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Design of Interface System With Hmi (Human Machine Interface) Based For Monitoring System of Generator With 3dr Telemetry 433mhz Communication

Sudjadi[1], Sumardi[2], Wildan Abdul Jabbar[3]
Electrical Engineering Department, Diponegoro University, Semarang, Indonesia
[1]sudjadi@undip.ac.id, [2]sumardi@elektro.undip.ac.id, [3]wildanajabbar@gmail.com

Abstract—*Generator set (genset) is a backup power supply which is used when the PLN supply is off. With such an important function, the generator set maintenance must be taken care of for long life durability. Monitoring activity is usually conducted on a regular basis, but still run manually by relying on operators who go directly to the plant. This research goes over the making of HMI remote control system for generator set in order to produce effective and continuous reporting. HMI is designed by Microsoft Visual Studio 2012 software with C # programming language. The data communication used is serial asynchronous wireless communication using 3DR Telemetry 433MHz. The prototype generator set uses an Atmega16 microcontroller which is programmed by CodeVision AVR 2.05.3. Daily data storage and reports use Microsoft Excel. Based on the tests performed, it can be concluded that the HMI system works well. The HMI monitoring system can accurately monitor the plant on fuel percentage and data difference of 1 celcius degree at temperature. The alarm test works well. The farthest test resulted was 84.6 meters. In testing data storage and daily reports all the required information can be stored properly.*

Keywords—Generator;HMI;3DR Telemetry 433MHz

1. INTRODUCTION

Generator set (genset) is a backup power supply which is used when the PLN supply is off. In general, generator set does not have the ability to replace power supply automatically when the PLN supply is disconnected. With such an important function, the generator set maintenance must be taken care of for long use durability. Therefore, the previous researcher has conducted a study with the title of Design of Automatic Transfer Switch (ATS) and Automatic Main Failure (AMF) System of PLN – Genset with PLC Based and Monitoring Equipped [1]. ATS is an automatic switch to move the power supply from PLN power source to generator power source and vice versa [2]. Other researchers have conducted research on maintenance of generator set. This study discusses the aspects that must be considered in the treatment so that the generator set can be used for a long time [3]. In the previous research, the treatment is usually conducted on a regular basis, but still operated manually by relying on operators who go directly to the plant. Thus, other researchers have conducted a study with the title of Monitoring of Remote Temperature Generator AC with Microcontroller Based [4]. Hence, this research goes over the making of HMI remote control system with 3DR Telemetry 433MHz communication for generator set which has been designed by Sigit Satrio Bimantoro previously in order to produce effective monitoring and continuous reporting [5].

2. RESEARCH METHODS

2.1 Automatic Generator Set

In general, generator set does not have the ability to replace power supply automatically when the PLN supply is disconnected, therefore the ATS (Automatic Transfer Switch) system is created. In general the function of the ATS is to connect loads with two power supply (main supply & backup supply) or more which are separated for maintaining the availability and reliability of the supply power to the load. The ATS function is to transfer power to the load automatically from a main supply (PLN) to a backup supply (Genset) when an interruption occurs at the main supply. Thus, the generator set turns on automatically when the main supply is off, which is also equipped with monitoring system of temperature level and generator fuel level [5]. Figure 1 shows the diagram block of an ATS system that has been created.

