Design of Automatic Hand Sanitizing Dispenser System for Multi-Users

Adesina Afunlehin & Samuel Omolola
Department of Electrical & Electronic Engineering
Federal Polytechnic, Ilaro, Ogun state, Nigeria
opeyemi.afunlehin@.federalpolyilaro.edu.ng; samuel.omolola@.federalpolyilaro.edu.ng

ABSTRACT
This paper presents an ideal design by synthesis for making automated hand sanitizing dispenser for multi-user with hope to drastically reduce the challenges of the pandemic as security measures that can be taken to curb the spread of the corona-virus pandemic (COVID-19). Viruses such as COVID-19 are transferrable through touch and contact. There are WHO guidelines to clean or sanitize hands regularly to reduce the risk of infection. Provision of sanitizer from bottle and storage would require manual intervention. The system can sense the closeness with the help of ultrasonic sensor and sends signal to microcontroller. The controller processes the sensor data and actuates the pump and solenoid valve. The sanitizer liquid dispenses through mist nozzle. Findings show that biomedical gadgets should be made available for precautionary measures to prevent uncertainty in social, general gathering and industrial sectors. The challenges of the pandemic have led to provision of surgical mask, respirator, mechanical ventilator, nebulizer, oxygen therapy machine. Automated hand sanitizing system will facilitate easily dropping of soap and water for several users and reduces wastage. The design presents here is in line with availability of components and easy fabrication. The design has been proven beyond reasonable doubt through operation with respect to the content of the containing sanitizer; it can be used in multi-tasking environment for the multi-users.

KEYWORDS: Automatic dispenser, Biomedical engineering, Corona-virus, Microcontroller, Ultrasonic proximity sensor

1. INTRODUCTION

A hand sanitizer dispenser is a device used in controlling the amount of sanitizer gel for use immediately. Hand sanitizers are essential in adding the liquid for disinfecting our hands regularly. Hand sanitizer dispensers are wall-mounted or table-mounted, where it can be easily accessible to users. Sanitizer dispensers can be placed in the restroom, corridors, gate entrances, receptions, etc.

Hand sanitizer dispensers come in various forms. Some are automatic, where hand are placed underneath the sensor enabling the sanitizer to dispense. Hand sanitizer dispensers can also function as liquid soap dispensers, and this is because soap and sanitizer share typical viscosities.

An automatic soap dispenser is a device that dispenses a controlled amount of soap solution (or a similar liquid such as a hand sanitizer). They are often used in conjunction with automatic faucets in public restrooms. They function to conserve the amount of soap used and stem infectious disease transmission. Automatic soap dispensers are not just modern and fancy-looking but also very convenient. The most significant and most crucial advantage of an automated hand sanitizer or soap dispenser compared to a regular one is the fact that it can be used without actually touching it. It eliminates a contact point and means fewer bacteria (virus) and a cleaner surface for a longer time and deliver a standardized dose of soap every time with convenient.

The overall design of the dispensers is modern and straightforward. The container clear and the rest of the body featured a combination of different color finish details. The dispenser can be kept on the countertop or to have it wall-mounted in which the infrared sensor detects a hand from as far as 10mm.

One of the ways to avoid the spread of infectious disease control measures for COVID-19 transmission or an easy way to help to combat the regular flu season, is by using no-hand touch dispensers to help minimize exposure in any environment. As more and more businesses are now having employees start returning to work in the wake of the COVID-19 pandemic, implementing public safety strategies into facility is more crucial than ever. Employees want to feel comfortable going back to the office or warehouse knowing well that they would have access to proper sanitation measures. Safety guidelines recommended by the CDC include practicing social distancing, frequently disinfecting workspaces, and consistent hand-washing by employees.

Hand sanitizer stands facilitate sanitation and are extremely efficient at killing viruses like COVID-19 when filled with effective sprays, wipes, and sanitizers. Biomedical engineers can design and manufacture sanitizer stands to provide the most accessible sanitation for all employees in any organization (facility). As opposed to sanitation alternatives, a no-touch hand sanitizer provides an abundance of benefits to the facility that can extend past the sanitation measures of COVID-19.

