COMPILER
Vol.10, No.2, November 2021, pp. 89-98
ISSN: 2252-2403 (Print), ISSN: 2549-2403 (On Line)
Aaccredited Fourth Grade by Kemenristekdikti, Decree No:200/M/KPT/2020
DOI: 10.28989/compiler.v10i2.1111

Sterilizer chamber design with telegram-based internet of things (IoT) applications

Nurwijayanti KN[1,*], Reza Ananda[2]
[1, 2]Department of Electrical Engineering, Universitas Dirgantara Marsekal Suryadarma

Article Info

Article history:

Received November 10, 2021
Accepted November 26, 2021
Published November 30, 2021

Keywords:

Internet of Things
Telegram
Disinfectan Liquid
Sterilizer Chamber
Corona Virus

ABSTRACT

In order to reduce the spread of the corona virus in office areas, malls or housing, a sterilizer chamber is installed. It is used to detect someone who will enter an area and he must be sterilized first by spraying the entire body with disinfectant liquid automatically. By combining the sterilizer chamber tool with IoT technology, the sterilizer chamber tool can be monitored continuously at a certain distance using a sensor as a detector which will provide information to one of the operators of the tool condition, about the remaining liquid, the number of people who have been sterilized. The system works by providing information on the liquid spray time of about 5 seconds and information on the liquid level in the tube from level 5-70. The average output pin voltage is 4.89 V when the sensor detects an obstacle in front of the sensor and the NODEMCU will receive a voltage 4.89 V from the output pin and ultrasonic sensor HC-SR04. The highest voltage reaches 673.2 Mv, when the distance to the object is 40 cm with the lowest voltage is 100.3 mV with the closest distance being 5 cm.

Corresponding Author:

Nurwijayanti KN,
Teknik Elektro,
Universitas Dirgantara Marsekal Suryadarma,
Protokol Halim Perdanakusuma, Bandara Halim PK, Jakarta Timur
Email: nurwijayanti_kn@yahoo.com

1. INTRODUCTION

The corona virus or known as COVID-19 has hit Indonesia for a year, exactly since February 2020, to deal with the corona virus, we have to do from prevention to the treatment. The application of 3M (Washing hands, Wearing Masks and Maintaining Distance) to 5 M (Washing hands, Wearing Masks, Maintaining Distance, Reducing traveling and avoiding crowds [1] is still not fully effective in eliminating the transmission of the Corona Virus which is increasingly spreading with all its variants [2].

The current problem is how to reduce the spread of the corona virus, especially in the office areas, malls or housing, a sterilizer chamber is installed, in order to detect someone who will enter an area, especially closed and air-conditioned areas such as office buildings, malls and many more. The people who entered must be sterilized first by spraying the entire body with disinfectant liquid automatically, for half a minute or 30 seconds.

Along with advances in technology, especially in the field of telecommunications, as well as utilizing the wi-fi network that is already evenly distributed, especially in both government and private offices, some campuses have also used wi-fi as a means of communication both data, voice and image, as well as IoT (Internet of Think) technology. It has been applied in all fields, even at home, in hotels, in offices, using IoT technology to facilitate all activities related to electronic devices [3].

Thus, the purpose of making this sterilizer chamber tool by combining IoT technology is to reduce the spread of the corona virus in closed space, especially those with air conditioning by detecting how many people have been sprayed and the rest of the disinfectant liquid. It can be monitored at any time remotely as long as it is still affordable with the internet network. IoT devices consist of sensors as data collection media, internet connections as communication media and servers as information collectors received by sensors for analysis. The initial idea of the Internet of Things was first raised by Kevin Ashton in 1999 in one of his

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presentations. The sterilizer chamber can be monitored continuously at a certain distance, by one operator using a sensor as a detector, which will provide information to one of the operators about the condition of the device. The infomation sent is the remaining disinfectant liquid, the number of people who have been sterilized, and people's body temperature who are in the room. This tool can work for 24 hours so it is hoped that the spread of the virus during the pandemic will be effectively reduced with an error value close to 0%.

2. RESEARCH METHOD

The research methods in this study are:

2.1. Internet of Things

Internet of things or known as IoT is a term for greater use of the internet, adopting mobile money computing and connectivity and then incorporating it into everyday life. IoT is related to DoT (Disruption of Things) and as an introduction to the change or transformation of internet use from the previous Internet of People to the internet of M2M (Machine-to-Machine).

