International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-9 Issue-3 September 2020

Multi-Station Automated Hand Washing System (MSAHWS)

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Abstract: The paper presents a design and development of a multi-station automated hand-washing system (MSAHWS) that could be integrated into overall solution strategies for combating the threat of SARS-Cov-2 infections and minimizing the health and economic devastation the virus spread can inflict. The researchers seek to create a system that uses a single micro-controller and caters to several users, each of them being served independently of each other. The MSAHWS development follows a four-part methodology: formulation of the sanitary, operational, manufacturing and economic requirements; design, modeling, and simulation of the micro-controller-based control system; MSAHWS hardware prototype development; and system test and data collection. The MSAHWS design and development focuses on a double-station system that uses a single Arduino Uno, an ultrasonic sensor for each station, 4 FET's, 4 liquid pumps, a water tank, a soap reservoir, a power supply and a frame to house the system. The non-contact system eliminates possible viral transmission from one person to another via the hand washing machine yet ensures the required cleanliness of the hands. The system is first simulated in PROTEUS to test its functionality and responses based on the demanded or required criteria. A prototype is then built to test and verify the system's actual operation and responses and thence to make the necessary adjustment of parameters to realize an acceptable performance level. Tests show that all the requirements are met. Photos of the built and tested prototype, a diagram of the initial system design concept, a screen capture of the control system software model, a schematic diagram of the control system, a sketch with dimensions of the hand washing machine frame or housing, and the flowchart on which the Arduino script is developed. The operation and user-interaction of the actual system is also described.

The control system program is written such that the resulting hand washing activity complies with the WHO standard on hand washing duration and makes entirely possible a complete and hygienic hand washing activity with soap and water. The system is envisioned for strategic deployment in public and private areas like public markets, banks, hospitals, schools, offices, residences, and many others.

The paper has shown that it is possible to control multiple hand washing stations, each acting independently of each other, using a single micro-controller and a proper control system programming.

Key Words: Arduino Automated System, Covid19, Handwashing, Hygiene, Proteus.

Revised Manuscript Received on August 05, 2020.

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I. INTRODUCTION

The spread of the dreaded and potentially deadly SARS-Cov-2 that causes COVID-19 has become a global concern in so short a time since it was first detected in Wuhan, China. In one of its recent daily updates[1] on COVID-19, World meters reported that worldwide there are more than 15 million reported cases of infection, over six hundred thousand deaths, and more than 9 million recoveries. Based on its update on the same day, in Ethiopia[2] 11,072 got infected, 180 died, and 5,448 recovered. In a published article[3], African countries, such as Ethiopia, are projected to be especially vulnerable to the viral onslaught due to limited and ill-equipped health care facilities. Their health care systems could potentially get overwhelmed and, in the absence of effective strategies to overcome the spread of the viral infection, death by the millions, from COVID-19 and from hunger due to derailed economic activity, can be expected. In the absence of a reliable and proven COVID-19 vaccine that may only be made available far into the future, which, according to the Coalition for Epidemic Preparedness Innovations (CEPI)[4], could possibly be during the first quarter of next year, 2021, under emergency use protocols, the sooner established health protocols or their enhanced and modified versions get implemented, the speedier appropriate and required infrastructures, such as isolation, quarantine, and/or treatment facilities, are developed and deployed, and the more rapid test laboratories and equipment are acquired and put to use, the more capable will these countries be in meeting the daunting and intensifying pandemic challenges. The researchers view the Multi-Station Automated Hand-washing System (MSAHWS) being presented to be a simple yet effective part of an overall strategy to combat the spread of the SARS-Cov-2 and minimize the virus impact to the health of the people and economy of the country Promoting practice of hand washing with soap and water is one of the simplest, low tech and most cost effective public health measure to prevent transmission of COVID 19 as well as many other communicable diseases[8].

In the study of Hurriyatul Fitriyah , Edita Rosana Widasari, Eko Setiawan, and Brian Angga Kusuma fully automatic faucet for hand-washing has been developed using Interaction Design process to maximize its usability.

The analysis on Verification, Validation and User-Participation test has shown that it functions well to force users to use soap in their handwashing routine and to scrub in 20 seconds as well as excel the usability in different terms7.On Testing the Effect of Faucet Flowrate on Handwashing Efficacy from the resident flora microbial loads found out that Handwashing had a nonsignificant, minor effect on the resident flora, removing only approximately 1% of the recoverable microbes.

