International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.7 September - October – 2023
DOI:10.46647/ijetms.2023.v07i05.062 ISSN: 2581-4621

An Arduino based Automated Faucet with Hand Dryer and Voice Announcement

B.K.Saravanan[a,*], Dr.S.Ramesh Babu[a], P. Arunkumar[a], M.Kannan[b]
[a]*Faculty of Mechanical Engineering, KPR Institute of Engineering and Technology, Coimbatore-641407,India*
[b]*Design Engineer, Milacon India Private Ltd, Coimbatore-641030,India*

Abstract
This paper is presented about automatic faucet system called SOWAIER to facilitate the people by avoiding the interaction between system and person. This system is developed to keep the people safe from infections and minimize the usage of water during hand washing. The ultrasonic sensors and IR sensors to make voice announcement and detect the people. There are 3 IR sensors used in this system for delivering soap water, clean water and hand dryer. Initially, relay module with integrated with solenoid valve gets signals from microcontroller to actuate submersible pump for delivering soap water for 20 secs. Then, clean water is delivered for 15 secs and finally hand dryer system is actuated for 10 secs. The hand dryer system uses air blower. The simulation study is carried out by using ANSYS software to evaluate the temperature and velocity magnitude at the outlet of hand dryer system. The simulation results suggested that the sufficient air flow rate is achieved at outlet of hand dryer system with appropriate temperature. Moreover, this study also dealt with water scarcity on the earth. Hence, this system is made to cut off the water flow to avoid the accidental flooding even the user leaves it in the running conditions.
Keywords: Sowaier; Automated faucet system; Arduino; ANSYS; Sensors

1. Introduction

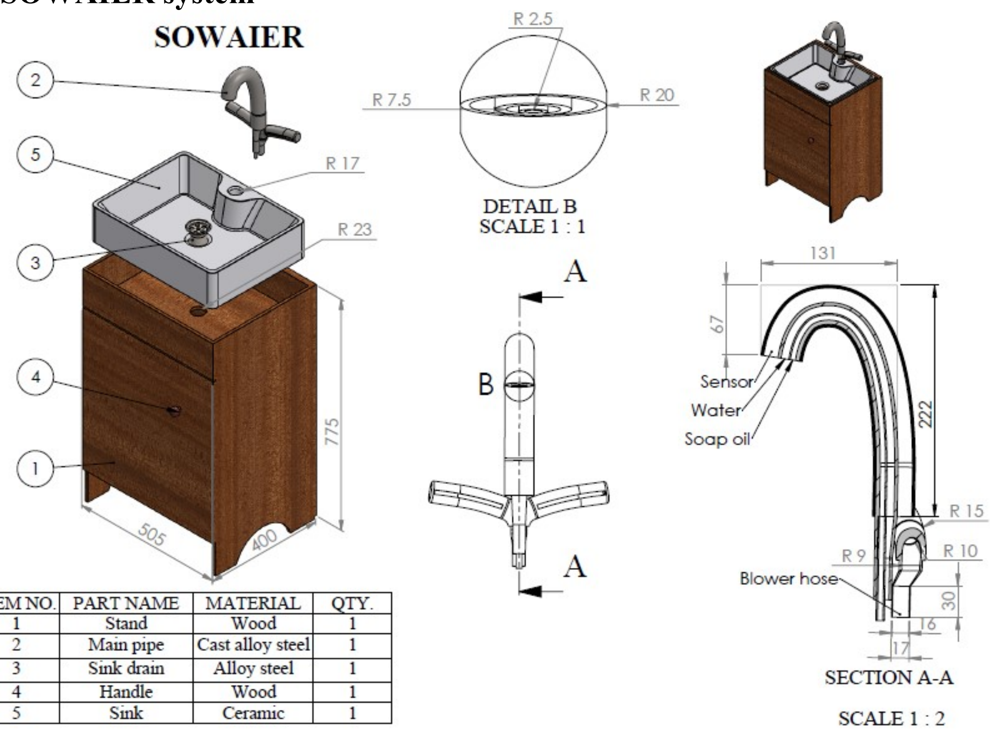
Hand hygiene is important characteristic to keep the people safe by preventing infections incurred during contact. According to the guidelines of sanitation and health by WHO, it is mandatory to people wash their hands for minimum 10 times a day and each with 20 sec [1]. Larson *et al* [2] reviewed descriptive studies of compliance with hand washing and barrier precautions for various kinds of users based on their profession such as health care workers, nurse, physician, dentists, hygienists, etc. Pittet *et al* [3] conducted a survey on improvement of compliance with hand hygiene by implementing hospital wide program. The study ensured that the frequency of hand disinfection is increased to avoid the cross infection. Burton et al [4] experimented to determine the effect of water and liquid soap on bacterial contaminants presented in the human hands. They concluded that hand washing with non-antibacterial soap is effective way of removing bacterial contaminants than using water alone in order to prevent the transmission of diarrheal diseases. Boscart et al [5] developed the wearable monitoring device for enhancing the hand washing frequency among the patients and staffs in the healthcare institutions.

