Jurnal Inovasi Pendidikan dan Sains
Vol. 5 No.3, Desember 2024: 100-106 ISSN 2721-9119 (Online)

ENERGY SAVING HANDWASHER DESIGN USING INFRA RED OBSTACLE SENSOR BASED ON ARDUINO MICROCONTROLLER

Jumrianto[1]*, Dewi Purnamasari[1]

[1]Program Study Sistem dan Teknologi Informasi Faculty Sains dan Teknologi University IVET Indonesia

*Email: jumrianto.ivet@gmail.com

Accepted: October 19th 2024. Approved: December 1th 2024. Published: December 15th 2024

Abstract: The Covid-19 pandemic is over, the good habit of washing hands with soap must be maintained, because it concerns a clean and healthy lifestyle. The unavailability of automatic hand washing devices on the IVET University Campus is a motivation to create an application tool, in its application it will use an infrared obstacle sensor by coding commands through Arduino software. Based on a review of previous research, no one has designed a hand washer device with an energy-efficient infrared obstacle sensor. Utilizing Arduino software and hardware with a current consumption of <0.050 amperes on standby. When operating, this device consumes a current of <0.5 amperes which opens and closes the water tap. The operating voltage of the microcontroller is 5 volts, so this device consumes 2.5 watts of electricity, and if it operates for 1000 hours or for ±41 days continuously without stopping, it only uses 2.5 KWh of electricity and when on standby for 1000 hours this device uses 0.25 KWh of electricity.

Keywords: handwasher, servo, arduino

INTRODUCTION

The end of the Corona Virus Disease 2019 (COVID-19) Pandemic in the territory of the Unitary State of the Republic of Indonesia is marked by the stipulation of Presidential Decree (Kepres) No. 17 of 2023, effective on June 21, 2023. However, the community must continue to implement a clean and healthy lifestyle. Among them is washing hands as often as possible. More than 5,000 toddlers suffering from diarrhea die every day worldwide due to lack of access to clean water and sanitation facilities and health education. The eight recommended times for us to wash our hands include: Every time our hands are dirty: (eg typing, holding money, animals, gardening), After defecating, Before breastfeeding a baby, After cleaning a baby or child, Before eating and feeding a child, before handling food and after eating, After playing in mud or dirty places and after sneezing/coughing. The United Nations (UN) has launched a Global Handwashing Day (HCTPS) attended by 20 countries, one of which is Indonesia, namely October 15 at the Annual World Water Week which took place on August 17-23, 2008 in Stockholm [1]. Three determinant factors in people's handwashing behavior, namely: Predisposing factors, Enabling factors, Reinforcing factors [2]. Soap must be in contact with the skin for at least 10 seconds and clean both hands and fingers for 10-15 seconds [3]. The Automatic and Hygienic Hand Washing Machine Based on Camera uses a waterproof ultrasonic sensor so that there are no problems with water splashes on the sensor [4]. The Automatic Hand Washing Machine Using an Optocoupler Sensor works well, with a delay of 5.5 seconds with an error of 10%. If the hand detection sensor is blocked by an object for more than 5 seconds, there will be a delay of 77 milliseconds for the next ON state [5]. Hand Washing Tap Automation System using Infrared and AT89S51 Microcontroller. The system consists of two pairs of infrared sensor circuits, a comparator circuit, a relay, an AT89S51 microcontroller, and an LCD display [6]. Cheap Automatic Hand Washing Device Without a Microcontroller With an Infrared Distance Sensor in 2020, has the advantage of being able to operate anywhere and anytime and is very stable [7]. Making a Hand Washing Device that can function properly to help prevent the spread of Covid-19 [8]. The 300 liter Touchless Moveable Hand Washing Device with a heavy iron frame uses an ultrasonic sensor [9]. An automatic hand washing device based on solar energy with a water tap and water pump that uses a lot of electrical energy of 400 watts [10]. The hand washing device uses a waterproof ultrasonic sensor, namely the JSN-04T type and a camera that requires a long process to recognize human hand objects. This of course also requires expensive costs [4]. Hand Sanitizer and Automatic Hand Washing Device electric dispenser pump, relay and ultrasonic sensor [11]. Portable automatic hand washing tool with water pump and solenoid valve that uses large electrical power [12]. Hand washing tool with Ultrasonic Sensor HC-SR04, Arduino Nano Atmega 168, NodeMCU Microcontroller, DC water pump, Relay, IOT-based system in the application connected to the smartphone, namely Blynk which will display the remaining water volume in the water tank [13]. Portable Automatic Hand Washing Tool With Arduino Uno Microcontroller Technology based on solar panels using a pump that uses large power [14]. Automatic Hand Washer and Hand Dryer With Human Interface Module (Hmi) Using T Ft Adafruit 2.8 ”Based on Arduino Mega2650 Servo Motor, Arduino 2.4” E TFT Touch Shield, 12Vdc/7.5A DC motor that uses quite a lot of electrical energy [15]. The Smart Trash Bin then tests the current capacity on the Arduino ESP8266 module of 23 milli Amps (mA), the current on the Servo

