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A Compact Hygiene and Sterilization Prototype to Curb the Outbreak of Covid-19 and Other Contagious Diseases

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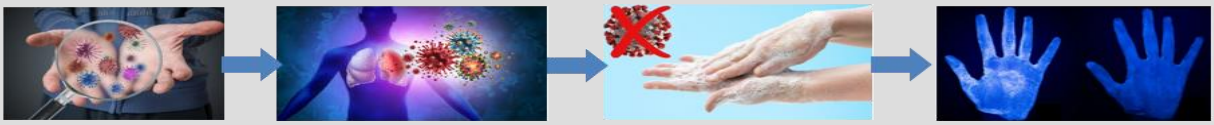
Abstract: With the spread of deadly virus such as Covid-19, which is so far incurable and mainly transferrable through touch and contact, only precautionary measures are considered to prevent it. As per the guidelines of WHO, provided for Corona Virus, washing hands and sanitizing them frequently is one of the prime effective solutions. There are hundreds of other contagious diseases that spread through the contact of hands. In addition to that, sterilization of accessories such as mobile phone, keys, wallet etc. with least manual intervention is also need of the time. There are separate systems available in the market but there is no compact system that contains all the necessary features on single platform. Therefore, taking all these factors into consideration, this project proposes a novel design of one-stop compact touch-less station for hand washing, sanitization, and manual sterilization. The hand hygiene prototype works on a very low power of 12v. It avoids contact of people with system to get Water, Soap and Sanitizer. This prototype based on the range of 4cm to 18cm from which 4 to 8cm is for soap, 12 to 14cm for sanitizer and 16 to 18cm for water according to defined ranges the prototype is properly working and it is also showing a 20 second timer after the user takes soap. This prototype may prove to be helpful in controlling the hygiene standards in private as well as public places like Educational Institutes, Hospitals, Malls, Offices, Mosque, Railway Stations and all other places where human intervention is involved. This device is helpful for controlling the blowout of transmittable infections.

Graphical Abstract:



Keywords: Automatic Hygiene System, COVID-19, Hygiene, Microcontroller, Sanitizer, Sterilizer, Public Health Technology, Touchless Technology, World Health Organization.

1. Introduction

A sudden outbreak of a deadly virus happened in December 2019 which altered the complete lifestyle of people of the entire world. This highly contagious virus proliferated very quickly all around the

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world[1]. To avoid the outburst of this virus people, maintain social distancing, regular cleaning, and sanitization of their homes[2],[3]. Self-hygiene plays the most important role in the prevention of this disease. COVID-19 can proliferate through direct touch to the diseased individual or through the contact of the contaminated surfaces[4]. Other diseases caused by pathogenic microorganisms like Pneumonia[5], Common Cold[6], influenza[7], Hepatitis A[8], Noro virus disease[9], Pink Eye[10], Salmonellosis[11], Staph Disease, Strep Throat, and Giardiasis also transmit through hands[12], to stop the spread of these diseases the most important precaution is to wash hands in a proper way suggested by World Health Organization (WHO)[13]. The recommended procedure includes five steps for 45-60 seconds in which an individual need to scrub hands with soap or hand wash for at least 20 seconds to remove infectious entities from the hands. And use sanitizers when water and soap are not accessible[13].

In addition to self-hygiene, decontamination of daily use accessories like wrist watches, wallet, mobile phones, keys, glasses, face masks and gloves are also very important because these are the vectors through which pathogenic microorganism transfers to healthy individual. There are many manual and automatic devices designed in different countries everywhere in the world to improve hygiene standards and to facilitate the users to improve the health conditions in this pandemic. In the university of Nigeria Students, turned [14] the conventional machine for hand washing and drying into automatic device using touchless technology which works on the 220 volts. Standard hand washing practice is emphasized with the development of automatic hand wash faucet by Hurriyatul Fitriyah[15] and co-members by using IR proximity sensor. In start system stops water and give soap then the 20 seconds start which is shown using led to let user scrub hands. In two different institutes of Indonesia and India an automatic sanitizer dispenser is designed to reduce the risk of pathogen transmission using ultrasonic sensor[16],[17],[18]. Elena Sevillano[19] developed a portable ultraviolet C equipment to estimate disinfection ability of ultraviolet. Badre El Majid [20] in Morocco gives a concept of a wearable sanitizing wristband to disinfect objects near and around the hand using UVC lamp.