2. LITERATURE REVIEW

The automatic hand sanitizer dispenser is a unique piece of recent technology (Huppert, etal 2011). Alcohol based hand sanitizers were invented in the 1960's but gained widespread popularity in the 1990's when several flu pandemics spread across the globe (Sasso et al., 2003). Using infrared motion sensor technology, automatic hand sanitizer dispensers are able to provide hand hygiene in situations where hand washing is impractical or unavailable (Cronin et al., 1989). A 2007 study estimated that in the year 2002, infections spread at hospitals in the United States caused or contributed to nearly double the number of deaths caused by AIDS and firearms combined. These infections were spread mainly through skin to skin contact, primarily because of lapses in hand hygiene (Aiello et al., 2008). Using an automatic hand sanitizer dispenser eliminates the need for hand washing in most cases. Touchless hand sanitizer dispensers can be placed in virtually any location and easily relocated when needed.

Most people think of automatic hand sanitizer dispensers and assume that and sanitizers dry out hands. However this is not true. Using hand sanitizer kills 99.9% of germs on your hands while maintaining moisture on your skin (Tomes., 2000). Also, specially designed emollients in Germstar hand sanitizer leave skin feeling hydrated and smooth.

Facilities that use automatic hand sanitizers have lower rates of absenteeism. Schools, offices, and hospitals with automatic, touch-free hand sanitizer dispensers are prepared for upcoming flu season (Lenius et al., 2005).

Hygiene is an important aspect of life to remain healthy (Huang et al., 1990). There are various aspects of hygiene. A clean hand is one of them. Hands generally are touched at various surfaces and can be exposed to direct contamination. Cleaning hands at regular interval is recommended by various health organizations including WHO. Hand hygiene is now regarded as one of the most important element of infection control activities. In the wake of the growing burden of health care associated infections (HCAIs), the increasing severity of illness and complexity of treatment, superimposed by multi-drug resistant (MDR) pathogen infections, health care practitioners (HCPs) are reversing back to the basics of infection preventions by simple measures like hand hygiene (Boyce et al., 2002). This is because enough scientific evidence supports the observation that if properly implemented, hand hygiene alone can significantly reduce the risk of cross-transmission of infection in healthcare facilities (HCFs) (Kampf.,2004).

Evidence suggests that hand sanitization significantly reduces the transmission of healthcare-associated pathogens and the incidence of HCAI (healthcare associated infections) (Daniels et al.,1999). According to the Center for Disease Control and Prevention (CDC), hand hygiene encompasses the cleansing of your hands using soap and water, antiseptic hand washes, alcohol-based hand sanitizers (ABHS), or surgical hand antiseptics. These days, alcohol-based hand sanitizers are increasingly being used instead of soap and water for hand hygiene in healthcare settings. Poor or inadequate hand washing and/or hand hygiene is known to be problematic in hospital settings, and is a major source of infections contracted while patients are admitted to a hospital. While hand washing and hygiene policies and training are important and can be effective in reducing the spread of infections, the problem of infections due to unsatisfactory hygiene of staff, medical professionals, and even patients continues to be problematic. It is known to place hand washing stations and hand sanitizer dispensers throughout medical facilities including in examination rooms, hallways, lobbies, and even patient rooms. However, such systems are purely mechanical and are incapable of providing an automated means of establishing accountability of good hygienic practices (Sickbert-Bennett et al., 2016). The infamous Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is the virus that was first reported in Wuhan, China on December 31, 2019, and was announced as a pandemic by the World Health Organization on March 11, 2020. The need of touch-less automatic dispenser is identified after observing that it is the point of contact for contamination (Knighton., 2013). In this paper we present a novel design of automatic hand sanitizer dispenser. The circuit includes a ultrasonic sensor SC-04. The sensor senses the proximity of hands under the machine. The machine is designed for wall mount at a height of 4ft such that anyone can reach to get sanitizer dispense. The sensor send signal to the microcontroller and the controller takes decision to actuate the pump and valve simultaneously to dispense the liquid sanitizer through a mist nozzle.

2.1 Mode of operation

When there is need to have the sanitizer or wash our hands, the user's hands are placed under the nozzle and before the sensor. The activated sensor will further activate a pump that dispenses a specific amount of sanitizer (or soap) from the nozzle. Modern sensors used in electronic faucets, electronic flush valves and electronic soap dispensers use infrared light with wavelength in the range of 850 nm. The sensor employs an emitter and a collector.

