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ARTIKEL JURNAL INTERNASIONAL BEREPUTASI**

**Judul Artikel** : IMPLEMENTATION OF FUZZY LOGIC FOR FIRE  
DETECTION SYSTEMS IN BUILDINGS BASED ON  
INTERNET OF THINGS

**Jurnal** : NeuroQuantology

**Penulis** : Agus Ramdhani Nugraha, Dadang Haryanto, Aneu Yulianeu, Andri  
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No	Perihal	Tanggal
1	Bukti konfirmasi submit artikel	20 September 2022 9:37 AM
2	Bukti konfirmasi artikel yang disubmit	20 September 2022 9:42 AM
3	Bukti konfirmasi submit revisi pertama, respon kepadareviewer, dan artikel yang diresubmit	25 Oktober 2022 1:57 PM
4	Bukti konfirmasi artikel accepted	7 November 2022 3:37 PM
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# 1. BUKTI KONFIRMASI SUBMIT ARTIKEL (20 SEPTEMBER 2022, 9:37 AM)

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Thank you for submitting the manuscript, "IMPLEMENTATION OF FUZZY LOGIC FOR FIRE DETECTION SYSTEMS IN BUILDINGS BASED ON INTERNET OF THINGS" to NeuroQuantology. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

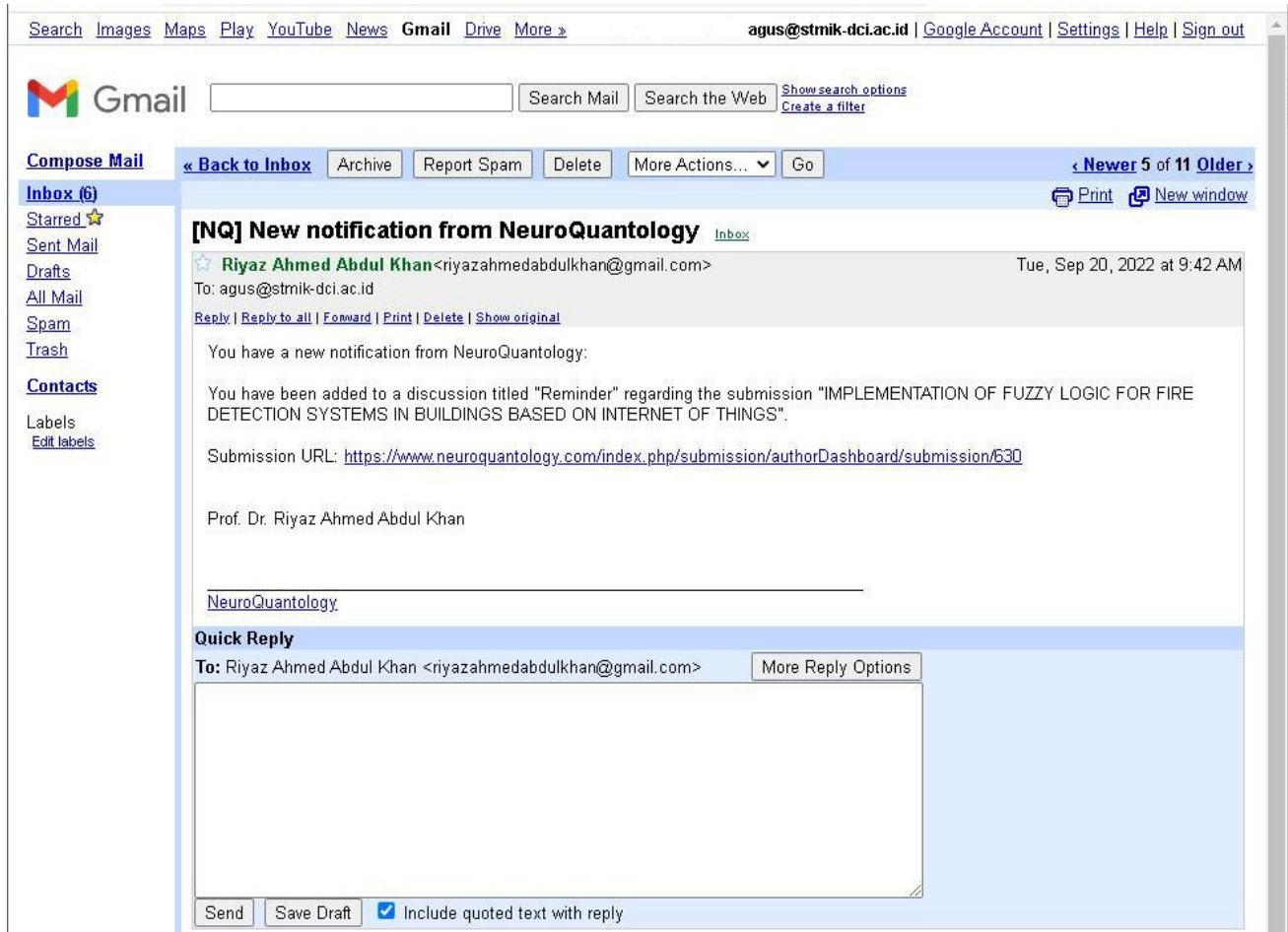
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3. BUKTI KONFIRMASI SUBMIT REVISI, RESPON KEPADA REVIEWER,  
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Agus Ramdhani Nugraha:

We have reached a decision regarding your submission to NeuroQuantology, "IMPLEMENTATION OF FUZZY LOGIC FOR FIRE DETECTION SYSTEMS IN BUILDINGS BASED ON INTERNET OF THINGS".

Our decision is: Revision Required

Reviewer A:

There are numerous strengths to this study, but there is still a lot to improve, including:

    - In general, I did not find this study to make a valuable contribution to the literature or to science.
    - Correction to a typographic, spelling, or grammatical mistake.
    - Additional content more background on a topic in the introduction, and expanded reflection on a finding in the Discussion.
    - Revision research method, using SDLC for system development.
    - Reference is not less up to date, should use the last 5 years.

Recommendation: Resubmit for Review
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# Implementation of Fuzzy Logic for Fire Detection Systems in Buildings Based on Internet of Things

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## Abstract

Fire disaster is a condition or condition where a building in one place is engulfed in fire. This results in loss of assets/property and loss of life in places such as factories, buildings, markets, housing, gas stations and even forests. The purpose of this study is to manufacture an internet of things based fire detection system using the fuzzy logic method which functions to provide early warning to residents who are outside the home and can monitor if a fire occurs so that it can be dealt with early and minimize losses due to fire. The method used is fuzzy logic. The results of the research after conducting analysis, design, and testing showed that the automatic fire detection system could detect the surrounding conditions correctly, and also the use of a fuzzy logic system in this system can make the fire detection system more informative by having more fire level indicators namely SAFE, Towards ALERT, ALERT, Towards DANGER, and DANGER. The distance needed by the device to detect fire is about 1 meter.

**Keywords:** Fire Detection Systems, Fuzzy Logic, Internet of Things, Microcontrollers, Arduino Mega.

## INTRODUCTION

In this country there are many buildings and housing that are located very close to one another. As a result, fires often occur due to electrical short circuits. This fire disaster is very detrimental to humans, in particular it can cause its own trauma for those who experience it. There are so many causes and impacts of every fire disaster that occurs to cause casualties.

A fire disaster is a condition or condition in which a building is engulfed in flames. This resulted in loss of assets and loss of life in places such as factories, buildings, markets, housing, gas stations and even forests. Based on world data on occupational safety and health accidents, the most serious deaths due to factory fires occur in almost every country in the world with a ranking below natural disasters such as earthquakes or tsunami disasters (ILO, 2018).

