Design of a Monitoring System for The Number of Visitors in The Polinema Library

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***Abstract*— In general, public spaces are places where people gather to meet in high numbers for the purpose of using facilities provided by the government, both free and paid.Since the covid-19 pandemic which began to enter the country of Indonesia on Monday, March 2, 2020 and began infecting Indonesian residents returning from abroad. After there were Indonesian residents exposed to the covid-19 virus, the government immediately handled it with a lockdown. The purpose of this research is to design a monitoring system for the number of visitors at the Polinema Library by creating a system that uses ultrasonic sensors to detect visitors who enter the library. The sensor is calibrated first by determining the tolerance value for the error value of the ultrasonic sensor. The arduino nano microcontroller will process the ultrasonic waves read by the sensor and display on a dot matrix with a size of 16x32 which there are 2 pieces. After that for data transmission media that will be sent to the adafruit for monitoring results and data retrieval results using the LoRa E220 module. Based on the test results, it can be seen that two ultrasonic sensors have an error value of 1.1 after calibration. In the process of sending data from the transmitter to the receiver using LoRa E220, the maximum range after getting an obstacle in the form of a house reaches 200 m with the power value received by the receiver.**

***Keywords*— Adafruit, LoRa E220, Public Spaces, RSSI, Ultrasonic Sensor.**

I. INTRODUCTION

Public service space is a place used by the community for a series of activities in the form of goods and services to meet community needs and in the context of implementing legislation organized by public service providers. The public can obtain information and carry out various activities. One example of a public space is a library. However, the condition of public service spaces must be limited because the pandemic caused by Coronavirus Disease (COVID-19) requires a limit on the number of visitors in each public service space.

The pandemic caused by COVID-19 also requires people to comply with health protocols, namely maintaining distance, wearing masks and always washing hands. Of the total cases, 372,266 or 84 percent of them have been declared cured or free from Covid-19. Meanwhile, as many as 14,689 patients or 3.33 percent of all positive cases have died [1]. Based on Minister of Health Regulation Number 9 of 2020 concerning guidelines for large social restrictions in the context of accelerating activities in public places or facilities as referred to in paragraph 1 letter c, it is implemented in the form of limiting the number of people and setting the distance of people. On limiting the number of users of the number of people and setting the distance of people. In limiting the number of users for public facilities or public spaces, it is very difficult to control which results in frequent overcapacity that has been determined if there are no officers resulting in crowds. The public room is one of the vulnerable rooms considering that there are so many people who make arrangements such as banking, population and others [2].

Based on these problems, a study was made entitled, "Design of a Monitoring System and limiting the Number of Visitors in Polinema Library". This system is expected to monitor the number of people entering and exiting the library accurately and realtime.

II. METHOD

A. Block Diagram

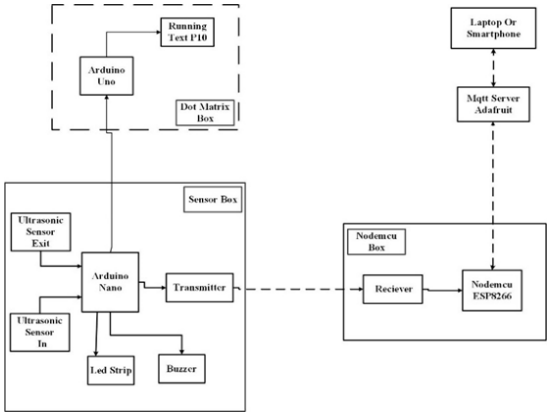

Figure 1. Block Diagram

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The system design as shown in Fig 1. is explained sequentially as follows:

1. The hc-sr04 ultrasonic sensor reads objects in the form of humans by the method of emitting sound waves at ultrasonic frequencies.
2. After the ultrasonic sensor detects an object in the form of a human, the data is sent to the Arduino Nano microcontroller.
3. When the data is sent to the Arduino Nano microcontroller, the rgb led strip which was green turns blue when it detects an object, the buzzer sounds.
4. Arduino nano sends data to arduino uno to change the number of incoming visitors and the remaining visitors in the polinema library room.
5. Lora e220 Transmitter connected to arduino nano sends data in the form of radio waves to LoRa e220 reciever.
6. After the LoRa e220 reciever receives the data, the data is sent to Nodemcu esp8266.
7. Finally, Nodemcu sends data to the Adafruit mqtt server to display the number of visitors entering and the remaining visitors in the room via the internet which can be viewed on a laptop or smartphone.