However, tests with participants whose hands were initially purposefully contaminated with E. coli confirmed that handwashing resulted in a removal of approximately 99.3% of the added E. coli microbes, and these results were likewise comparable with similar studies reported in the literature[10] COVID-19 pandemic is regularly expanding by the time, so people should comprehend clearly the needful knowledge to limit or stop-up this disease outbreak. Besides, in order to protect people should diligently wash hands with soap and water (or warm water) or use alcohol-based hand sanitizers, thoroughly cook meat and eggs, cover mouth and nose in speaking, coughing, and sneezing, avoid close contact in crowds to reduce the risk of COVID-19 spread through the community[11].The Sensor-activated faucets with Thermostatic Mixer Valves(TMVs) are generally more contaminated than clinical valves without thermostatic mixers. This allows us to conclude that the technologies typically chosen by a hospital do not correspond with the water microbiological environment that can develop in the Surgical Handwashing Outlets (SHWOs). The microbial interaction with the selected technologies, pipeline and faucet materials, and chemical-physical water characteristics result in an environment that, in semi-critical and critical areas, can lead to serious risks for patients, hospital staff, and stakeholders involved in maintenance procedures [12].

II. METHODOLOGY

The development of the multi-station automated hand washing system follows a four-part methodology: formulation of the sanitary, operational, manufacturing and economic requirements; design, modeling, and simulation of the micro-controller-based control system; MSAHWS hardware prototype development; and system test and data collection.

A. System Requirements

WHO protocol requires that hand washing should be done for duration of 40 to 60 seconds and using a right technique. The system is to be designed to help meet these requirements. The control system components are to be selected so that they are the cheapest possible or can be sourced from junk materials. The frame or housing of the multi-station hand washing system should be able to use any locally available materials and could be built in any way, provided that it meets the requirement on physical distancing, meaning that the stations should be acceptably well separated from each other. Physical distancing is also one of the widely known WHO-recommended practices to avoid the virus spread. The code for the micro-controller should be written so that it can easily be modified to suit the actual components used and make the hand washing system respond accordingly. The code should easily be modifiable for the possible future development of hand washing systems with expanded capability, such as being able to accommodate three or more stations from a single micro-controller. It should be completely hands-free or would require no physical contact from any part of the user's body for the hand washing system to get activated. The hand washing system should be able to deliver water and soap when needed and only in such needed amounts as to conserve on water and soap.

B. Control System Design

The design of the control system is illustrated by way of the MSAHWS schematic diagram shown in Fig 1.

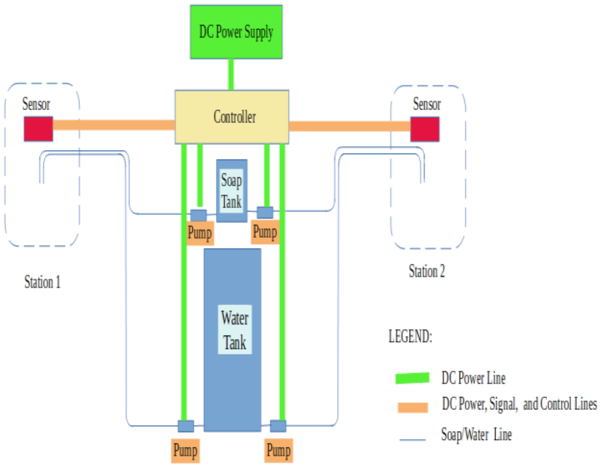

Figure-1: MSAHWS Schematic Diagram

At each washing station an ultrasonic sensor is located, and for each a soap pump and a water pump are assigned. As may be seen in the figure, the two stations are served by common water and soap tanks. The DC power supply provides the power needs of the controller and the pumps. When the sensor at a station gets activated, water and soap are delivered at the station for specified lengths of time and at a certain sequence. A station gets activated when a user comes within a preset distance from the station's sensor. The controller receives data from a station's ultrasonic sensor and determines whether a user is within the activation distance or not. If so, it fires activating and timed control signals, first to the water pump, then to the soap pump, and then again to the water pump. There are timed pauses between the powering up of the pumps. A pause, a short and the first one after the first water delivery will allow for water to get spread all over the hands before soap is supplied. Another pause after soap is delivered, this time for a much longer duration, will allow the user to wash his hands following the WHO's six-step technique. This technique is shown in an illustration, one for each station, posted on the board facing the user. The same steps are suggested for the user to follow as he goes through the hand rinsing process during the final water delivery. The longer water time after the long pause allows for soap to be completely rinsed off. At the heart of the controller is Arduino Uno which receives the input signals from the ultrasonic sensors and send actuating signals at preprogrammed times to the pumps via the power FETs acting as power switches.