IoT technology aims to extend the benefits of continuously connected internet connectivity that allows connecting machines, equipment, and other physical objects with network sensors and actuators to acquire data and manage their own performance.

Figure 1 explains the IoT concept which is actually quite simple with the way it works referring to 3 main elements in the IoT architecture, namely: Physical Goods equipped with IoT modules, Connection Devices to the Internet such as Modems and Speedy Wireless Routers.

Figure 1. IOT Concept

The basic working principle of IoT devices is that objects in the real world are given a unique identity and can be multiplied in a computer system and can be represented in the form of data in a computer system. At the beginning of the implementation of the idea of IoT, the identifier is used so that objects can be identified and read by a computer. In addition, it uses a barcode (Barcode), QR Code (QR Code) and Radio Frequency Identification (RFID).

2.2. IoT implementation

Machines are made to make human work easier, at first time, machines were made only to help humans and operated manually. As time goes by, the machine can run itself (automatically), but in its development the use of machines as a tool in a system will encounter obstacles when it comes to distance and time. To overcome this case, the idea of the internet of things is applied where all electronic machines/devices can be connected to each other with an IP address identifier using the internet network as a communication medium (exchanging data) [4]. The application is shown in figure 2.

Figure 2. The application of IoT in the sterilizer chamber

Installing sensors at several points, one of which is at the entrance and where the liquid is disinfected, at the entrance to find out the number of people who have been sterilized, while the sensor is at the place where the liquid is disinfected where all sensors will be connected to IoT as information to the operator, for the number of people and to find out the remaining liquid. It is available to be refilled immediately.

2.3. Open Control System (Open Loop)

In this Sterilizer Chamber, it uses an open control system. An open loop control system is a control system whose output has no effect on the controlling action. So, in an open loop control system, such as in Figure 3, the output is not measured or feedback to compare with the input [5].

In any open-loop control system, the output is not compared with the reference input. Thus, for each reference input, there is a constant operating condition.

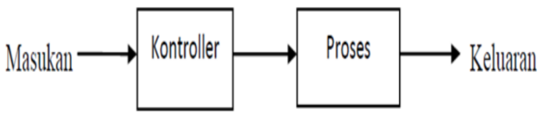

Figure 3. Open Loop Control System

2.4. Disinfectant Liquid

A disinfectant is an antimicrobial agent designed to inactivate or destroy microorganisms on moist surfaces. Although capable of killing microorganisms, but not all can die with just a disinfectant. Some extreme microorganisms still have to work by destroying microbial cell walls or interfering with metabolism [6]. In this Sterilizer Chamber, Disinfectant is the main ingredient after the Process (Output), as shown in Figure 4.

Figure 4. Disinfectant Liquid Image

2.5. Volume Use of water and disinfectant

In the use of disinfectants, the volume and amount of water consumption must be considered. By calibrating the spray tool. It is very important to carry out proper calibration of each type of sprayer, nozzle, and travel speed before starting spraying or at certain times, so that the use of disinfectants becomes efficient and effective, as in formula (1)

$$D = \frac{100xC}{(6XB)xA} \qquad (1)$$

Calibration Procedure

D = Spray Volume
A = Measure the average spray width (meters)
B = Measure the distance (m) by the operator for 10 seconds
C = Measure Output or flow rate (litters/minute) at optimum pump pressure(1kg/cm²)

The following is the calculation of the need for spray volume (liters/Number of People) by referring to formula (1):

$$D = \frac{100xC}{(6XB)xA}$$ or Liters/number of people come

$$= \frac{100 x liter / menit output}{(6 x Range m / 10 Second) x Spray Width} \qquad (2)$$

Example:
A = Average spray width is 1 meter
B = Average walking distance is 0.5 meters per 5 seconds
C = Average spray output is 1 litter/minute
D = What is the spray volume (litters / Number of people)

$D = \frac{100 \times 1}{(6 \times 2,5) \times 1} = \frac{100}{15} = 6,6$ Liter/100 People's

It can be concluded that the Volume of Disinfectant Spray and Water for 100 people is 6.6 Litters or per 1 person to 66 ml.

