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Design of home automation base on internet

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Abstract - *Technological advancement are now triggering the human mindset to be able to create innovations to facilitate work for better performance. At this time the Internet of Things (IoT) system has been developed which makes it easier for humans to access electronic devices through the internet. When traveling, sometimes someone forgets to turn off the lights or close the gate. Therefore, in this research created a NodeMCU-based home automation design which can control lights and determine the status of the light and a gate controlled by DC Motor through a web server. The web server uses the hosting site and uses the PHP web programming language and uses WiFi internet network as an internet connection on NodeMCU. Testing is done by pressing the light and gate button, afterwards examine the status and sensor value, as well as measuring the time response speed of the light switch and gate.*

Key Words: Internet of Things, home automation, web server, NodeMCU

1. INTRODUCTION

Technological advances are now making people's mindsets to be able to produce innovations to make works for better performance. For example, to turn on and off the lights in the house, residents of the house must walk to the light switch. When traveling, residents of the house cannot check the state of the lights and the gate at home. Without a doubt, humans today can be said to be very close to smartphones that are facilitated everywhere.

The problem is that we cannot turn on and turn off the lamp and open and close the fence without our involvement and we don't know whether the lamp has been turned on, turned off, or it has been damaged also whether the gate is open or closed if we went outside.

Many studies have developed the Internet of Things (IoT) technology that controls home appliances or can be called home automation. Some of those are research the control of lamp through the internet using an Android-based Arduino Uno microcontroller. In this study the lamp is controlled by Arduino Uno which has been installed ESP8266 WiFi module with a web server and IoT platform [1]. Another research discussed the implementation of the Wifi NodeMCU ESP8266 module to monitoring vehicle ventilation system. The system activated by mobile application and controlled using on/off [2].

This paper proposed to make a prototype of devices to turn on and turn off the lights, to open and close the gate driven by a DC motor, and to know the status on lights and gate. All this function controlled through a web page.

2. METHODOLOGY

2.1 Hardware Design

The design of hardware is divided into controlling the lamp and the gate. The lamp control system requires an internet connection to connect communication between the microcontroller and the web server through NodeMCU, with the relay as the on/off controller. The gate using a DC motor to operate and controlled by the NodeMCU through commands given from the web server. The hardware design block diagram can be seen in Fig -1.

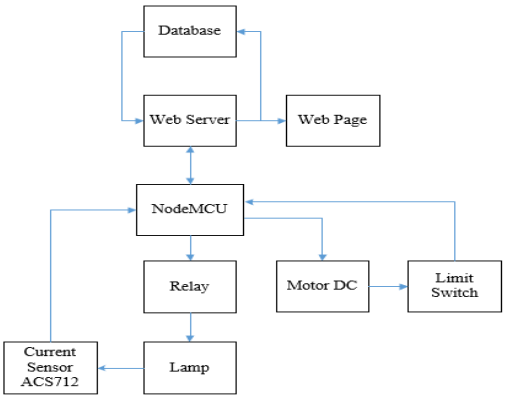

Fig -1: Block diagram of hardware design

The explanations of the hardware design block diagram are:

1. Web server, as an API that connects communication between databases and web page [3].

2. Database, as a storage for login data, current sensor value, and the conditions for relay and limit switches. The current sensor value taken by the NodeMCU is sent to the database which will then be displayed on the web page.

3. A web page, as an interface that displays function button such as "Turn On" and "Turn Off" on the lamp section as well as "Open" and "Close" on gate section. It can also display status of the lamp and motorbike fence. The function buttons need PHP scripting so that it can be connected to the database, so the function of turning on and off the lamp can run. To display the current sensor

status on the web display there is a table that displays the value of the current sensor taken from the database in accordance with the specified value limit.

4. NodeMCU used as controlling the entire system as a microcontroller and internet communication system [4].

5. Relay is an output that is used as a switch to open and close the circuit of the lamp which is controlled by a web server [5].

6. Lamp is the output on this system, because there is a current sensor that reads currents value through the lamp, the status of the lamp can be known, either on, off, or there are errors.

7. Current sensor ACS712, is an input sensor used to read electrical currents flow through the lamp which can be sent to the web page so the value of the currents and state of the lamp can be known [6].

