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Pedal Based Hand Washing Machine with Water Level Indicator

[1]Mariam Abdulazeez Ahmed, [2]Bilyamin Muhammad, [3]Ibrahim Haruna and [4]Mohammed Aliyu Abdullahi

[1,2,3,4] Department of Computer Engineering, Kaduna Polytechnic, Kaduna State, Nigeria

[1]a.mariam@kadunapolytechnic.edu.ng,
[2]bilyaminmuhammad@kadunapolytechnic.edu.ng,
[3]harunaebrahim@gmail.com,
[4] aliyuaya16@gmail.com

Abstract— The rate of increase in the spread of communicable diseases in our society necessitated the need for an efficient mechanism to provide proper hygiene. Hand hygiene is the most effective means of preventing the spread of these diseases. Therefore, this study presents the development of a pedal based hand washing machine for the sole purpose of hand washing. The proposed system incorporates the standard mechanical hand washing machine with digital water level indicator. The mechanical part of the system employed the use of primer pumps attached to the foot pedals to dispense water and soap through different outlets. In addition, an Arduino based water level indicator which comprises of ultrasonic sensor and liquid-crystal display (LCD) is utilized to display the amount of water present in the reservoir. The developed system is easy to operate and can function under any weather condition

Keywords—Arduino Uno, LCD, Pedal, Primer Pump, Ultrasonic Sensor.

I. Introduction

One of the most prominent problems facing the world today is the spread of communicable diseases such as scabies, pneumonia, cholera, dysentery, as well as the newly discovered Coronavirus Disease 2019 (COVID-19). Presently, the outbreak of the novel COVID-19 is viral and has infected a whole lot of people not just in Africa but the world at large. This is due to the fact that the hydrophilic heads are very sticky, meaning the virus is very effective at sticking to the hands and can be spread through contaminated surfaces [1]. Hence, making it easier to be transmitted from one person to another. Effective hand washing has proven to be the single most important activity for reducing the spread of these diseases [2]. Therefore, it is of paramount

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importance for technologies to be developed to ensure that no areas of the hands are missed during the washing process. This can be achieved by the use of hand washing machine [1].

Hand washing machine is a mechanism developed for the purpose of preventing our hands from virus, bacterial, microorganism as well as any other of harmful diseases that are spread through hand contact [3]. There are two main types of hand washing machine namely; automatic and manual hand washing machines. The automatic hand washing machine is the type of machine that requires electricity and sensors to operate [4]. While the manual hand washing machine does not require any form ofelectricity, rather a primer or pneumatic pump to operate. Among the two, the manual hand washing machine is easier to operate, cost effective, and can be deployed to any environment due to its ability to function under any form of weather condition [5].

In this work, the authors present a simple and reliable manual hand washing machine with water level indicator system that is been operated with the aid of pedals. The water level indicator system comprises of ultrasonic sensor placed at the supply unit to sense the level of water; a Liquid Crystal Display (LCD) to display the percentage of the water; and Arduino Uno board which serves as the central controller of the water level indicator system. The rest of the paper is structured as follows: Section 2 presents review of related works, the proposed methodology is presented in section 3, and section 4 presents the result and discussion, while conclusions are presented in section 5.

II. Related Works

Many researchers have developed a hand washing machine, so as to reduce the spread of communicable diseases via hand. A semi-automated hand washing machine was developed using a pedal and a sensor [6]. The authors first employed the use of pedal to dispense water. Furthermore, a sensor was then utilized to dispense soap. Although, the developed machine is simple to use but it is not reliable because the senor needs regular maintenance in order to avoid malfunction. In addition, the manual hand washing machine is cheaper and affordable compared to the semi-automated hand washing machine.

A non-motorized manual hand washing machine that utilizes two foot pedals was presented in [7]. The developed machine uses the pedals to control the flow of water and detergent from multiple taps placed at a suspended basin. A similar project was carried out in the department of Computer Engineering that uses two foot pedals to operate [8]. The author constructed the machine using pneumatic pump for soap dispensing. In addition, a ball gauge coupled with scalar was employed

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for water dispensing. The machine works efficiently and its user friendly. Nevertheless, the machine is incapable of indicating water level because it lacks the relevant components that will aid in performing such task.

Another manual hand washing machine was developed using foot pedal and clutch cable to operate [2]. The developed machine comprises of clutch cable, extension spring, water and soap dispenser pedals, and compressor spring. The authors placed the extension spring at the tapwhen the cutch cable is tensioned as a result of the pedal, the tap will open allowing water to gash out. When the pedal is released, the extension spring returns to the initial position, closing the tap as a result. The same method was then applied to the soap dispensing process. The experimental result indicates that the developed machine dispenses both water and soap efficiently. However, it is incapable of displaying the level of water present in the storage.

In view of these limitations identified from the review of related works, it is evident that the existing technologies come with one or more shortcomings. To address these limitations, the authors seek to develop an efficient hand washing machine with water level indicator that is reliable, affordable, and easy to operate.

III. Materials and Method

This section presents the proposed methodology for the development of a pedal based hand washing machine with water level indicator. The first stage for developing the proposed system is the construction of a manual hand washing machine. Then, a water level indicator system is constructed and incorporated with the hand washing machine. The overall methodology can be summarized in the block diagram shown in Figure I. An explanation of each block is presented herewith.

