicate the on/off of an AC.
7. Jumper cables as a means of connecting the Arduino with other components by connecting the pins of each component for which a path is available.

A rule is a knowledge structure that connects some information that is already known to other information so that it can be concluded. A rule is a form of procedural knowledge. A rule-based expert system is a computer program for processing problems from specific information contained in active memory with a set of rules in a knowledge base, using an inference engine to generate new information. The rule structure logically connects one or more antecedents (also called premises) located in the IF section with one or more consequences (also called conclusions) located in the THEN section. In general, a rule can

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have multiple premises connected by AND statements (conjunctions), OR statements (disjunctions) or a combination of both.

In a rule-based expert system, domain knowledge is stored in a set of rules and included in the knowledge system base. The system uses these rules with information while it is in active memory to solve problems. A rule-based expert system has an architecture that can be explained as follows:

1. User interface Used as a medium by users to view and interact with the system.
2. Developer interface Media used to develop systems by engineers.
3. Explanation facility Sub system that functions to provide explanations in the reasoning system.
4. External programs Programs such as databases, spreadsheets, that work in support of the entire system.

RESULT

Membership Function Design

Determining the decision to make a smoke sensor to activate the alarm is carried out using a very simple Fuzzy method, namely using several If - Then to determine limits and decisions. The use of the fuzzy method for decision making is used to detect whether smoke is present or not. If smoke is detected, the device alarm will be active and if smoke is not detected, the alarm will not be active, and the device will send information to the user and display it on the 16x2 LCD.

A. Smoke Sensor

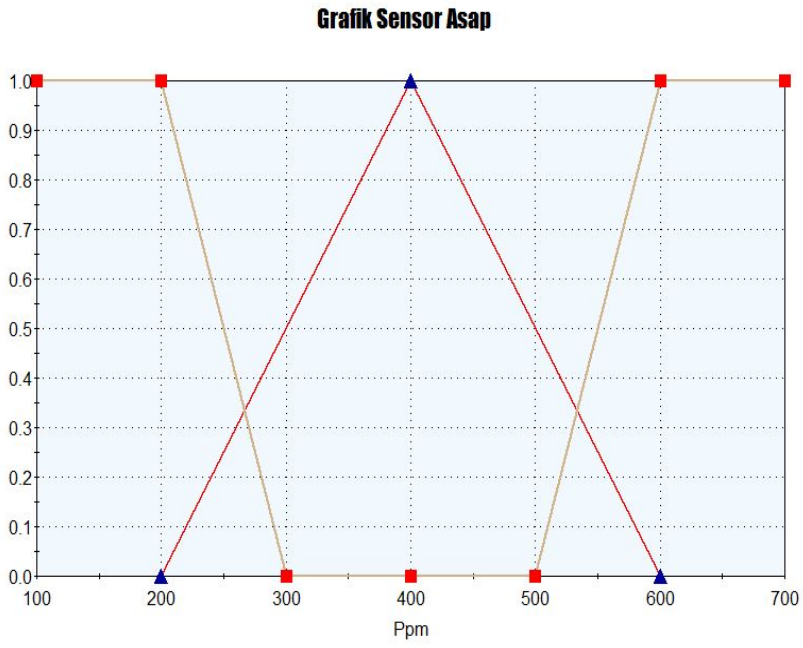

Figure 4. Smoke Sensor GraphParameter Asap

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Table 2. Smoke Sensor Observations

Source Conditions	Source Conditions	Source Conditions	Source Conditions	Source Conditions
1	Match Smoke	10 cm	150 ppm	Not detected (Low)
2	Candle Smoke	10 cm	200 ppm	Not detected (Low)
3	Anti-Mosquito Coal Smoke	15 cm	250 ppm	Detected (Medium)
4	Cigarette smoke	15 cm	350 ppm	Detected (Medium)
5	Paper Burning Smoke	20 cm	450 ppm	Detected (Medium)
6	Dry Grass Smoke	1 m	500 ppm	Detected (High)
7	Big Smoke Source	2 m	> 600 ppm	Detected (High)

Smoke level membership function in the smoke level variable in the smoke sensor installed in the AC on/off automation device in the AC room. Set Domain:

Low (Not Detected) : [0 200]
Medium (Detected) : [250 450]
High (Detected) : [500 >600]
Low (Not Detected) : [0 200]

$$\mu LOW\,[40] = \begin{cases} 0, & x \le 0 \\ \frac{40-0}{200-0}, & 0 \le x \le 200 \\ 1, & x \ge 200 \end{cases}$$

$$= \left\{\frac{40}{200}\right. = 0{,}2$$

$$\mu LOW\,[80] = \begin{cases} 0, & x \le 0 \\ \frac{80-0}{200-0}, & 0 \le x \le 200 \\ 1, & x \ge 200 \end{cases}$$

$$= \left\{\frac{80}{200}\right. = 0{,}4$$

$$\mu LOW\,[120] = \begin{cases} 0, & x \le 0 \\ \frac{120-0}{200-0}, & 0 \le x \le 200 \\ 1, & x \ge 200 \end{cases}$$

$$= \left\{\frac{120}{200}\right. = 0{,}6$$

$$\mu LOW\,[160] = \begin{cases} 0, & x \le 0 \\ \frac{160-0}{200-0}, & 0 \le x \le 200 \\ 1, & x \ge 200 \end{cases}$$

$$= \left\{\frac{160}{200}\right. = 0{,}8$$

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$$\mu LOW\,[200] = \begin{cases} 0, & x \le 0 \\ \frac{200-0}{200-0}, & 0 \le x \le 200 \\ 1, & x \ge 200 \end{cases} = \left\{ \frac{200}{200} \right. = 1$$

Membership degrees:

μ [X]

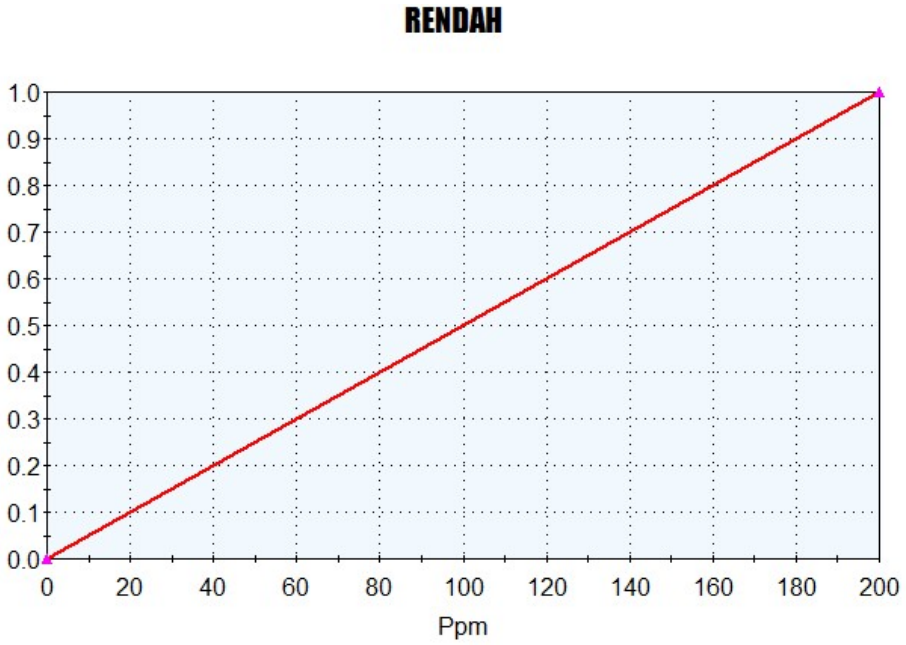

Figure 5. Fuzzy Smoke Set: Low (Not Detected)

Medium (Detected) : [201 450]

$$\mu_{MEDIUM}\,[250] = \begin{cases} 0, & x \le 201 \\ \frac{250-201}{450-201}, & 201 \le x \le 450 \\ 1, & x \ge 450 \end{cases} = \left\{ \frac{49}{249} \right. = 0{,}19 = 0.2$$

$$\mu_{MEDIUM}\,[300] = \begin{cases} 0, & x, \le 201 \\ \frac{300-201}{450-201}, & 201 \le x \le 450 \\ 1, & x \ge 450 \end{cases} = \left\{ \frac{99}{249} \right. = 0{,}39 = 0.4$$

$$\mu_{MEDIUM}\,[350] = \begin{cases} 0, & x \le 201 \\ \frac{350-201}{450-201}, & 201 \le x \le 450 \\ 1, & x \ge 450 \end{cases}$$