There are several factors that cause fires, such as electrical installation short circuits, gas stove explosions, cigarette butts, and others. In general, a fire is known when the fire has started to grow or the smoke has started to turn black or has been billowing out of the building. A security system in buildings (buildings or housing) is needed because the fire hazard does not know the time, so that early prevention can reduce the occurrence of fires, and greater losses (Matrouk, 2022).

The purpose of this research is to create an internet of things based fire detection system using the fuzzy logic method which functions to provide early warning to residents who are outside the home and can monitor if a fire occurs so that it can be dealt with early and minimize losses caused by fire.

## LITERATURE REVIEW

### Definition of Fire Detection Systems

According to the National Fire Protection Association, fire is an oxidation event where 3 elements meet, namely materials, oxygen and heat which can cause material loss or even human death (NFPA, 2021). Every fire can cause various kinds of losses such as damage to production equipment, production materials, and loss of working time during the production process (Linawati & Purba, 2020).

Detection is a process to examine or examine something using certain methods and techniques (Fauzi, 2019). Detection can be used for various problems, for example in a disease detection system (Berutu, 2020), where the system identifies problems related to disease which are commonly called

**Comment [WU1]:** Please explain the method of data analysis and the tool used to test the system development

**Comment [WU2]:** Additional content more background on a topic in the introduction, and expanded reflection on a finding in the Discussion

symptoms (Sinarsari, 2022). The purpose of detection is to solve a problem in various ways depending on the method used to produce a solution (Pambudi, 2020).

#### Definition of the Internet of Things

According to (Sari et al., 2017) Internet of Thing (IoT) can be defined as the ability of various devices that can be connected to each other and exchange data through the internet network (Sharma et al., 2020). IoT is a technology that allows control, communication, collaboration with various hardware devices, data via the internet network (Gómez et al., 2013). So that it can be said that the Internet of Things (IoT) is when we connect something (things) that are not operated by humans, to the internet (Petrenko et al., 2018). But IoT is not only related to controlling devices remotely, but also how to share data, virtualize all real things in the form of the internet, and so on (Patel et al., 2016). The internet becomes a link between machines automatically. In addition, there is also a user who serves as a regulator and supervisor of the working of the tool directly (Abdul-Qawy et al., 2015). The benefit of using IoT technology is that work done by humans becomes faster, easier and more efficient (Zeinab & Elmustafa, 2017).

#### Definition of Fuzzy Logic

Fuzzy is linguistically defined as fuzzy or vague which means a value can be true or false simultaneously (Schwartz, 1985). In fuzzy, it is known that the degree of membership has a range of values from 0 (zero) to 1 (one) (Dzitac et al., 2017). Fuzzy logic is a logic that has a value of fuzziness or ambiguity between right or wrong. In fuzzy logic theory a value can be true or false simultaneously (Ross, 2009). But how much truth and error depends on the weight of membership it has (McNeill & Thro, 2014).

Fuzzy logic has a degree of membership in the range 0 to 1 and fuzzy logic shows how far a value is true and how far a value is wrong (Soleymani et al., 2017). Fuzzy logic is an appropriate way to map an input space into an output space and has a continuous value (Vuorimaa, 1994). Fuzzy expressed in degrees of membership and degrees of truth. Therefore something can be said to be partly right and partly wrong at the same time (Sulaiman et al., 2020).

### RESEARCH METHOD

System analysis is the process of analyzing information and problems obtained from the initial stage and also analyzing overall and detailed requirements. System Design, at this stage program design, circuit models, and flowcharts are carried out. In the stage of writing the program code, at this stage, the coding is carried out into a predetermined programming language based on the overall design. The device assembly stage, namely assembling the tools that have been determined based on the design that has been made. In the final stage of system testing, at this stage, the tool will be tested for suitability with what has been designed and carried out tests to detect existing problems and make improvements.]

**Comment [WU3]:** Revision research method, using SDLC for system development.

**Comment [WU4]:** add reference

#### System Analysis

Analysis is a detailed study or research by conducting an experiment which results in conclusions from the decomposition of a complete system into its component parts with the intention of identifying and evaluating all problems that arise, obstacles that occur as well as opportunities and needs so that solutions can be created to overcome problems that arise can build the system to be made.]

