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WEB-BASED HUMAN MACHINE INTERFACE (HMI) DESIGN FOR BABY INCUBATORS

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Abstract

Baby monitoring in many baby incubators on the market today still use human labor, where nurses, doctors, or medical personnel monitor directly to the baby incubator's treatment room to provide medical action or directly review the condition of babies. In terms of information on the condition of the baby, the medical staff cannot monitor the development of the condition of the baby one by one at any time. Therefore, an HMI system is needed that can function to overcome problems in terms of monitoring, controlling, and data acquisition in the application of baby incubator medical equipment. In this study, a web-based Human Machine Interface (HMI) was designed for baby incubator prototypes that can facilitate medical staff in performing monitoring functions remotely in a control room. In this design using the ATmega16 microcontroller and ESP8266 wireless module. From this study, it was found that HMI can monitor well. The average time for sending data in offline mode is 12.25 seconds. The average time for sending data in online mode is 11.42 seconds. All features that are made are already running well. All data acquired on the HMI are in accordance with the data in the baby incubator sent to the database.

Keywords: Baby Incubator, Microcontroller ATmega16, ESP8266, Monitoring, Web

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INTRODUCTION

Monitoring babies given treatment in the incubator babies were still using human power to give direct medical action or review the condition of the babies. It shows the lack of effectiveness of the time and effort of the medical officer in performing the monitoring. In terms of the baby's condition information, the medical officer cannot every time monitor the development of the baby's condition one – by one. On the other hand the medical officer to get data or information from the incubator babies manually. Therefore, it needs a system that can serve HMI overcome problems in terms of monitoring, control, and data acquisition on application incubator baby medical equipment.

In the previous research by Michael A.P.L entitled Designing Supervisory Control And Data Acquisition (SCADA) System in Temperature Control in Hot Room Prototype SCADA system design for temperature control was carried out in a Hot Room prototype using Proportional Integral (PI) control method. In this study, the control system and monitoring of prototype hot rooms are designed on a web-based internet network using the help of the ESP8266 wireless module. In this study 3 variations of temperature reference were carried out, namely at temperatures of 42 ° C, 43 ° C, and 48 ° C which can produce a stable temperature output in accordance with variations in the temperature reference to be achieved. The results of control and monitoring through the web have been successful and running well.[1]

On research compiled by Pallerla Akshay Kumar, Akshay Naregalkar, Thati Anush Kumar, Anusha and Badrinath Jagannath titled Real Time Monitoring And Control Of Neonatal Incubator Using LabVIEW-based systems implementation done the Web in real-time to monitor and control the temperature, humidity, and weight as well as the physical condition in infants by creating design models that simulated in software LabVIEW2011 and obtained results that the addition of more sensors parameters more in the monitoring and control of the condition of the babies will be very beneficial to be implemented because it can reduce noise and vibration that occurs so it can rescue a baby from death. Remote monitoring and control is very useful in the case of incubators especially for inadequate medical facilities. [2]

This research will be designed for Human Machine Interface (HMI) to monitor performance through HMI web incubator. Microcontroller ATmega16 will send performance data towards the baby incubator databases. Infant incubator performance parameter data sent is the parameters of temperature, humidity, heavy, and alarm. Module wireless communication as a media ESP8266 delivery data from the microcontroller incubator towards database.

HARDWARE DESIGN

Microcontroller ATmega16 with ESP8266 Wireless Module Communication System

In general, the design of the HMI system for infant incubators can be seen in the block diagram as shown in Figure 1.

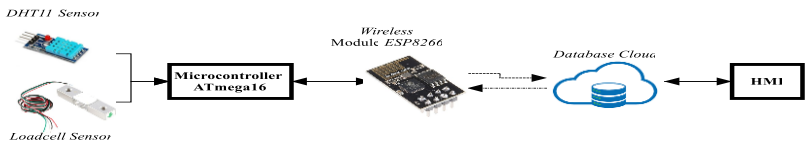

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Figure 1: Diagram of HMI-Based Infant Incubator Systems

Figure 1. explains that the microcontroller has a DHT11 sensor input and load cell. The ATmega16 microcontroller has an output that is connected by UART with the ESP8266 wireless module. The ESP8266 wireless module serves as a communication medium to send the output to the HMI database.

Microcontroller ATmega16 serves to read data obtained from sensors, processing temperature and humidity control of baby incubators, and sending data to HMI from reading sensors and alarms. The ATmega16 microcontroller also functions to receive control data from the HMI. Communication of sending and receiving to AT Mega 16 microcontrollers using ESP8266 wireless module. The allocation of each port of the baby incubator prototype can be divided by function as follows:

1. The function of the ATmega16 microcontroller as reading sensor data is divided into two parts, namely as follows:

a. As a reading of the data DHT11 sensor data in PORTA.

b. As a reading of data load cell sensor on PORTA.0 and PORTA.1.

2. The function of the ATmega16 microcontroller transmits sensor data and alarms and processes the receipt of data point settings from HMI by using USART communication contained in the ATmega16 microcontroller where PORTD.0 as a receiver (RX) is connected to the TX communication device and PORTD.1 as a transmitter (TX) which is then connected to RX on the communication device.

Hardware design is shown in Figure 2.