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$$= \left\{ \frac{149}{249} \right| = 0.59 = 0,6$$

$$\mu_{MEDIUM}[400] = \begin{cases} 0, & x \le 201 \\ \frac{400-201}{450-201}, & 201 \le x \le 450 \\ 1, & x \ge 450 \end{cases}$$

$$= \left\{ \frac{199}{249} \right| = 0,79 = 0,8$$

$$\mu_{MEDIUM}[450] = \begin{cases} 0, & x \le 201 \\ \frac{450-201}{450-201}, & 201 \le x \le 450 \\ 1, & x \ge 450 \end{cases}$$

$$= \left\{ \frac{249}{249} \right| = 1$$

Membership degrees: $\mu_{[X]}$

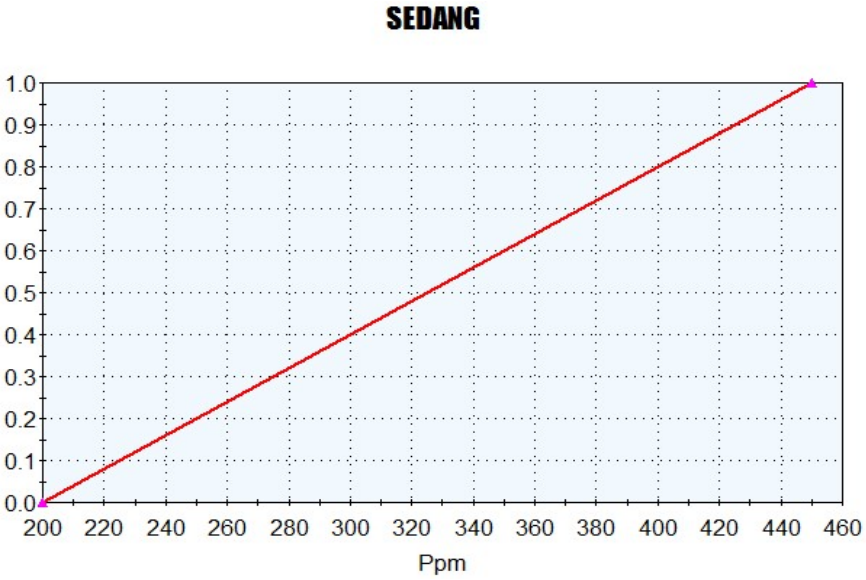

Figure 6. Fuzzy Smoke Set: Medium (Detected)

1. Tinggi (Terdeteksi) : [451 >600]

$$\mu_{TINGGI}[480] = \begin{cases} 0, & x \le 451 \\ \frac{480-451}{600-451}, & 451 \le x \le 600 \\ 1, & x \ge 600 \end{cases}$$

$$= \left\{ \frac{29}{149} \right| = 0,19 = 0,2$$

$$\mu_{TINGGI}[510] = \begin{cases} 0, & x \le 451 \\ \frac{510-451}{600-451}, & 451 \le x600 \\ 1, & x \ge 600 \end{cases}$$

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$$= \left\{ \frac{59}{149} \right. = 0{,}39 = 0{,}4$$

$$\mu_{TINGGI}[540] = \begin{cases} 0, & x \le 451 \\ \frac{540-451}{600-451}, & 451 \le x \le 600 \\ 1, & x \ge 600 \end{cases}$$

$$= \left\{ \frac{89}{149} \right. = 0{,}59 = 0{,}6$$

$$\mu_{TINGGI}[570] = \begin{cases} 0, & x \le 451 \\ \frac{570-451}{600-451}, & 451 \le x \le 600 \\ 1, & x \ge 600 \end{cases}$$

$$= \left\{ \frac{119}{149} \right. = 0{,}79 = 0{,}8$$

$$\mu_{TINGGI}[600] = \begin{cases} 0, & x \le 451 \\ \frac{600-451}{600-451}, & 451 \le x \le 600 \\ 1, & x \ge 600 \end{cases}$$

$$= \left\{ \frac{149}{149} \right. = 1$$

Derajat keanggotaan :

μ [X]

