DESIGN OF LEARNING AIDS ON MUSICAL INSTRUMENTS TRADITIONAL TALEMPONG BASED ON THE ON INTERNET OF THING

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***Abstract*— Minangkabau West Sumatra has one of the traditional musical instruments called Talempong. This instrument has a gong-like shape that has a tone in each gong. Talempong itself is very much found in every area of West Sumatra. Talempong is one of the cultural heritage of Minangkabau people obtained from their ancestors through generations who have a type of instrumental music. In learning talempong music is not easy, because in each gong has a different tone so that one must be able to memorize and understand the tone on each gong. In learning this instrument takes a long time. In this era of technology is growing rapidly, one of the technologies that is developing today is IoT (Internet of Things). By using IoT makes a job easier, one of them can be used in the learning process of talempong musical instruments. In this Final Task research, we created a tool that can facilitate the learning process of Talempong instruments, so that it does not take long to learn it using IoT technology. The system used is to use the website as a controller for song selection and phases, there are 10 songs and 3 phases in it. The phase consists of phase 1 as checking IoT tools and Talempong instruments whether it is appropriate, phase 2 as the phase used to perform the learning process and phase 3 as a challenge for users. The results of this study obtained that 100% of websites and tools are in accordance with the expected and have an average system time for phase 2 2.5652s and phase 3 2.7992s.**

Keywords—Internet of Things, Talempong, Arduino

I. INTRODUCTION

Minangkabau West Sumatera has one of the traditional musical instruments named Talempong. This musical instrument has a shape like a *gong* that has a tone in each *gong*. The Talempong itself is very much encountered in every area of West Sumatera. Talempong is the one of cultural heritage of the Minangkabau people obtained of their ancestors from generation to generation that has a type of isntrumental music.

Talempong is the main choice in enlivening various ritual, ceremonial and religious contexts entertainment by the Minangkabau people. Usually Talempong music is used by some people in rural areas, for urban comunities, The Talempong tradition is admittedly not included in the choice of music and entertainment appeal in general, especially on a larger scale.

In the process of learning Talempong musical instrument, they still use the guidance by a teacher who practices directly in front of the students and then students it follows it. The process takes a long time so that student can master the tone of each *gong*.

In this era technology is developing rapidly, one of the technologies that currently developing is IoT (Internet of Things). By using IoT to create a work is getting easier, one of which can be used in the process of learning musical instruments Talempong.

This final project is made to implement and apply how the system IoT makes it easy to learn and play Talempong musical instruments, which this system will be more effective than the guidance system.

The system will work using a vibration sensor and also an *LED* as an aid to make it easier to direct the tone to be hit and use the microcontroller as a controller the brain of this system.

I. BASIC THEORY

A. Internet of Things (IoT)

The Internet of Things (IoT) in its application can identify finding tracking, monitor and trigger related event objects automatically or in real time. Internet of Things (IoT) is a scientific development that promises to optimize life based on intelligent sensors and smart devices that worktogether over the internet. [1]

B. Internet of Musical Things

According to the Turchet Internet of Musical Things (IoMusT) definition from a computer science perspective. The vision of the internet of musical things refers to the assimilation of protocol interfaces and representations that associated with music for information that enables services and and applications to serve the purpose of music is based on the interaction between humans and musical objectsalone.

The Internet of Musical Things (IoMuT) is a new research field positioned in the intersection of the Internet of Things (IoT), a new interface for musical expression, music everywhere,human-computer computer, artificial intelligence, and participatory arts. From computer science, IoMusT refers to a network of computing devices embedded in physical objects (musical objects) that dedicated to the production and reception of musical content. IoMusT presents a vision where IoMusT enables connection of digital and physical domains by means of information technology and appropriate communication as well as developing new music applications and services. Associated Ecosystem with IoMusT includes interoperable devices and services connecting musicians and musical instruments. [2]

C. Mikrocontroller

Microcontroller is a digital electronic device that has input and output controlled by a program that can be written and erased in a special way, how it works microcontroller is reading and writing a data [3].

