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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Development of a Portable Hand Sanitizer Based on Arduino

Norfadhilah Binti Hasan [a], Wahidah Binti Abd Manap [b], Saiful Azizi Bin Abdullah [c]*

[a,b,c] *Jabatan Kejuruteraan Elektrik, Politeknik Sultan Mizan Zainal Abidin, Terengganu, Malaysia.*

DOI: https://doi.org/10.55248/gengpi.4.723.48037

A B S T R A C T

In the ongoing era of the COVID-19 endemic, hygiene is an important aspect that needs to be emphasized. Hand sanitization is one of the most effective tools in preventing the transmission of microorganisms, which are the cause of diseases. This created portable hand sanitization project aims to provide an alternative that is more effective and practical than manually used soap. The project is equipped with an ultrasonic sensor and an Arduino UNO microcontroller to detect hand movements and automatically dispense a sanitizing spray. This makes it user-friendly and easy to use. The advantage of this project is that it does not require hand contact and is suitable for everyone, especially individuals with disabilities and children. Additionally, with its attractive design, this project is seen to be able to attract users' interest, especially among students. The development of this project is seen as a significant contribution to the efforts to combat the spread of contagious diseases and prevent the continuous transmission of COVID-19.

Keywords: Hand sanitizer, portable, Arduino

1. Introduction

The twenty-first century has witnessed the emergence of a formidable viral adversary that has reshaped the world as we know it the coronavirus, scientifically identified as SARS-CoV-2. Since its initial identification in December 2019, this virus has unleashed a wave of devastation, leaving an indelible mark on humanity (Gautam, 2022 & G, 2023). Its rapid transmission, combined with its profound and often deadly consequences, has rightfully earned it a place among the deadliest viruses in recent history. As a result, the urgent need to address health issues has become a paramount concern in global discussions. Health now is a vital aspect of life, and one of the simplest ways to maintain overall well-being is by practicing proper hand hygiene, such as washing hands regularly. By prioritizing health, individuals can enhance their productivity and contribute to the well-being of their families. Maintaining hand hygiene is particularly crucial since our hands are frequently exposed to germs during daily activities, making them a common pathway for bacteria to enter our bodies and cause illness. However, by practicing regular handwashing, the potential mortality rate from infections can be reduced (Gozdzielewska, 2022).

To address this concern, the use of hand sanitizers presents an additional preventive measure. Hand sanitizers typically contain alcohol, which exhibits high effectiveness to controlling viruses and bacteria (Abuga.K, 2021). Nevertheless, hand sanitizers also have limitations. Research has highlighted the potential risk of germ exposure associated with traditional hand sanitizers due to the need to touch the dispenser, which can inadvertently spread germs to others (Lee J, 2020). This issue becomes even more challenging for individuals with disabilities, such as those using wheelchairs or young children, as traditional hand sanitizers are often positioned too high or inconveniently placed.

To address these concerns, an innovative solution has emerged: the Portable Hand Sanitizer. This groundbreaking device revolutionizes hand hygiene by eliminating the need for physical contact. It incorporates a built-in sensor that detects the presence of hands and dispenses sanitizer automatically. By simply extending their hands, individuals can effectively maintain hand hygiene without the risk of transmitting germs to themselves or others.

This remarkable alternative to traditional sanitizers offers a touch-free and convenient experience, especially beneficial for individuals with disabilities. By utilizing an ultrasonic sensor, the system accurately detects hand motions or presence. The sensor captures this data and seamlessly transmits it to an Arduino Uno microcontroller, which activates the pump to dispense sanitizer automatically. Rigorous testing has demonstrated the system's smooth operation with minimal errors in data transmission, ensuring its reliability and effectiveness in delivering a hygienic and hassle-free hand sanitization experience.

2. Methodology

This hand sanitizer project is divided into two main parts: hardware and software.

2.1 Hardware design

Figure 1 depicts the block diagram of the project, with the Arduino Uno serving as its central component. The project relies on an ultrasonic sensor to provide input by detecting motion, specifically hand movement during product usage. To power the Arduino, a power bank capable of supplying around 5V is required. Moving on to the output, this project utilizes a relay module. When the sensor receives a signal, the relay acts as a switch (Surani, 2021), triggering the activation of a water pump. Consequently, the pump dispenses sanitizer liquid from a designated container.