8. DC motor is an output used as a rotating the gate to open and close. The DC motor rotation is controlled by the L298N driver and to stop the rotation it is controlled by the limit switch as input [7].

2.2 Software Design

Web server services hosting sites uses jogjahost.co.id. It has cPanel as a web hosting control panel and phpMyAdmin as a MySQL database manager and uses the PHP programming language. This web server hosting site uses as the main page for controlling lamp and gate. On this page there are “Turn On” and “Turn Off” buttons on the LAMP section and there are “Open” and “Closed” buttons on the GATE section. The program design flowchart on a web server can be seen in Fig -2.

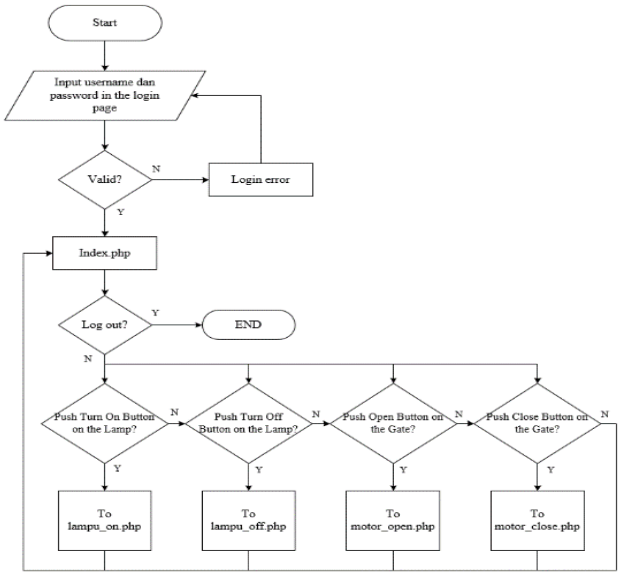

Fig -2: Flowchart of web server design

Program design on a web server starts from entering the login page. First of all when accessing the URL will directly enter the login page first to complete the user verification process. If the user enters the username and password correctly then proceed with entering the main page index.php, if the user incorrectly enters a username or password then the user cannot enter the main page until user can fill in correctly. The appearance of the login page can be seen in Fig -3.

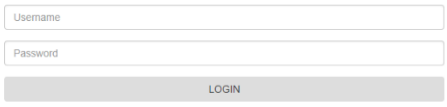

Fig -3: Login page display

On the login page there is a username and password column filled in to verify the user, which for the two columns is filled with the word "admin". After filling both columns correctly then by pressing the login button the user will enter the main web page. If the user has entered index.php, the main web page is displayed in Fig -4.

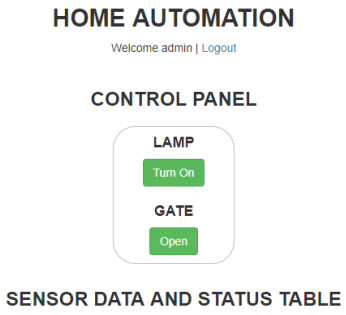

Fig -4: Main web page of home automation

On the main page displayed the title of the "HOME AUTOMATION" web page and on the below displayed the text ‘Welcome "user name"’ and the logout button. The next part is the control panel of this web server, there is a LAMP control section consisting of the Turn On and Turn Off buttons and also the GATE which consists of Open and Close. If the Turn On button is pressed, then directly access the PHP page inside cPanel, namely lampu_on.php, which change the string value in JSON in the first row to 1. For example if the initial string value in JSON is 00 then if the button is pressed it will changed to 10. Likewise with the Turn Off button, if pressed it will access the PHP page lamp_off.php which causes the string value to be 0. The state of this string value will be received by the NodeMCU so that the light will turn on or off. The GATE panel has the same work method as the LAMP panel, when the Open button is pressed then motor_on.php will be accessed so that it changes the string value on the second row to JSON to 1, and when the button is closed the motor_close.php page is accessed and the string value in the second row to 0, so a change in value will be received by NodeMCU resulting in the gate open or close.

Each button directs to the respective PHP page, but after that if the user wants to go back to the index.php page it is necessary to return to the previous page which is quite inconvenient, so the refresh feature is added when pressing the button so it will immediately directed to index.php.