D. Talempong

Talempong has long been known in Minangkabau, not even a few circlesidentify Talempong with everything that has Minangkabau nuances [4]. Generally people know what is meant by talempong is a kind of musical instrument that is beaten in the form of a small gong made of copper, brass and tin . [5]

E. Arduino Mega 2560 Pro

The Mega Pro Embed CH340G / ATmega2560 board is based on a microcontroller ATmega2560 and USB-UART adapter CH340, and compatible with Arduino Mega 2560. Arduino Mega 2560 Pro has a mini size of 38X55mm. Arduino Mega 2560 Pro has 70 pins digital input/output, where 14 pins can be used as PWM outputs, 16 pins as input analog, and 4 pins as UART (Serial Hardware Port), 16 MHz crystal oscillator, and has micro USB connection that allows to connect the microcontroller to a computer via USB-UART adapter CH340 (Driver installation may be required). [6]

F. ESP32 Wi-fi

ESP 32 is a microcontroller introduced by Espressif System which is the successor of ESP8266 microcontroller. In this microcontroller, there is already a Wi-Fi module in the chip so that very supportive to create an Internet of Thing application system. The ESP 32 has multiple pins out which serves as input and output. [7]

G. Vibration Sensor

Is one of the sensors that can measure the vibration of an object which later data will be processed for experimental purposes or used to anticipate another possibility. This vibration sensor module will produce a HIGH logic output on the when detecting vibration/vibration. [8] In this tool, the vibration sensor functions to detect the vibration of each gong when struck. Data from the sensor is sent electronically vianetwork to be read by the microcontroller and further processed.

II. Discussion

A. General Overview of The System

Figure 1 describes the groove of a smart lamp that uses an IoT system inside. First the smart lamp will be retrieved data based on user behavior, then the data will be sent to Antares for storage. An overview of the Talempong musical instrument system using the IoT system inside it. First, the user will select the song and phase by using the website as the user interface, after that the website will send data to the database. ESP32 will request data via API with GET command. If the condition is 0 then ESP32 Wi-Fi will send data to Arduino Mega 2560 Pro according to existing conditions. Arduino Mega The 2560 Pro will update the 0/check sound state to the state sent by the ESP32 Wi FI.

After the song is finished, the condition will return to 0/check sound. This system is made using a vibration sensor and also red and green LEDs which will then be installed on each Talempong gong. This system is designed using Arduino Mega 2560 Pro as the brain of the system/microcontroller that will regulate and operate the sensors in accordance with their respective duties. In the microcontroller itself there is data from the music that will be displayed studied.

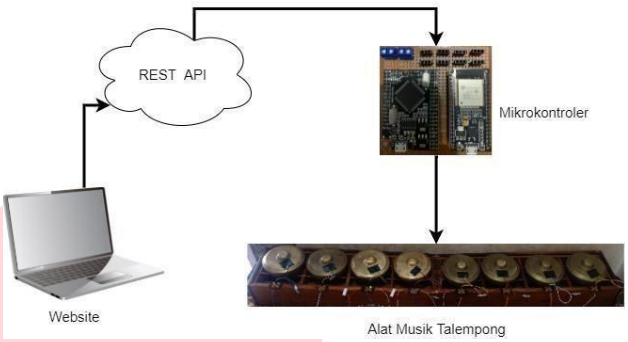

Fig. 3. General Overview of The System

Figure 3.1 is an overview of the system to be created, divided into several processes, including:

1. Website is a device used to select songs and phases that musical instrument users want to use.

2. REST API is a place to store databases and other resources that are used to connect the microcontroller with the website.

3. The microcontroller is the brain of the system made using Arduino Mega 2560 Pro and ESP32 Wi-Fi.

Talempong is a musical instrument used for learning in this system. In this tool there are three levels of phases, namely, phase 1, phase 2 and phase 3. Each phase has its own way of working.