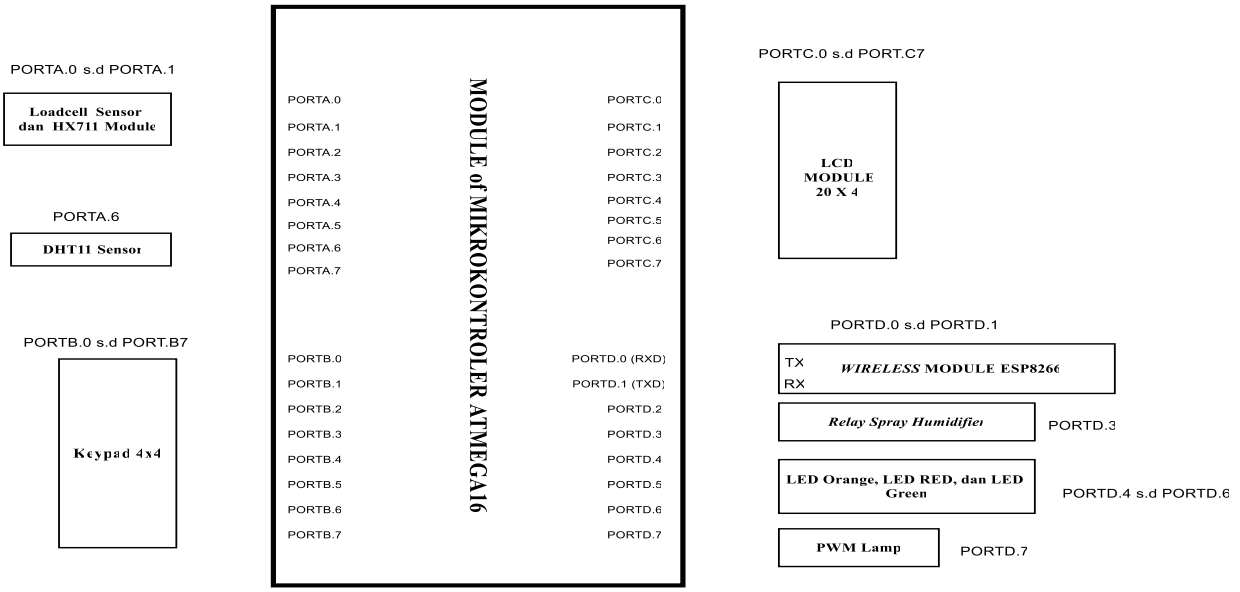

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Figure 2: Hardware Design of Microcontroller ATmega16

HMI Design

In designing the HMI, two levels of access rights were designed to carry out the login process, namely the level of doctor/nurse and operator level. The difference between the access rights between the doctor/nurse level and the operator level is that at the operator level there is a command function to enter the temperature parameter setting point and the baby data input function to the database while at the doctor/nurse level there is no. The design of the HMI software in this study is divided into 5 parts, namely:

a. Design of Layout HMI

The design of the layout of the display, HMI design consists of a log in page, the design of the home page design, HMI input data, designing baby home monitoring, and data acquisition design of HMI in the form of tables and graphs.

b. Design of Database System

The Database Management System or DMS used in this design is the My Structured Query Language (MySQL) Database and uses Hypertext Pre-processor (PHP) programming. Figure 3. Diagram shows the context to describe the flow of data is designed on a prototype incubator babies.

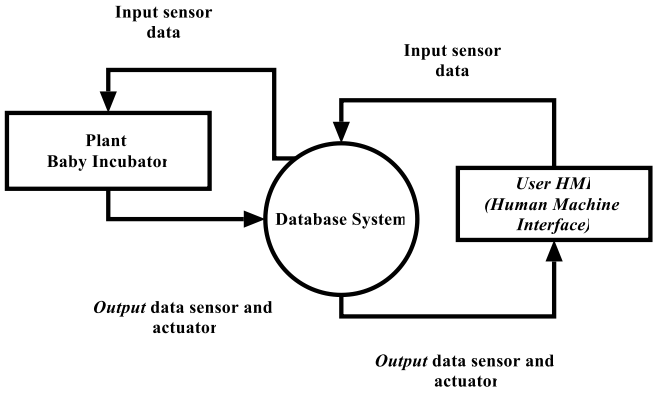

Figure 3: Context Diagram Flow of data in the Database.

This database design uses several tables that have specific functions, namely tables for the process of sending and receiving data, tables for data logging processes, tables for users, and baby data tables. Figure 4. is a draft table that will be used.

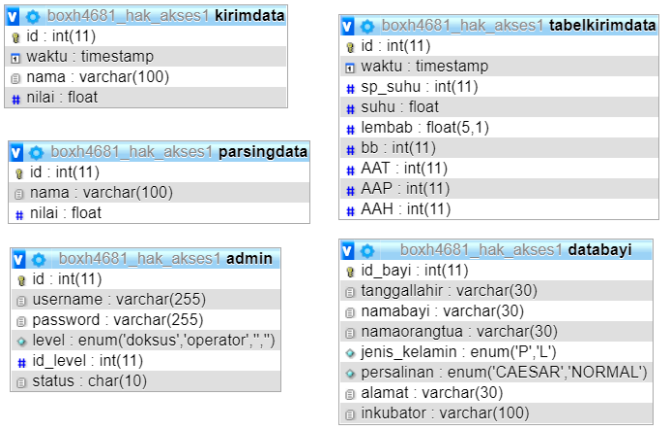

Figure 4: Design Table of Database System

c. Design of Displaying Data HMI

The design of HMI display for both doctor/nurse and operator users has a feature to show monitoring data of the baby incubator's performance in the form of temperature, humidity and weight parameters of babies sent to the database

d. Design of Sending Data Setting Point From HMI

The design of HMI display for user operators has a feature of sending temperature data setting points from HMI to database. Data point settings that have been successfully received by the database will be sent to the ATmega16 microcontroller.

e. Design of Alarm System

The alarm program is designed using the If else logic where it is worth 1 if active and is worth 0 if it is inactive. High temperature alarms are designed if the alarm database to be designed includes alarm / incandescent light, alarm humidifier, and high temperature alarm.