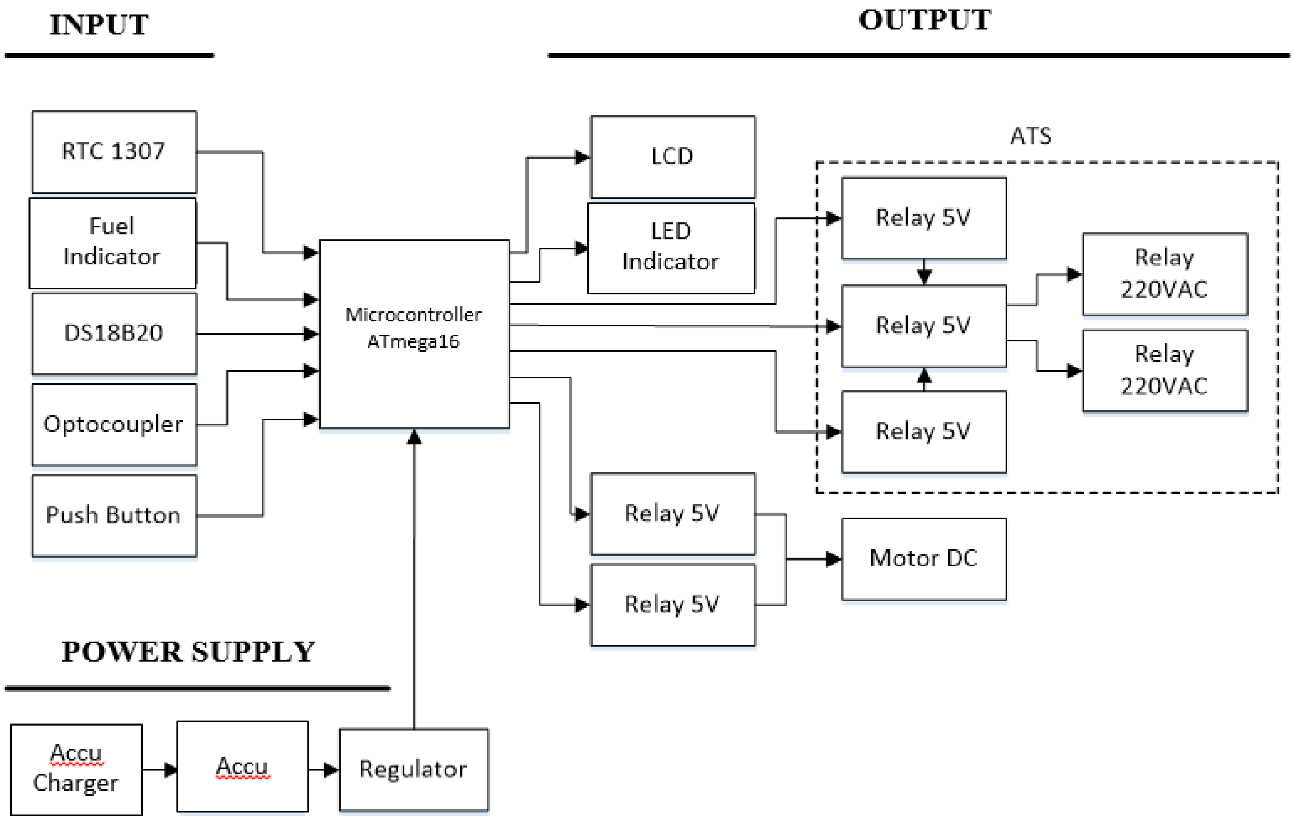

Fig. 1. Diagram block of ATS/AMF generally [5]

2.2 Software Design

2.2.1 HMI Design

On the main page, HMI is divided into several tabs with their own specific function. The tabs are a screen tab for general plant functions, controls and alarms, database tab for viewing and storing data in tabular form, and connect tab to enable and disable serial communications. Human Machine Interface (HMI) is an interface software in the form of a computer-based Graphical User Interface that connects operators with machines or equipment controlled and acts at the supervisor level [6]. HMI displays data on the operator screen and provides input controls for operators in various forms, such as graphics, schematics, pull-down menu windows, touch screens, and so on. HMI can be a touch screen, tool, or computer itself [7].

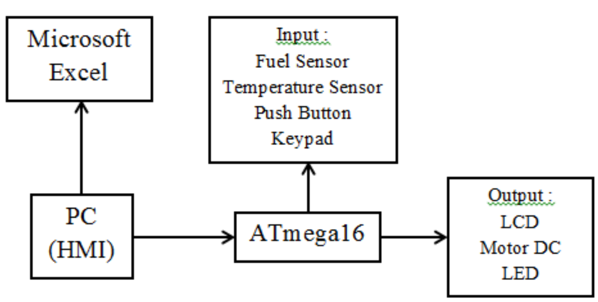

Fig. 2. Diagram block of general system

Figure 2 shows diagram block of general system. It also describes the connection between HMI and generator set.

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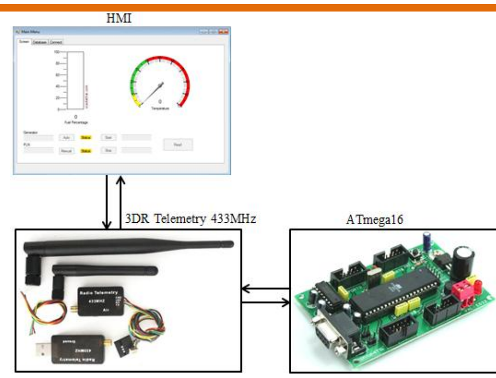


Fig. 3. Design of general system

Figure 3 describes the design of general system between HMI, 3DR Telemetry 433MHz and Atmega16 of generator set.

