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Design of a Low-Cost Automatic Hand Sanitizer Dispenser

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Abstract*— The importance of healthy hygiene cannot be over emphasized. A system to promote personal hygiene has been designed. The aim achieved in this paper was to design and implement an automatic hand sanitizer capable of detecting an object (hand) within a proximity ranging from 0-6 meters via an ultrasonic sensor. This in turn sends a signal to the Arduino microcontroller which processes and activates the servo motors. A rotational force by the servo motors mounts pressure on the sanitizer cap and forces a spillage of the alcohol-based liquid within a period of 2 seconds. The process continues whenever an object is detected by the ultrasonic sensor. The developed system eliminates every form of physical contact while getting the hands sanitized, serving has a preventive measure for the wide spread of COVID-19

Indexed Terms*— Hand sanitizer, COVID-19, Arduino, Servo motor, Ultrasonic sensor

I. INTRODUCTION

The last quarter of 2019 recorded a collection of unusual etiology cases which went from a local concern into a global pandemic in a short period of time [1] [2]. The infamous Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2) was identified as the virus reported first in Wuhan City, Hubei Province, China on December 31, 2019 [3]. This was later announced as a Global Pandemic by the World Health Organization (W.H.O) on March 11, 2020 [4].

As a result of the novel coronavirus disease of 2019 (COVID-19) pandemic, all countries around the world carried out an emergency response to curtail the fast spread of the virus. With the upsurge around the world, Nigeria confirmed her index case on February 27, 2020, according to Nigeria Centre for Disease Control (NCDC) [5]. This resulted in a vast implementation of public health interventions such as complete and partial lockdown, social distancing, use of hand sanitizers, washing of hands with soap and water, use of face shields and nose masks, closure of boarders, ban on social and religious gatherings across the country- to restrict the fast spread of the disease. As of November 20, 2020, the NCDC which coordinates the public health intervention response to COVID-19 in Nigeria has reported 65,839 confirmed cases, 61,573 discharged cases and 1,165 deaths recorded in 36 states and the Federal Capital Territory [5].

Despite the scientifically proven preventive measures and as of the time of writing this article, at least three vaccines developed by AstraZeneca, Moderna and Pfizer pharmaceutical companies have been identified with an efficacy not less than 90%. Nevertheless, there is still a daily confirmation of cases of the coronavirus disease across the world. The world gradually is adapting to the new behavioral changes in social engagements [6]. Hence, the need for personal hygiene is of utmost importance to stay healthy amidst the pandemic. In line with this, the WHO and NCDC recommended practicing daily preventive measures such as frequent washing of hands with soap and water, social distancing and use of face shields and nose masks to stay safe and healthy. It is to this effect that the author presents a low-cost automatic hand sanitizer dispenser. It is a design that saves cost, can be sourced locally, and reduces the risk of contamination since it functions automatically; thereby promoting healthy living.

II. MATERIALS

The materials used were sourced locally, comprising of Arduino microcontroller (uno r3), ultrasonic sensor (HC-RS04), alcohol-based sanitizer, Jumper wires, chip board, macro and fabric ankara-material, rivets, copper wires, aluminum sheet, carboard and a hose.

The design was based on the availability and reliability of materials used.

III. SYSTEM DESIGN AND IMPLEMENTATION

In this paper, the approach to the implementation of the design was determined in four stages. The procedure followed are presented via block diagram, flow chart, circuit diagram and system design body projection.

A. Block diagram

The block diagram in -Fig. 1 illustrates the activities and processes followed in designing the dispenser. The power supply is a variable input of 9v or 5v dc source. The Arduino as a microcontroller received power from the input supply voltage and delivered 5v at the output. This was used to power both the Ultrasonic sensor and the servo motors. The ultrasonic sensor was used as a distance sensor that received signal after detecting an object when placed within the predefined range of communication and sent it to the Arduino for processing. The Arduino sent the data and initiated an action on the two servo motors. The motors rotated in opposite direction to dispense the liquid at the outlet.