In this program the threshold of the sensor reading value of 200mA has been determined which will be used to know the status of the lamp where the threshold value is determined from the middle value when the lamp is off to on and vice versa. If the value of the lamp registered in the database is 0 or in other words after pressing the Off button but the sensor value is more than or equal to 200mA then the status of "There is an error in the sensor" will be displayed, if the sensor value is less than 200mA the status "Off" will be displayed. If the string of the lamp in the database is 1 or in other words after pressing the "Open" button and the sensor value is less than 200mA then the status of the "There is an error on the lamp" is displayed, if the sensor value is greater than 200mA the "On" status will appear, and if there is a condition other than which has been mentioned, the status will be undefined. The output of the sensor value can be seen in the serial monitor on the Arduino IDE and the determination of the threshold value can be seen in Fig -5 and Fig -6.

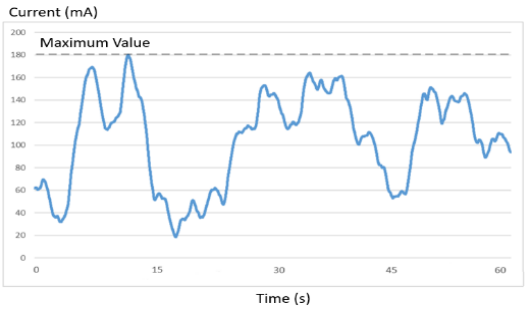

Fig -5: Current sensor output when the lamp is off

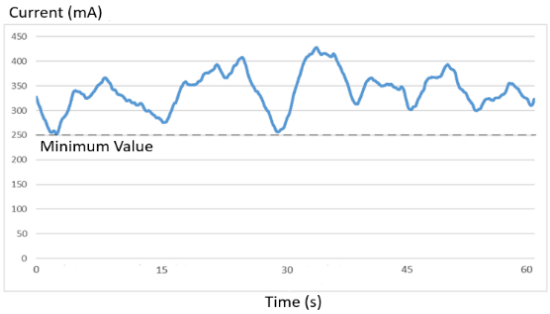

Fig -6: Current sensor output when the lamp is on

In Fig -5 displayed the current sensor output when the lamp is turned off for 60 seconds, the current fluctuates which has a maximum value of 180mA and in Fig -6 displayed the sensor output sample when the lamp is turned on for 60 seconds. It can be seen fluctuating and having a minimum value of 250mA threshold. To determine the sensor status the current sensor value is taken from the middle value of 180mA and 250mA which is 200mA. After getting the threshold to determine the sensor status, the graph of the lamp status can be seen in Fig -7, Fig -8, Fig -9, and Fig -10.

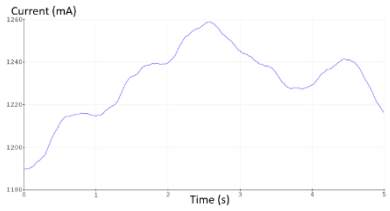

Fig -7: Current sensor output when the lamp is on

The On status will be displayed if the user presses the Turn On button and the sensor value exceeds the 200mA threshold value. The graph can be seen within 5 seconds the sensor value exceeds the threshold value and the sensor value is seen to be fluctuating, but still above the threshold value where this condition meets the conditions for the On status.

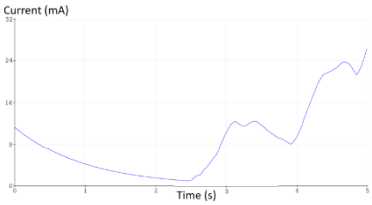

Fig -8: Current sensor output when the lamp is off

The Off status will be displayed if the user presses the Turn Off button and the sensor value is less than the 200mA threshold value. The graph can be seen within 5 seconds the sensor value is less than the threshold value and the sensor value is seen to be fluctuating, but still below the threshold value where this condition meets the conditions for the Off status.

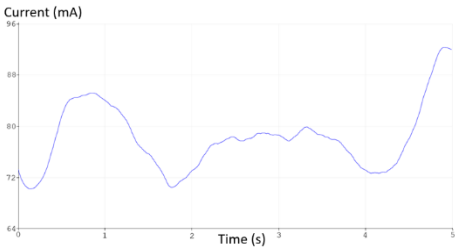

Fig -9: Current sensor output when the lamp is an error

"There is an error on the lamp" status will be displayed if the user presses the Turn On button and the sensor value is less than the 200mA threshold value. The graph can be seen within 5 seconds the sensor value is less than the threshold value and the sensor value is seen to be fluctuating, but still below the threshold value where this condition meets the conditions for the lamp status "There is an error on the lamp".