Fig. 4. Main Page

Figure 4 is a view of main page of HMI after the user success to login.

2.2.2 Serial Communication Design

This serial communication uses 3DR Telemetry 433MHz with baud rate of 57600 bps, with 8 bit communication parameters and 1 stop bit without parity bit. This serial communication consists of serial data receiving, serial data transmission, and microcontroller serial communication. The speed of data transmission is expressed by the term baud rate with unit of bits per second (bps) [8].

3. Results and Analysis

3.1 Start and Stop Buttons Test

The start button is tested by pressing the start button and the stop button is tested by pressing the stop button on the control page. The test is done 3 times in each mode with the indication of success by turning the generator on or off. Table 1 shows the test results of start and stop buttons.

Table 1 : The test results of start and stop buttons.

Mode	Test	Generator Condition
Automatic	1	*On*
	2	*On*
	3	*On*
Manual Start	1	*On*
	2	*On*
	3	*On*
Manual Stop	1	*Off*
	2	*Off*
	3	*Off*

Table 1 shows from the total of 3 tests on each mode, each time the start button is pressed on HMI then the generator will turn on and whenever the stop button is pressed on HMI then the generator will turn off. This indicates that the start and stop buttons have worked successfully.

3.2 Monitoring System Test

3.2.1 Read data test

Read data is tested by pressing the open port button on the connect tab. After the button is pressed then the data will be transferred from the generator set to HMI. The test is done 3 times in each mode with the indication of success by presenting the value of each variable test. Table 2 shows the test results of the read data.

Table 2 : The test results of the read data

Mode	Test	HMI Output	LCD Output	Error
Generator Supply	1	Off	PLN Supply	Not found
	2	Off	PLN Supply	Not found
	3	On	PLN Disconnected	Not found
PLN Supply	1	Off	PLN Disconnected	Not found
	2	On	PLN Supply	Not found
	3	On	PLN Supply	Not found
Fuel Percentage	1	105%	105%	0
	2	66%	66%	0
	3	44%	44%	0
Temperature Level	1	31^{o}C	31,1^{o}C	0,1
	2	31^{o}C	31,1^{o}C	0,1
	3	31^{o}C	31,1^{o}C	0,1

Table 2 shows from the total of 3 tests on each test variable, each time the open port button is pressed on HMI, the data from the plant is sent to HMI. This indicates that the data transfer has worked successfully on every test variable. Then, from the total of 3 tests on each variable are found that the output on the HMI equal to the output on the LCD. However, at temperatures there is a difference of 0.1. It occurs because the HMI setting allows only integers display, does not show the numbers behind the commas.

3.2.2 Alarm test

The alarm is tested in two conditions, the condition of the empty fuel and the overheat temperature. Fuel lower limit is set 20%, so if the tank level is less than 20%, then the alarm will display an error notification. Temperature upper limit is set 40^{0}C, so if the temperature is more than 40^{0}C, then the alarm will display an error notification.