RESULT AND ANALYSIS

In this section we conduct several tests, including testing data updates on the database, parsing data testing, and testing the HMI system.

Testing of Data Updates in Database

Testing updates the data in the table is done by checking the suitability of the data in the database and the data that appears in the table of data acquisition. This test is taken sample test data delivery data offline and online. The results of offline data delivery recap is shown in table 1.

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Table 1: Interval of time sending Data to the Database on Mode Offline

No`	Data	Time intervals
1.	0 to 1	12 seconds
2.	1 to 2	13 seconds
3.	2 to 3	12 seconds
4.	3 to 4	12 seconds
…	…	…
17.	16 to 17	12 seconds
18.	17 to 18	12 seconds
19.	18 to 19	13 seconds
20.	19 to 20	12 seconds
	Mean Delivery time Interval	12.25 seconds

From testing the data offline in Table I, the data obtained has been successful with the average time of sending data to the database in the process of sending data offline is 12.25 seconds.

While the results of online data recap are shown in Table 2.

Table 2: Interval of time sending Data to the Database on Mode Online

No`	Data	Time intervals
1.	0 to 1	11 seconds
2.	1 to 2	12 seconds
3.	2 to 3	11 seconds
4.	3 to 4	11 seconds
5.	4 to 5	16 seconds
6.	5 to 6	12 seconds
…	…	…
18.	17 to 18	11 seconds
19.	18 to 19	12 seconds
20.	19 to 20	11 seconds
21.	20 to 21	11 seconds
Mean Delivery time Interval		11.42 seconds

From testing the data online, the data obtained has been successful with the average time of sending data to the database in the process of sending data online is 11.42 seconds.

Figure 5. and Figure 6. Are graphical displays of HMI data acquisition and graphs of data processing from databases for temperature parameters?

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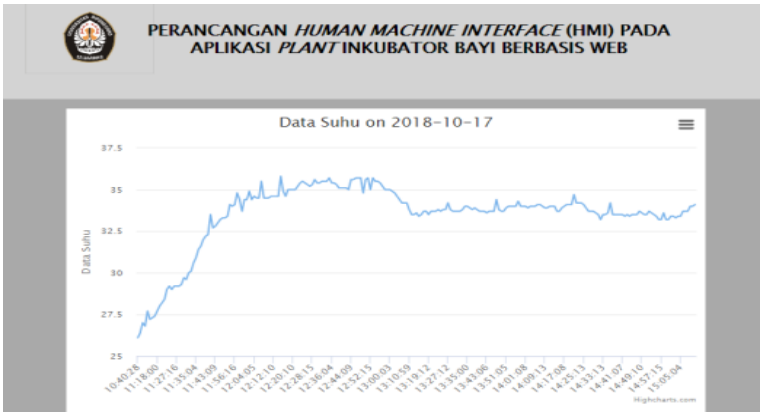

Figure 5: Display Graph Temperature Data Acquisition Parameters

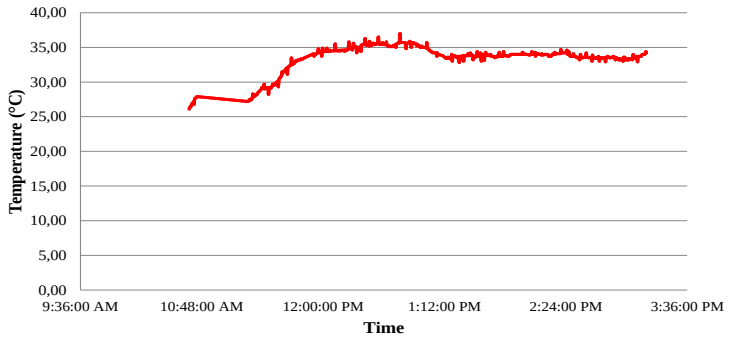

Figure 6: Data Processing Graph of Temperature Parameter

From Figure 5. And Figure 6. There is a match between the HMI data acquisition graph with a graph of the data processing temperature parameters from the database.

Figure 7. And Figure 8. are the graphs of HMI data acquisition charts and data processing charts from the database for humidity parameters.