B. Flow of Data Collection

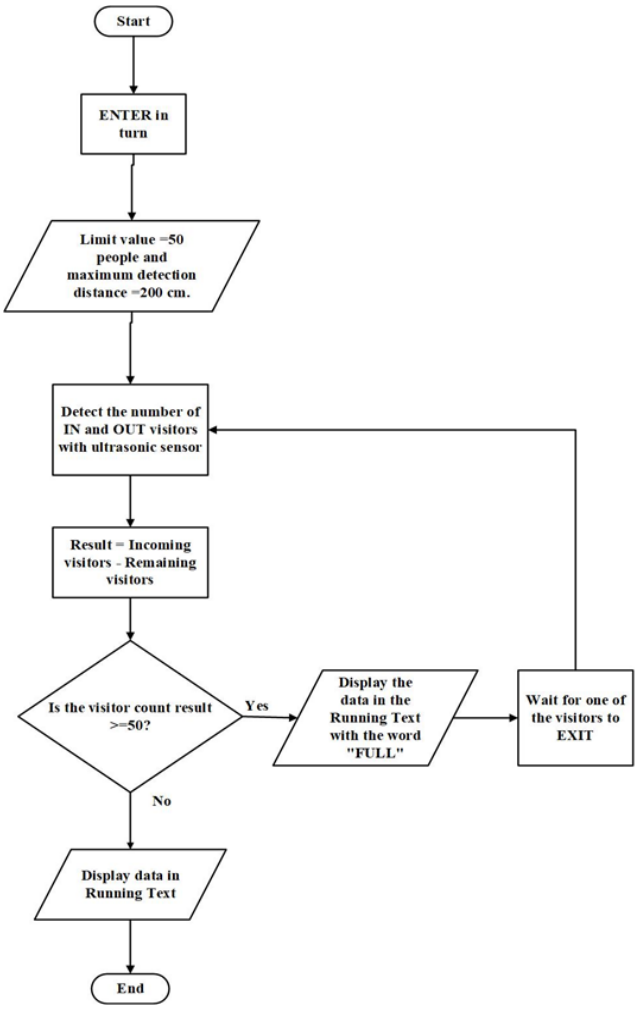

Figure 2. Flow of Data Collection

The data collection plan which displayed in Fig. 2 can be explained as follows:

1. The tool will be turned on during library opening hours, namely at 08.00 WIB
2. Entering the limit value of visitors who can enter the polinema library. Minimum and maximum detection limits.
3. The process of counting people entering and leaving the polinema library room.
4. Whether the visitor counting process exceeds the predetermined limit or not, if it has exceeded the limit must wait first until the visitor in the room leaves the polinema library room.
5. After the room is still not full which can be informed through the Running Text panel, visitors are allowed to enter in turn.
6. At 16.30 WIB the device is turned off by the admin and the retrieval process has been completed.

C. Process Flow of Counting the Number of Visitors

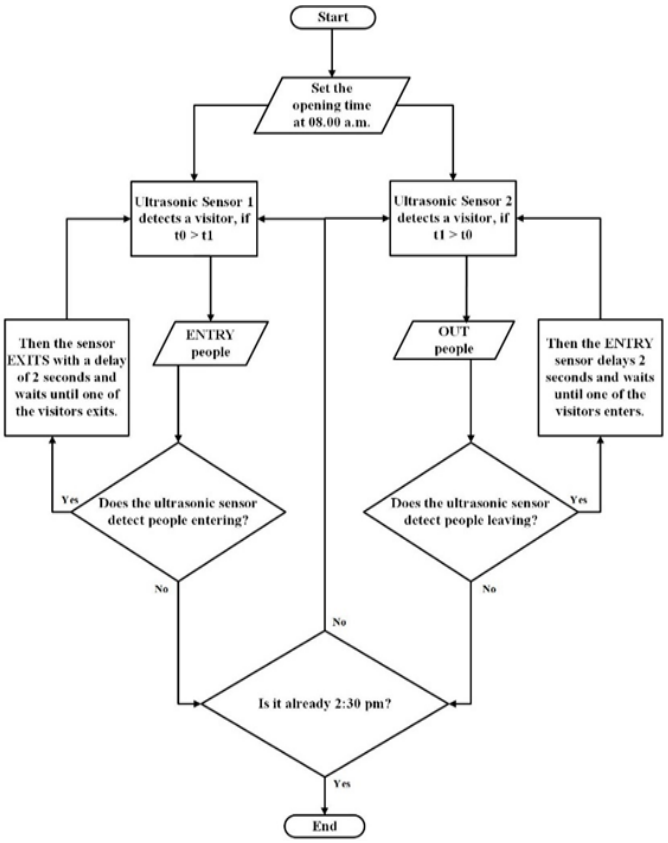

Figure 3. Process Flow of Counting the Number of Visitors

Where the flowchart of counting the number of visitors planning in Fig. 3 is explained as follows:

1. Setting the opening time of the polinema library which opens at 08.00 WIB
2. If a visitor enters it will be detected by ultrasonic sensor 1 or if a visitor leaves it will be detected by ultrasonic sensor 2.
3. Whether there are visitors entering, ultrasonic sensor 2 will turn off and wait until visitors until visitors leave or vice versa there are visitors who will leave, ultrasonic sensor 1 will turn off and wait for visitors to enter. After that ultrasonic sensor 1 and ultrasonic sensor 2 will detect again.

4. If not whether the time has shown 2:30 pm, if so the test is complete and if not yet the time shows 2:30 pm then ultrasonic sensor 1 and ultrasonic sensor 2 will still run to detect visitors.

D. Flowchart of Visitor Counting Results

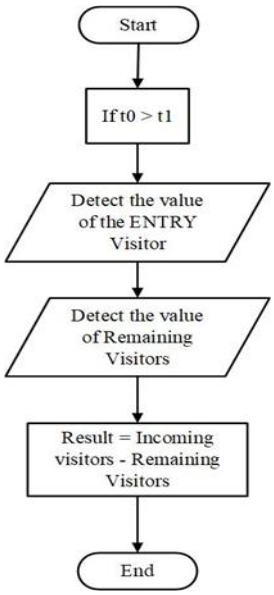

Figure 4. Flowchart of Visitor Counting Results

The flowchart of visitor counting results in Fig. 4 is explained as follows:

1. If the ultrasonic sensor time sensor 1 detects faster, it means that there are visitors who enter the polinema library.
2. Entering the value of incoming visitors obtained from the limit value of polinema library visitors.
3. Entering the value of the remaining visitors obtained by ultrasonic sensor 1 that detects visitors.
4. After entering the value, the result can be obtained from the subtraction of the value of the incoming visitors minus the value of the remaining visitors who can enter the Polinema library.

E. Ultrasonic Sensor Design

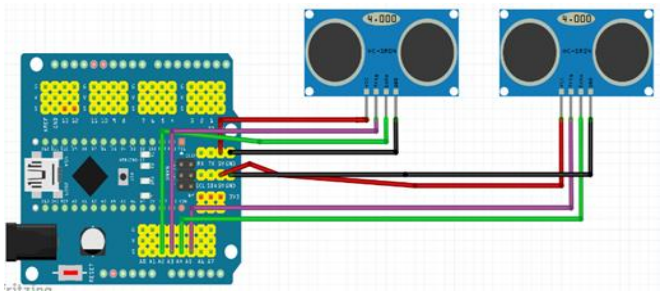

Figure 5. Ultrasonic Sensor Design

In Fig. 5 the sensor component design there are 2 pieces, namely ultrasonic sensor 1 to detect visitors entering and ultrasonic sensor 2 to detect visitors leaving. The design is considered to detect people entering when ultrasonic sensor 1 detects first than ultrasonic sensor 2, and vice versa The design is considered to detect people leaving when ultrasonic sensor 2 detects first than ultrasonic sensor 1 [3], [4].

In Fig. 5 the ultrasonic sensor VCC pin is connected to the 5v pin and the ultrasonic sensor ground pin is connected to the arduino nano ground pin. The trig pin serves to emit ultrasonic waves on an object and the echo pin serves to receive reflected ultrasonic waves from objects detected by the sensor. The trig pin of ultrasonic sensor 1 is connected to pin A5 and the trig pin of ultrasonic sensor 2 is connected to pin A3. On the echo pin, ultrasonic sensor 1 is connected to pin A4 of the Arduino nano and the echo pin of ultrasonic sensor 2 is connected to pin A2 of the Arduino nano [5], [6].