1. Phase 1 is that the user of the musical instrument will check whether the instrument and Talempong are functioning properly by hitting each gong. After that, the green LED installed on each gong will light up according to what was hit to be able to play the song that has been provided.

2. Phase 2 works to guide the user of the musical instrument by following the green LED light according to the selected song chord until the song is finished. However, when the user makes a mistake on the beat, the red LED will light up and the green LED will again guide the beat according to the existing chord and so on.

3. While phase 3 will allow users of musical instruments to play the instrument but only assisted by a green LED light that lights up at the beginning to show the chords of the Talempong song being played from the beginning of the song to completion in a fast time, after all the chords are shown then the user of the instrument will immediately play Talempong without the help of an LED and when the user makes a tap error, the red LED light will light up and notify that the user made a mistake on the beat.

In phase 3, the system will test how smoothly the user plays the Talempong musical instrument and when the user is fluent until the song is finished, all green LED lights will light up to notify that the song is complete and correct.

B. *General Overview of The Device*

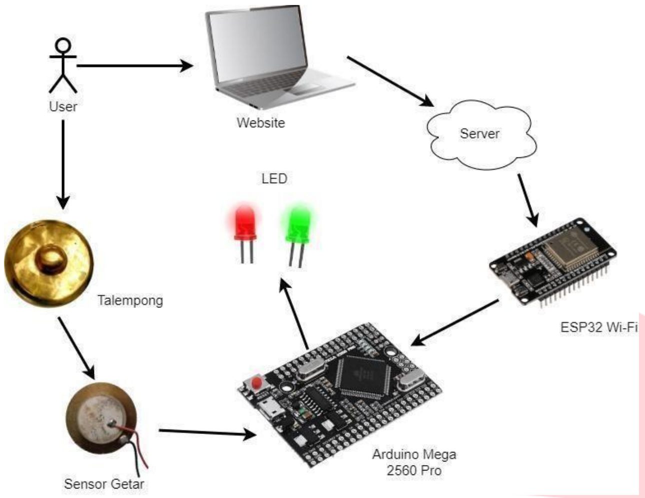

Fig. 2. General Overview of The Device

In Figure 3.2 an overview of the device describes the design of the tool to be built, using the Arduino Mega 2560 Pro microcontroller which is connected to the ESP32 Wi-Fi module to make an internet connection so that it can be controlled with the Website. Each Talempong gong will be installed with a vibration sensor to detect the gong and also an LED. These LEDs It has two colors, namely, green and red. The green LED has a function to direct chords for guidance in learning Talempong music, while the red LED serves as a marker if there is a wrong hit when playing a Talempong musical instrument. Arduino Mega 2560 Pro will be connected in this system as a microcontroller that will send and receive data. The music data that will be studied will be stored directly into the Arduino Mega 2560 Pro as a data set. To perform phase selection and also song selection, the website is used as the interface and is connected directly to the Arduino Mega 256 Pro.

C. *Hardware Design*

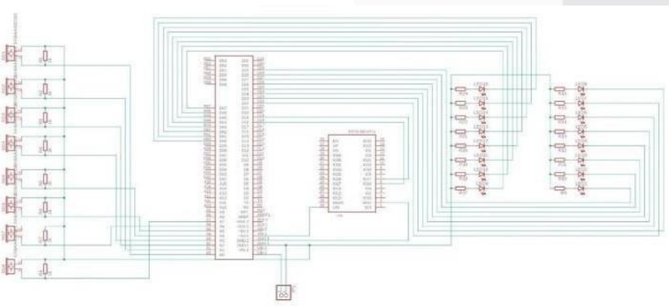

Fig. 3. Systematics of Hardware Design

There are 8 green LEDs and 8 red LEDs as outputs, 8 piezoelectric units as vibration sensors, 1 ESP module as communication between the website and the microcontroller. The negative pole on the red LED has a resistor value of 330 Ohms which is connected to the digital pin of the microcontroller and the positive pole is connected to ground. The negative pole on the green LED has a resistor value of 220 Ohm which is connected to the digital pin of the microcontroller and the positive pole is connected to ground. In the piezoelectric section there is a 1M Ohm resistor connected in parallel which serves to reduce the sensitivity of the vibrations received by the piezoelectric.