**Comment [WU5]:** Additional content more

### SYSTEM DESIGN

#### Design of Fire Detection System

This section contains the general design of automatic fire detectors and the following is a block diagram regarding the hardware for automatic fire detectors that are being designed

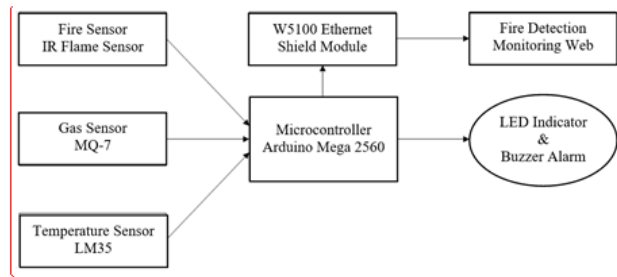


Figure 1. General Fire Detection System Design

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### Fuzzy Logic Design

The design of the Fuzzy Logic system itself is divided into several stages, including:

1) Create a Fuzzy set

Creating a Fuzzy set is the first step in which at this stage the number of linguistic variables to be used is determined and the distribution of data on each linguistic variable. This fire detection system uses 3 input variables where the input variables are the output values from the fire, temperature, and gas sensors. Each of these input variables also each has 3 linguistic variables. So for the design of the fuzzy system input on this fire detector are as follows:

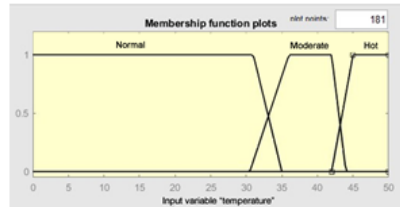


Figure 2. Temperature Input Variable

In Figure 2, 3 linguistic variables are made, which include Normal (0 °C to 35 °C), Moderate (30 °C to 45 °C) and Hot (40 °C onwards). So that in Figure 4.3 if translated it will form the following equation:

$$\begin{aligned}
 \text{Normal} &= \begin{cases} 1, & x \leq 31 \\ \frac{35-x}{4}, & 31 \leq x \leq 35 \\ 0, & x \geq 35 \end{cases} & \text{Moderate} &= \begin{cases} 1, & 36 \leq x \leq 42 \\ \frac{44-x}{2}, & 31 \leq x \leq 35 \\ \frac{x-30,5}{5,5}, & 31 \leq x \leq 35 \\ 0, & 30,5 \geq x \text{ dan } x \leq 44 \end{cases} \\
 \text{Hot} &= \begin{cases} 1, & x \geq 45 \\ \frac{x-42}{3}, & 42 \leq x \leq 45 \\ 0, & x \leq 42 \end{cases}
 \end{aligned}$$

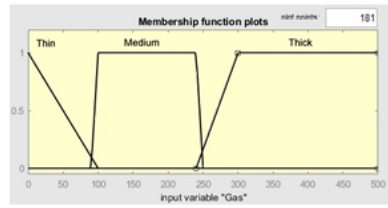


Figure 3. Gas Input Variable

In Figure 3 the gas input variables also have 3 linguistic variables, namely Thin (0 ppm – 100 ppm), Medium (90 ppm – 250ppm) and Thick (240 ppm onwards). So that in Figure 4.4 if translated it will form the following equation:

$$\text{Thin} = \begin{cases} 1, & x \leq 0 \\ \frac{100 - x}{100}, & 0 \leq x \leq 100 \\ 0, & x \geq 100 \end{cases} \quad \text{Medium} = \begin{cases} 1, & 100 \leq x \leq 220 \\ \frac{250 - x}{30}, & 220 \leq x \leq 250 \\ \frac{x - 90}{10}, & 90 \leq x \leq 100 \\ 0, & x \geq 250 \text{ dan } x \leq 90 \end{cases}$$

$$\text{Thick} = \begin{cases} 0, & x \leq 240 \\ \frac{x - 240}{60}, & 240 \leq x \leq 300 \\ 1, & x \geq 300 \end{cases}$$