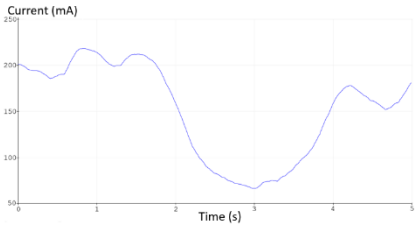

Fig -10: Current output when the sensor is an error

"There is an error in the sensor" status will be displayed if the user presses the Turn Off button and the sensor value exceeds the 200mA threshold value. It can be seen in the graph that the sensor output has exceeded the threshold and for a period of 5 seconds the sensor value is seen to be less stable, and it has significant fluctuations that indicate an error in reading the current value.

The gate has 5 statuses, there are Closed, Closing, Opened, Opening, and the motor has encountered a problem. Closed status will be displayed if the value of the JSON string on the motor is 0 and the value of the limit switch is 0, which means that the gate has touched the limit switch close. Closing status will be displayed if the value of the JSON string on the motor part is 0 and the value of the limit switch is 1, which means the gate has not touched the limit switch close. Opened status will be displayed if the value of the JSON string on the motor part is worth 1 and the reading of the value from the open limit switch is 0 which means the gate has touched the limit switch open. Opening Status will be displayed if the value of the JSON string on the motor part is 1 and the value from the opened limit switch is 1, which means the gate has not touched the limit switch open. The motor has encountered a problem will be displayed if the process of closing or opening the gate exceeds the specified time of 10 seconds.

3. RESULTS AND DISCUSSION

The testing includes the functionality test, lamp and motor response time test, and gate travel time. Functional testing consists of two tests, including responsive web testing and status of lamp and gate display test. The second test is testing the response time of the lamp and motor done by calculating the time when the button on the web page is pressed and then the lamp is turned on or off, as well as the motor is spinning. The last test is gate travel time which is carried out by calculating the time needed for the gate from the gate button is pressed until it is closed or opened.

3.1 Responsive Web

This test is done by comparing the appearance of the http://monitoringphsuhu.com/home_automation webpage displayed on the PC screen with the smartphone screen. Display of web pages accessed from a resolution of 1920*1080 monitor screen can be seen in Fig -11.

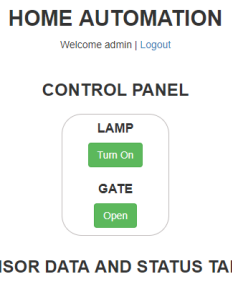

Fig -11: Web page display on monitor screen

The appearance of the web page accessed through the PC screen shows that the sensor table and status are long and there is still empty space around the page, but the display is still comfortable to see and access. Display on the screen of a resolution of 720*1280 smartphone can be seen in Fig -12.

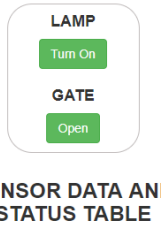

Fig -12: Web page display on 720*1280 smartphone

The display on the smartphone screen is more tight and not all pages are included on the screen. This is because there is a bootstrap feature that is implemented on web pages. Bootstrap is an open source framework that is used to design sites and web applications. This software contains design templates based on HTML and CSS for typography, shapes, buttons, navigation and other interface components, and can manage web pages responsively so that they can be seen on all screen variations, such as desktop and smartphone screens. In this test, it can be concluded that the bootstrap feature regulates web responsiveness so that if displayed on a PC screen the status table will look longer and look a lot of blank space on the page and if displayed on a smartphone screen it looks denser.

3.2 Testing of Lamp Status Display

This test is performed by testing the display status of the lamp. In the status table in the lamp column there are 4 statuses, there are On, Off, there is an error on the lamp, and There is an error on the sensor. The status of the sensor is determined by a threshold value of 200mA. The status display on the lamp and sensor are shown in Fig -13.

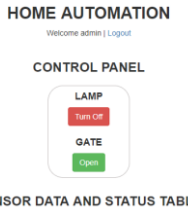

Fig -13: Status and sensor data of lamp - On

The status "On" is displayed if the user pressed Turn On button and the current exceeds 200mA, in this test the current is 318.47mA.