C. Control System Software Modeling and Simulation

The PROTEUS software model of the MSAHWS control system described above is shown in Fig. 2. It is a complete circuit representation of the micro-controller-based MSAHWS control system used for simulation

Simulation Model Parts List:

1 – Arduino Uno
2 – Ultrasonic sensors (HC SR-04)
4 – Simple DC motor model
1 – 12-V DC voltage source
1 – 5-V DC voltage source
4 – N-channel power MOSFET Transistor (IRF620)
4 – 10KΩ resistors
4 – 150Ω resistors
2 – 1K potentiometers
2 – Virtual DC Voltmeters
4 – Diodes

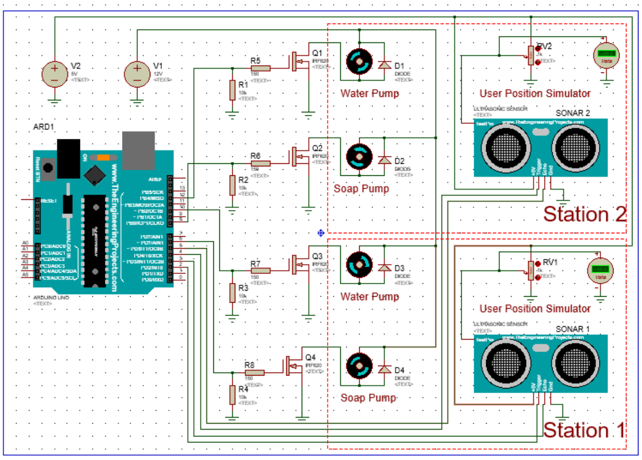

Figure- 2: MSAHWS Control System Software Simulation Model

In the PROTEUS schematic, the motors represent the soap water pumps. It could also be seen that the test pin of every ultrasonic sensor is connected to its associated potentiometer's wiper terminal. The position of the potentiometer's moving contact represents or simulates the position of the user; the closer the wiper terminal to the ground terminal, the closer the user is to the actual sensor. The wiper position that activates the station corresponds to the upper limit of the activation distance and will be referred to as the uppermost activation point (UAP). The UAP and all the other points below it are all within the sensor activation range. Therefore, with the wiper within the activation range or, equivalently, with the user at or within the upper limit of activation distance from the ultrasonic sensor, the station gets activated. Once activated, the system is expected to complete the wash cycle. Before running a simulation case, the wiper terminals are all set to the their topmost position, mimicking users as being farthest from and undetected by their respective sensors. Several cases that replicate all actual possible cases that may occur in the use of the MSAHWS are considered for simulation. In each case, the response of the system indicated by the operations of the motors and are taken to mean soap and water have been delivered as programmed is verified.

Simulation Cases

Case 1: A User Approaches a Station

In this case, Station 1 wiper is slid down until it reaches the UAP or beyond and activates Station 1. This is equivalent to a user approaching the station within activation range. If the system is responding properly, that is, it has been programmed properly, it will run and stop the soap and water pumps at the right time. The station response must be a complete wash cycle even when the wiper is slid back to the original topmost position or above UAP at any time during the wash cycle. This case is also performed for Station 2.

Case 2: Users Approach a Station One After The Other

The initial wash cycle is effected as in Case 1, but at this time without moving back the wiper outside of the activation range. This simulates users coming one after the other to the station right at or within the activation distance. If the system is responding properly, it will keep on going through the wash cycles and provide the programmed break between any two consecutive wash cycles. After enough cycles, the wiper is moved back outside the activation range. This simulation case is repeated for the other station.

Case 3: A User Approaches a Station and, Later, Another User Approaches the Other Station

In this case, Station 1 wiper is slid down to activate Station 1 and slid back up above the UAP. Sometime later during its wash cycle, the same is done to Station 2 wiper. If the system is responding correctly, each station will complete the wash cycle. This is repeated with the order of station activation reversed.