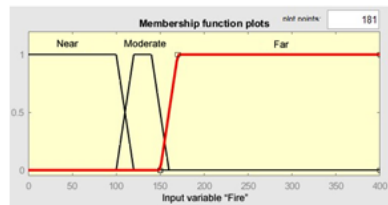


Figure 4. Fire Input Variable

In Figure 4 the fire input variable also has 3 linguistic variables, namely Near (0-120), Moderate (100-160) and Far (150-170). So that in Figure 4.5 if translated it will form the following equation:

$$\text{Far} = \begin{cases} 1, & x \geq 170 \\ \frac{x - 150}{20}, & 150 \leq x \leq 170 \\ 0, & x \leq 150 \end{cases} \quad \text{Moderate} = \begin{cases} 1, & 110 \leq x \leq 140 \\ \frac{160 - x}{20}, & 140 \leq x \leq 160 \\ \frac{x - 100}{10}, & 100 \leq x \leq 110 \\ 0, & x \geq 160 \text{ dan } x \leq 100 \end{cases}$$

$$\text{Near} = \begin{cases} 1, & x \leq 100 \\ \frac{120 - x}{20}, & 100 \leq x \leq 120 \\ 0, & x \geq 120 \end{cases}$$

In addition to designing fuzzy input variables, at this stage the output variables are also designed and the design of the output variables in this system is as follows:



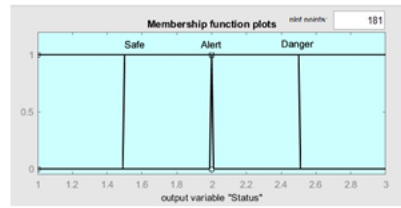


Figure 5. Status Output Variable

#### Variabel *output* Status

In Figure 5 it can be seen that the output variables of the fuzzy system are designed to have 3 linguistic variables and the three variables are Safe (1 – 2), Alert (1.5 – 2.5) and Danger (2 – 3). It is from this output variable that the level of a fire can be predicted by the fire detection system.

#### Hardware Design

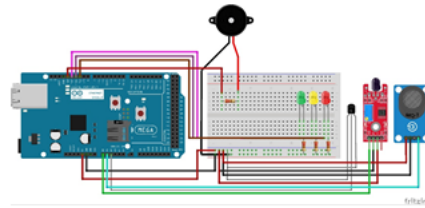
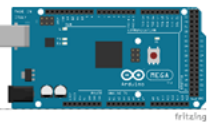
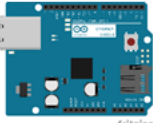

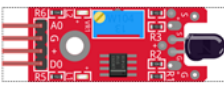





Figure 6. Hardware Design

An explanation of the hardware used in the Fire Detection System in figure 6 is in table 1 below.

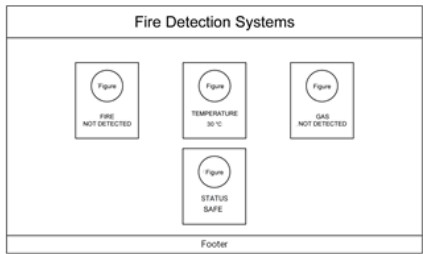
Table 1. Hardware Description

No.	Hardware	Information
1		Arduino Mega 2560 microcontroller is used as a tool that processes input data which will send data to output devices.
2		This Ethernet Shield module is used to send input data to the existing database on the web server.
3		The LM35 temperature sensor functions as a sensor that detects the temperature in the room.

4		The Arduino Uno functions as a microcontroller that coordinates the operations of the other components.
5		The MQ7 gas sensor functions as a sensor that detects gas levels in a room.
6		The buzzer is an output device that receives information from the data sent by the Arduino in the form of sound.
7		The LED light serves as an indicator of whether a fire has occurred or not.