2.6. NodeMCU

NodeMcu is an open source IoT platform and development kit that uses the Lua programming language to help programmers create prototypes of IoT products or can use sketches with the Arduino IDE. This development kit is based on the ESP8266 module, which integrates GPIO, PWM (Pulse Width Modulation), IIC, 1-Wire and ADC (Analog to Digital Converter) all in one board [7].

NodeMcu in Figure 5 is one of the products that has special rights from Arduino to be able to use Arduino applications so that the programming language used is the same as Arduino boards in general.

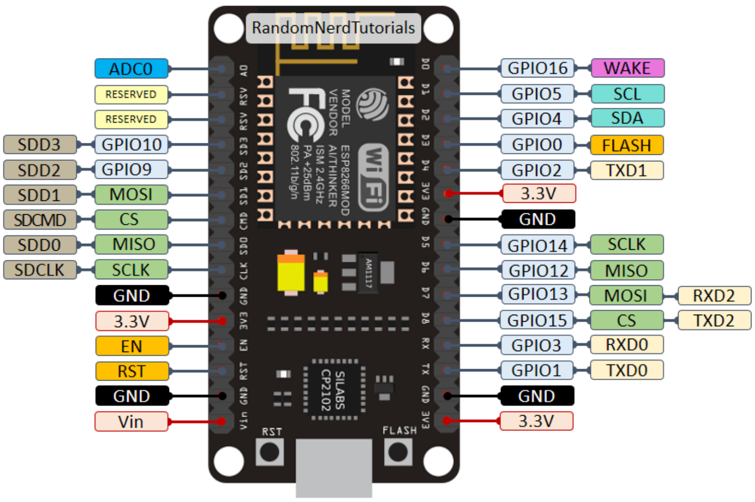

Figure 5. Mapping NodeMCU

2.7. Ultra-sonic HC-SR04

This type of sensor is an electronic module that detects an object using sound. The ultrasonic sensor consists of a transmitter (transmitter) and a receiver (receiver) [8]. Transmitter serves to emit a sound wave towards the front. If there is an object in front of the transmitter, the signal will bounce back to the receiver, like in Figure 6.

Figure 6. Sensor Ultrasonic HC SR04

2.8. Infrared e18-D80NK

The E18-D 80NK is an infrared proximity sensor, this tool has a detection range that can be adjusted from 3 cm to 80 cm with NPN output [9], the tool is small and easy to use and easy to assemble and the relatively affordable price. It is one of the reasons to choose this tool. It is shown in Figure 7, the examples of robots, interactive medians, industry and others.

This sensor does not need direct contact with the instrument, only by infrared shots at the object to be measured.

Figure 7. ***Infrared Sensor***

2.9. LCD

LCD (Liquid Crystal Display) is a type of display media that uses liquid crystals as the main display. LCD has been used in various fields such as electronic devices such as televisions, calculators, or computer screens. The LCD has a function as a viewer which will later be used to display the working status of the tool [10], as shown in Figure 8.

Figure 8. 20x4 LCD Character Display with I2C module

The LCD used is 20x4 character LCD with an additional I2C chip module to make it easier for programmers to access the LCD later.

2.10. I2C Module

The I2C module is a two-way serial communication standard using two channels specifically designed to send and receive data, as shown in Figure 9 [11]. The I2C system consists of SCL (Serial Clock) and SDA (Serial Data) channels that carry data information between I2C and its controller [12]. Devices connected to the I2C Bus system can be operated as Master and Slave. Master is a device that initiates data transfer on the I2C Bus by generating a Start signal, ending data transfer by generating a Stop signal, and generating a clock signal.

Figure 9. Physical Form of I2C

3. RESULTS AND ANALYSIS

The material to be discussed is a block diagram of the entire system from design to testing.

3.1. System Block Diagram

Figure 10 depicts the entire apparatus system of the *Sterilizer Chamber*.