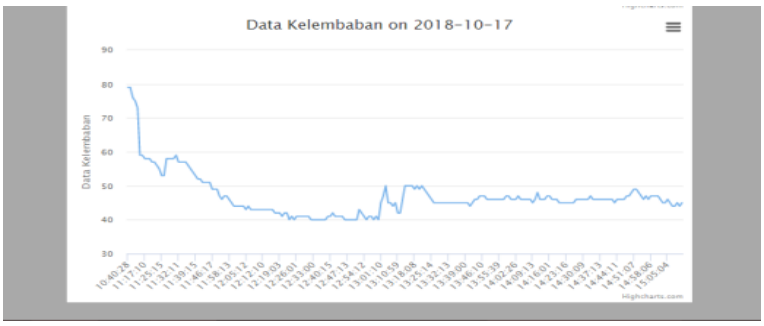

Figure 7: Display Graph Data Acquisition Parameters Of Humidity

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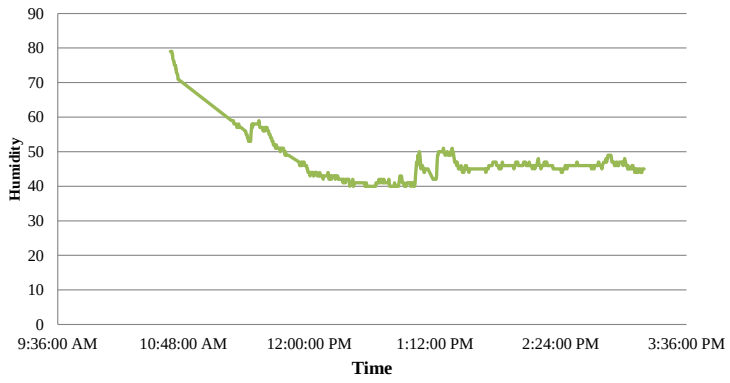

Figure 8: Data Processing Graph of Humidity Parameter.

Figure 7. and Figure 8. Above there is a conformity between the data acquisition graph displayed by HMI with graphs of data processing of moisture parameters from the database. This shows that the process of updating the data entered and displayed in the HMI data acquisition graph has been going well.

Testing of Data Parsing

Data parsing testing consists of testing in online mode and offline mode. Online mode testing is done by sending the value of the temperature setting point to the database which will then be sent to the baby incubator and processed by the ATmega16 microcontroller as the setting point value. In this test, the value of setting temperature is 30 ° C. Figure 9. is data that enters the database during the online mode process. Figure 10. is an LCD display of data that has been successfully transmitted by HMI and received by the microcontroller.

8958	2018-11-27 16:47:56	30	30.2	54.0	6	0	0	1
8957	2018-11-27 16:47:45	30	30.2	54.0	6	0	0	1
8956	2018-11-27 16:47:34	30	30.2	54.0	6	0	0	1

Figure 9: Online Mode Data Testing On Database

Figure 10: LCD Display of Online Mode Data Testing.

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From Figure 9. And Figure 10. Obtained results of conformity data setting point temperature of 30 ° C is transmitted through the HMI display can be accepted by the database and microcontroller ATmega16. In the next process there are still constraints in the process of online mode where in the process the delivery setting point temperature towards the incubator requires a very long time and tend to occur a delivery failure. This happens because the microcontroller failed to get the setting point temperature that was sent from the HMI. The condition also affects internet connection this delivery process.

Offline mode testing is done by sending the value of the setting point temperature towards a database which will be delivered by the incubator babies through the keypad buttons and processed by a microcontroller ATmega16 as the value of the setting point. On testing this sent the value of the setting point temperature of 36 ° c. Figure 11. is the data that is entered into the database when the offline mode process. Figure 12. the LCD display of the data that is sent by the HMI and accepted by the microcontroller.

8798	2018-11-27 16:16:52	36	35.8	44.0	0	0	1	1
8797	2018-11-27 16:16:39	36	35.8	44.0	0	0	1	1
8796	2018-11-27 16:16:27	36	35.8	44.0	0	0	1	1
8795	2018-11-27 16:16:15	36	35.8	44.0	0	0	1	1
8794	2018-11-27 16:16:03	36	35.8	44.0	0	0	1	1

Figure 11: Offline Mode Data Testing On Database

Figure 12: LCD Display of Offline Mode Data Testing

From Figure 11. and Figure 12. Obtained results of conformity data setting point temperature of 36 ° C which is delivered via the keypad keys can be accepted by the database and microcontroller ATmega16. After the data is received, the microcontroller will process data the point setting on the system of incubator babies. From the above testing shows that testing offline mode works.

Testing of HMI System

The HMI System Test consists of testing the log in system and testing the HMI data display monitoring.

a. Testing of Log In System

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Testing the log in system to find out the user's access rights is divided into 3 tests, namely doctor / nurse level testing, operator level testing, and incorrect testing of username and password.

Doctor/nurse level testing is performed with the fill in the appropriate username and password with your username and password belonging to the user doctors/nurses in the design of the form log in. User-level test results the doctor/nurse shown in Figure 13.

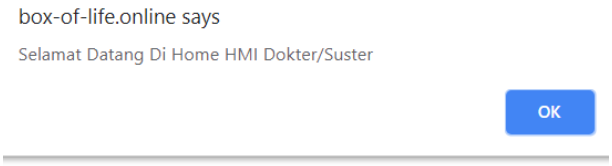

Figure 13: User-level test results of doctor/Nurse

Operator level testing is done by entering a username and password in accordance with the username and password owned by the user operator found in the design of the log in form. The operator level test results are shown in Figure 14.