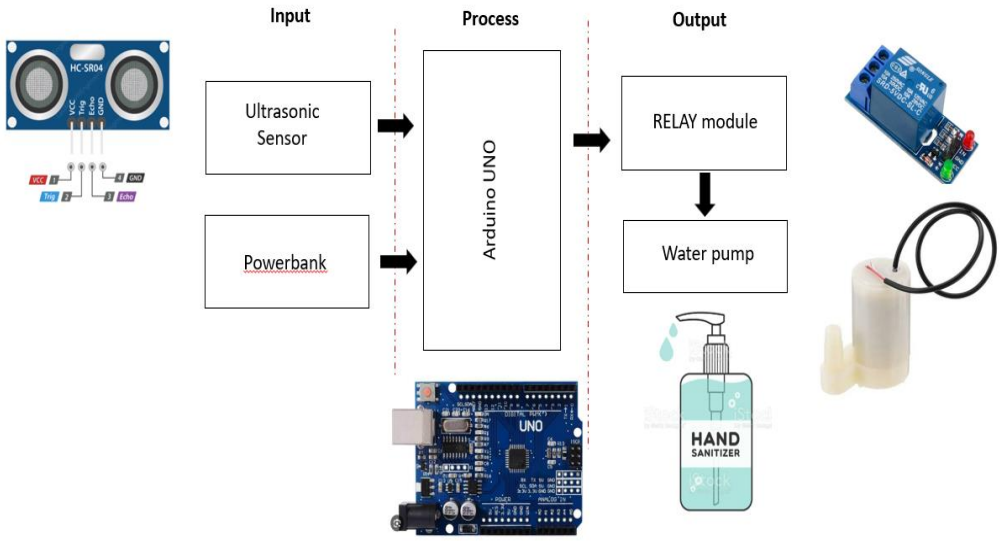

Fig. 1 - Block diagram of hand sanitizer.

The detailed connections for this portable hand sanitizer can be observed in the schematic diagram presented in Figure 2 below. Based on the developed schematic circuit, it can be seen that the ultrasonic sensor circuit is connected to the Arduino circuit using a circuit board known as a breadboard. Next, the Arduino is connected to the relay module circuit, which serves as a switch. The water pump is directly connected to the relay module. A power bank is used as the power supply to activate components such as Arduino and others. The power bank is chosen for its convenience and compact size.

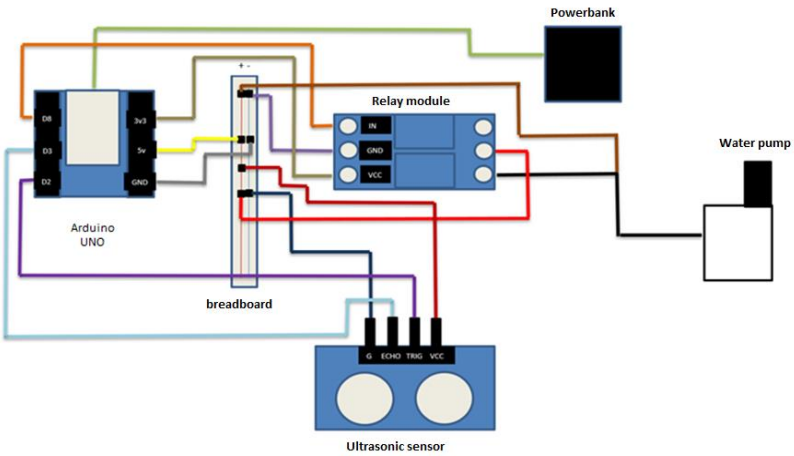

Fig. 2 - Schematic diagram of portable hand sanitizer.