The researchers found that the developed wearable electronic portable hand hygiene device is successfully explored with acceptability and usability in clinical practices. Gould et al [6] reviewed various interventions that has been established to implement hand hygiene compliance. University Hospital Lewisham established the system to improve the frequency of hand washing process [7]. Swoboda et al [8] conducted three phase quasi-experiments to identify the effect of electronic monitoring of hand hygiene on nosocomial infection rate in surgical practices. The significant improvement is made in the hand hygiene compliances from each experimental phase. It is suggested that the electronic monitoring and voice prompt are successful for short term as well as long term effect. Salman et al [9] also developed monitoring system for hand hygiene compliance of health care workers for 28 days. They experienced that the use of particular technology for hand

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.7 September - October – 2023
DOI:10.46647/ijetms.2023.v07i05.062 ISSN: 2581-4621

hygiene is promising to the health care system and also explored the strong safety culture to avoid the cross infections among health care workers. Hugonnet et al [10] performed seven observational survey to promote the compliance with hand hygiene and studied about alcohol based hand rubbing. Aiello et al [11] identified the influence of hand hygiene on rates of gastrointestinal and respiratory illnesses using meta-analysis. They also suggested that the use of non-antibacterial soap is effective way of removing bacterial contaminants and to prevent both gastrointestinal and respiratory illnesses. Ikechukwu et al [12] designed automatic hand washing machine with hand dryer system to improve the hygienic conditions of individuals. Heat requirement, power requirement of motor, time required for drying process, efficiency of blower, efficiency of pump, and rate of flow are considered as significant parameters in this study. Sandora et al [13] also worked with alcohol based hand sanitizer for hand-hygiene to reduce illness. Willmott et al [14] conducted systematic review on establishing the effectiveness of hand washing among the school students and staffs in educational environment. Ban et al [15] carried out the randomized trial among the children to encourage the multiple cleaning to reduce acute respiratory and gastrointestinal illness. The present paper is focused on the design and development of automatic faucet system is developed to facilitate the user for proper hand washing without human interaction with the system. The deliver liquid soap, delivery of clean water and hand dryer system are main objectives in this system. The simulation study is carried out using ANSYS CFD software to evaluate the temperature and velocity magnitude at the outlet of hand dryer system.

2. Design of SOWAIER system



ITEM NO.	PART NAME	MATERIAL	QTY.
1	Stand	Wood	1
2	Main pipe	Cast alloy steel	1
3	Sink drain	Alloy steel	1
4	Handle	Wood	1
5	Sink	Ceramic	1

Fig. 1. Design of SOWAIER system

The design of SOWAIER system is performed using SOLIDWORKS software as shown in Fig. 1. The main elements involved in the system are base structure and handle made of wood, main pipe made of cast alloy steel, sink drain made of alloy steel and sink made of ceramic.

3. Integration of Hardware system

The hardware is designed based on the structure of the system and it is controlled electronically. However the operation is initiated by the presence of hands. The ultrasonic sensor is used for the voice announcement. Once the ultrasonic sensor receives the ultrasonic waves from the target, it converts the wave signal into electrical signal and passes it to the microcontroller. The

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.7 September - October – 2023
DOI:10.46647/ijetms.2023.v07i05.062 ISSN: 2581-4621

microcontroller receives the signal and sends it to the relay. Once the relay gets the signal, it makes the voice announcement. An infrared-based proximity sensor is to detect the motion of human's hands. Once the hands are detected, this sensor sends signal to a microcontroller to actuate the inlet valve of liquid soap. The pump is used to deliver the liquid soap and this process is carried out for 3 secs. Then, relay is used to switch the inlet valve to cut off the delivery of liquid soap for 20 secs to allow the users for scrubbing their hands. Then, rinsing phase is started when the solenoid valve receives the signal from controller. Thus the water flows through the faucet for 70 seconds. However, additional infrared-based proximity sensor is used to supply the water for additional 70 secs when the user finds that the flow of water is insufficient. Another infrared-based proximity sensor is used for actuating hand dryer system after rinsing process. The hand drying process is carried out for 30 secs by actuating the heating coil and fan. Finally, the system is returned to initial condition when the user's hand is removed from the faucet system.

4. Housing design

The following components are used as housing for the hardware system.

- Soap container: A plastic box is used a container in which the liquid soap is filled.
- PVC tube: It is used to transfer the soap water from the outlet of the container to the inlet of the faucet.
- PVC pipes: It is used to transfer the water from the outlet of the solenoid valve to the inlet of the faucet.
- Cardboard box: It is used as a box in which the heating coil and is placed inside to make it as a blower setup.
- Faucet: It is used as an outlet for the soap water and water.