a. Buzzer Design

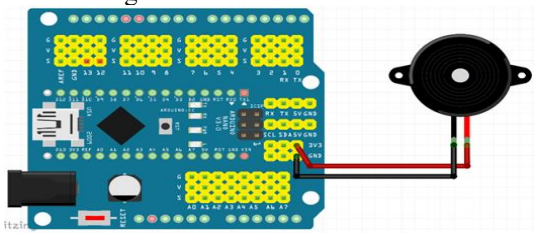

Figure 6. Buzzer Design

In Fig. 6 the design of the buzzer component that functions as a sound notification when the ultrasonic sensor detects people and when the capacity of visitors in the room is full. In Figure 5 the buzzer vcc cable is connected to pin 3v3 arduino nano and the buzzer ground cable (GND) is connected to the ground pin (GND) arduino nano [7], [8].

b. Led Strip Design

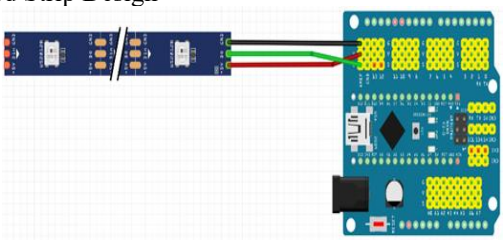

Figure 7. Led Strip Design

In Fig. 7 the design of the led strip component functions for notification of the color of the lamp used as a marker of the room is full or there are still visitors who are allowed to enter [12], if the color of the led strip light is green visitors are still allowed to enter and if the color of the led strip light is red visitors must wait first until one of the visitors comes out of the room [11]. In Figure 6 pin 5v of the led strip is connected to pin V (Volt), pin D0 of the led strip is connected to pin S (Source) or digital input pin, and pin GND (Ground) of the led strip is connected to pin G (Ground) of arduino nano [8], [9].

c. LoRa E220 Design with Arduino Nano

In Fig. 8 the design of LoRa E220 which is installed on the Arduino Nano microcontroller functions as a transmitter to send data obtained from the detection of ultrasonic sensors to the receiver [10]. In Figure 7 the GND (Ground) pin of the LoRa E220 is connected to the G (Ground) pin of the arduino nano, the vcc pin of the LoRa E220 is connected to the V (Volt) pin of the arduino nano [11], the TXD pin of the LoRa E220 is connected to pin 8 of the arduino nano pin [12], the RXD pin

of the LoRa E220 is connected to pin 9 of the arduino nano, pin m0 of the LoRa is connected to the ground pin and pin m1 of the LoRa E220 is connected to the ground pin of the arduino nano [13].

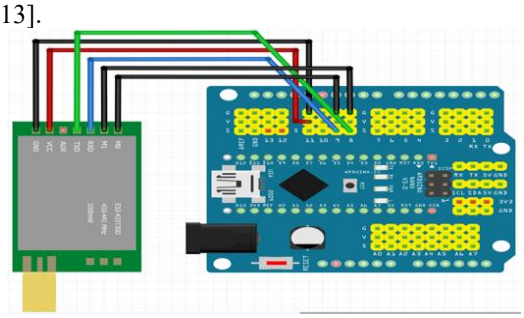

Figure 8. LoRa E220 Design with Arduino Nano

d. LoRa E220 Design With Nodemcu

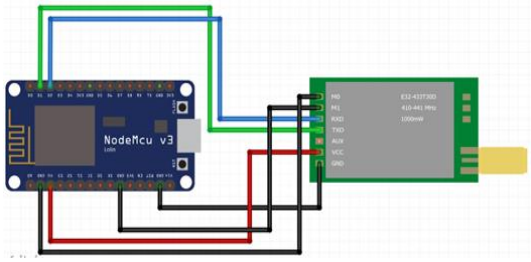

Figure 9. LoRa E220 Design With Nodemcu

In Fig. 9 the LoRa E220 design connected to Nodemcu, it functions to receive data sent from the transmitter which will be uplouded to the mqtt server adafruit [14]. In picture 8 the GND (Ground) pin of LoRa is connected to the GND (Ground) pin of Nodemcu, the vcc pin of LoRa is connected to the 3v3 pin of nodemcu [15], the TXD pin of LoRa is connected to the D1 pin of Nodemcu, the RXD pin of LoRa is connected to the D2 pin of Nodemcu, the m0 pin of Lora is connected to the G (Ground) pin of Nodemcu, and the m1 pin of LoRa is connected to the G (Ground) pin of Nodemcu.

III. RESULTS AND DISCUSSION

A. Block Diagram

In testing the error value of the sensor distance at the entrance with a distance of 10 cm to 130 cm which can be seen in Fig. 10.