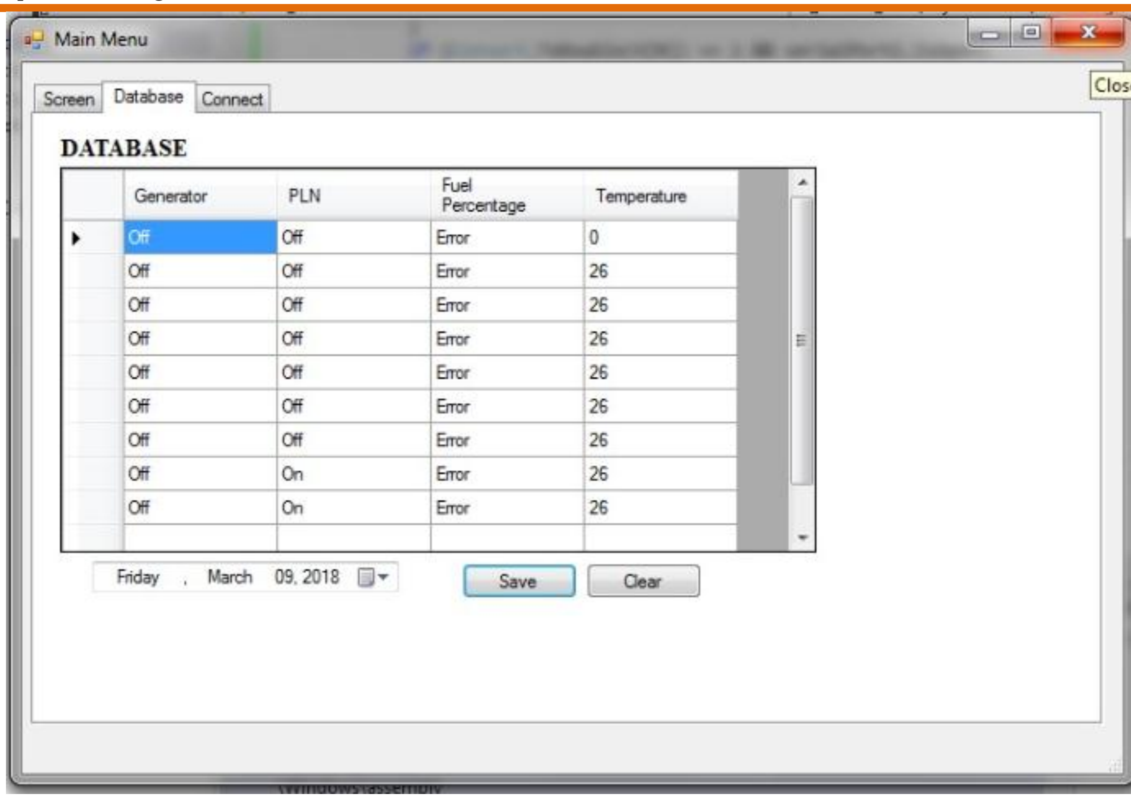
Table 3 : Alarm test

Mode	Test	Value	Alarm Plant	Alarm HMI
Fuel Percentage	1	0	Active	Active
	2	11	Active	Active
	3	20	Non-active	Non-active
Temperature	1	40	Non-active	Non-active
	2	41,6	Active	Active
	3	42,8	Active	Active

From Table 3 it can be seen that from the total of 3 tests of fuel percentage, on every test that exceeded the lower limit, the alarm is active and from the total of 3 tests of temperature level, on each test that exceeded the upper limit, the alarm is active. This indicates that the alarm indicator goes well.