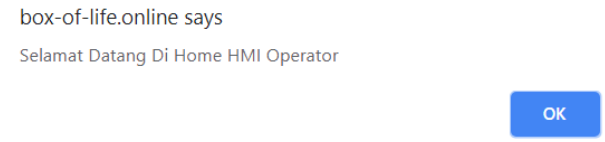

Figure 14: User-level test results of operator

Testing the incorrect username and password is done by entering a username and password that is not registered with the user who has been designed in the user form log in database. The results of testing the incorrect username and password are shown in Figure 15.

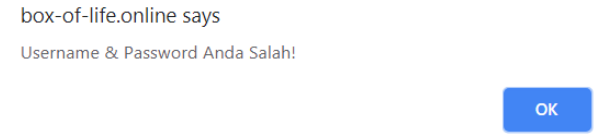

Figure 15: The test results of the incorrect Username and Password

b. Testing of Monitoring Data HMI Displays

Testing of Monitoring Display HMI data consists of testing the display of HMI data acquisition, button testing on HMI display, Testing of Data Acquisition Display in the form of Tables and Graphs and testing of HMI display alarm system.

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Testing the display of HMI data acquisition is done by observing the results of the acquisition of baby temperature, humidity and weight parameters displayed on the main page of the HMI. Figure 16, Figure 17 and Figure 18 respectively show data entered into the database, display data acquisition at the doctor / nurse level and display data acquisition at the operator level.

id ▾ 1	waktu	sp_suhu	suhu	lembab	bb	AAT	AAP	AAH
9674	2018-11-29 14:27:59	30	29.6	62.0	0	0	1	1
9673	2018-11-29 14:27:46	30	29.5	63.0	0	0	1	1
9672	2018-11-29 14:25:38	30	27.3	70.0	0	0	1	1
9671	2018-11-29 14:25:26	30	27.2	69.0	0	0	1	1
9670	2018-11-29 14:25:13	30	27.1	69.0	0	0	1	1
9669	2018-11-29 14:25:01	30	27.2	68.0	0	0	1	1

Figure 16: Data entry into the Database

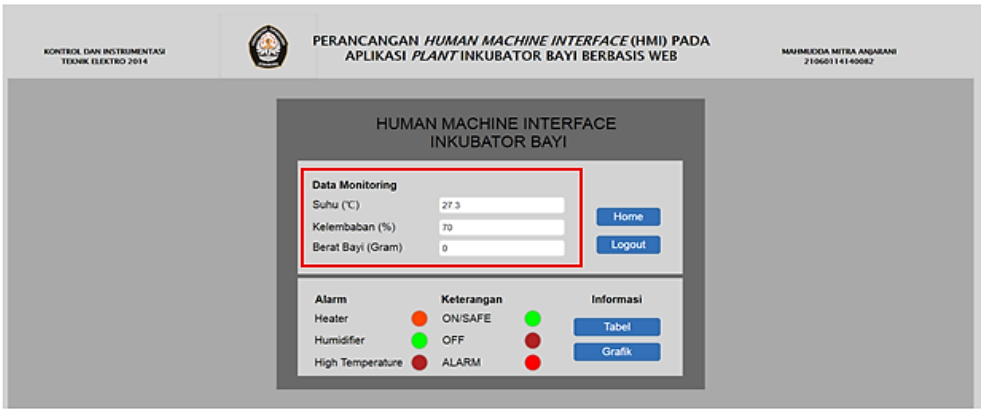

Figure 17: HMI Display by Doctor/Nurse's User

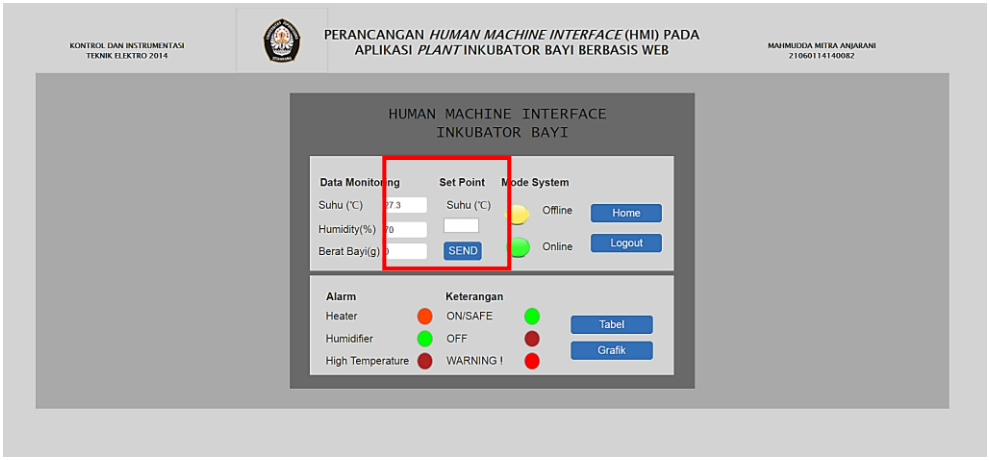

Figure 18: HMI Display by Operator's User

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The test button on the HMI display is done by clicking the button on the HMI display. The actions and results of the tests carried out on each button are explained in Table 3.