2.2 Software design

Moving on to the software aspect, the Arduino IDE (Integrated Development Environment) is utilized as the software platform for programming and controlling the hand sanitizer system. The Arduino IDE provides a user-friendly interface and a wide range of programming tools and libraries to facilitate the development process. The programming has been successfully completed and integrated into the Portable Hand Sanitizer system project. Within this programming system, a time duration of 2 seconds has been set for liquid dispensing. When the ultrasonic sensor detects hand movement, a signal is sent

to the relay module through a program created in the Arduino IDE. The relay module activates the water pump for a duration of 2 seconds to dispense the sanitizing liquid. This 2-second duration is sufficient for cleaning the user's hands.

```
sketch_dec14a§
const int trigPin = D2;
const int echoPin = D3;
const int relayPin = D8;

long duration, distance;

void setup()
{
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
pinMode(relayPin, OUTPUT);

 }
void loop()
{
digitalWrite(trigPin, LOW);                 // Clears the trigPin
delayMicroseconds(2);                     // Sets the trigPin on HIGH state for 10 microseconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);                    // Reads the echoPin, returns the sound wave travel in us
duration = pulseIn(echoPin, HIGH);                  // Calculating the distance
distance = duration*0.034/2;                // Prints the distance on the Serial Monitor

  if(distance<5){
      digitalWrite(relayPin,LOW);
      delay(1000);
      digitalWrite(relayPin,HIGH);
      }

    else {
      digitalWrite(relayPin,HIGH);

    }
  Serial.print("distance: ");
  Serial.println(distance);
}
```

Fig. 3 – Example of portable hand sanitizer programming.

With the combination of hardware and software components, the hand sanitizer project aims to create an effective and aesthetically pleasing solution for maintaining hand hygiene and promoting cleanliness.

3. Result and Discussions

Figure 4 presents a comprehensive flowchart illustrating the operational flow of the Portable Hand Sanitizer, specifically designed to automate the dispensing of sanitizer liquid. The flowchart outlines a series of sequential steps that define the system's functionality. The process initiates with the system being powered on and initializing its components. Once initialized, the ultrasonic sensor starts detecting motion in its proximity. Upon detecting motion, indicative of a hand's presence, the system proceeds to dispense the sanitizer liquid. The program is configured to dispense the liquid for a duration of 2 seconds, typically adequate for sanitizing both hands. Subsequently, the system reverts to its normal state, ready to detect further motion. In the absence of motion, the system remains idle, refraining from dispensing any liquid. By automating this process, the system offers a convenient and touch-free solution to promote effective hand hygiene.

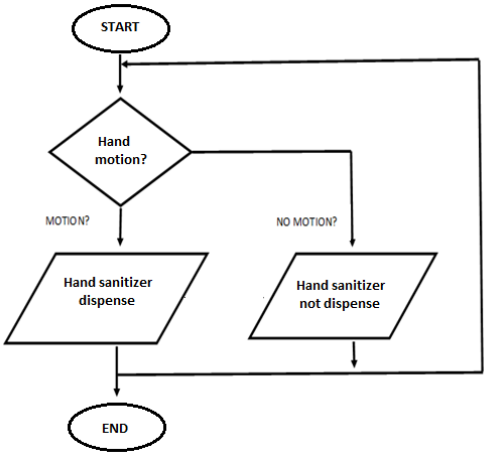

Fig. 4 Flowchart of the portable hand sanitizer.

In the Portable Hand Sanitizer system, careful consideration is given to the strategic positioning of the circuit and water pump to optimize operational efficiency (refer to figure 5). The circuit, comprising the Arduino board, ultrasonic sensor, relay module, and power supply, is typically housed within a dedicated control unit or enclosure. This arrangement ensures the protection and organization of the electronic components, promoting the system's overall reliability. As for the water pump, its placement is designed to be in close proximity to the sanitizer solution container or reservoir. This proximity allows for a seamless connection between the pump and the liquid source. The water pump is connected to the relay module, which serves as the control interface, receiving signals from the ultrasonic sensor. These signals trigger the relay module to activate or deactivate the water pump accordingly. It's important to note that the exact placement of the circuit and water pump may vary depending on the specific design and implementation of the Portable Hand Sanitizer system. However, regardless of the configuration, it is crucial to ensure that the circuit is correctly connected to all relevant components, and the water pump is positioned to facilitate efficient dispensing of the sanitizer liquid when activated by the relay module.