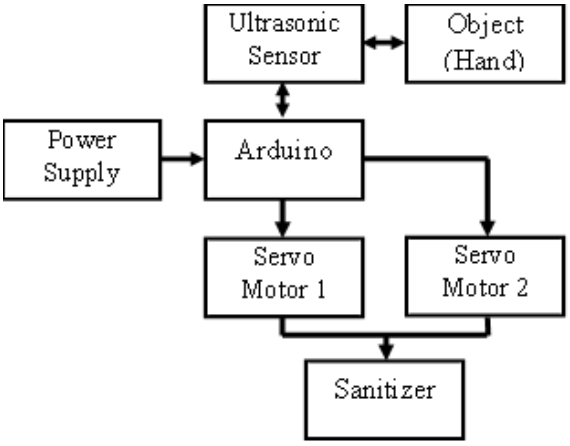


Fig 1. Block diagram of automatic hand sanitizer

B. Flow chart

Using the block diagram in -Fig.1, an algorithm was built in the form of a flow chart as described in -Fig 2. This was used to determine the codes and commands to be processed by the Arduino microcontroller.

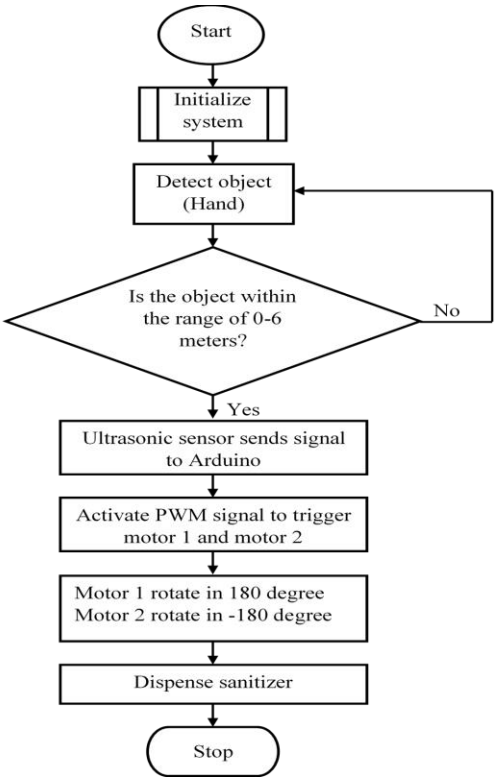


Fig 2. Flowchart of automatic hand sanitizer

The system starts once it is powered by the main supply. Thereafter, every component is initialized as predetermined. The ultrasonic sensor detects an object placed within the range of 0-6 meters. If the decision is false it returns the signal back to the ultrasonic sensor, if it detects an object, it sends the signal to the Arduino microcontroller for processing. The Arduino activates the servo motors to rotate in opposite directions of 180 degrees. The rotation of the motors mounts pressure on the load placed on the cap of the sanitizer container to dispense the liquid. The system stops and gets activated again upon detection of an object.

C. Circuit

The Digital pins of the Arduino board were used to send data to the ultrasonic sensor and the servo motors; Pin D9 was connected to Pulse Width Modulation (PWM) of servo motor 1, pin D5 was connected to PWM (pin 1) of servo motor 2, pin D3 and pin D2 were connected to the echo and trig pins of the ultrasonic sensor respectively. All ground pins were grounded to ensure proper flow of signals. The Arduino sends 5v signal to the Vcc of the ultrasonic

sensor as well as pin 1 of server motor 1 and servo motor 2.

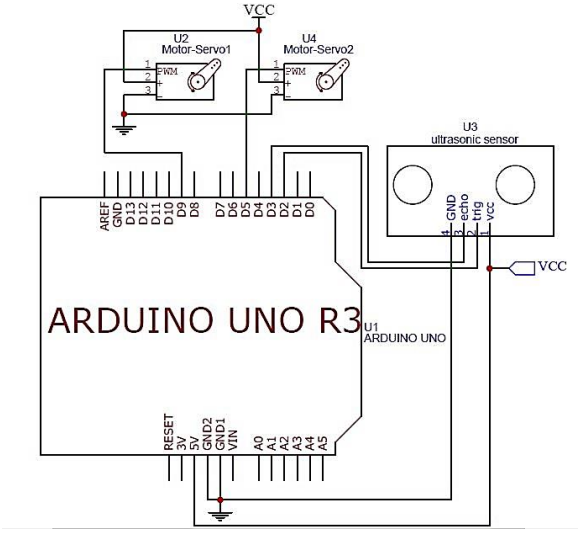
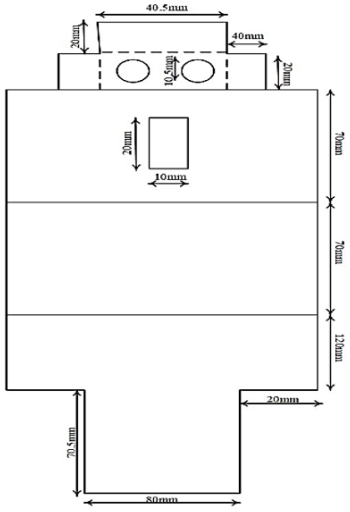