Table 3: Button Action Test Result on HMI

No	*Button*	Action	Result
1.	*SEND*	On the display the user Operator: Enter the value of the setting point temperature to the table parsingdata and sends the data to the database and prototype incubator babies.	The SEND button has managed to send the value of the setting point to the database.
2.	*OFFLINE*	On view Change Operator: user mode system settings point to value "0" with the aim of can only make changes to the system settings mode point via button keypad on the prototype incubator babies.	The OFFLINE button has managed to send a value of 0 to the database and baby incubators in an offline mode.
3.	*ONLINE*	On view Change Operator: user mode system settings point being worth "1" with the aim of can only make changes to the mode system settings through the menu point on page monitoring HMI incubator babies.	Button ONLINE has managed to send a value of 1 to the database and baby incubators in an online mode.
4.	*INPUT*	On the display the user operator: redirect the home page the operator data input page toward the baby.	Button INPUT has managed to redirect the home page the operator data input page toward the baby.
5.	TABEL	Doctor/nurse on the user and the operator will transfer towards HMI web pages display table.	Button TABLE has managed to divert towards HMI web pages display table.
6.	GRAFIK	Doctor/nurse on the user and the operator will transfer towards HMI display web page graphics.	Button GRAPHICS has managed to divert towards HMI display web page graphics.
7.	*LOG OUT*	Doctor/nurse on the user and the	The LOG OUT

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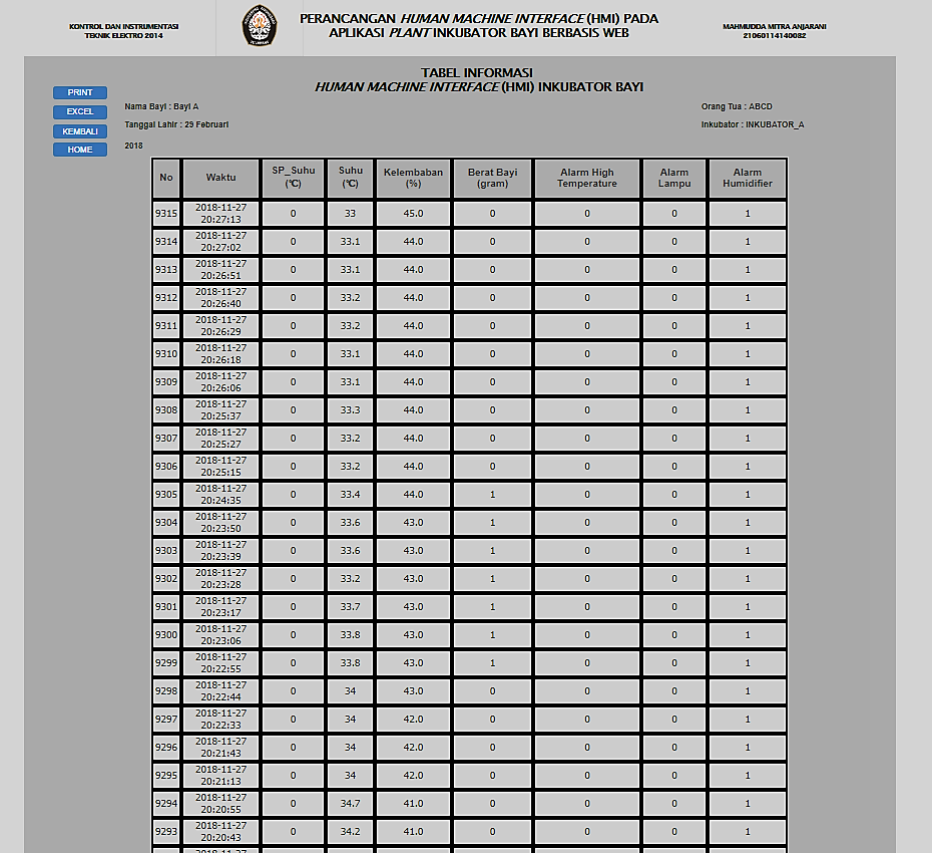
		operator will redirect web page log in page towards HMI HMI incubator babies.	button has managed to divert towards the log in page HMI incubator babies.

Testing the display of data acquisition is performed by taking data – data that is sent to the database by the microcontroller ATmega16 and displayed in the form of tables and graphs. Figure 19. the display shows the data acquisition in the form of tables to level the doctor/nurse or operator level.



No	Waktu	SP_Suhu (°C)	Suhu (°C)	Kelembaban (%)	Berat Bayi (gram)	Alarm High Temperature	Alarm Lampu	Alarm Humidifier
9315	2018-11-27 20:27:13	0	33	45.0	0	0	0	1
9314	2018-11-27 20:27:02	0	33.1	44.0	0	0	0	1
9313	2018-11-27 20:26:51	0	33.1	44.0	0	0	0	1
9312	2018-11-27 20:26:40	0	33.2	44.0	0	0	0	1
9311	2018-11-27 20:26:29	0	33.2	44.0	0	0	0	1
9310	2018-11-27 20:26:18	0	33.1	44.0	0	0	0	1
9309	2018-11-27 20:26:06	0	33.1	44.0	0	0	0	1
9308	2018-11-27 20:25:37	0	33.3	44.0	0	0	0	1
9307	2018-11-27 20:25:27	0	33.2	44.0	0	0	0	1
9306	2018-11-27 20:25:15	0	33.2	44.0	0	0	0	1
9305	2018-11-27 20:24:35	0	33.4	44.0	1	0	0	1
9304	2018-11-27 20:23:50	0	33.6	43.0	1	0	0	1
9303	2018-11-27 20:23:39	0	33.6	43.0	1	0	0	1
9302	2018-11-27 20:23:28	0	33.2	43.0	1	0	0	1
9301	2018-11-27 20:23:17	0	33.7	43.0	1	0	0	1
9300	2018-11-27 20:23:06	0	33.8	43.0	1	0	0	1
9299	2018-11-27 20:22:55	0	33.8	43.0	1	0	0	1
9298	2018-11-27 20:22:44	0	34	43.0	0	0	0	1
9297	2018-11-27 20:22:33	0	34	42.0	0	0	0	1
9296	2018-11-27 20:21:43	0	34	42.0	0	0	0	1
9295	2018-11-27 20:21:13	0	34	42.0	0	0	0	1
9294	2018-11-27 20:20:55	0	34.7	41.0	0	0	0	1
9293	2018-11-27 20:20:43	0	34.2	41.0	0	0	0	1