D. *Software Design*

System there is a flow chart, namely the program flow chart on the microcontroller and the programming flow chart for processing data from the microcontroller into the website and vice versa. The program contained in the microcontroller functions to process data sets that are already available and read command data from websites that are sent to the microcontroller.

In programming the microcontroller there are two systems, namely to process the data sets that are already available and receive orders from the website which will process the selection of songs and the phase that users want to play musical instruments.

While programming on the website is used to send system commands that you want to use and display song data along with the phases of the IoT-based Talempong traditional musical instrument learning program.

In this system there are 3 phases as the level of learning the Talempong musical instrument. Phase 1 is useful for checking musical instruments and Talempong. On the Talempong musical instrument, a vibration sensor and LED will be installed on each gong, the green LED will light up to direct the user to determine which stroke to hit. The LED will work based on the data set from the microcontroller which receives data from the vibration sensor. Then the vibration sensor will send data to the microcontroller and the microcontroller will continue with the next LED light according to the gong in the data set. This process will be repeated continuously until the user feels the tool is functioning properly.

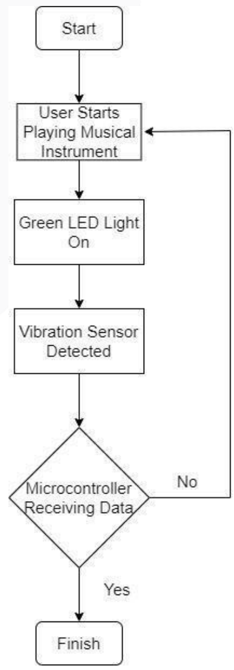

Fig. 4. Flowchart on Phase 1

In Figure 5 this will explain the system in phase 2. In phase 2, the microcontroller already has a data set for the chord song to be played. The green LED will light up and direct the beat to be hit according to the selected song from the beginning of the song to the end of the song. In this phase 2, if there is one wrong tap, the red LED will light up to notify that the user has hit the wrong tap, while the green LED will light up to direct the correct beat. Phase 2 also has additional features, namely, if the user forgets or there is a pause when hitting Talempong within 15 seconds, the LED will light up automatically, this system will continue until the song ends.