For assimilating in this new normal with hand hygiene practices and sterilization of daily use accessories, there is a need to stipulate people with adequate water, sanitizer, hand wash, and portable diminutive sterilizer at their Workplace, Educational Institute, Mosque, Hospitals, Restaurants, Markets, Parks, Cinemas, and other Public Places. For encouraging sanitization, hand washing and disinfection of small objects and objective of this paper is to design a compact device containing hand hygiene essentials and mini sterilizer to disinfect daily use items for that purpose this paper aims to design a compact device containing hand hygiene essentials and mini sterilizer to disinfect daily use items.

2. Materials and Methods

Hand Hygiene system prototype is based on three units: Sensing, Microcontroller and Output unit. In sensing unit ultrasonic sensor (HC-SR04) detects hand when place within its range which is set in the program as it senses hand, signal sends to microcontroller (8-bit ATmega328P) unit which process and triggers the response unit in the system and get outcomes in the four forms as Water, Soap, Sanitizer and Air[21][22]. Outcome is based on the user hand placement distance.

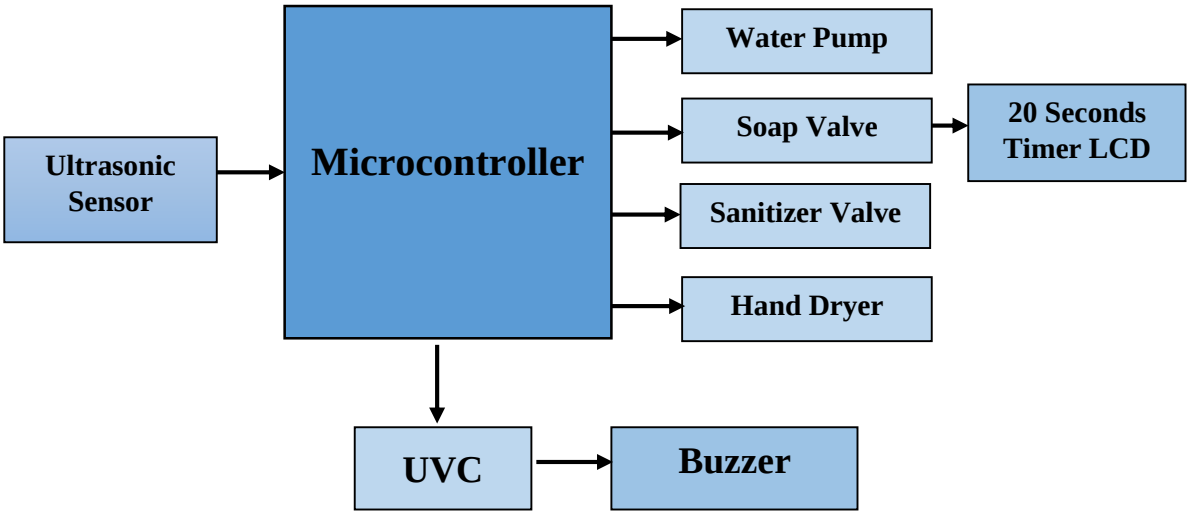

Fig. 1- Concept of Hand Hygiene System

The system also contains Liquid Crystal Diode (LCD) that displays 20 second hand wash timer which start immediately when soap is released from the faucet[23], Sterilizer is based on UVC Germicidal Strips when switch is on[24], signal is sent to the Arduino and it starts UVC according to set time in the sketch as time ends buzzer beeps to indicate user about the sterilization process is complete and take the object back[25]. overall system design concept shown in Figure 1. Flow chart explains the working of complete system of hand hygiene prototype as shown in Figure 2.