**Software Design**

Software design is useful as the main controller on Arduino to carry out functions from other devices.



**Figure 7. Interface Design Results**

**Hardware Logic**

**Table 2. Hardware Logic Information**

	Status	Green LED	Yellow LED	Red LED	Buzzer
Condition	DANGER	Low	Low	High	Beep
	ALERT	Low	High	Low	Beeps every 1 second

**Comment [WU7]:** Additional content more or description detail



	SAFE	High	Low	Low	No Beep
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Comment [WU8]: Additional content more or description detail

## IMPLEMENTATION

System implementation is a process of implementing the system that has been designed, where this stage is the stage of putting the system ready for use and also as an effort to realize the system that has been designed.



### Hardware Requirements

Computer with specs:

- 1) Processor : AMD Ryzen 5-3550H 2.1GHz
- 2) Storage : Harddisk 1 TB + SSD NVMe 256 GB
- 3) RAM : 8GB DDR4 2400MHz SDRAM

Arduino Mega 2560

Arduino Ethernet Shield Module

Flame Sensor

Temperature Sensor LM35

Gas Sensor MQ7

LED

Jumper Cable

Breadboard

Adaptor 9 Volt

Access Point

LAN

### Software Requirements

Operating System

Windows 11 Home Single 64-bit

Code Editor

Arduino IDE & Visual Studio Code

Simulator Design

Fritzing

Diagram Design

Microsoft Visio 2016

Web Server

Apache

Database Server

MariaDB

Comment [WU9]: Please make it in table form

### System Usage Guide

How to Use a Fire Detection System:

- 1) Give Power to the Arduino by inserting the power cable from Arduino to the mains.
- 2) After Arduino is connected to electricity, the sensor will automatically turn on and start detection.
- 3) If the green light is on then it indicates that the status is safe.
- 4) If the yellow light is on and the buzzer sounds every 1 second then it indicates that the status is alert.
- 5) If the red light is on and the buzzer sounds then it indicates that the status is dangerous.

### Device Installation

Device installation is the process of assembling and installing all the hardware components.

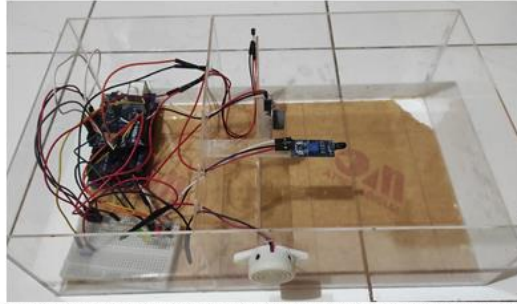


Figure 8. Results of Fire Detection Systems Hardware Implementation

### Results of Software Implementation

#### Guide to Using Fire Detection Systems

- 1) Give Power to the Arduino microcontroller by inserting the power cable from Arduino into the mains.
- 2) After the Arduino microcontroller is connected to electricity, the sensor will automatically turn on and start the detection.
- 3) If the green light is on then it indicates that the status is safe.
- 4) If the yellow light is on and the buzzer sounds once every 1 second then it indicates that the status is alert.
- 5) If the red light is on and the buzzer sounds then it indicates that the status is dangerous.



Figure 9. Results of Implementation of Fire Detection System Software

### CONCLUSION AND RECOMMENDATIONS

#### Conclusion

After conducting system analysis, design, and testing, it can be concluded that an automatic fire detection system can detect the surrounding conditions correctly and also the use of a fuzzy system in this system can make the fire detection system more informative by having more fire level indicators, namely SAFE, Towards ALERT, ALERT, Towards DANGER, and DANGER. The distance required by the system to detect a fire is relatively close, which is around less than 1 meter.

#### Recommendations

The following are suggestions that the compiler can use for the development stage of this system, including:

- 1) This system cannot be connected directly to the fire department so that fires can be handled quickly.
- 2) This system has not yet reached the stage where it can be implemented in daily activities because the sensors used are still limited to prototypes.
- 3) The first prevention feature can be added, such as pouring water so that the fire does not spread.