The emitter emits pulses of infrared light while the collector which is positioned to face in the same direction as the emitter, "sits" dormant waiting to sense the emitted pulses. When no hands are present in front of the device, no reflection of light takes place, and therefore, no pulse is sensed. When hands are present in the path of the emitted light, a portions of the emitted infrared light is bounced back in the direction of the collector which then becomes excited by the light (in the event a photodiode is used) and generates voltage to switch the pump on. If a photo transistor is utilized, then the photo transistor, upon sensing the infrared pulse, will simply switch the pump on and dispense the sanitizer or liquid soap.

Infrared sensors detect infrared energy that is emitted by one's body heat. When hands are placed in the proximity of the sensor, the infrared energy quickly fluctuates. This fluctuation triggers the pump to activate and dispense the designated amount of soap.

2.2 Advantages of hand sanitizer dispenser

- **Non-contact:** When various individuals use the dispenser, they will leave behind a variety of bacterial colonies. These colonies will interbreed and lead to a more resistant strain of bacteria that can re-contaminate different hands and would not be completely eliminated by the anti-bacterial soap. Wider spectra or higher levels of resistance, in the colonies that are present, are due to interaction and/or complementation between the resistance genes. Without having a wide variety of individuals touching the dispenser, bacterial transmission will be eliminated and so it is for other forms of transmittable diseases.

- **Dispenses pre-measured quantity:** Dispensers will only distribute a set amount of sanitizer or soap per motion activation. A predetermined amount to be dispensed can be set to a highly efficient quantity in which waste will be minimal.

- **Versatility (work for both soap and other liquids):** The mechanisms of the dispenser that work for soap may also work for other liquids: soap, hand sanitizer, lotion, laundry detergent etc.

3. METHODOLOGY

This project provides a simple design in building an Auto Hand Sanitizer Dispenser with an LCD which also shows the live count of Corona-virus cases. This project will use ESP32, Ultrasonic Sensor, 16 x 2 LCD Module, Water pump, and Hand Sanitizer. We are using Esri's API Explorer to get the live data of Covid19 infected people. An ultrasonic sensor is used to check the presence of hands below the outlet of the sanitizer machine. It will continuously calculate the distance between the sanitizer outlet and itself and tells the ESP to turn on the pump whenever the distance is less than 15cm to push the sanitizer out.

Components Required: Automatic Hand sanitizer dispenser System

1. ESP32 Dev Module
2. Ultrasonic Sensor
3. 16 X 2 LCD Display
4. Relay Module
5. Mini DC Submersible Pump
6. Hand Sanitizer

Figure 1 shows the mode of operation of Automatic Hand sanitizer dispenser System using ESP32 as the main controller, it is a Wi-Fi module that can easily connect to the internet.

Fig. 1: Automatic Hand sanitizer dispenser System

API link for Live Data Acquisition on Corona-Virus

Data must be acquire from the internet and then send it to ESP32 to display it on 16 x 2 LCD. For that, an HTTP get request is invoked to read the JSON file from the internet. Therefore using the API provided by Corona-virus Disease GIS Hub. You can easily compile the correct query URL to get the total confirmed and recovered cases for Nigeria and can also change the country/Region if you want to use this for a different country.

Parsing program

```
const size_t capacity = JSON_ARRAY_SIZE(1) + JSON_ARRAY_SIZE(6) + JSON_OBJECT_SIZE(1) + 2*JSON_OBJECT_SIZE(2) + 5*JSON_OBJECT_SIZE(6) + 3*
DynamicJsonDocument doc(capacity);
```

```
JsonObject features_0_attributes = doc["features"][0]["attributes"];
const char* features_0_attributes_Country_Region = features_0_attributes["Country_Region"]; // "India"
int features_0_attributes_Confirmed = features_0_attributes["Confirmed"]; // 194
int features_0_attributes_Recovered = features_0_attributes["Recovered"]; // 20
int features_0_attributes_Deaths = features_0_attributes["Deaths"]; // 4
int features_0_attributes_Active = features_0_attributes["Active"]; // 170
```

Circuit Diagram

The complete circuit diagram for this **Covid19 Tracker and automatic hand sanitizer dispenser machine** is given in figure 2