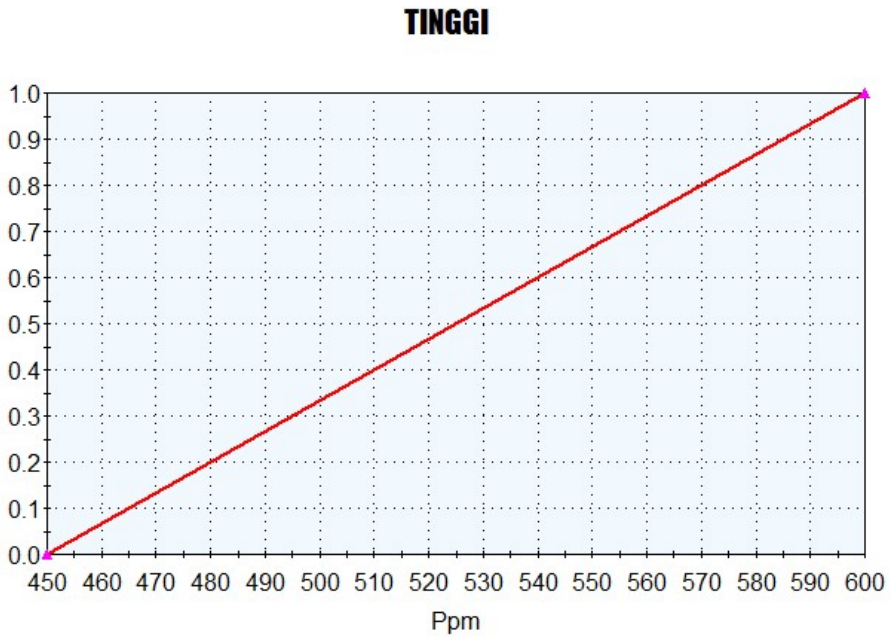

Figure 7. Fuzzy Smoke Set: High (Detected)

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Smoke sensor observations where tests of burning paper and mosquito repellent embers were not detected because the sensor did not detect the presence of smoke. On a lighter, the candle is not detected because the sensor also does not detect smoke. In cigarette smoke, torches and larger flame sources, sensors can detect the presence of smoke because there is a level (parts per million) of the smoke detected.

Condition

IF Smoke = Low THEN Buzzer = OFF

IF Smoke = Medium THEN Buzzer = ON

IF Smoke = High THEN Buzzer = ON

Software Design for AC On/Off Automation Tool when Detecting Smoke

Software design is important, to regulate all activities of the AC on/off automation tool controlled by the Arduino Uno R3 which has been programmed according to its performance. In research on the design of AC on/off automation tools when detecting smoke, there are several software tools used in making the tool, including:

1. Proteus 8.1
   This software is used to draw schematic circuits that will be used in making tools.
2. Arduino IDE 1.6.5
   This software is used to write programs that will create commands into the Arduino system.
3. yEd Graph Editor
   This software is used to draw block diagrams and flowcharts of the tools to be created.

After collecting the data, we continue with selecting the attributes needed for the ANN Algorithm process.

Table 3. Data from selection results

NO	M.AQ	BING	M.PK	GPA2
1	8.50	7.00	7.60	2.77
2	8.75	7.20	7.38	2.11
3	8.00	8.00	8.14	2.31
4	7.00	6.00	7.71	2.98
5	3.75	6.20	8.40	2.64
6	8.50	8.60	7.23	3.16
7	5.33	7.60	7.00	3.18
8	3.25	7.40	7.96	2.87
9	9.33	9.40	7.35	2.48
10	3.50	6.00	8,10	2.44
11	9.00	9.20	8.88	3.09
12	6.75	7.20	8.01	2.64
13	5.50	8.00	8.48	2.39
14	7.50	8.60	7.70	2.42
15	7.25	7.40	8.05	2.97

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16	7.50	8.00	7.82	2.56
17	7.75	6.20	8.55	2.08
18	9.50	9.00	7.38	2.76
19	6.00	7.60	6.13	3.00
20	6.75	5.00	7.80	1.70
21	9.25	8.40	9,12	3.09
22	3.50	4.60	7.37	2.91
23	6.50	7.40	7.50	2.70
24	7.25	8.20	8.23	3.10
25	3.00	5.40	6.53	2.89
26	8.00	6.20	8.47	2.44
27	8.75	6.40	6.25	1.69
28	4.25	6.80	7.32	1.80
29	8.50	8.20	8.35	3.50
30	7.50	8.40	8.73	3.07
31	3.00	4.60	7.67	2.80
32	7.75	7.00	7.13	3.20
33	2.25	4.40	7.49	2.39
34	7.00	7.60	8.42	3.13
35	7.50	6.20	8.18	2.75
36	8.00	8.80	8.49	2.56
37	3.00	7.60	8.25	3.29
38	8.50	5.60	7.38	3.18
39	5.00	7.80	8.87	2.71
40	4.50	6.20	7.45	2.76

CONCLUSION

After designing, testing and analyzing the system. So it can be concluded that several things can be used for further improvement and development, namely: The Mq-2 sensor can detect the presence of smoke based on the scope of the area and the distance that has been determined to the smoke source. The time needed to decompose smoke in a room can be seen based on the amount of smoke content read by the smoke sensor. The more or thicker the smoke, the longer the time to decompose the smoke.

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