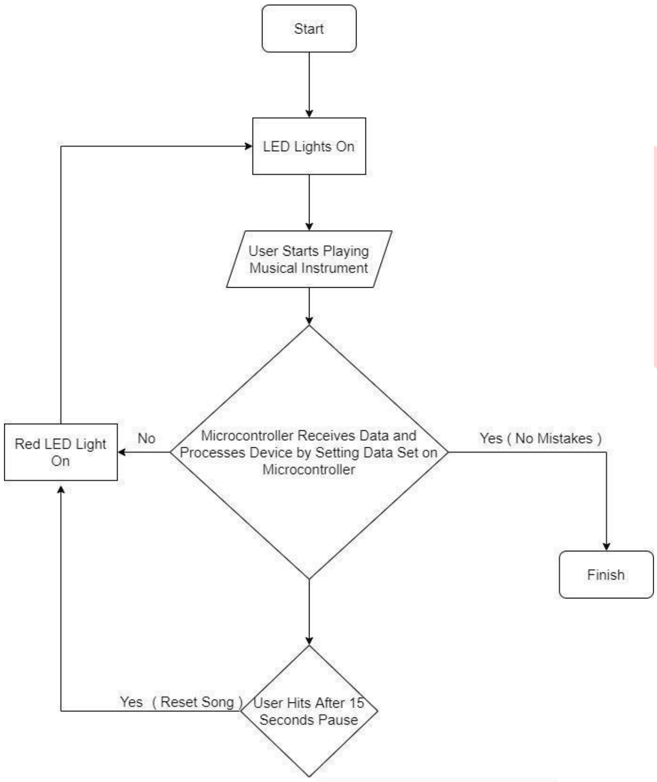

Fig. 5. Flowchart on phase 2

Figure6 describes the phase 3 system. In phase 3, musical instrument users will get a challenge from the system, users will play Talempong musical instruments only with directions from the green LED light from the beginning of the song to the end of the song at the beginning when they have chosen what song to play. In phase 3, it will assess the user's skill in learning the Talempong musical instrument that has been learned in phase 1 and phase 2. If the user is wrong in determining the beat, all red LEDs will light up as a notification that there is a wrong beat. After the red LED lights up, all systems will automatically reset to the beginning when the user will select a song.

In phase 3 also has an additional feature, namely, if the user forgets or there is a pause when hitting Talempong within 20 seconds, the LED will light up automatically and the system will reset. This system will continue until the song ends. When the song ends, all the green LEDs will flash simultaneously to notify that the song is finished and performed correctly.

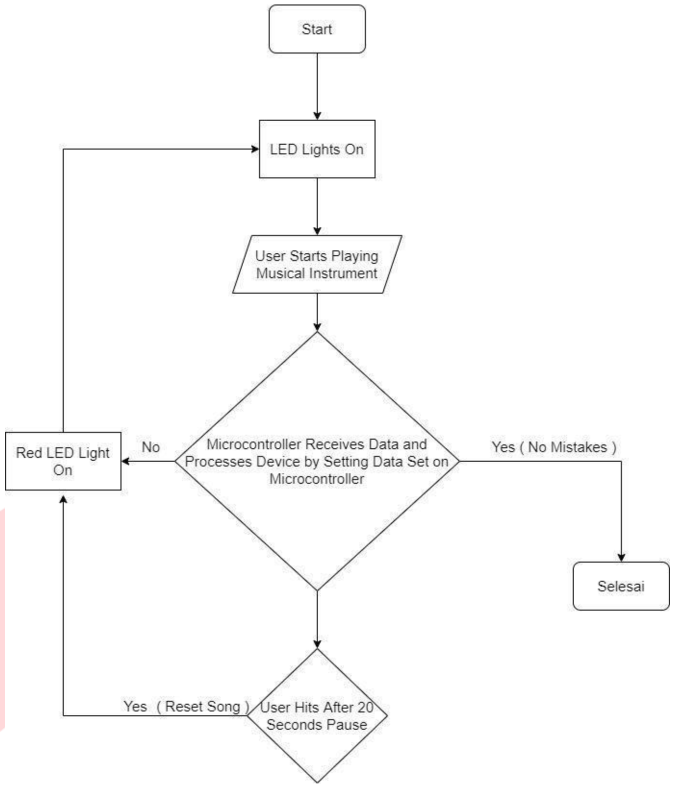

Fig. 6. Flowchart on phase 3

III. IMPLEMENTATION AND TESTING

A. Implementation of Interface Design

The implementation of the website interface for song selection and phase selection includes the website's home page, the song selection table with phase 2 and the song selection table with phase 3. The following is the website interface display.

1. Website Homepage

The start page of the website is a page that shows a glimpse of Talempong. This page displays several images that can be seen by users to become a visual representation of Talempong.

Fig. 7. Website Main Page

2. Song Selection Table With Phase 2

This page is a page where we want to choose a song to play with phase 2. This page shows several song titles to choose from, including Ibu Kita Kartini, Mudiak Arau, Balonku, Bagimu Negeri, Burung Kakak Tua and Abang Bakso On this page after the user After selecting a song, the command will go directly to the microcontroller and Talempong is ready to be played according to the selected phase. In this phase, the user will be given a guide on what Talempong chords to tap to adjust the song selection to completion.