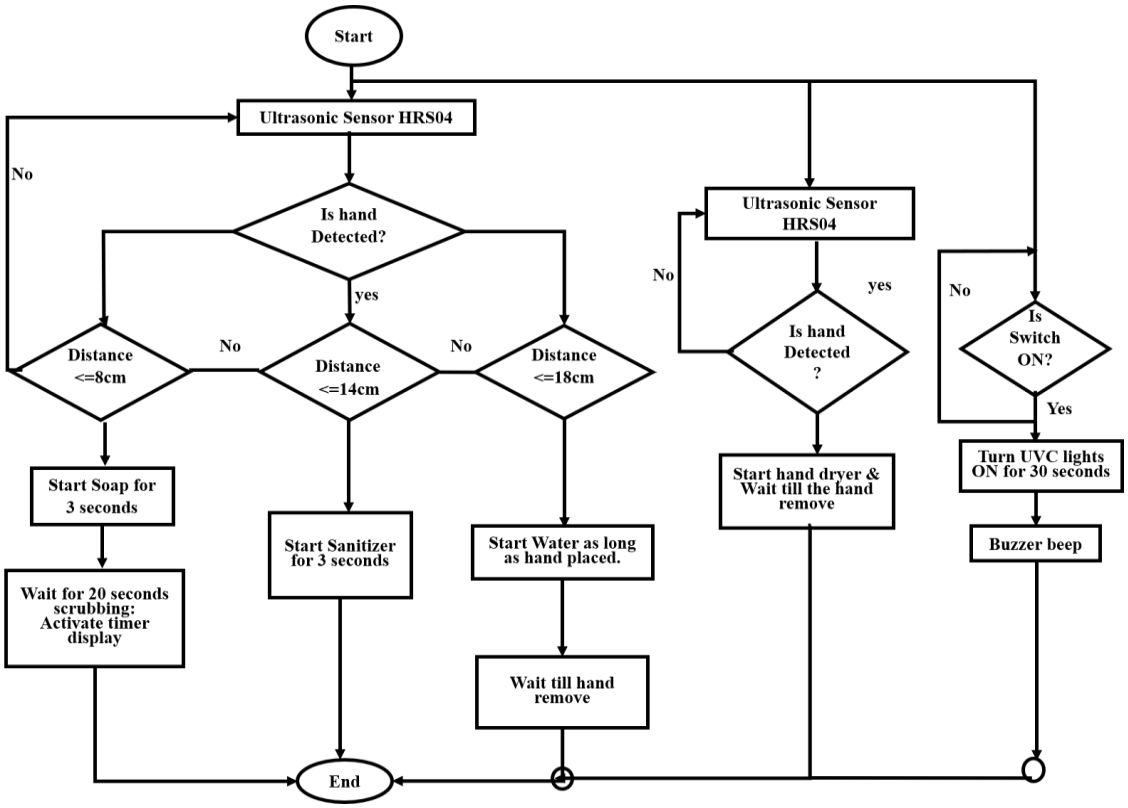

Fig. 2-Flow Chart of Hand Hygiene and Sterilization System

Circuit diagram of hand Hygiene prototype as shown in Figure 3 uses a common ultrasonic sensor for the detection of the presence of hand, there are three different ranges of ultrasonic sensor are set through programming in microcontroller using Integrated development environment (IDE) software

and uploaded code in Arduino board , the first range is for soap that is between 4 to 8 cm, the second range is for sanitizer which is in between 12 to 14 cm and the last one is for water which is from 16 cm to 18 cm. As ultrasonic sensor detects hand within any of the defined ranges the microcontroller of Arduino gives command to the pumps to open and close accordingly. If hand is placed in the range of water, then pump of water is opened unless the hands are removed from the sensor range. If hands are placed in the range of soap, then pump of soap is opened for 3 seconds then the pump is closed and LCD display shows 20 seconds timer for the rubbing of hands, after 20 secs the timer ends and the user can place hands again within the range of water for cleaning the soap.

The alternative option of sanitizer is also available if hands are placed in the range of sanitizer the pump is opened for 3 secs and then again closed. This complete system is operated by 12-volt rechargeable battery, the voltage coming from the battery is bifurcated for providing separate 5-volts to Arduino.