Motor module of 156.7 mA, the current on the HC-SR04 Sensor module of 2.7 mA, and the LED Indicator Wear of 9.67 mA [16]. Laily Muntasiroh and Radiktyo Nindyo Sumarno made a Smart Trash Can then tested the Current capacity on the Arduino ESP8266 module of 23 milli Amps (mA), the Servo Motor module Current of 156.7 mA, the HC-SR04 Sensor module Current of 2.7 mA, and the LED Indicator Wear of 9.67 mA [17]. Ellys Kumala et al., made a hand washing device manually, then modified it by pressing or turning the lever to become semi-automatic [18]. Izza Anshory et al., made a hand washing device with a sensor and microcontroller to activate the timer relay that will move the DC motor on and off [19]. Marcelinus Petrus et al., implemented an automatic hand washing system and liquid soap bottle based on the Arduino nano Atmega328 microcontroller on a sink with an IR Obstacle sensor that can function properly [20]. Didik Sugiyanto et al., have succeeded in making a hand washing device using a footrest mechanism on a 120 liter water tank. When the pedal is released, it returns to its original position because the spring is attached to the footrest, the flowing water will automatically stop [21]. Muchlis Kurnianto, made an Arduino-based automatic hand washing prototype with components that can be connected and function properly so that the device can work optimally [22]. Sujiliani Heristian made a hand washing device with a Raspberry PI microcontroller, connected to the Internet of Things (IoT) to monitor the amount of water in the tank via the Message application, when the water starts to run out, a notification will be sent to Telegram [23]. Tri Hannanto made a hand washing device with an infrared sensor to detect the presence of hands. Water is released through a pump controlled by a solenoid valve. Relays are used to control input and output so that water and soap liquid can come out automatically [24].

State Of the Art and Novelty

Review of previous research, no one has designed a hand washer device with an energy-saving infrared obstacle sensor. On average, using an electric pump motor, relay and electric valve that uses large electrical power. Researchers and teams utilize gravity in the flow of water, thus saving the use of electrical energy in its use. Therefore, the research team determined the state of the art, namely making an automatic hand washer without touch with an energy-saving infrared obstacle sensor by utilizing the gravity of the water flow, so that the use of electrical energy is very efficient, because it does not use a pump, relay and electric valve. And to facilitate mobilization, it can be carried anywhere according to needs or portable.

RESEARCH METHODS

1. Block Diagram

Block Diagram (Block Diagram) Research Planning will be carried out as Figure 1. By using the Obstacle sensor as the main sensor. If the soap sensor is blocked by hand, the microcontroller will read and order the servo motor to move to open the soap tap, as well as the sensor to open the water tap.