Fig. 8. Song Selection Table with Phase 2

3. Song Selection Table With Phase 3

This page is the page where we want to choose a song to play with phase 3. This page displays several song titles to choose from, including *Ibu Kita Kartini*, *Mudiak Arau*, *Balonku*, *Bagimu Negeri*, *Burung Kakak Tua* and *Abang Tukang Bakso*. On this page, after the user has selected a song, the command will go directly to the microcontroller and Talempong is ready to be played according to the selected phase. In this phase the user will be challenged to be able to finish the song without the help of the LED lights as a song guide.

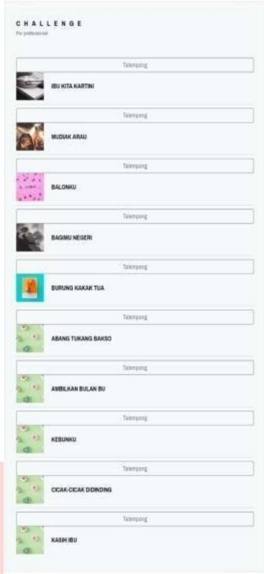

Fig. 9. Song Selection Table with Phase 3

B. *Alpha Testing*

Alpha testing is a type of testing carried out to identify all possible problems, errors or deficiencies in the application and bugs before a software application is released to users. The tests carried out are said to be successful if the results of those made are appropriate or meet the performance of the design objectives. This test starts from the process of starting the application, namely starting the application, the process of controlling the outside and inside lights and displaying the latest status of each lamp.

Based on the results of the alpha testing that has been carried out, it can be concluded that the process still allows errors to occur, but the functionality of the system has been able to produce the expected output or has run 100% as expected.

C. *Beta Testing*

Beta testing is the second stage of software testing where users try out the device. The purpose of beta testing is to put the application in the hands of real users where to find out how far the quality of the application is built. In addition, to get feedback from these users with satisfaction in using the application. This test is also often referred to as a field test by filling out a questionnaire to the user.

D. *System Time Analysis*

Research Objectives: To see how long it takes the system to transmit data and control data, receive data and control data, Cloud Antares and Android Stuido application for system realization. Data collection was carried out 30 times to get a more accurate value

Testing Tools:

1. Arduino-IDE
2. WeMos D1 Mini
3. Android Studio Application Testing Steps:

• Trying to measure time using a stopwatch from the start, Android sends a command to Antares then it is received by Antares cloud and after that it is read by WeMos D1 Mini to run the command.

E. System Time In Phase 2

Table 1 System Time In Phase 2

Sending Data to-	Total System Time from Website to Device For Phase 2 (second)	Song Selection	Condition
1	1.24	1	Succeed
2	2.62	1	Succeed
3	2.28	1	Succeed
4	3.32	1	Succeed
5	2.79	1	Succeed
6	4.25	1	Succeed
7	1.94	1	Bug's found
8	3.60	1	Succeed
9	2.06	1	Succeed
10	2.66	1	Bug's found
11	2.41	2	Succeed
12	1.07	2	Succeed
13	3.38	2	Bug's found
14	3.69	2	Bug's found
15	3.00	2	Succeed
16	2.97	2	Succeed
17	3.91	2	Succeed
18	1.50	2	Succeed
19	1.20	2	Succeed
20	2.89	2	Succeed
21	2.88	3	Succeed
22	2.46	3	Succeed
23	1.10	3	Succeed
24	1.04	3	Succeed
25	2.17	3	Succeed
26	3.25	3	Succeed
27	3.09	3	Succeed
28	2.35	3	Succeed
29	3.09	3	Succeed
30	3.65	3	Succeed
31	2.07	4	Succeed
32	3.57	4	Succeed
33	3.30	4	Succeed
34	3.03	4	Succeed
35	2.35	4	Succeed