Case 4. Cases 2 and 3 Combined

This means that Station 1 wiper is slid down to activate Station 1 and kept at that position. Sometime later during Station 1's wash cycle, Station 2 wiper is slid down to activate Station 2 and also kept at that position. If the system is responding correctly, both stations will complete their wash cycles with breaks between any two consecutive wash cycles at the given station. This is repeated with the order of station activation reversed, that is, Station 2 is activated first..

Case 5, Users Simultaneously Approach the Stations

In this case the wipers are slid down simultaneously to their activation positions. It is not, however, possible to simultaneously slide the wipers, it being a physical impossibility given the circuit configuration. However, to simulate this case, the original software model is reconfigured as shown in Fig. 3. With this model, sliding Station 2 User Position Simulator to the UAP to activate both stations simultaneously.

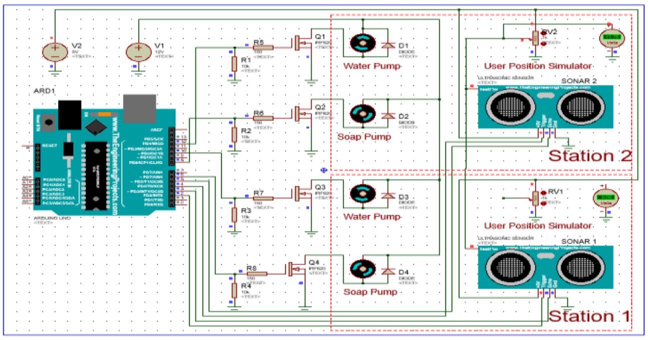