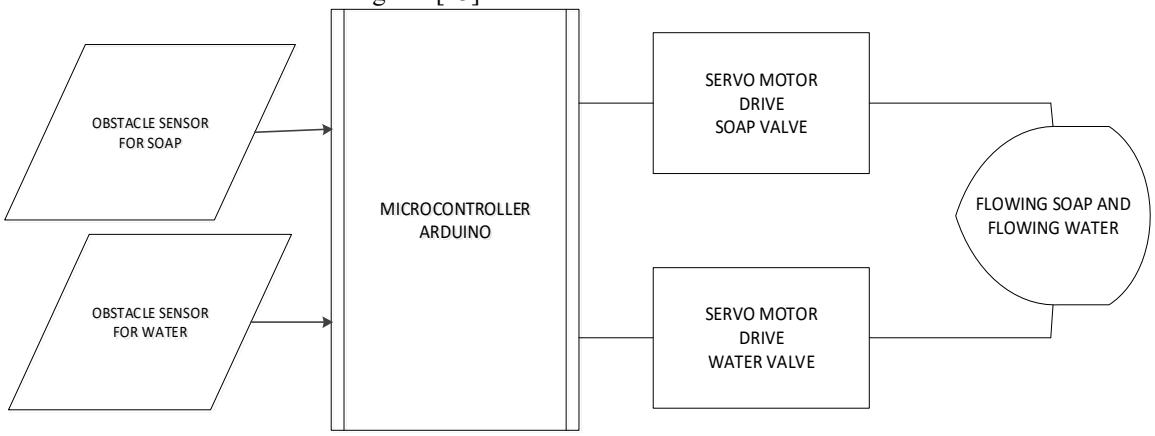

Figure 1. Block Diagram of Automatic Hand Washer Manufacturing

2. Software Flow Chart

The flow chart for making an Automatic Hand Washer is shown in Figure 3.2. It begins with Start, then initializes the microcontroller, determines the input port and output port used, then checks whether the soap sensor and water sensor are in LOW condition, if the condition is LOW, then the microcontroller orders the servo motor to move 120 degrees to open the soap tap and water tap. The soap sensor will continue to open if the condition is LOW or when the sensor is blocked by a hand. While the soap sensor when in LOW condition, will order the servo motor to move 120 degrees to open the water tap for 10 seconds according to the standard hand washing time of 10-15 seconds.

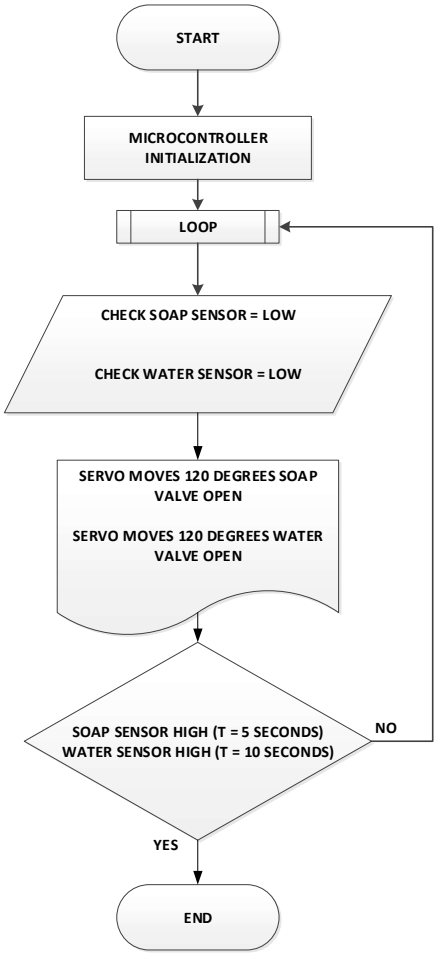

Figure 2. Flow Chart of Portable Automatic Hand Washer Control Software

3. Research Steps

Creating a Hand Washing Hardware Design, with the following steps:

a. Making a Frame and Box for the hand washing place by utilizing construction from plates, iron, PVC pipes, etc.

Figure 3. Preparation for designing the device

b. Create a device layout on the box and frame, so that they do not interfere with the function of each tool.

Figure 4. Device layout fitting

c. Design the piping layout to suit the water flow and soap flow, making it easier to wash hands.