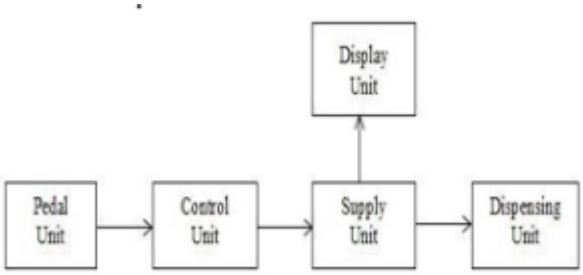

Figure I. Block Diagram of the Proposed System

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A. Control Unit

The first step carried out for the successful realization of the manual hand washing machine is the construction of the control unit. This unit controls when and how the machine operates, and it's made up of primer pump bulbs. When pressed, the primer pump utilizes the compressed air to generate an amplified level of pressure that fetches the water/soap from the supply unit via a piping system. Figure II shows the constructed control unit.

Figure 3. Control Unit

B. Pedal Unit

In this unit, two foot pedals are constructed using plywood. These pedals are connected to the control unit to key-start the machine. The unit works in such a way that when a user applies force on either of the pedals, the primer bulb activates and dispenses liquid fetched from the supply unit to the tap outlet placed at the dispensing unit. Figure III presents the constructed pedals placed on top of the primer pump bulbs.

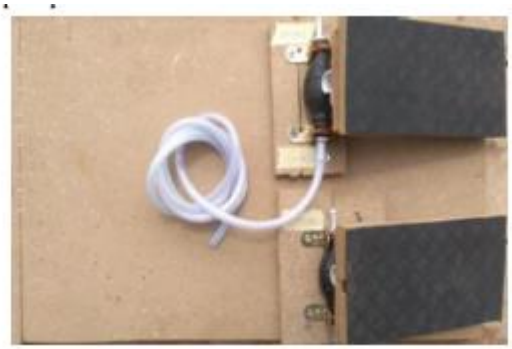

Figure 4. Pedal Unit

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C. Display Unit

This unit monitors and displays the amount of water present in the supply unit. The unit comprises of 5V power supply, Arduino Uno board, ultrasonic sensor, and LCD module. The procedure followed in developing the display unit is summarized in the block diagram shown in Figure

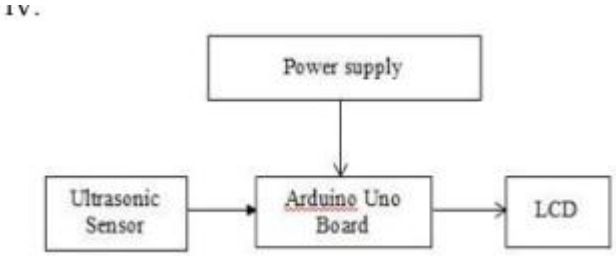

Figure 5. Block Diagram of the Display Unit

I. Power supply

To power the entire display unit, an LM7805 voltage regulator was employed so as to regulate the 9V DC battery to 5V.

II. Arduino uno board

The Arduino Uno board is a self-contained USB development board centered on an ATMega328P IC and serves as the central controller to the display unit. Based on the signal received from the ultrasonic sensor, the Arduino sends command to the LCD to display the percentage of water present in the supply unit.

III. Ultrasonic sensor

The ultrasonic sensor works by employing its transmitter to send an ultrasonic wave, which is been reflected by the surface of the water in the reservoir back to the receiver. When in operation, it enables the system to detect the water level in the supply unit. The ultrasonic sensor is utilized in this system due to its stability and high ranging accuracy.

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Figure 6 shows the final construction of the developed system incorporated with the display unit.

Figure 6. Developed System

IV. Results and Discussion

This section present the results obtained after the successful realization of the proposed system. Various tests were conducted, and the performance of the system was validated and compared with an existing work presented of Saidu [8] based on efficiency and effectiveness. The results obtained are summarized in Table I.

Table I. Results of the proposed system and that of Saidu [8]

Performance Metrics	Existing Work [8]	Proposed System	Improvement (%)
Efficiency	92%	98.6%	7.17%
Effectiveness	95%	100%	5.26%

The results presented in Table I indicate that the developed system obtained higher efficiency and effectiveness rates when compared with the existing work presented in [8]. This is attributed to the fact that the developed system can be utilized under any atmospheric condition. Figure VI shows the bar chart of the comparative results obtained by the proposed system compared with the existing work based on efficiency and effectiveness rates.

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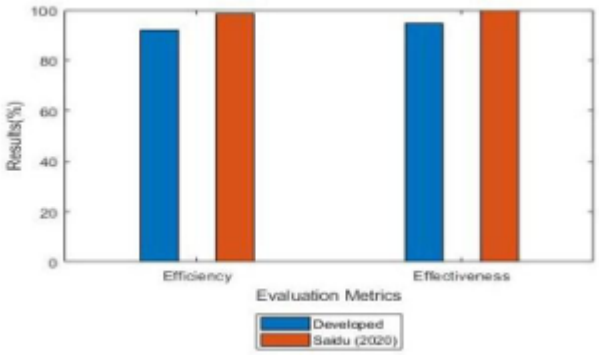

Figure 7. Comparison Results of the Proposed Approach

It can be observed that the developed system has an improved performance in terms of efficiency and effectiveness rates with a value of 7.17% and 5.26% respectively when compared with work presented in [8].

V. Conclusion

In this study, the authors presented an efficient pedal based hand washing machine to reduce the spread of communicable diseases in our society. The developed machine is incorporated with an arduino-based water level indicator for displaying the percentage of water present in the reservoir. The machine was tested under different weather conditions. The performance of the developed system was compared with an existing technology using efficiency and effectiveness as validation measures. The results obtained shows that the developed system outperforms the existing technology in terms of all the evaluation metrics.

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