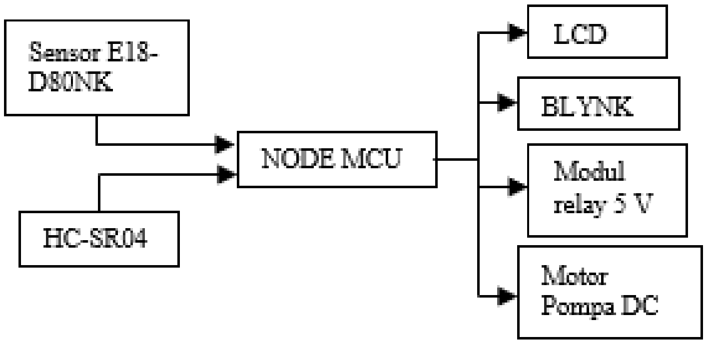

Figure 10. Block Diagram System

From the description of the block diagram in Figure 10 above, it can be explained how it works.
1) NODEMCU is to control all the components so that the system can run according to the program that has been made.
2) LCD 4x20 serves for monitoring to make it visible and controlled.
3) 12 Volt Power Supply is as the main power source to turn on the tool.
4) Relay module serves to turn on the DC pump motor with an input voltage of 12 volts.
5) DC pump motor serves to remove the sterilizing liquid in the tube [13].
6) Sensor HC-SR04 serves to detect the water level in the sterilized water tube.
7) Blynk has function to make the state of the tool can be monitored remotely via a smartphone [14].

3.2. Flowchart

The flow of the booth making process can be seen in Figure 11, where the sensor reads the presence of high/low voltage to the relay to count the number of people entering the booth using the BLYNK application, followed by an ultrasonic sensor to read the distance from the spray to the object (human). After spraying, the residual/level of the disinfectant liquid will be seen, if it is OUT then there will be a notification "Out of Water".

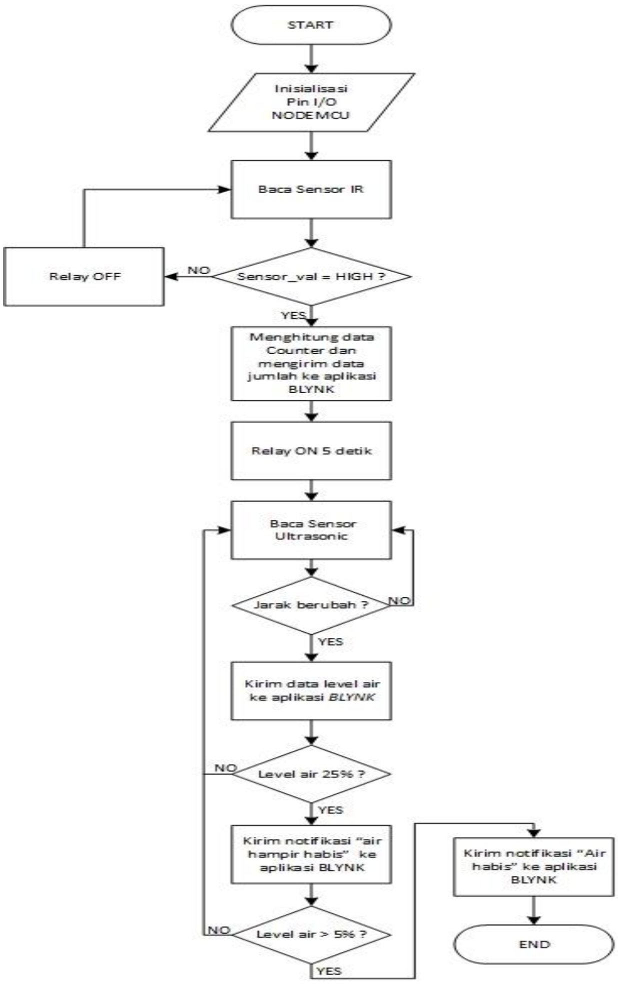

Figure 11. ***Flowchart*** **System**

3.3. Tool Design

In this stage, all components will be installed in accordance with the system circuit that has been made in the previous stage. LCD, Relay, Ultrasonic Sensor, Nodemcu, and Infrared sensor will be connected in a circuit and will be loaded in a place so that the components are protected from water, as shown in Figure 12.

Figure 12. System Box on the Pole

Figure 13 is the infrared system which is stored to make it waterproof when exposed to disinfectant spray.