Sending Data to-	Total System Time from Website to Device For Phase 2 (second)	Song Selection	Condition
36	1.46	4	Succeed
37	2.59	4	Succeed
38	2.82	4	Succeed
39	1.34	4	Succeed
40	1.20	4	Succeed
41	1.54	5	Succeed
42	1.50	5	Succeed
43	3.82	5	Succeed
44	1.78	5	Succeed
45	1.35	5	Succeed
46	3.39	5	Succeed
47	3.12	5	Succeed
48	2.87	5	Succeed
49	2.62	5	Succeed
50	3.62	5	Succeed
51	2.62	6	Succeed
52	1.62	6	Succeed
53	2.47	6	Bug's found
54	2.69	6	Succeed
55	2.34	6	Succeed
56	1.96	6	Succeed
57	3.04	6	Succeed
58	4.93	6	AdaBug
59	1.94	6	Succeed
60	2.79	6	Succeed
61	1.22	7	Succeed
62	4.50	7	Succeed
63	2.45	7	Succeed
64	4.10	7	Succeed
65	3.05	7	Succeed
66	1.36	7	Succeed
67	1.62	7	Succeed
68	2.40	7	Succeed
69	3.03	7	Succeed
70	2.98	7	Succeed
71	1.45	8	Succeed
72	1.49	8	Succeed

Sending Data to-	Total System Time from Website to Device For Phase 2 (second)	Song Selection	Condition
73	1.16	8	Succeed
74	3.82	8	Succeed
75	3.60	8	Succeed
76	3.66	8	Bug's found
77	2.99	8	Succeed
78	3.23	8	Succeed
79	2.28	8	Succeed
80	3.23	8	Succeed
81	1.18	9	Succeed
82	3.79	9	Succeed
83	2.82	9	Succeed
84	1.24	9	Succeed
85	1.70	9	Succeed
86	3.08	9	Succeed
87	1.44	9	Succeed
88	2.68	9	Succeed
89	2.16	9	Succeed
90	2.24	9	Succeed
91	2.43	10	Succeed
92	1.78	10	Succeed
93	3.14	10	Succeed
94	2.36	10	Succeed
95	2.42	10	Succeed
96	2.88	10	Succeed
97	2.95	10	Succeed
98	2.81	10	Bug's found
99	2.42	10	Succeed
100	3.78	10	Succeed
Rata-rata	2.5652		

Table 1 shows the results of the time obtained from sending data from the website to the server and from the server to the Arduino Mega 2560 in time unit(s) with an average time required of 2,5652s. In phase 2, there are Succeed and bug's found conditions, and bugs occur because the sensitivity of the vibration sensor affects and is very sensitive.

F. System Time In Phase 3

Table 2 System Time In Phase 3

Sending Data to-	Total System Time from Website to Device For Phase 3 (second)	Song Selection	Condition
1	3.94	1	Succeed
2	3.31	1	Succeed
3	3.93	1	Succeed
4	4.00	1	Succeed
5	1.79	1	Succeed
6	3.26	1	Succeed
7	3.41	1	Succeed
8	1.84	1	Succeed
9	3.59	1	Succeed
10	3.84	1	Succeed
11	2.29	2	Succeed
12	2.85	2	Succeed
13	1.61	2	Succeed
14	3.59	2	Succeed
15	4.77	2	Bug's found
16	2.63	2	Succeed
17	3.62	2	Succeed
18	2.22	2	Succeed
19	3.68	2	Succeed
20	2.25	2	Succeed
21	2.35	3	Succeed
22	2.70	3	Succeed
23	3.95	3	Succeed
24	3.50	3	Succeed
25	2.53	3	Bug's found
26	3.04	3	Succeed
27	3.24	3	Succeed
28	2.84	3	Succeed
29	3.06	3	Succeed
30	2.68	3	Succeed
31	4.22	4	Succeed
32	2.28	4	Succeed
33	1.65	4	Succeed
34	1.81	4	Succeed
35	2.95	4	Succeed
36	2.66	4	Succeed