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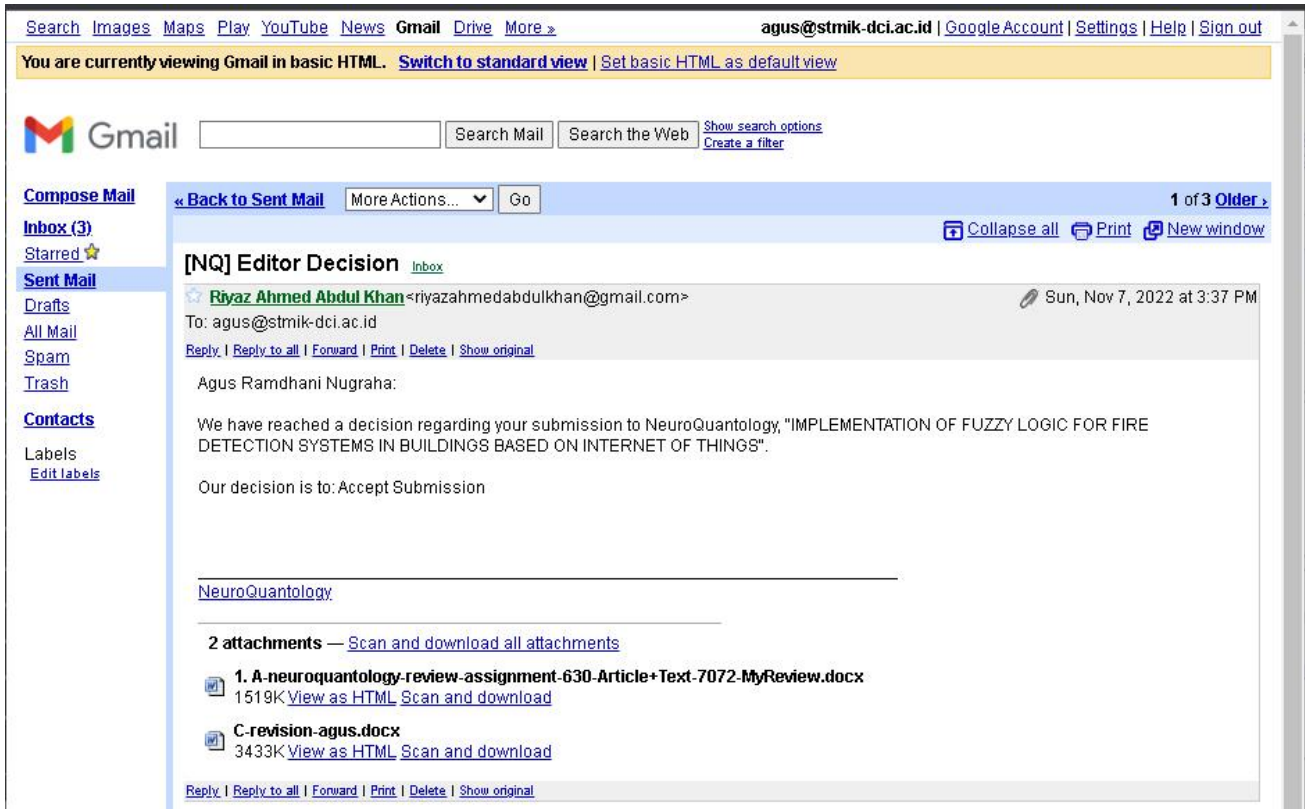
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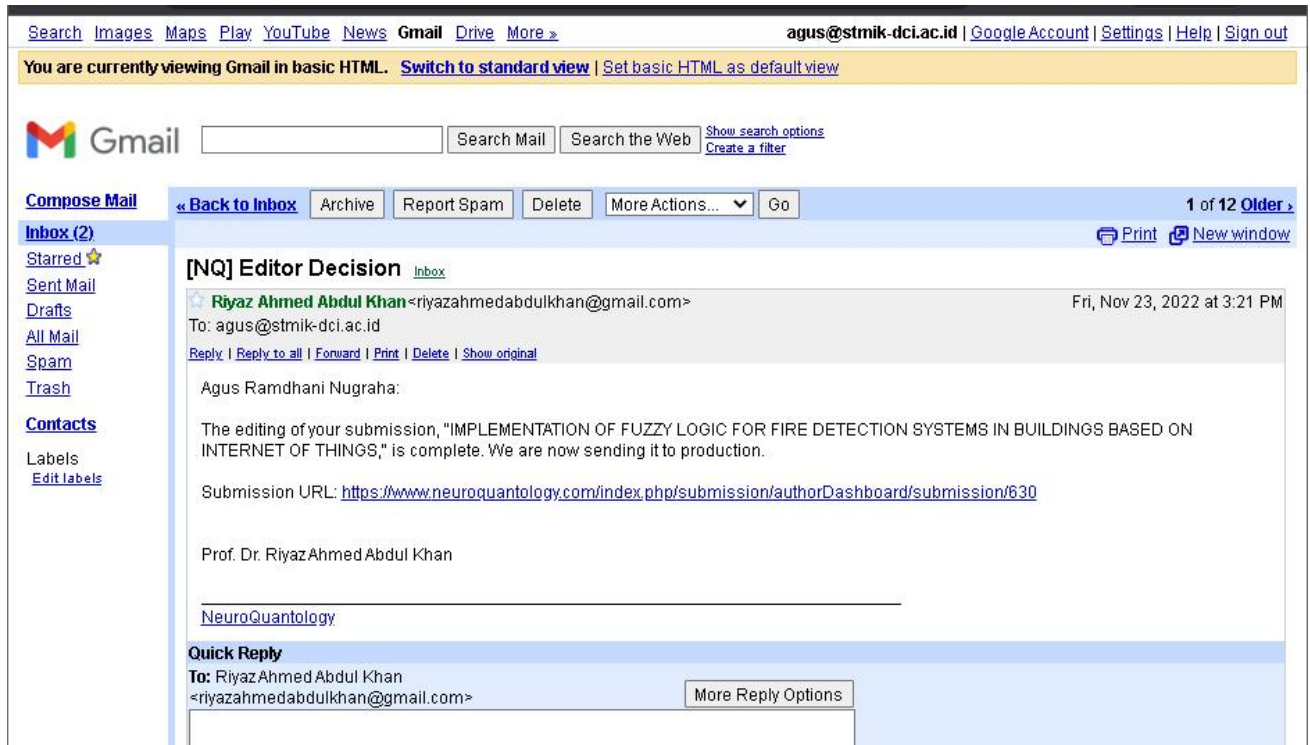
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  - To:** agus@stmik-dci.ac.id
  - Body:** Agus Ramdhani Nugraha: We have reached a decision regarding your submission to NeuroQuantology, "IMPLEMENTATION OF FUZZY LOGIC FOR FIRE DETECTION SYSTEMS IN BUILDINGS BASED ON INTERNET OF THINGS". Our decision is to: Accept Submission.
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- Body:** We would like to thank you for accepting our manuscript entitled "IMPLEMENTATION OF FUZZY LOGIC FOR FIRE DETECTION SYSTEMS IN BUILDINGS BASED ON INTERNET OF THINGS" for publication in the Journal. Final version of our article and proof of payment for our publication is attached below.
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The editing of your submission, "IMPLEMENTATION OF FUZZY LOGIC FOR FIRE DETECTION SYSTEMS IN BUILDINGS BASED ON INTERNET OF THINGS," is complete. We are now sending it to production.

Submission URL: <https://www.neuroquantology.com/index.php/submission/authorDashboard/submission/630>

Prof. Dr. Riyaz Ahmed Abdul Khan

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