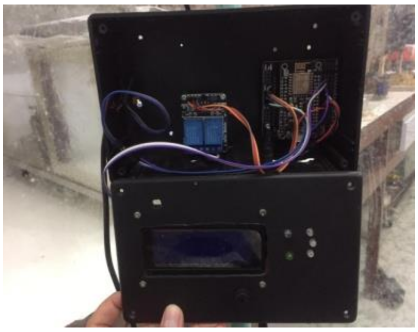

Figure 13. Infrared box

Figure 14 is a booth that will be installed in front of an office building, so that everyone who enters will be sprayed first in the booth.

Figure *14. Sterilizer Chamber*

After that, it will be proceeded with testing the tool after the tool is successfully assembled. The testing is carried out on each component.

3.4. Testing Tool

The next stage is to test this tool as a whole, so that it can be seen whether the system on this tool is running according to the programmed commands or not.

1. Testing the E18-D80NK Infrared Sensor
   This test is carried out to determine the level of accuracy of the sensor to some predetermined distance. This test is carried out by determining several points of distance. First, it uses a meter and then it is given an obstacle according to the target. After that counting, it is to count the number of people who enter the booth.
   The distance data obtained from the reflected infrared light will be processed by NODEMCU to analyze the sensitivity level, as shown in Table 1

Table 1. Sensor Test

NO	Distance (cm)	Status	Output Sensor (mVdc)
1	0	No Obstacle	0
2	5	Obstacle Available	100,3
3	10	Obstacle Available	177,8
4	20	Obstacle Available	345,4
5	30	Obstacle Available	508,9
6	40	Obstacle Available	673,2

2. *Ultrasonic HC-SR04 Sensor Testing*

This test is carried out with the aim of knowing the level of accuracy of the sensor in measuring a distance. This test is carried out by providing a barrier at the front of the sensor and will be changed periodically at several distance points that have been determined in Table 2.

Table 2. Water level distance test

NO	Distance (cm)	Status	Output Sensor (Vdc)
1	0	No Obstacle	0
2	20	Obstacle Available	4,89
3	40	Obstacle Available	4,90
4	60	Obstacle Available	4,89
5	70	Obstacle Available	4,89

From the table above, it can be concluded that the farther the distance of the water level (obstacle) which is read by the ultrasonic sensor HC-SR04, the greater the voltage sent by the sensor output pin to the NODEMCU digital pin.

3. Testing the whole tool

This test is to find out how accurate the sterilizer chamber system is using the NODEMCU microcontroller, where this section is very important to reduce errors and delays, in Table 3.

From the test results, all systems can run, the duration of communication between the NODEMCU and the BLYNK application is strongly influenced by the internet signal or not on both devices is strong.

The ultrasonic sensor works well in detecting the water level in the tube, as well as the infrared sensor which can quickly detect the presence of objects so that the system can work quickly.

Table 3. Output measurement on Arduino uno.

Status	Level air	Sensor E18	Delay with distance 27 KM	*Spray time*	Description
Empty	70	0 V	5,39 Seconds	Not Active	Counting Off
Available	70	4.89 V	5,89 Seconds	Active 5seconds	Active Counting
Available	25	4.90 V	6,89 Seconds	Active 5seconds	Active Counting
Available	40	4.89 V	7,56 Seconds	Active 5seconds	Active Counting
Available	5	4.89 V	5,13 Seconds	Active 5seconds	Active Counting

From the test results above, all systems can run, the duration of fast communication between the NODEMCU and the BLYNK application is strongly influenced by the internet signal or not on both devices is strong.

The ultrasonic sensor works well in detecting the water level in the tube, as well as the infrared sensor which can quickly detect the presence of objects so that the system can work quickly.

4. CONCLUSION

The IoT system has worked well by providing information in real time, namely the liquid spray time of about 5 seconds and information on the height of the remaining liquid in the tube from level 5-70. The sensor sends data to the MCU Node with an average output pin voltage of 4.89 V when the sensor detects an obstacle in front of the sensor.

The farther the distance read by the ultrasonic sensor Ultrasonic sensor HC-SR04, the greater the voltage sent by the sensor output pin to the NODEMCU digital pin, the highest voltage reaches 673.2 mV when the distance to the object is 40 cm, and the voltage will decrease. when the distance that is read is close, i.e., with the lowest voltage is 100.3 mV with the closest distance is 5 cm.

ACKNOWLEDGEMENTS

I hereby declare that this journal is the original result of my research and that of my colleagues, I thank the Head of the Electrical Engineering Study Program who has supported this research.

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