Figure-3: MSAHWS Case 5 Control System Software Simulation Model

Flowchart

The Arduino Uno script is shown based on the flowchart shown in Figs. 4

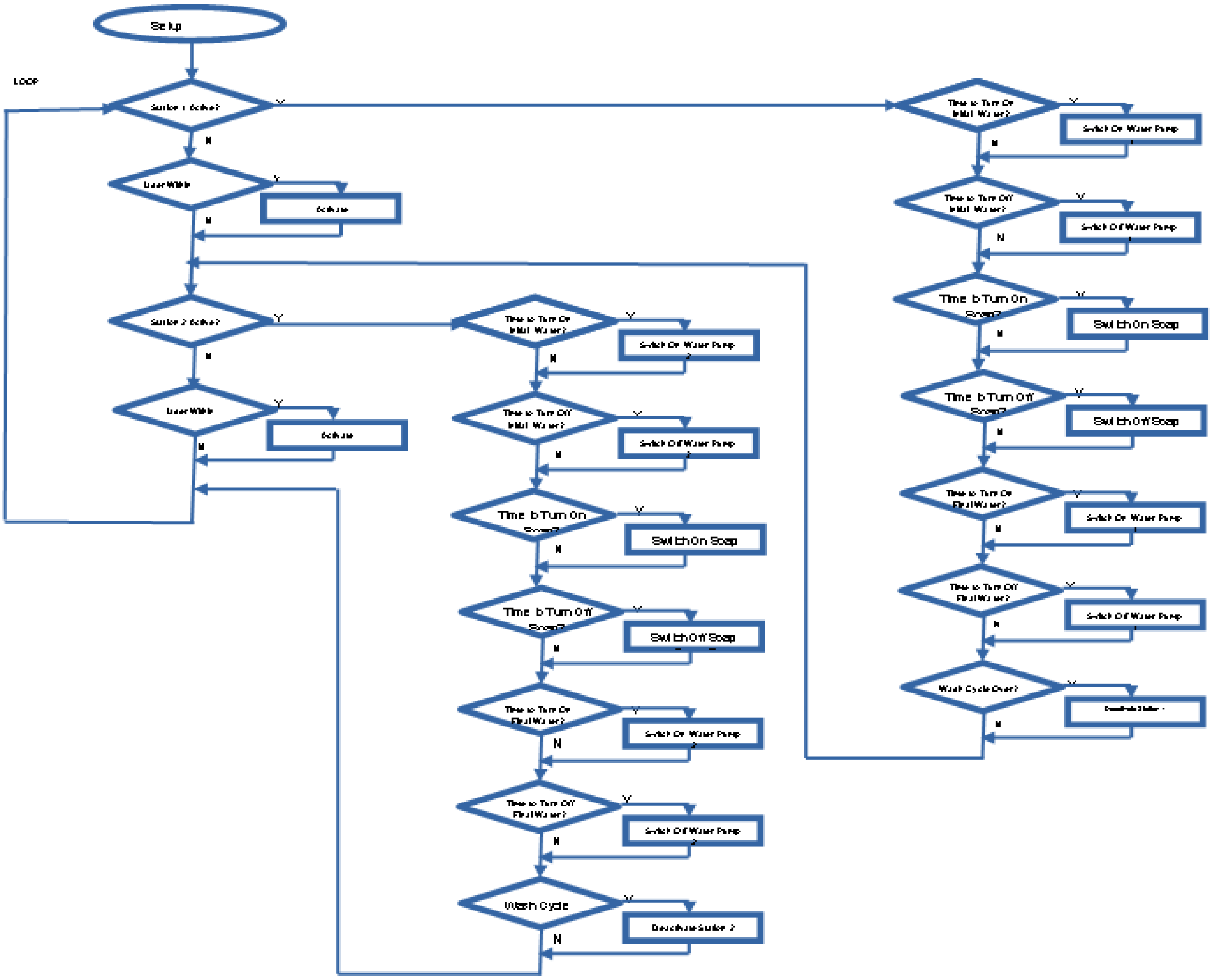

Figure- 4: Loop Flowchart

D. MSAHWS Hardware Prototype Development

The development of the MSAHWS hardware prototype is done in two stages. The first stage is embodied by the control system hardware implementation shown in Fig. 5, showing an Arduino Uno, 4 FET's, and four pumps, 2 each for water and soap. The hardware is tested under the same cases carried out in the control system software simulation. The second and final stage involves the construction of the MSAHWS frame and the installation on it of the control system implemented and tested in the first stage. The water and soap tanks are put in place along with the flexible plastic tubes acting as the water and soap supply lines. The conceptual MSAHWS prototype design is shown in Fig. 7A, and the final MSAHWS prototype is shown in Fig. 6b. Fig 7a&b shows dimensions of the MSAHWS prototype.