Figure 19: Display Data in a Table Form

The appearance of data acquisition in graphical form both at the doctor / nurse level and operator level can be shown in Figure 20

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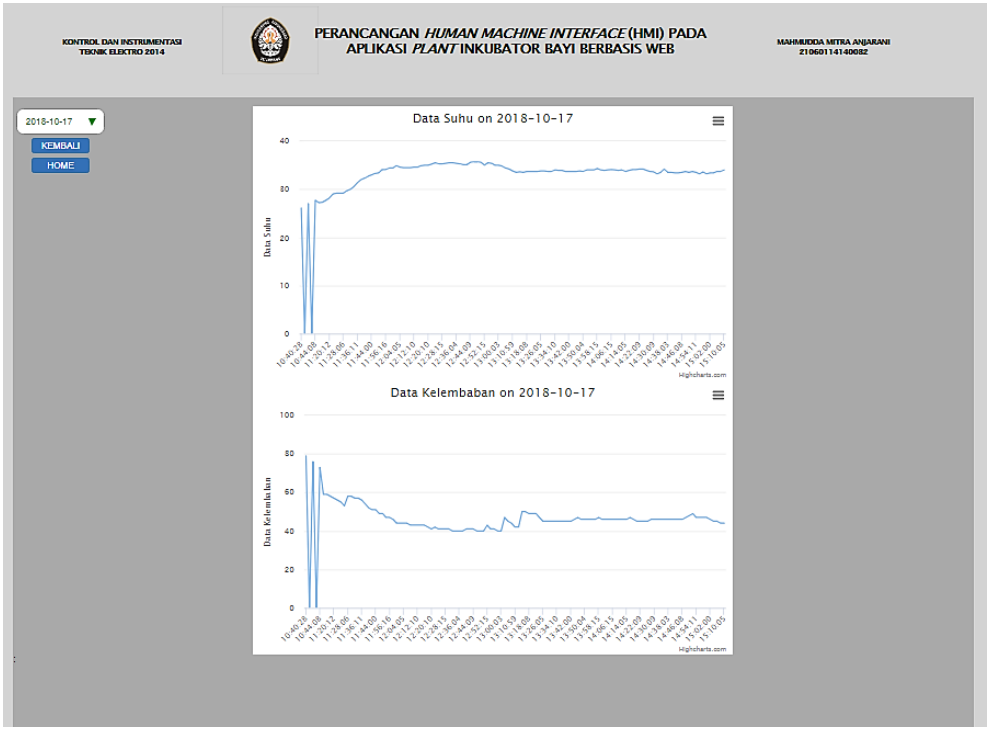

Figure 20: Display The Data In The Form Of A Graph

Testing alarm systems can be divided into 3 parts namely testing alarm heater/incandescent lamp, humidifier, and alarm testing test high temperature alarm. Figure 21. shows the results of testing the alarm heater/incandescent lamp.

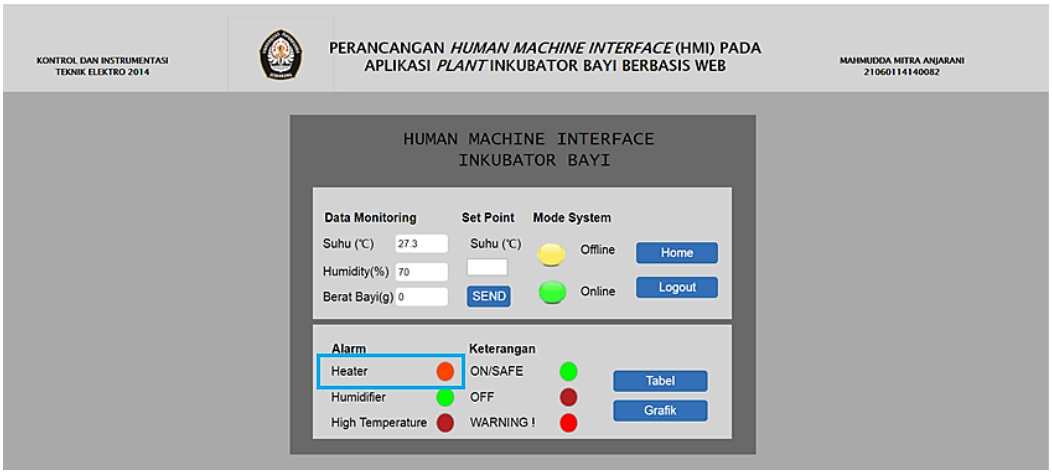

Figure 21: The Results of the Test Alarm Heater on View HMI

Figure 21. The results show that when the orange LED on the active baby incubator and the AAP alarm data received by the database is "1", the heater indicator HMI display shows an orange color.