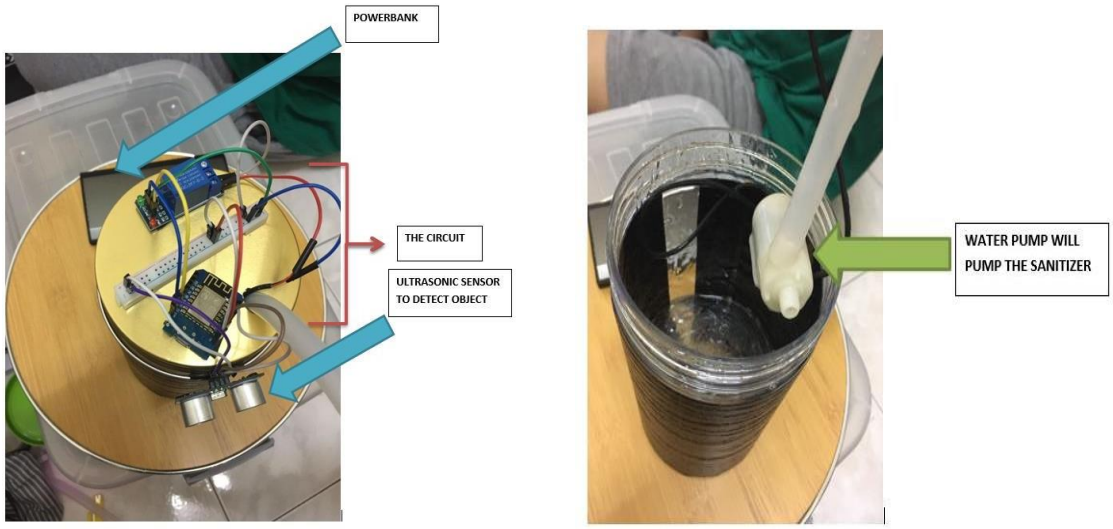

Fig. 5 Circuit and water pump location in the system

Fig. 6 The portable hand sanitizer.

The final product of the portable hand sanitizer can be seen in Figure 6. It features a compact and highly portable design, making it incredibly convenient for users to carry it with them wherever they go.

Additionally, this portable hand sanitizer system incorporates an ultrasonic sensor that is connected to the microcontroller. This sensor functions automatically to detect the motion of objects, particularly the presence of a hand. When the ultrasonic sensor receives a signal indicating the presence of an object, the system activates the pump, resulting in the automatic dispensing of the sanitizer liquid. This touch-free operation helps prevent the spread of bacteria or viruses since there is no direct need to touch the water pump.

To evaluate the performance of the ultrasonic sensor system, seven experiments were conducted, varying the distance between the sensor and the object. The experimental distances ranged from 10 mm to 80 mm. The results of these experiments are summarized in Table 1. The sensor was found to successfully detect hands at distances less than 60 mm, while no detection was observed beyond that threshold. This research provides valuable insights into the functionality of the ultrasonic sensor system, demonstrating its effectiveness in detecting hand motion and triggering the automatic dispensing of sanitizer liquid. By accurately detecting objects within the specified range, the system ensures reliable and hygienic operation.

Table 1 – Distance hand from the sanitizer.

Distance (mm)	Result
10	Sensor detect
20	Sensor detect
30	Sensor detect
40	Sensor detect

50	Sensor detect
60	Sensor detect
70	Sensor not detect
80	Sensor not detect

The practicality of the product has been demonstrated through its successful utilization in lecture halls at the institutions as illustrated in Figure 7. Furthermore, its versatility allows it to be easily taken to different events or celebrations. The students who use this portable hand sanitizer are especially fascinated by its robot-like appearance.

Fig. 7 Implementation of portable hand sanitizer in lecture halls.

4. Conclusion

In conclusion, the comprehensive testing and analysis conducted on the automatic hand sanitizer system have yielded promising results. The system demonstrates smooth operation with minimal detection errors during data transmission. The ultrasonic sensor effectively detects hand motion within a range of up to 60mm. The ultrasonic sensor successfully sends data to the Arduino. With these findings, it can be confidently concluded that the developed system functions seamlessly, effectively contributing to the prevention of the spread of COVID-19. By providing a touch-free hand sanitization experience, this innovative solution offers a reliable means of maintaining hygiene and reducing the risk of germ transmission. The successful implementation of such a system holds great potential in safeguarding public health and combating the ongoing COVID-19 pandemic.

Acknowledgements

We would like to express our sincere gratitude to Politeknik Sultan Mizan Zainal Abidin, Dungun, Terengganu, Malaysia for providing us with the opportunity to complete this project.

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