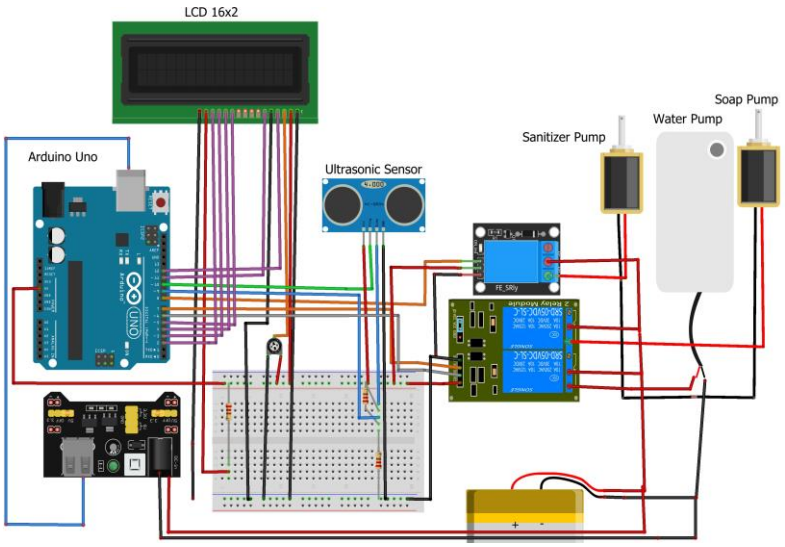

Fig.3- Circuit of Hand Hygiene System

Hand dryer system is shown in the Figure 4, ultrasonic sensor trigger and echo pin are connected at Arduino digital pins 9 and 10 where relay input pin is connected at pin 11 of Arduino and 12V DC blower fans are connected with normally close pin of single channel relay.

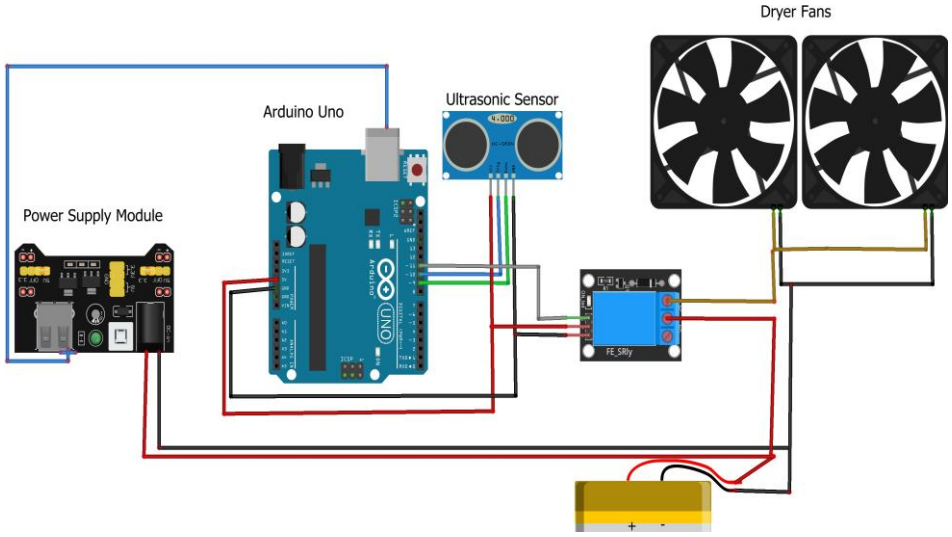

Fig. 4- Circuit of Automatic Hand Dryer

The circuit comprises of Arduino UNO, UVC lights, switch, buzzer and MOSFET as shown in Figure 5, UVC lights are turned on for 30 seconds as specified in the programming when the switch is on, after this duration UVC lights turn off and buzzer starts to beep to notify the user that sterilization is completed. Positive terminal of UVC lights is attached to gate pin of MOSFET and connected to pin number 8 of Arduino UNO. Buzzer and switch are connected to pin 3 and 7 of Arduino UNO.

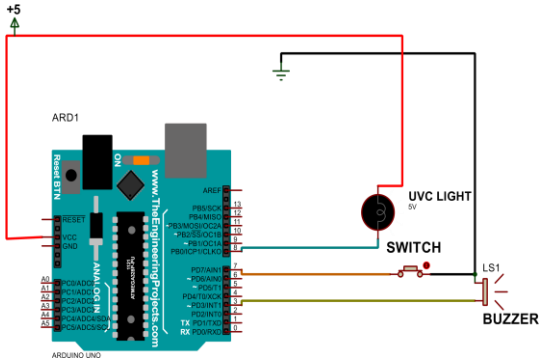

Fig. 5- Circuit of UVC Sterilizer

3. Results and discussions

The hand hygiene prototype works on a very low power of 12v. It avoids contact of people with system to get Water, Soap and Sanitizer. The whole system is designed using different ranges for ultrasonic sensor to get water, soap and sanitizer from a single faucet. This prototype based on the range of 4cm to 18cm from which 4 to 8cm is for soap, 12 to 14cm for sanitizer and 16 to 18cm for water according to defined ranges the prototype is properly working and it is also showing a 20 second timer after the user takes soap.