Figure 22. Shows the results of testing the humidifier alarm.

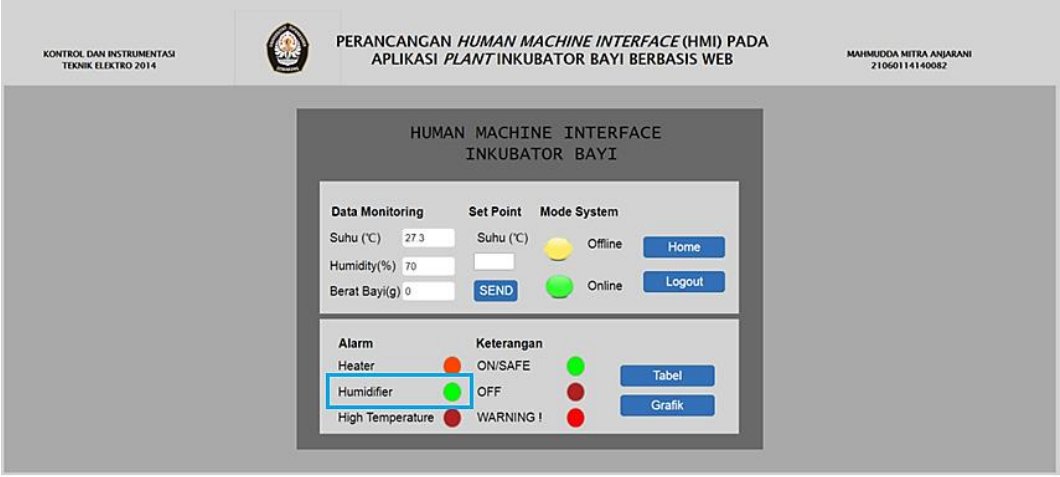

Figure 22: The Test Results Display in The Humidifier Alarm HMI

Figure 22. The results show that when the green LED on the active baby incubator and the AAH alarm data received by the database is worth "1", the HMI indicator of the humidifier indicator shows green.

Figure 23. shows the results of testing high temperature alarms.

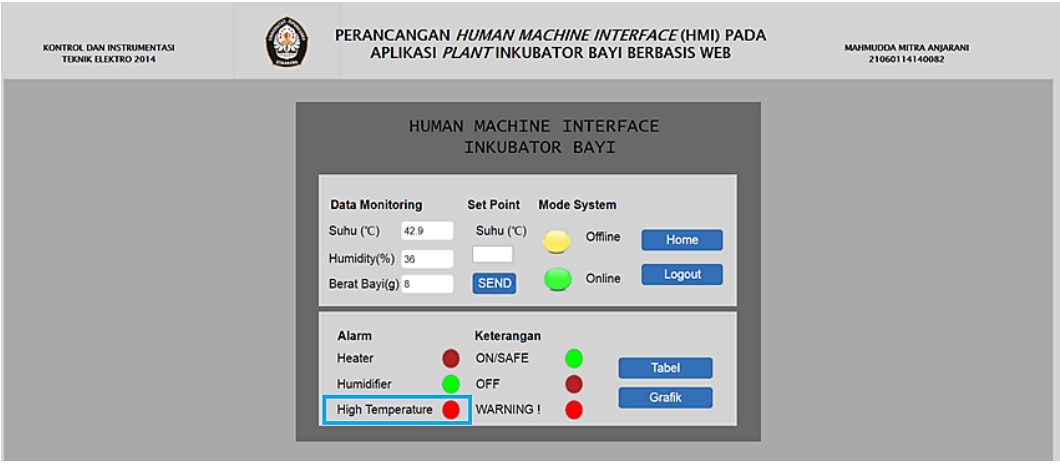

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Figure 23: The Test Results Display In The High Temperature Alarm HMI

Figure 23. The results show that when a bright red LED on the active baby incubator and the AAT alarm data received by the database is worth "1", the HMI display of the high temperature indicator will show red.

OTHER RECOMMENDATIONS

Based on testing and analysis that has been done that the whole system HMI to prototype an incubator baby can run well. The average time for sending data in offline mode is 12.25 seconds. The average time for sending data in online mode is 11.42 seconds. All data acquired on the HMI are in accordance with the data in the baby incubator sent to the database. For the development of further research can be done on real multi HMI monitoring incubator so as to represent the needs of real world medical infant incubator.

References

A. P. L., Michael, “Design a Supervisory Control and Data Acquisition (SCADA) System in Temperature Control on Hot Room Prototype,”, Department of Electrical Engineering, Diponegoro University, Semarang, October 2017.

Kumar, Pallerla Akshay; Akshay, Naregalkar; Kumar, Thati Anush; Sama , Anusha; and Jagannath, Badrinath, “Real Time Monitoring And Control Of Neonatal Incubator Using Lab VIEW”, International Journal Of Application or Innovation In Engineering & Management, volume 2, issue 4, April 2013.

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