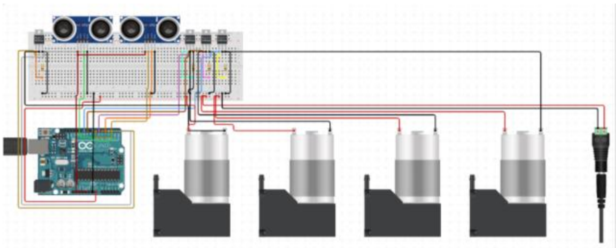

Figure-5: Control System Hardware Implementation

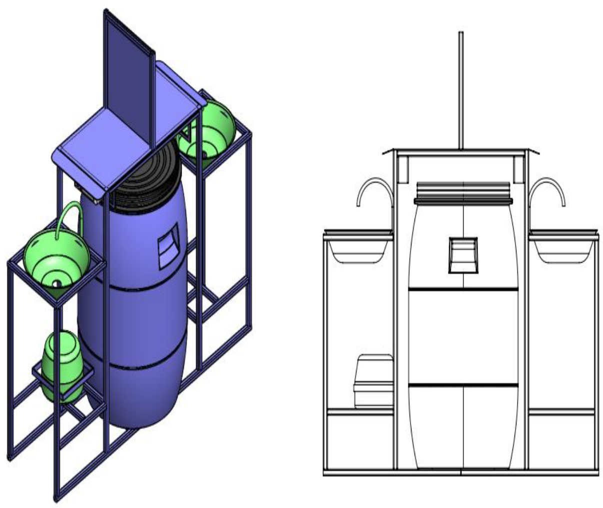

Figure-6a: MSAHWS Prototype Design Concept

Figure-6b: MSAHWS Prototype

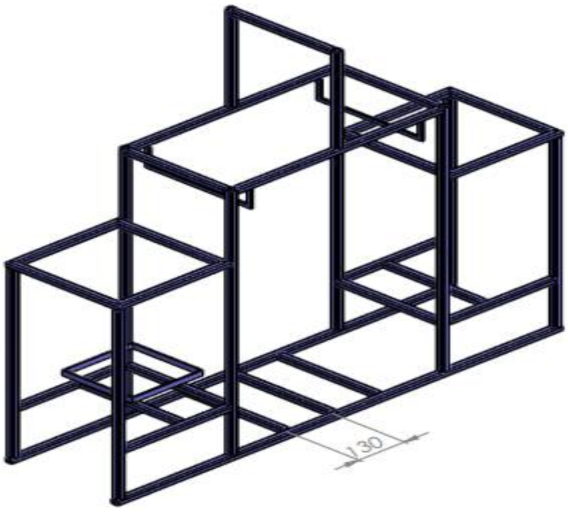

Figure-7a: MSAHWS Frame Dimensions

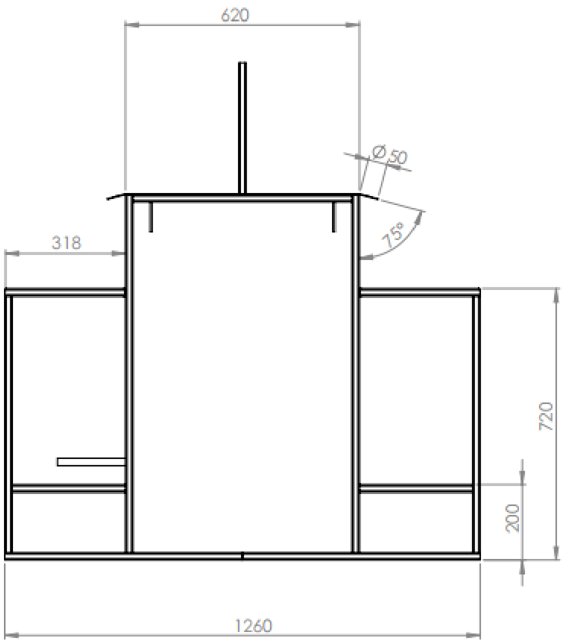

Figure- 7b: MSAHWS Frame Dimensions

E. System Tests and Data Collection

Throughout the number of iterations undertaken in the development of the MSAHWS, from its control system software model through its final hardware prototype, a series of similar tests are conducted. The control system software simulation model shown in Fig. 2 is subjected to Cases 1 through 4. Case 5 is carried out using the reconfigured model shown in Fig. 3. Test cases similar to the software simulation cases are applied to the control system hardware implementation shown in Fig. 6. Given the hardware model, it is only necessary to move the hand close to or away from the ultrasonic sensors to to verify the system response under the different five cases. The same tests are repeated on the final hardware MSAHWS prototype shown in Fig. 6, but, in addition, users go through the hand washing cycle by actually performing the hand washing act. A number of things are looked into the actual hand washing performance. Can the WHO-recommended hand washing technique be effectively carried out from the time is dispensed to the time rinsing water is provided? Is the amount of liquid soap dispensed enough? Is the amount of final water dispensed over its allotted time sufficient enough to wash off the soap? Is the activation distance reasonable enough? The answer to these questions from the actual use of the MSAHWS are made the bases for the readjustments of the parameter values, namely, those that set how long a time the soap and water pumps are active, when these pumps become active, and how close a user needs to be for station activation. The parameter values in the preset up part of the flowchart reflect the final adjustments. With the final values of the parameters fixed, the amount of soap and total water delivered are measured.

III. RESULTS AND DISCUSSION

A. Hand Washing Cycle

For discussion reference, the hand washing cycle is shown in Fig. 8. Note that the time scale is not drawn to scale for diagramming convenience. The figure shows the sequence of activity a station takes when a user comes to within 45 cm of its sensor till the end of the station's hand washing cycle. The duration of each activity is also indicated as well as the point in time each starts and ends. As may also be noted, the researchers prescribe the WHO-recommended hand-washing technique to be repeated twice, once when soap has been dispensed and also when the rinsing water is being supplied, all for a more effective washing of the hands. The WHO-recommended hand-washing technique is shown in Fig. 9.