According to the placement of hand in range of ultrasonic sensor, as shown on table.1, shows ON and OFF state of water pump, soap and sanitizer valves. When hand places at the range of 2cm all the supplies are off and hence no any response detected. When hand places at the range of 4cm to 8cm the soap supply working properly and releases soap within the range. When hand places at the range above than 8 cm and at 10 cm all supplies remain off and no any response detected. When the hand places at the range of 12 cm to 14cm the sanitizer supply remains on and releases sanitizer from valve. When hand places at the range of 16cm to 18cm the water supply became activates and releases water from faucet. At the range of 20cm all supplies remain off. Figure 6 shows the complete system design and experimental results that performed.

Table. 1- Hand detection from 2cm to 20 cm

Distance in Cm	Description
2cm	All Supplies are OFF
4cm	Soap supply ON
6cm	Soap supply ON
8cm	Soap Supply ON
10cm	All Supplies are OFF
12cm	Sanitizer Supply ON
14cm	Sanitizer Supply ON
16cm	Water Supply ON
18cm	Water Supply ON
20cm	All Supplies are OFF

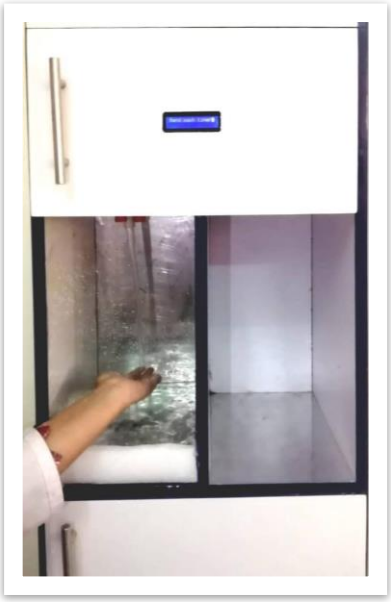

Fig. 6- Experimental Results of Hand placed at distance 16 to 18 cm

The hand wash timer displayed on the LCD in Figure 7. (a) indicates that the system is operational and the water, soap, and sanitizer containers are available for usage. When a hand is identified within the soap's detection range, the soap is released from the soap faucet and the timer begins, as indicated by the 20-second timer displayed in Figure 7 (b) and in Figure 7 (c) The LCD display indicates done.

(a) (b) (c)

Fig. 7- (a) LCD Display, (b) LCD Display Showing Hand Wash Timer, (c) LCD Display After Hand Wash Time Complete

The hand dryer ranges from 2cm to 20cm. When a hand is detected between these ranges, the dryer blows air; however, when a hand is placed at a distance of 25cm, the dryer does not blow air, as shown in Table 2.

Table. 2- Results of hand detection within the range of a hand dryer

Distance in Cm	Sensor
2cm	Hand Detected
5cm	Hand Detected
9cm	Hand Detected
13cm	Hand Detected
15cm	Hand Detected
20cm	Hand Detected
25cm	Not Detected

According to the predetermined programming, once the regularly used accessories such a cell phone, glasses, wallets, masks, keys, and so on placed into the sterilizer container, the UVC turns on for 30 seconds and continues to function normally. After that time, a buzzer sounds to signal that the sterilizations of item are done as shown in Figure 8.

Fig. 8- The UVC sterilization compartment turns on for thirty seconds.

4. Conclusion

The research aims to build a touchless hand hygiene system along with small UVC based sterilizer. This device is a compact system that contains multiple features for users like all essentials of hand hygiene such as automatic water, soap and sanitizer merged in a single faucet and contactless hand dryer. There is an LCD display that shows 20 seconds timer after the administration of soap for proper rubbing of hands. There is a small sterilization compartment attached to the hand hygiene which is mainly not available at public places however, the sterilization. This system is a wholesome solution for improving the hygiene standards in private as well as public places like Educational Institutes, Hospitals, Malls, Offices, Mosque, Railway Stations and all other places where human intervention is involved. This device is helpful for controlling the blowout of transmittable infections such as COVID-19, Flu, Common Cold, Hepatitis and diseases that grow due to hand contact. However, in future this prototype may be modified by integrating voice guidance in multiple languages for children's, blind, and illiterate people so everyone can also utilize this system. The sterilizer is manual and transform this to automated by adding more components like object recognition sensors, motors so that it is operated on its own. And it may be updated by assessing the performance of UVC sterilization via suitable testing method.

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