The status “Off” is displayed if the user pressed the Turn Off button, then the status of the lamp and the sensor value can be seen in Fig -14.

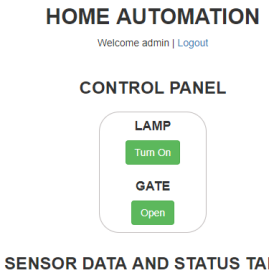

Fig -14: Status and sensor data of lamp - Off

The status "Off" is displayed if the user pressed the Turn Off button and the current is less than 200mA, in this test the current is 24.03mA.

The status “There is an error on the lamp” is displayed if the user pressed Turn On button, then the status of the lamp and the sensor value can be seen in Fig -15.

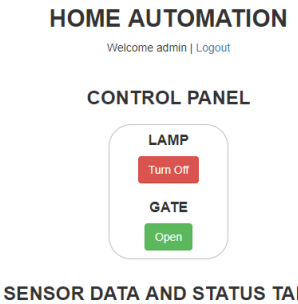

Fig -15: Status and sensor data of lamp - There is an error on the lamp

The status "There is an error on the lamp" is displayed if the user pressed Turn On button the current less than 200mA, in this test the current is 1.32mA.

The status “There is an error on the sensor” is displayed if the user pressed the Turn Off button, then the status of the lamp and the sensor value can be seen in Fig. -16.

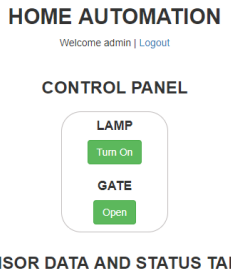

Fig -16: Status and sensor data of lamp - There is an error on the sensor

The status "There is an error on the sensor" is displayed if the user pressed Turn Off button the current exceeds 200mA, in this test the current is 389.19mA.

3.3 Testing of Gate Status Display

This test is performed by testing the display status of the gate. In the status table in the Fence column there are 5 states, there are Opening, Opened, Closing, Closed, and the motor has encountered a problem. The gate status is determined by the button pressed and the state of the limit switches. The status “Opening” displayed if the user pressed the Open button, then the status of the gate and sensor data can be seen in Fig -17.

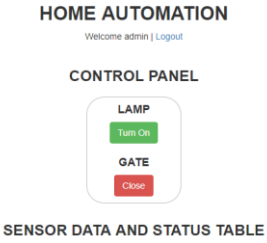

Fig -17: Status and sensor data of gate - Opening.

The status "Opening" is displayed if the user pressed the Open button and the gate has not touched the limit switch open, which can be known from “Limit switch open Off” in data sensor.

The status “Opened” is displayed if the user pressed the Open button, then the status of the gate and sensor data can be seen in Fig -18.

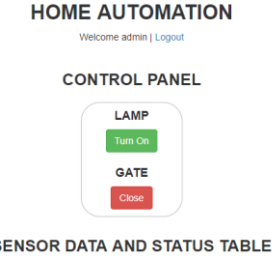

Fig -18: Status and sensor data of gate - Opened.

The status "Opened" is displayed if the user pressed the Open button and the gate has touched the limit switch open, which can be known from "Limit switch open On" in data sensor.

The status "Closing" is displayed if the user pressed the Close button, then the status of the gate and the sensor data can be seen in Fig -19.

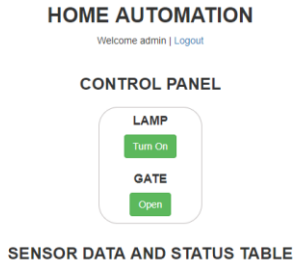

Fig -19: Status and sensor data of gate - Closing.

The status "Closing" is displayed if the user pressed Close button and the gate has not touched the limit switch close, which can be known from "Limit switch close Off" in data sensor.

The status "Closed" is displayed if the user pressed the Close button, then the status of the gate and the sensor value can be seen in Fig -20.

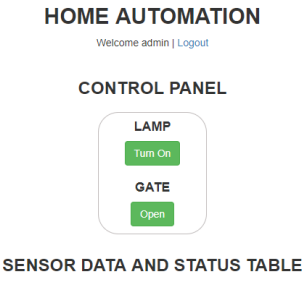

Fig -20: Status and sensor data of gate – Closed.