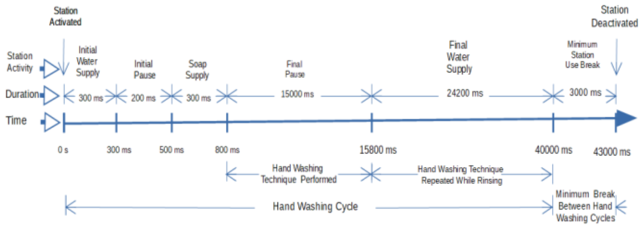

Figure-8: MSAHWS Hand Washing Cycle

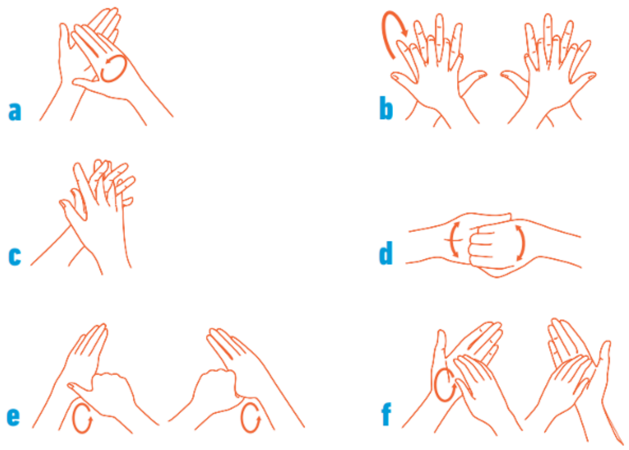

Figure-9: WHO-Recommended Hand-Washing Technique

B. Hand Washing Instructions

The following set of instructions, along with the WHO-recommended hand-washing technique shown in Fig. 9, is posted in each station to help guide the user:

Step 1: Stand close and in front of the station.

Step 2: Put hands under the soap-and-water outlet to receive water and soap.

Step 3. Do the WHO-recommended hand-washing technique while waiting for the rinse water.

Step 4: Do again the WHO-recommended hand-washing technique while rinsing.

Step 5: Leave the station when the water stops flowing.

C. Tests Conducted and Results

The tests conducted and the results for 1) Control System Software Model Tests, 2) Control System Hardware Model Tests, and 3) MSAHWS Prototype Tests are all similar. The results are summarized as shown in Table 1.

Table-I: Summary of System Responses under the Different Test Cases

Test Case	Description	Result/System Response		
		Control System Software Model	Control System Hardware Model	MSAHWS Prototype
1	A User Approaches a Station	Correct	Correct	Correct
2	Users Approach a Station One After The Other	Correct	Correct	Correct
3	A User Approaches a Station and, Later, Another User Approaches the Other Station	Correct	Correct	Correct
4	Cases 2 and 3 Combined	Correct	Correct	Correct
5	Users Simultaneously Approach the Stations	Correct	Correct	Correct

Note that the above tests are performed to check the correctness of the Arduino script as demonstrated by the way any of the station go through the prescribed wash cycle once activated. At the same time, the tests are also undertaken to check the performance of the various hardware components. The tests turned out acceptable or correct results. It is only in the tests of the MSAHWS that the parameter values are needed to be repeatedly adjusted to suit the WHO requirements on hand washing duration and technique.

D. Soap and Water Consumption

The amount of hand washing soap solution supplied per wash cycle is approximately 5 ml. Given the five-liter capacity of the soap container used in the MSAHWS prototype, the number of wash cycles available for a full soap container would be 1000. The total approximate amount of water used for both the initial and final water dispensed during a hand washing cycle is 290 ml and represents the average of measurements taken when the 250-liter water tank used in the final prototype is almost empty, half-full, and full. At full capacity, the water container can provide water for approximately 860 wash cycles.

IV. CONCLUSION

The current work has demonstrated that it is possible to control several independent hand washing stations using a single micro-controller and an appropriately programmed control system. The MSAHWS is shown to provide complete and hygienic hand washing activities with soap and water through its several stations that apparently and essentially operate independently of each other, satisfy the WHO hand washing duration standard and accommodate the WHO hand washing technique. The MSAHWS uses eight (8) of the I/O pins of Arduino Uno, leaving 6 pins unused. Four (4) pins are needed for each station. Thus, it is possible to add another station. Other Arduino boards have more pins.

A future work may include more than two stations controlled from a single Arduino board and use as many as possible of the board's pins. The MSAHWS uses a water tank. It is possible to design another system that sources its water directly from water supply lines available in homes, offices, factories, and other institutions.