Fig 3. Circuit of the automatic hand sanitizer

D. System design body projection

The design was built around the ultrasonic distance sensor (HC-SR04), servo motor (SG-90) and Arduino microcontroller has the main components. The Arduino Uno R3 was selected based on available resources, the Arduino board boast of a 16MHZ clock speed with dimensions given as 68.6mm X 53.4mm [7]; and runs on the Atmega328P microcontroller IC. A projection of the system body frame has been illustrated with the dimensions shown in -Fig 4.



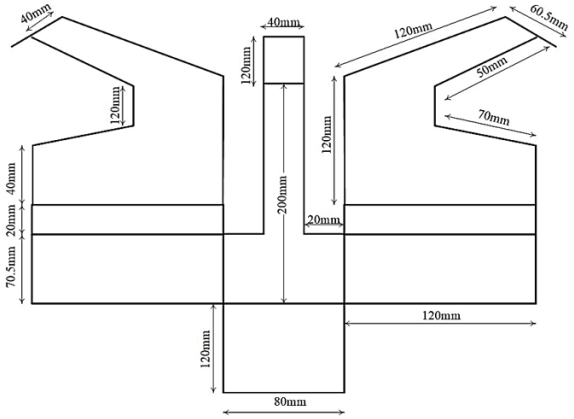


Fig 4. System design body projection

IV. TESTS AND RESULTS

The results of the hand sanitizer dispenser as shown through the stages of developments are reflected in. -Fig 5 - Fig 9.

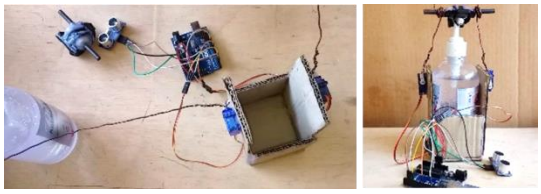


Fig 5. Stage One - Assembling and placing all components and wiring.

Fig 6. Stage Two - Constructed body frame using chip board and macro.

a b

Fig 7. Stage Three: a) Fabric (Ankara material) used to wrap body frame. b) Wrapped body frame with assembled components.

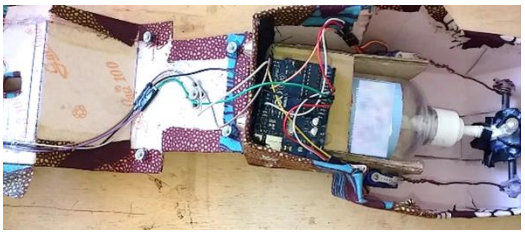


Fig 8. Stage Four - Assembling and sealing up of components and body frame.

Fig 9. Stage Nine - Finished design of automatic hand sanitizer system.

V. DISCUSSION OF RESULTS

Copper wires of size 0.6mm as shown in -Fig. 5 were attached to the servo motors and used to apply pressure on the cap of the sanitizer container whenever the servo motors get activated. In -Fig 6. macro and chip boards were used to provide a body frame following the dimensions projected in -Fig 4. The fabric (ankara material) was used as in -Fig 7a. to wrap the body frame of the dispenser. -Fig 8 shows an illustration of assembled components and materials used to realize the product. -Fig 9. The finished system design can be powered via a single power bank with a capacity of 6000mah (Milli Ampere Hours) and delivers a maximum of 2.1A (Ampere). The dispenser can be mounted on a wall or at a desired location. The servo motors upon activation were able to dispense between 3-4ml of liquid sanitizer per portion which can be spread over the palm, fingers, back of the hand and wrists. It took approximately two (2) seconds to dispense the liquid upon detection of an object (hand). It dispenses the sanitizer at about 60 degrees out of a total angle of 180 degrees rotating in opposite directions.

CONCLUSION

The main aim of implementing a low-cost automatic hand sanitizer dispenser was fully achieved and subjected to testing. It worked as designed and highly effective in compliance with the WHO and NCDC recommendations in practicing safe hygiene as a preventive measure for COVID-19. It can be installed in any private, public, or social institution and serves the purpose of sanitizing the hands without contamination. This can be helpful in limiting the chances of community transmission of COVID-19 and other known diseases.

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