Sending Data to-	Total System Time from Website to Device For Phase 3 (second)	Song Selection	Condition
37	1.44	4	Succeed
38	4.13	4	Succeed
39	3.00	4	Bug's found
40	1.31	4	Succeed
41	3.74	5	Succeed
42	2.78	5	Succeed
43	3.60	5	Succeed
44	2.21	5	Succeed
45	3.76	5	Succeed
46	3.13	5	Succeed
47	1.94	5	Succeed
48	2.15	5	Succeed
49	2.20	5	Succeed
50	3.13	5	Succeed
51	3.31	6	Succeed
52	2.70	6	Succeed
53	3.31	6	Succeed
54	1.69	6	Succeed
55	1.47	6	Succeed
56	1.45	6	Succeed
57	1.46	6	Bug's found
58	3.95	6	Bug's found
59	4.22	6	Succeed
60	1.20	6	Succeed
61	3.33	7	Succeed
62	3.34	7	Succeed
63	2.93	7	Succeed
64	2.74	7	Succeed
65	3.99	7	Succeed
66	3.00	7	Succeed
67	3.78	7	Succeed
68	1.97	7	Succeed
69	3.85	7	Succeed
70	3.26	7	Succeed
71	4.33	8	Succeed
72	1.37	8	Succeed
73	2.74	8	Succeed
74	3.07	8	Succeed
75	3.65	8	Succeed
76	1.90	8	Succeed
77	3.66	8	Succeed
78	1.44	8	Succeed

Sending Data to-	Total System Time from Website to Device For Phase 3 (second)	Song Selection	Condition
79	1.96	8	Succeed
80	1.31	8	Succeed
81	1.45	9	Succeed
82	3.52	9	Succeed
83	2.75	9	Succeed
84	1.71	9	Succeed
85	2.12	9	Succeed
86	1.77	9	Succeed
87	2.16	9	Succeed
88	2.03	9	Succeed
89	2.43	9	Succeed
90	2.88	9	Succeed
91	1.27	10	Succeed
92	3.59	10	Succeed
93	2.61	10	Succeed
94	3.07	10	Succeed
95	2.02	10	Bug's found
96	2.94	10	Succeed
97	3.00	10	Succeed
98	3.75	10	Succeed
99	2.74	10	Succeed
100	3.33	10	Succeed
Rata-rata	2.7992s		

Table 2 shows the time results obtained from sending data from the website to the server and from the server to the Arduino Mega 2560 Pro in unit time(s) with an average time required of 2.7992s. In phase 3, there is a Succeed condition, and a bug's found, a bug occurs because the sensitivity of the vibration sensor affects and is very sensitive.

G. Total System Time

Table 3 Total System Time

System Mode	Total System Time From Website to Arduino Mega 2560 Pro (*second)*
	Talempong
Fase 2	2.5652
Fase 3	2.7992

Table 4.3 shows the total time results obtained from sending website control data using phases 2 and 3 to the server and then from the server to the Arduino Mega 2560 Pro in unit time(s) with the total time required for each load is different.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusions

Based on the results of this final project, several conclusions can be drawn including:

1. Based on the results of alpha testing that has been done, it can be concluded that the functionality of the system works very well and 100% produces output as expected. Based on the test results that have been done can be concluded that the system functionality works very well and 100% produces output as expected and the system is easy to understand.
2. Total System Control Time
   • Full System Remote Control takes 1.24s.
   • Room Habit Control System takes 1.56s.
3. Based on the results of beta testing that has been done that there are no invalid questions and the system is 100% easy to understand.

B. Suggestions

Based on the results of this final project, the authors suggest for further research, namely:

The tool can be developed by adding a motion detector to detect people more accurately and face recognition to find out who the user is using the room habits of personal users.

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