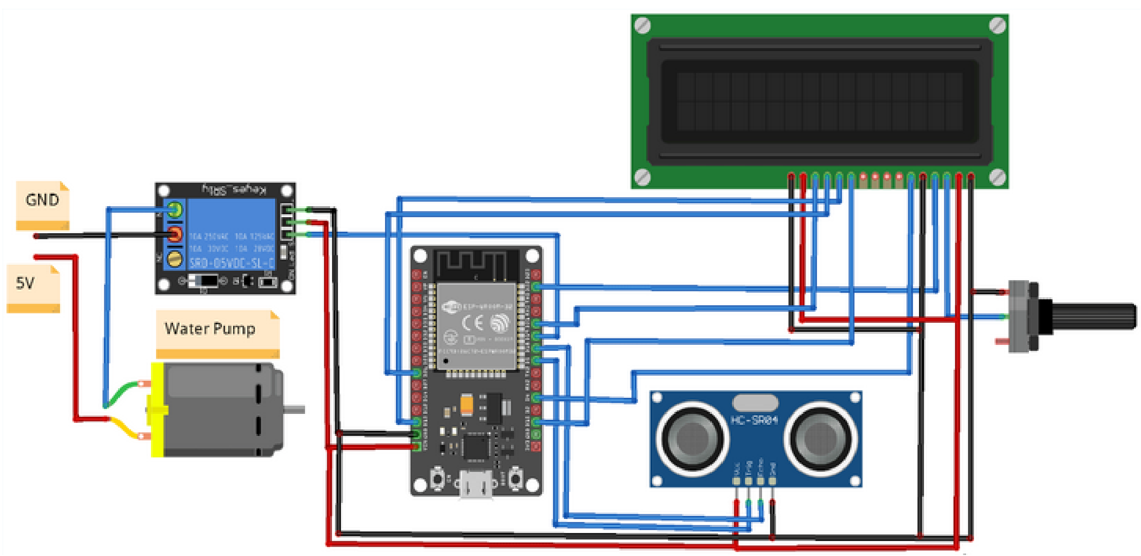

Fig. 2: Circuit diagram for this **Covid19 Tracker and automatic hand sanitizer dispenser**

The water pump is connected to the ESP32 through a relay module. Vcc and GND pins of the relay are connected to Vin and GND pins of ESP32 while the input pin of the relay is connected to the D19 pin of ESP32. Trig and Echo pins of the Ultrasonic sensor are connected to D5 and D18 Pins of Arduino. Table 1 shows complete connections of the Arduino connectivity.

Table1: Complete connections

LCD	ESP32
VSS	GND
VDD	5V
VO	Potentiometer
RS	D22
RW	GND
E	D4
D4	D15
D5	D13
D6	D26
D7	D21
A	5V
K	GND
Ultrasonic Sensor	ESP32
Vcc	Vin
GND	GND
Trig	D5
ECHO	D18

The hardware for the motion sensor hand sanitizer dispenser are shown in Figure 3.

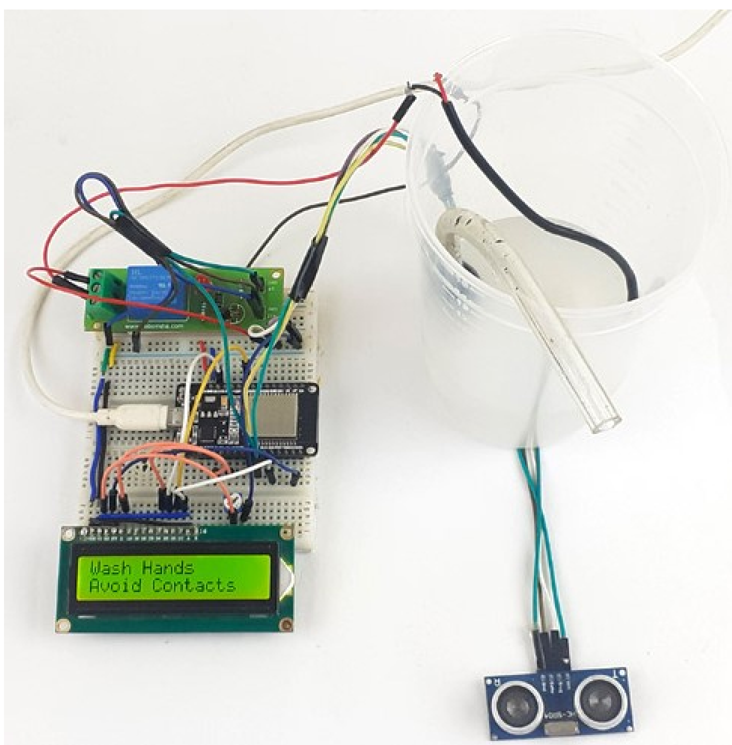

Fig. 3: Automatic Motion Sensor Hand Sanitizer Dispenser

However, after the assembly of the hardware required for the system, the entire circuitry network can be placed in a casing to facilitate mobility of installation so that the package can look as in Figure 4.