5. Circuit connection

SMPS is used to provide 12V power supply to the microcontroller system. It is interfaced with ultrasonic sensor, IR sensor, solenoid valve, heating coil, relay and fan as shown in Fig. 2 and 3. The working process of SOWAIER is divided into two stages. The stage I dealt with voice announcement and stage II dealt with the delivery of liquid soap and water.

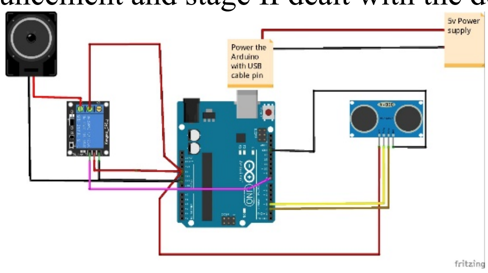


Fig. 2. Circuit connection for voice announcement

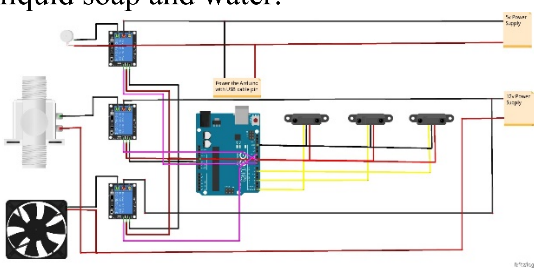


Fig. 3. Circuit Connection for delivery of liquid soap and water

The circuit connection for voice announcement is shown in Fig. 2. When a person comes in front of the device, an ultrasonic sensor is placed here which emits the sound waves using piezoelectric crystal detects the person and receives back the sound waves from the person. Then the sound wave is converted into electric signal. This electric signal is transmitted from the sensor to the Arduino board. There the signal is transmitted to the relay and it turns on the relay. When the relay is turned ON, it transmits electric signal to the speaker module. When the speaker module receives the signal, it gives the instruction about SOWAIER.

The circuit connection for the delivery of liquid soap and water is shown in Fig. 3. After the voice announcement of SOWAIER system, the user places the hand in front of the faucet where the infrared sensor is placed. The infrared sensor detects the hand and sent the electrical signal to the Arduino board. After it is transmitted to the relay where it is turned ON. During the ON period of relay, the soap water is allowed to flow through the faucet. i.e. the relay turns on the submersible pump which pumps the soap water from the tank to faucet. After 20secs, the signal is transmitted to the 2nd relay. The 2nd relay opens the solenoid valve to allow the flow of water through faucet. After hand washing, the dryer system started. For drying process, the user places their hand near the blower setup where the infrared sensor is placed. After drying, the system is returned to its rest condition. The fabricated SOWAIER system is shown in Fig. 4.

Fig. 4. Fabricated SOWAIER system

6. Thermal analysis of hand dryer system

Fig. 5. Mesh model of hand dryer system

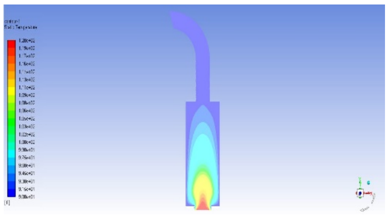


Fig. 6. Contour plot of static temperature

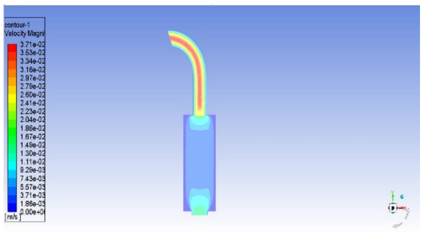


Fig. 7. Contour plot of velocity

The thermal analysis is performed on hand dryer system to evaluate the temperature and velocity characteristics at the outlet using ANSYS CFD. The mesh model of hand dryer system is shown in Fig. 5. The inlet conditions of temperature and velocity is maintained as 120 °F and 0.011 m/s respectively. From the Fig. 6 and 7, the outlet conditions are obtained as temperature of 35.5°C and velocity of 0.0334 m/s.

7. Confirmation study

The verification test on faucet system functionality is performed to find the performance of adjustable IR reflection sensor, pump connectivity, heating coil and solenoid valve. In a confirmation test, a user is asked to perform hand wash using the developed automatic faucet as shown in Fig. 8-11. The hand wash standard procedure which emphasizes usage of soap and scrubbing duration of 20 secs is achieved with the help of developed automatic faucet system.