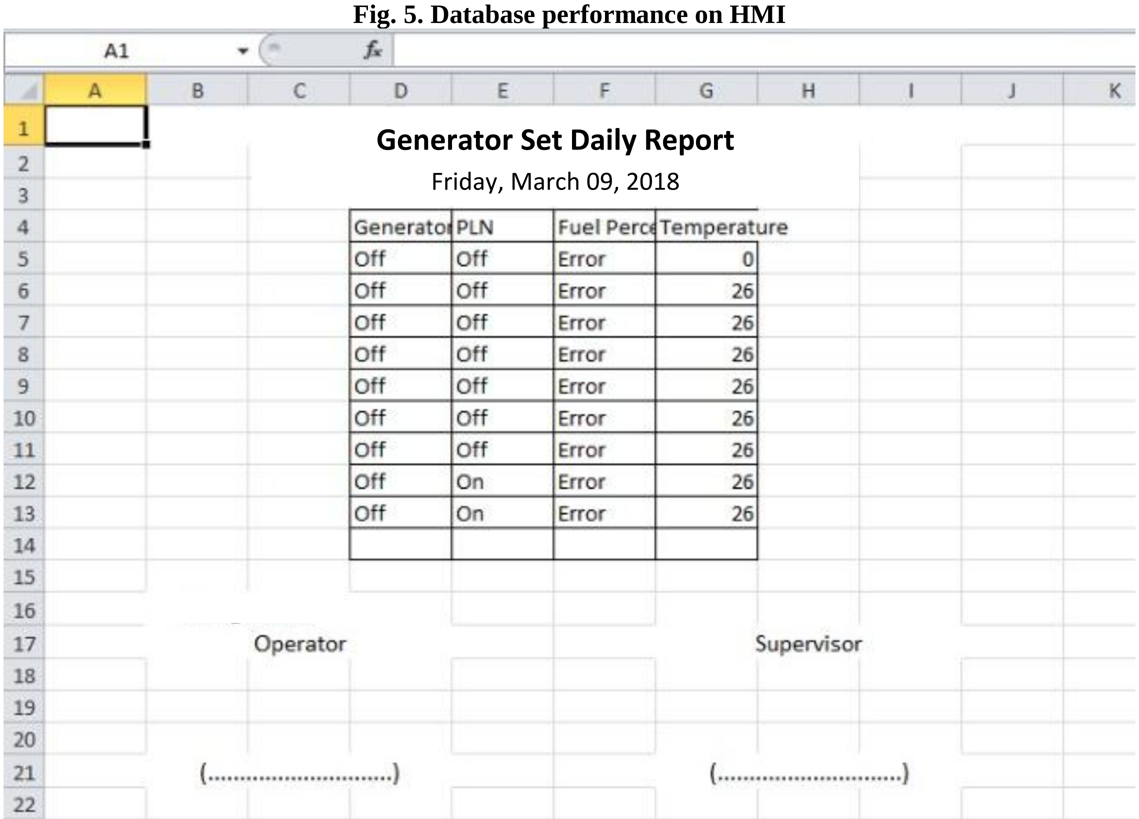
3.3 Daily Report Test

The creation of an Excel document on HMI works by exporting the component state of the HMI into an Excel document. HMI can also create daily reports by adding table formats and dates. Daily report is tested by running the process then pressing the save button on HMI to create daily reports on the form of Excel documents.



Generator	PLN	Fuel Percentage	Temperature
Off	Off	Error	0
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	On	Error	26
Off	On	Error	26

Fig. 5. Database performance on HMI



Generator Set Daily Report

Friday, March 09, 2018

Generator	PLN	Fuel Perce	Temperature
Off	Off	Error	0
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	Off	Error	26
Off	On	Error	26
Off	On	Error	26

Operator (............................)

Supervisor (............................)

Fig. 6. Daily report performance

From Figure 5 and Figure 6 it can be seen that component state data, Excel documents, and daily reports are the same. The similarity of data proves that the data export function and daily report on HMI has been running well.

3.4 Serial Communication Test

Serial communication is tested by selecting the port names on the connect tab. Then, choose the baud rate that has been provided in the combo box. Then, press open port button, then the status bar will turn green and the received here box will say "Connection complete" which is indicating that HMI communication and the device have been connected.

Table 4 : Serial communication test

Mode	Test	Port Names	Baud Rate	Status Bar	Received Here
Open Port	1	✓	✓	✓	✓
	2	✓	-	-	✓
	3	-	✓	-	✓
	4	-	-	-	✓
Close Port	1	-	-	-	-

From Table 4 it can be seen that if the port names and baud rates have been selected, then the status bar is active and received here will show the notification succeeded. Meanwhile, if one or both have not been selected, then the status bar is off and received here will show a warning notification. Then, when the close port is pressed, it will return to the start mode.

Table 5 : Baud rate test

Test	Baud Rate	Fuel Percentage	Temperature
1	9600	-	-
2	57600	✓	✓
3	115200	-	-

From the test results obtained that if the baud rate is appropriate, then the data successfully sent. Conversely, if the baud rate is not appropriate, then the data fails to be sent as Table 5. Furthermore, the weakness of the use of 433 MHz telemetry radio is that if there is transmission of data with the same frequency, it will affect the results of the data obtained.

3.5 Distance Communication Test

The distance communication is tested by placing the prototype generator set in front of the Laboratory of Department of Electrical Engineering and bringing the HMI to 4 different points, then pressing the open port button on the connect tab. Then, the variable will be delivered. Testing is done 5 times at each point with the indication of success is the value of fuel percentage and temperature level appeared on the database. Table 6 shows the results of distance communication test.

Table 6 : Distance communication test result

Point	Range	HMI	LCD	Error
Electrical Engineering Park	50 m	31°C	31,3°C	0,3
	60 m	31°C	31,3°C	0,3
	70 m	31°C	31,3°C	0,3
	74,8 m	31°C	31,1°C	0,1
	76 m	Signal lost	31,3°C	31,3
Electrical Engineering Cafeteria	30 m	31°C	31,3°C	0,3
	40 m	31°C	31,2°C	0,2
	50 m	31°C	31,3°C	0,3
	52,1 m	31°C	31,3°C	0,3
	55 m	Signal lost	31,3°C	31,3
Power Laboratory Backyard	20 m	31°C	31,3°C	0,3
	25 m	31°C	31,4°C	0,4
	30 m	31°C	31,3°C	0,3
	32,7 m	31°C	31,3°C	0,3
	35 m	Signal lost	31,3°C	31,3