The status "Closed" is displayed if the user pressed the Close button and the gate has touched the limit switch close, which can be known from "Limit switch close On" in data sensor.

The status "The motor has encountered a problem" is displayed if the user pressed either of Open or Close button then the status of the gate and the sensor data can be seen in Fig -21.

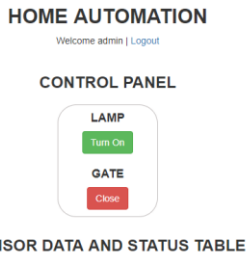

Fig -21: Status and sensor data of gate - The motor has encountered a problem

The status "The motor has encountered a problem" is displayed if the user pressed either of Open or Close button and the gate has touched neither of limit switch open or close, which can be known from "Limit switch close Off" and "Limit switch open Off" in data sensor.

3.4 Testing of Lamp and Gate Response Time

This test is performed by calculating the time when the button on the web page is pressed and then the lamp is turned on or off, as well as the motor is spinning. The time calculation uses a stopwatch so there will be a little time calculation error due to the time response when the light is turned on or off and when the finger pressing the stop button on the stopwatch there will be slightly different time difference. Calculation of lamp and motor response times are shown in Table I.

Table -1: Lamp and Gate Response Time

No.	Time (s)			
	Lamp		Gate	
	Turn On	Turn Off	Open	Close
1.	2.9	2	2.1	1.7
2.	1.9	2.4	1.4	2
3.	1.9	2.1	1.8	1.6
4.	2	2.1	2.7	1.7
5.	2.1	2	5.7	1.6
6.	2.9	1.9	1.3	2.5
7.	1.8	1.8	2.2	2.7
8.	1.3	2.2	2	2.4
9.	2.1	2.3	2.7	1.8
10.	2.3	1.6	2.6	4.5
Average	2.12	2.04	2.45	2.25

Testing performed by 10 trial of response times which is calculated by the average time of response time when the light switch is pressed until the light is on is 2.12 seconds and when the light switch is turned off until the light goes out is 2.04 seconds. The average response time when the gate open button is pressed until the gate opens is 2.45 seconds and

when the gate close button is pressed until the gate closes is 2.25 seconds. Time response speed is influenced by the speed of the internet network when testing, the faster the internet network, the faster the response time.

4. CONCLUSIONS

This paper presents the testing results of responsive web, lamp status display, gate status display, lamp, and gate response time, as well as gate travel time. On the responsive design test the display on the smartphone screen is more tight and not all pages are included on the screen. This is because there is a bootstrap feature that is implemented on web pages. It can be concluded that the bootstrap feature regulates web responsiveness so that if displayed on a PC screen the status table will look longer and look a lot of blank space on the page and if displayed on a smartphone screen it looks denser.

On the lamp status display test the status "On" is displayed if the user pressed Turn On button and the current exceeds 200mA. The status "Off" is displayed if the user pressed Turn Off button and the current less than 200mA. The status "There is an error on the lamp" is displayed if the user pressed Turn On button and the current less than the 200mA. The status "There is an error on the sensor" is displayed if the user pressed Turn Off button and the current exceed 200mA.

On the gate status display the status "Opening" is displayed if the user pressed the Open button and the gate has not touched the limit switch open, which can be known from “Limit switch open Off” in data sensor. The status "Opened" is displayed if the user pressed the Open button and the gate has touched the limit switch open, which can be known from “Limit switch open On” in data sensor. The status "Closing" is displayed if the user pressed the Close button and the gate has not touched the limit switch close, which can be known from “Limit switch close Off” in data sensor. The status "Closed" is displayed if the user pressed the Close button and the gate has not touched the limit switch close, which can be known from “Limit switch close Off” in data sensor. The status "The motor has encountered a problem" is displayed if the user pressed either of Open or Close button and the gate has touched neither of limit switch open or close, which can be known from “Limit switch close Off” and “Limit switch open Off” in data sensor.

Average response time when the Turn On button is pressed until the light is on is 2.12 seconds and when the Turned Off button is pressed until the light goes out is 2.04 seconds. The average response time when the Open button is pressed until the gate opens is 2.45 seconds and when the Close button is pressed until the gate closes is 2.25 seconds.

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