Fig. 4: Packaging of Automatic Motion Sensor Hand Sanitizer Dispenser

4. RESULTS AND CONCLUSIONS

An automatic sanitizer dispensing system designed and developed is a wall mount at entrance gates of society, schools, colleges or any commercial building. It can spray 40 times with 100 ml liquid and is effective in optimize use of liquid sanitizer. The machine is tested for 24hour operation for more than a week and is working fine. It helped to reduce the contact for getting sanitizer and also reduce man power employed to spray sanitizer with a spray bottle. The power consumption is very low. For each spray the maximum current consumption is 2 Ampere at 24 V. It consumes 48W if run continuously for 1 hour. The control circuit is small in size and low cost as compared to available controllers. The power consumption is low and the system can help to achieve contactless sanitizer dispenser. It reduces the risk of community transmission of the virus.

The result has shown that, this design is the best option for economical and safety purposes, from the survey analysis by observation in the banks, supermarkets and other public places, almost everyone support the idea of automatic hand sanitizing dispenser system, unlike other alternative in which individual will press to have a drop and immeasurable quantity due to carelessness at times.

Meanwhile, it should be born in mind that making contact with the manual sanitizer is similar to making contact with real body because a COVID-19 victim is bound to transmit the virus in whatever he/she touches.

WHO continues to propose droplet and contact safety measures for those people caring for COVID-19 patients. WHO continues to recommend airborne precautions for situation and settings in which aerosol generating procedures and support treatment are performed, according to risk assessment.

REFERENCES

Guide to implementation of the WHO multimodal hand hygiene improvement strategy (2010, August 24)

WHO Guidelines on Hand Hygiene in Health Care (2010, August 24). First Global Patient Safety Challenge. Clean Care is Safer Care.

Boyce, J.M., Pittet, D.(2002). Guideline for Hand Hygiene in Health-Care Settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. PubMed, Google Scholar, Morb Mortal Wkly Rep. 2002; 51:1–44.

Kampf, G., Kramer, A.(2004). Epidemiologic background of Hand Hygiene and evaluation of the most important agents for scrubs and rubs. Clin Microbiol Rev. 2004;17: 863–93.

Daniels, I.R., Rees, B.I.(1999). Hand washing: simple but effective. Ann R Coll Surg Engl. 1999;81:117–8.

Sickbert-Bennett, E.E., DiBiase, L.M., Willis, T.M., Wolak, E.S., Weber, D.J., Rutala, W.A.(2016). Reduction of Healthcare-Associated Infections by Exceeding High Compliance with Hand Hygiene Practices. Emerging Infect. Dis. 2016 Sep;22(9):1628-30.

Knighton. (2013). Patent, google patent search.

Huppert., Michael. (2011). "Automatic Cleaning-liquid Dispensing Device – U.S. Patent 4,989,755

Sasso., Michael.(2003). "Hygienic Company Brings Space Age to Bathroom." Knight Ridder Tribune Business News [Washington] 24 Nov. 2003: 1. Print.

Cronin,W.A., Gröschel, D.H. (1989). "A no-rinse alcohol antiseptic and a no-touch dispenser for hand decontamination". Infection Control and Hospital Epidemiology. 10 (2): 80–3. doi:10.1086/645967. PMID 2926108.

Aiello., Allison E.; Elaine, L., Larson., & Richard., Sedlak. (2008). "Against Disease: The Impact of Hygiene and Cleanliness on Health". American Journal of Infection Control. 36 (10): S128–151. doi:10.1016/j.ajic.2008.09.005.

Tomes, N. (2000). "The making of a germ panic, then and now". American Journal of Public Health. 90 (2): 191–8. doi:10.2105/AJPH.90.2.191. PMC 1446148. PMID 10667179.

Lenius., Pat. (2005). "Sloan Valve". Supply House Times. 47 (12): 14.

Huang, N., Angeles, E. R., Domingo, J., Magpantay, G., Singh, S., Zhang, G., Kumaravadivel, N., Bennett, J., Khush, G. S. (1997). "Pyramiding of bacterial blight resistance genes in rice: marker-assisted selection using RFLP and PCR". Theoretical and Applied Genetics. 95 (3): 313–320.