Rector Building Park	60 m	31°C	31,8°C	0,8
	70 m	31°C	31,8°C	0,8
	80 m	31°C	31,8°C	0,8
	84,6 m	31°C	31,4°C	0,4
	86 m	Signal lost	31,3°C	31,3

The first test is carried out by walking toward the parking of electrical engineering. At a distance of 50-70 meters, the test results obtain that the data can still be captured properly. Then, at a distance of 72-74.8 meters, communication delays 2 seconds and completely lost at the range of 74.8-76 meters. The second test is carried out by walking toward the cafeteria of electrical engineering. At a distance of 30-50 meters the test results obtain that the data can still be captured properly. Then, at a distance of 50-52.1 meters, communication delays 2 seconds and completely disappeared at the range of 52.1-55 meters. The third test is carried out by walking toward the laboratory backyard. At a distance of 20-30 meters, the test results obtain that the data can still be captured properly. Then, at a distance of 30-32.7, communication delays 2 seconds and completely lost at the range of 32.7-35 meters. The fourth test is carried out by walking toward the rector building park. At a distance of 60-80 meters, the test results obtain that the data can still be captured properly. Then, at a distance of 80-84.6 meters, communication delays 2 seconds and completely lost at the range 84.6-86 meters. Thus, the test results obtain that the longest distance is successfully achieved at 84.6 meters to the rector building park.

4. Conclusion

The Human Machine Interface (HMI) design has run well. The output of the fuel indicator on the HMI and on the LCD are the same, whereas on the temperature indicator there is a difference of 1°C because the HMI setting does not display the numbers behind comma, whereas the LCD displays 1 digit behind comma. From the total of 3 tests of fuel percentage, on every test that exceeded the lower limit, the alarm is active and from the total of 3 tests of temperature level, on each test that exceeded the upper limit, the alarm is active. This indicates that the alarm indicator goes well. The data on the HMI is exported into Excel form. The result shows that the data on Excel is as same as the data on HMI. Thus, the conversion of data from HMI to Excel is declared successful. HMI transfers data successfully at the range of 60-80 meters without the wall as a barrier. At a distance of 80-84.6 meters, communication delays 2 seconds and completely lost if more than that, so that the furthest distance is 84.6 meters. HMI transfers data successfully when obstructed by the wall at the range of 20-30 meters. At a distance of 30-32.7, communication delays 2 seconds and completely lost if more than that, so that the furthest distance is 32.7 meters.

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Authors

Sudjadi, born on June 19th 1959 in Temanggung, Central Java. Graduated as a bachelor in Bandung Institute of Technology, majoring in Department of Electrical Engineering, in 1984. Got a master degree in 1998, majoring Instrumentation and Control Engineering, Gajahmada University, Having experience in some industrial control applications, research in University, making some electronic and electrical application using miceocontroller already used by Indonesia Power of Electrical (PLN). During 2004-2011 as head of department Electrical Enggineering, Diponegoro University, 2012-2016 as head of the University Computer Center, Now is as a lecturer and researcher at Electrical Engineering Department, Faculty of Engineering, Diponegoro University, Semarang, Indonesia.

Sumardi, was born in Sukoharjo, Central Java on November 11^{th} 1968. Graduated as a bachelor in Diponegoro University, Semarang, majoring in Electrical Engineering, Faculty of Engineering, in 1994. Got a master degree in 1998, majoring Instrumentation and Control Engineering Physics Program, Institute of Bandung Technology. Has followed some trainings including PLC training organized by OMRON as PLC producers and digital signal processing training organized by Institute of Bandung Technology. Has done some researches such as "Perancangan Sistem Kontrol Suspensi semi-aktif menggunakan Fuzzy Logik Control pada Model Kendaraan Seperempat", "Pengembangan Sistem Peringatan Dini Banjir berbasis SMS dan Web Studi Kasus Sungai Garang Semarang", and also has cooperated in the installation of flood early warning instrument with PT Jasa Trita, BBWS Southeast Sulawesi, etc. Current busyness is as a lecturer and researcher at Electrical Engineering Department, Faculty of Engineering, Diponegoro University, Semarang, Indonesia.

Wildan Abdul Jabbar, was born in Jakarta on April 17^{th} 1995. Graduated as a bachelor in 2018, majoring Electrical Engineering, Faculty of Engineering, Diponegoro University. His research interests are in Control System and Instrumentation.