A continuous water supply would then be available and preclude the need to refill a water tank now and then. The use of solenoid valves to control the pressurized water in this setup is possible. WHO notes that a most effective hand washing system uses warm water and a system for drying the hands, either by the use of a disposable hand towel or air hand dryer. This would especially be suitable or most needed in hospitals and other critical medical care facilities. A hand washing system that incorporates these features may also be designed and built Currently, the MSAHWS uses a 3-second break between hands washing cycles to avoid station reactivation by the same user who has just finished washing. The break gives the user ample time to leave the station. A future system may rewrite the Arduino sketch so that a station does need to have the required break between hands washing cycles. The sketch may be written so that the system does not get activated again when the current user does not leave the station, thus dispensing for the need for the specified minimum time break between users. It should be written so as not to affect the independent operation of two or more stations. So written, a given station can service a greater number of users.

REFERENCES

1. worldometer 2020, COVID-19 CORONAVIRUS PANDEMIC, worldometer, 22 July 2020, <https://www.worldometers.info/coronavirus/ >
2. 2.worldometer 2020, WORLD / COUNTRIES / ETHIOPIA, worldometer, 22 July 2020, <https://www.worldometers.info/coronavirus/country/ethiopia/ >
3. 3.OECD 2020, COVID-19 and Africa: Socio-economic implications and policy responses, OECD, 22 July2020, <https://www.oecd.org/coronavirus/policy-responses/covid-19-and-africa-socio-economic-implications-and-policy-responses-96e1b282/#section-d1e1646 >
4. Wikipedia 2020, COVID-19 vaccine, Wikipedia, 22 July2020,<https://en.wikipedia.org/wiki/COVID -19_vaccine#Compressed_timelines >
5. 5.Wikipedia 2020, Hand washing, Wikipedia, 22 July2020, <https://en.wikipedia.org/wiki/Hand_ washing >
6. 6.WHO 2020, Clean Care is Safer Care, WHO, 22 July2020, <https://www.who.int/gpsc/clean_hands_ protection/en/ >
7. Hurriyatul fitriyah,Edita Rosana Widasari,Eko Setiawan, and Brian Angga kusuma "Interaction Design of Automatic Faucet for Standard Hand-Wash" renew. Energy, matec web of conferences 154, 03003 (2018) icet4sd 2017
8. Swayam pragyan parida1, vikas bhatia2 "handwashing: a household social vaccine against covid 19 and multiple communicable diseases" international journal of research in medical sciences parida sp et al. Int j res med sci. 2020 jul;8(7): www.msjonline.org pissn 2320-6071 | eissn 2320-6012
9. Michael brauer1,2, jeff t zhao1 , fiona b bennitt1 , jeffrey d stanaway1 global access to handwashing: implications for covid-19 control in low-income countries"https://doi.org/10.1101/2020.04.07.20057117.
10. Sadru walji, shazia tanvir,marc aucoin, william a. Anderson" testing the effect of faucet flowrate on handwashing efficacy" t:https://www.researchgate.net/publication/338921497
11. Thi sin , tran thi thu ngoc vo2,3, tran thi bich chau vo4. id" handwashing in against of coronavirus disease 2019 infection" j res clin med, 2020, 8: 19 doi: 10.34172/jrcm.2020.019 https://jrcm.tbzmed.ac.ir
12. 12. Marta mazzotta 1, luna girolamini 1, maria rosaria pascale 1, jessica lizzadro 1, silvano salaris 1, ada dormi 2 and sandra cristino 1," the role of sensor-activated faucets in surgical handwashing environment as a reservoir of legionella" pathogens 2020, 9, 446

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Publications:

1. Wubishet Degife, Jolan Baccay S Y, 2020, Design and Analysis of Small-Scale Wind Turbine as An Alternate Power Source for Addis Ababa City Residents, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 09, Issue 06 (June 2020),
2. Wubishet Degife, *Experimental Analysis of Liter of Night Light*. Lambert Acadamic publishers, 2020.
3. Degife, W.; Bogale, W. Experimental Analysis of Liter of Night light for Potential Use in Rural Electrification. Preprints 2019, 2019080083 (doi: 10.20944/preprints201908. 0083.v1).
4. W. D. M. 3 Prabhakar. S 1* , Seid Endro 2, “EXPERIMENTAL ANALYSIS OF MAHUA OIL BLEND – AN SUSTAINABLE ENERGY,” *Int. J. Adv. Res. Basic Eng. Sci. Technol.*, vol. 4, no. 9, pp. 20–29. (ISSN (ONLINE):2456-5717)
5. Degife, Wubishet, et al. "Extracted Biodiesel as Feed for Internal Combustion Engine." *Journal of Mechanical Design and Vibration* 3.1 (2015): 1-7.

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