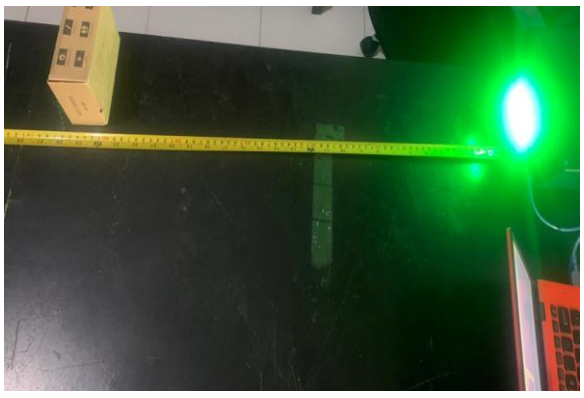

Figure 10. Error Value Of Ultrasonic Sensor Distance

TABLE I
ERROR VALUE OF ULTRASONIC SENSOR DISTANCE

Distance (cm)	Sensor (cm)	Error
10	9,40	0,6
20	19,23	0,77
30	28,42	1,58
40	38,23	1,77
50	48,08	1,92
60	57,97	2,03
70	67,46	2,54
80	77,11	2,89
90	86,94	3,06
100	96,55	3,45
110	106,44	3,56
120	116,58	3,42
130	126,29	3,71

From the comparison of the distance measured from the measuring instrument, namely the ruler compared to the distance measured by the ultrasonic sensor, the error is obtained from a distance of 10 cm, namely 0.6 to a distance of 130 cm, namely 3.71. With an average error value of 2.9, so the further the distance is measured, the higher the error value.

B. Calibration of Ultrasonic Sensors

This test aims to correct the error value of the ultrasonic sensor. In Fig. 11 there are the results of calibrating the ultrasonic sensor after being given a tolerance value of 1.02 cm.

TABLE II
CALIBRATION OF ULTRASONIC SENSORS

Distance (cm)	Sensor (cm)	Error
10	9,84	0,16
20	20,51	0,51
30	30,43	0,43
40	40,54	0,54
50	51,03	1,03
60	60,32	,32
70	70,54	0,54
80	81,27	1,27
90	91,34	1,34
100	101,52	1,52
110	111,85	1,85
120	122,46	2,46
130	132.26	2,26

From the calibration results of the ultrasonic sensor, the value of the error statement decreases from a distance of 10 cm with an error statement of 0.16 to a distance of 130 cm with an error statement of 2.26 and the average error statement is 1.1.

C. Test results of the visitor entry and exit monitoring system

This test aims to determine the process of reading the sensor against objects that pass through the ultrasonic sensor. In this case the object that passes through the ultrasonic sensor is a person. The results of device trials can be seen in Table III. At the time of testing the device has been placed on the right side of the visitor in order to detect accurately. Testing devices with ultrasonic sensors with a minimum distance of 10 cm to a maximum distance of 200 cm. The test time starts at 08.00 WIB

until 15.30 WIB. For the placement of the device at the test location can be seen in Fig. 11.

TABLE III
TEST RESULTS OF THE VISITOR ENTRY AND EXIT MONITORING SYSTEM

Experiment Go to	Visitor Entry	Visitor Exit	Number of Visitors in the Room
1	3	0	3
2	6	3	4
3	10	4	5
4	15	6	8
5	23	11	10

Figure 11. Test Results Of The Visitor Entry And Exit Monitoring System

D. Results of RSSI Testing

TABLE IV
RESULTS OF RSSI TESTING

Spreading Factor	Distance	DB	DBM
7	50 m	203	-52
7	100 m	171	-84
7	150 m	165	-90
7	200 m	155	-100

From the test results from the Table IV, at a distance of 50 m, a value of 203 db and -52 dbm was obtained, at a distance of 100 m a value of 171 db and -84 dbm was obtained, at a distance of 150 m a value of 165 db and -90 dbm was obtained, and at a distance of 200 m a value of 155 db and -100 dbm was obtained which worked at a frequency of 433 mhz [5].

IV. CONCLUSION

After testing and analyzing the system that has been made, it can be concluded that: The design of the monitoring system for the number of visitors in the room can detect visitors with the limitations of visitors who enter and exit must take turns so that ultrasonic sensor 1 and ultrasonic sensor 2 can run properly. The sensor error value for detecting people who walk is quite good with an average value of 2, 9 after calibrating the error value improves to 1.1 and the farther the measurement distance the greater the error value. Transmission of information from LoRa tranciever to LoRa reciever in real time, and can cover a considerable distance of 200 meters non-Los with a value of 155 db and -100 dbm.

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