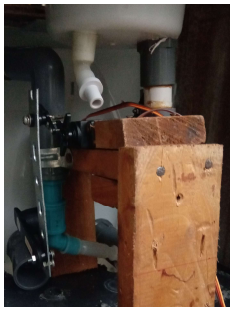

Figure 5. Designing the layout of pipes and taps

d. Design the layout of Arduino controls, sensors and servo motors according to their functions, and ensure that each does not cause delays in other devices.

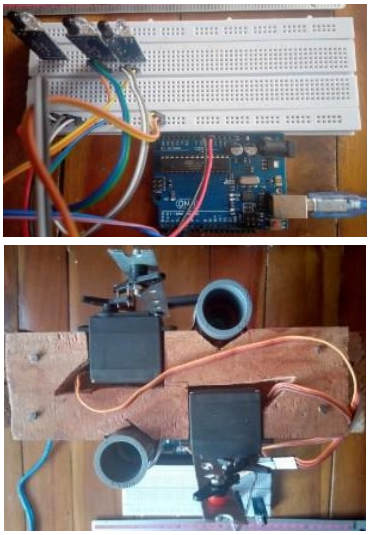

Figure 6. Arduino control layout

e. Design a water container using a 19-liter gallon that is widely available and can be refilled at various filling places. Meanwhile, the soap container is adjusted to a capacity of about 1 liter of water mixed with soap for each 19-liter gallon of water, and it is attempted to be even more economical.

Figure 7. Placement of water gallons

f. Test the water tap, whether it opens or closes at the right time, don't do it too late or too early when washing your hands.

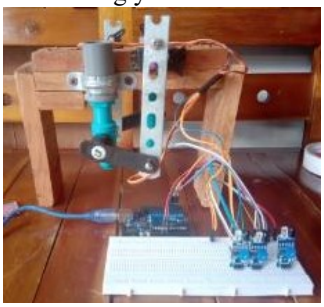

Figure 8. Water kra testing before installation

g. The soap faucet will open if the hand is directed and blocks the soap sensor with a distance of about 1 to 5 cm from the soap sensor, and the duration is according to needs. If a little soap is needed, then 1 - 3 seconds is enough, if a lot of soap is needed, then direct the hand to the soap sensor longer, if it is enough then the hand is directed to the water sensor.

Figure 9. Soap Faucet Testing

h. The water tap will open when the hand is directed at the water sensor. And the water will continue to flow for 3 to 5 seconds. If 5 seconds have been fulfilled, the water tap will close. If it still feels less clean, then it can be repeated by directing the hand at the sensor.

Figure 10. Water tap testing

i. The final stage is painting and labeling and providing instructions for the device so that there are no mistakes in operating the device.

RESULTS AND DISCUSSION

A. Hardware Design Realization

At the hardware realization stage, there is an Arduino UNO circuit placed in a box connected by a jumper cable. The IR Obstacle sensor is inserted into an Elbow-shaped PVC pipe to protect the sensor from water and from excessive light exposure that can cause errors in sensor readings. The function and work of each device are given in the following points:

1. Arduino UNO is a microcontroller from a device that is tasked with receiving data from each sensor. In this microcontroller, there are inputs and outputs that can be used as anything the programmer wants, whether as a place to receive commands or a place to issue commands.
2. The water tap opening and closing section is connected to a 180-degree servo motor actuator, type MG995 mini servo, which is

strong enough with a torque capacity of ±9 Kg/cm with a voltage of 5 volts.

3. The first HC-SR04 module (1), is used to read the condition of a full trash can. Where the module will convert analog values to digital values on the ultrasonic sensor.
4. The Infrared Obstacle Sensor Module is used to read the presence of the palms of people who will wash their hands or give soap. Where the module works by converting analog values to digital values with active low.

The finished and ready-to-operate device is shown in Figure 11 To facilitate interaction with the device, the soap sensor design is on the left and the water sensor is on the right.