International Journal of Engineering Technology and Management Sciences
Website: ijetms.in Issue: 5 Volume No.7 September - October – 2023
DOI:10.46647/ijetms.2023.v07i05.062 ISSN: 2581-4621


Fig. 8. Voice Announcement


Fig. 9. Deliver of liquid soap


Fig. 10. Delivery of water


Fig. 11. Hand dryer system

8. Conclusion

The design and development of automatic faucet system is developed to facilitate the user for proper hand washing without human interaction with the system. This system is aimed to achieve the following process such as deliver liquid soap, delivery of clean water and hand dryer. The ultrasonic sensors and IR sensors are used to make voice announcement and detect the user. Solenoid valve is used to switch the inlet and outlet valve of liquid soap and clean water. The deliver time of liquid soap and water is controlled through relay. The simulation study is carried out using ANSYS CFD software to evaluate the temperature and velocity magnitude at the outlet of hand dryer system. The simulation results suggested that the sufficient air flow rate is achieved at outlet of hand dryer system with appropriate temperature. The developed automatic faucet system is effectively used to avoid excess water flow due water flow due to accidental flooding even the user leaves it in the running conditions.

Reference

[1]. D. Pittlet, WHO Guidelines on Hand Hygiene in Health Care: a Summary. World Health Organization Patient Safety: University of Geneva Hospitals (2009)
[2]. Larson, E. L., & Kretzer, E. K. (1995). Compliance with hand washing and barrier precautions. Journal of Hospital infection, 30, 88-106.
[3]. Pittet, D., Hugonnet, S., Harbarth, S., Mourouga, P., Sauvan, V., Touveneau, S., & Perneger, T. V. (2000). Effectiveness of a hospital- wide programme to improve compliance with hand hygiene. The Lancet, 356(9238), 1307-1312.
[4]. Burton, M., Cobb, E., Donachie, P., Judah, G., Curtis, V., & Schmidt, W. P. (2011). The effect of handwashing with water or soap on bacterial contamination of hands. International journal of environmental research and public health, 8(1), 97-104.
[5]. Boscart, V. M., McGilton, K. S., Levchenko, A., Hufton, G., Holliday, P., & Fernie, G. R. (2008). Acceptability of a wearable hand hygiene device with monitoring capabilities. Journal of Hospital Infection, 70(3), 216-222.
[6]. Gould, D. J., Moralejo, D., Drey, N., Chudleigh, J. H., & Taljaard, M. (2017). Interventions to improve hand hygiene compliance in patient care. Cochrane database of systematic reviews, (9).
[7]. Jeanes, A. (2004). Establishing a system to improve hand-hygiene compliance. Nursing times, 100(8), 49-49.

[8]. Swoboda, S. M., Earsing, K., Strauss, K., Lane, S., & Lipsett, P. A. (2004). Electronic monitoring and voice prompts improve hand hygiene and decrease nosocomial infections in an intermediate care unit. Critical care medicine, 32(2), 358-363.

[9]. Al Salman, J. M., Hani, S., de Marcellis-Warin, N., & Isa, S. F. (2015). Effectiveness of an electronic hand hygiene monitoring system on healthcare workers' compliance to guidelines. Journal of infection and public health, 8(2), 117-126.

[10]. Hugonnet, S., Perneger, T. V., & Pittet, D. (2002). Alcohol-based handrub improves compliance with hand hygiene in intensive care units. Archives of internal medicine, 162(9), 1037-1043.

[11]. Aiello, A. E., Coulborn, R. M., Perez, V., & Larson, E. L. (2008). Effect of hand hygiene on infectious disease risk in the community setting: a meta-analysis. American journal of public health, 98(8), 1372-1381.

[12]. Ikechukwu, G. A., Clementina, O. O., & Onyebuchi, C. L. (2014). Design and characterization of automatic hand washing and drying machine. American Academic & Scholarly Research Journal, 6(4), 123.

[13]. Sandora, T. J., Taveras, E. M., Shih, M. C., Resnick, E. A., Lee, G. M., Ross-Degnan, D., & Goldmann, D. A. (2005). A randomized, controlled trial of a multifaceted intervention including alcohol-based hand sanitizer and hand-hygiene education to reduce illness transmission in the home. Pediatrics, 116(3), 587-594.

[14]. Willmott, M., Nicholson, A., Busse, H., MacArthur, G. J., Brookes, S., & Campbell, R. (2016). Effectiveness of hand hygiene interventions in reducing illness absence among children in educational settings: a systematic review and meta-analysis. Archives of disease in childhood, 101(1), 42-50.

[15]. Ban, H. Q., Tao, L. I., Jin, S. H. E. N., Jin, L. I., Peng, P. Z., Ye, H. P., & Zhang, L. B. (2015). Effects of multiple cleaning and disinfection interventions on infectious diseases in children: a group randomized trial in China. Biomedical and Environmental Sciences, 28(11), 779-787.