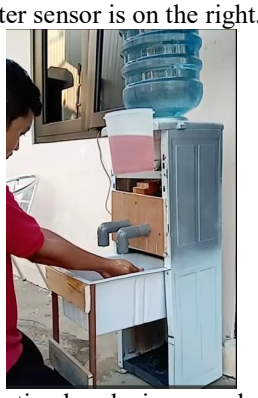

Figure 11. Testing by placing your hands on both sensors

B. Software Design Realization

Programming in this study uses the Arduino language which is already popular in the world of robotic and IOT coding. The core program is as follows:

```
void loop()
{
if ((digitalRead(sensor1))==LOW)
{myServo1.write(120);
delay(3000);}
else
{myServo1.write(0);}
delay(50);

if ((digitalRead(sensor2))==LOW)
{myservo2.write(120);
delay(5000);}
else
{myservo2.write(0);}
delay(50);
}
```

C. Realization of Device Testing

The testing phase must be carried out to determine the performance of hardware and software devices. The results of the power usage test on the device are written in Table 1.

Table 1. Power Consumption Capacity Testing when the Device is Operating

Componen Name	Voltage	Current	Power
Arduino UNO Module	5 V	50 mA	0,05 W
Motor Servo MG995	5 V	158 mA	0,158 W
Motor Servo MG995	5 V	158 mA	0,158 W
Sensor 1 IR Infrared Obstacle	5 V	43 mA	0,043 W
Sensor 2 IR Infrared Obstacle	5 V	43 mA	0,043 W
Total	5 V	452 mA	0,452 W

If seen from Table 1, the power consumption when the device is operating is less than 0.5 watts. This is certainly a consideration of the efficiency of this device in consuming electrical energy. Testing the success of the sensor in responding to the distance of the human hand to the water sensor when operating the device is written in Table 2.

From Table 2 it can be seen that the furthest distance that can be reached by the sensor to move the water valve opening servo motor is 8 cm. more than 8 cm can no longer be reached by the sensor. While the closest distance is 1 cm. So the sensor's range is 0-8 cm.

Table 2. Testing of Water Sensor valve and Servo Motor

Hand Distance Test on Water Sensor	Expected results	Note
1 cm	Motor Servo ON, valve ON 5 second	OK
2 cm	Motor Servo ON, valve ON 5 second	OK
3 cm	Motor Servo ON, valve ON 5 second	OK
4 cm	Motor Servo ON, valve ON 5 second	OK
5 cm	Motor Servo ON, valve ON 5 second	OK
6 cm	Motor Servo ON, valve ON 5 second	OK
7 cm	Motor Servo ON, valve ON 5 second	OK
8 cm	Motor Servo ON, valve ON 5 second	OK
9 cm	Motor Servo OFF, valve Close	NOK
10 cm	Motor Servo OFF, valve Close	NOK

Testing the success of the sensor in responding to the distance of the human hand to the soap sensor when operating the device is written in Table 3.

From Table 3 it can be seen that the furthest distance that can be reached by the soap sensor to move the soap valve opening servo motor is 8 cm. more than 8 cm can no longer be reached by the sensor. While the closest distance is 1 cm. So the range of the soap sensor is 0-8 cm

Table 3. Testing of Soap Sensor valve and Servo Motor

Hand Distance Test on Soap Sensor	Expected Results	Ket
1 cm	Motor Servo ON, valve Open 3 second	OK
2 cm	Motor Servo ON, valve Open 3 second	OK
3 cm	Motor Servo ON, valve Open 3 second	OK
4 cm	Motor Servo ON, valve Open 3 second	OK
5 cm	Motor Servo ON, valve Open 3 second	OK
6 cm	Motor Servo ON, valve Open 3 second	OK
7 cm	Motor Servo ON, valve Open 3 second	OK
8 cm	Motor Servo ON, valve Open 3 second	OK
9 cm	Motor Servo OFF, valve Close	NOK
10 cm	Motor Servo OFF, valve Close	NOK

CONCLUSION

When operating this device consumes a current of <0.5 ampere that opens and closes the water tap. The operating voltage of the microcontroller is 5 volts, so this device consumes 2.5 watts of electricity, and if operating for 1000 hours or for ±41 days continuously without stopping, it only uses 2.5 KWh of electricity and when on standby for 1000 hours this device uses 0.25 KWh of electricity. The range of the soap sensor and water sensor is 0-8 cm.

ACKNOWLEDGMENTS

Special thanks to IVET University Semarang Indonesia.

REFERENCES

[1] Kementerian Sekretariat Negara Republik Indonesia. (2023). Keputusan Presiden Republik Indonesia Nomor 17 Tahun 2023 Tentang Penetapan Berakhirnya Status Pandemi Corona Virus Disease 2019 (Covid-19) Di Indonesia.https://jdih.setkab.go.id/PUUdoc/177014/Salinan_Keppres_Nomor_17_Tahun_2023.pdf

[2] Suryani, S. I., & Sodik, M. A. (2018). Perilaku Cuci Tangan Pakai Sabun. https://doi.org/10.31227/osf.io/g3fw2

[3] Risnawaty, G. (2017). Faktor Determinan Perilaku Cuci Tangan Pakai Sabun (Ctps) Pada Masyarakat Di Tanah Kalikedinding. Jurnal PROMKES, 4(1), 70. https://doi.org/10.20473/jpk.v4.i1.2016.70-81.

[4] Ambarwati, E. R., & Prihastuti. (2019). Gerakan masyarakat hidup sehat (germas) mencuci tangan menggunakan sabun dan air mengalir sebagai upaya untuk menerapkan perilaku hidup bersih dan sehat (phbs) sejak dini. Celebes Abdimas: Jurnal Pengabdian Kepada Masyarakat, 1(1), 45–52. https://www.neliti.com/publications/280184/

[5] Sukri, H. (2019). Perancangan Mesin Cuci Tangan Otomatis dan Higienis Berbasis Kamera. Rekayasa, 12(2), 163–167. doi: 10.21107/rekayasa.v12i2.5540

[6] Santoso, H. (2008). Mesin Cuci Tangan Otomatis Menggunakan Sensor Optokopler. 69. https://repository.usd.ac.id/view/year/2008.type.html

[7] Wulandari, D. A. (2008). Sistem Otomatisasi Kran Pencuci Tangan. 1–6. http://eprints.undip.ac.id/6594/

[8] Baihaqi, M. (2020). Alat Cuci Tangan Otomatis Murah Tanpa Mikrokontroler Dengan Sensor Jarak Infrared. https://www.scribd.com/document/469902748/

[9] Juen Olive Manduapessy, Sigit Sugiarto, D. H. (2020). Rancang Bangun Prototipe Wastafel Cuci Tanganotomatis Menggunakan Arduino Mega 2560 Dan E18- D80nk Infrared Sensor Untuk Pencegahan Penyebaran Covid -19. https://www.academia.edu/43320883/

[10] Abdullah, N., Arif, Z., & Suheri, S. (2021). Alat Pencuci Tangan Movable Jenis Touchless Sebagai Alat Pemutus Rantai Penularan Covid-19. Abdi: Jurnal Pengabdian Dan Pemberdayaan Masyarakat, 3(1), 77–82. doi: 10.24036/abdi.v3i1.80

[11] Heri Suripto, U. S. J. (2021). Analisis Perancangan dan Pengujian Alat Cuci Tangan Otomasis Berbasis Energi Surya 100 WP. Accurate: Journal of Mechanical Engineering and Science, 2(1), 14–21. doi: 10.35970/accurate.v2i1.580.

[12] Muhammad Nur Iman, J. Y. (2021). Pembuatan Alat Hand Sanitizer dan Cuci Tangan Otomatis dalam pencegahan penularan Virus Covid-19. JATI (Jurnal Mahasiswa Teknik Informatika), 6(1), 38–44. doi: 10.36040/jati.v6i1.4304.

[13] Tri Hannanto, D. (2020). Rancang Bangun Mesin Cuci Tangan Otomatis Portable Untuk Mengurangi Efek Pandemi Covid 19. Logista Jurnal Ilmiah Pengabdian Kepada Masyrakat, 4(2). https://doi.org/10.25077/logista.4.2.534-540.2020.

[14] Khairunnisa, V. (2021). Perancangan Alat Cuci Tangan Otomatis Tanpa Kontak Fisik Berbasis Iot. September, 22. http://repository.unsri.ac.id/id/eprint/54510

[15] Febriansyach, R., Santoso, D. B., & Latifa, U. (2020). Rancang Bangun Alat Cuci Tangan Otomatis Portable Dengan Teknologi Mikrokontroler Arduino Uno. Electro Luceat, 6(2), 133–141. doi: 10.32531/jelekn.v6i2.225.

[16] Manullang, G. R. M. (2019). Rancang Bangun Alat Pencuci Tangan Dan Pengering Tangan Otomatis Dengan Human Modul Interface (Hmi) Menggunakan T Ft Adafruit 2.8" Berbasis Arduino Mega2650. Rabit : Jurnal Teknologi Dan Sistem Informasi Univrab, 1(1). http://digilib.unila.ac.id/id/eprint/56586

[17] Muntasiroh, L., & Sumarno, R. N. (2022). Rancang Bangun Smart Trash Can Dengan NodeMCU ESP8266 Menggunakan Sistem Monitoring Berbasis Komunikasi Telegram Messenger. Fidelity, 4(3), 49–56. https://doi.org/10.52005/fidelity.v4i3.125

[18] Pramartaningthyas, E. K., Hariyadi, M., Afiyat, N., & Ma'shumah, S. (2022). Implementasi Alat Pencuci Tangan Tanpa Kontak Otomatis Di Balai Desa Karang Agung Kecamatan Glagah Kabupaten Lamongan. Jurnal Abdi Masyarakat, 6(1), 81–92. doi: 10.30737/jaim.v6i1.3327.

[19] Anshory, I., Hadidjaja, D., & Sulistiyowati, I. (2021). Implementation of Automatic Handwashing Waist for Covid-19 Prevention. Jambura Journal of Health Sciences and Research, 3(2), 154–161. doi: 10.35971/jjhsr.v3i2.9798.

[20] Saptono, M. P., Murniyasih, E., Mustafa, R., Saint, P., Sorong, P., & Com, M. P. (2022). Design Implementation of Automatic Hand Washer and Liquid Soap Bottle Based on Arduino Nano Atmega328. Jurnal Elektro Luceat, 8(1). https://doi.org/10.32531/jelekn.v8i1.452

[21] Sugiyanto, D., Susanto, H., Siregar, R., & Darius, A. (2021). Pembuatan Alat Portable Hand Washer (PHW) Dengan Sistem Kran Injak Kaki Untuk Mencegah Penularan Covid-19. Jurnal Kajian Teknik Mesin, 6(1), 20–25. doi: 10.52447/jktm.v6i1.4355.

[22] Kurnianto, M. (2020). Prototipe Cuci Tangan Otomatis Berbasis Arduino Uno. https://eprints.ums.ac.id/88894/1/NASKAH%20PUBLIKASI.pdf

[23] Sujiliani Heristian, Rachmat Adi Purnama, A. R. (2022). Rancang Bangun Alat Cuci Tangan Otomatis Dengan Notifikasi Telegram Berbasis Raspberri PI. CONTEN : Computer and Network Technology, 2(1), 1–7. https://doi.org/10.31294/conten.v2i1.1119

[24] Tri Hannanto Saputra, Herda Agus Pamasaria, Bondan Wiratmoko, Reza Hermawan, R. S. (2013). Rancang Bangun Mesin Cuci Tangan Otomatis Portabel Untuk Mengurangi Efek Pandemi Covid 19. Logista-Jurnal Ilmiah Pengabdian Kepada Masyarakat, 53(9), 1689–1699. https://doi.org/10.25077/logista.4.2.534-540.2020