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Automated facemask dispenser using Arduino UNO R3

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Abstract

This study aimed to produce an automated facemask dispenser using Arduino Uno R3 to provide a relatively safe and effortless way to maintain basic personal hygiene and protect individuals from reaching any viral diseases. The researchers used an applied experimental research design and used four stages in developing and observing the product. The materials used in this study for dispensing housing were plywood, and gluing materials while for the automation were Arduino Uno R3, ultrasonic sensor, servo motor, and wirings. The Arduino Uno was configured with simple software to create the servo motor and ultrasonic sensor. The researchers used self-constructed questionnaires and 15 respondents who participated in the experiments and tested the product in order to determine the acceptability of the product. Based on the result of the experiment, it is proven that the automated face mask dispenser is convenient to use in public places and dispense one facemask at a time and the elements affecting the ultrasonic sensor's recognition rate were the hand size, placement, and the distance from it. Further, there is a very high positive correlation between the distance of the hand from the Ultrasonic Sensor and the time it takes to be detected. Thus, the researchers propose weekly maintenance to maintain basic personal hygiene and protect individuals from any viral diseases, and it is recommended the use of LED lights for notification if the ultrasonic sensor can recognize it and to future researchers the dispenser's supply capacity is suggested to be increased.

Keywords: facemask, Arduino UNO R3, ultrasonic sensor, applied experimental research, automated

Automated facemask dispenser using Arduino UNO R3

1. Introduction

Facemasks have become a requisite item when going out as it is mandatory in different places and establishments. People's reliance on facemasks is constant. Still and all, transmission of COVID-19 disease continues to spread. Facemasks act as a barrier to prevent respiratory droplets from spreading in the air (UNICEF, 2020). Many people are not aware that improper storage and care of facemasks contribute to the rise of COVID-19 cases (DOH, 2023). As many people still do not fully comprehend or put these concepts into practice. With all of those in mind, the researchers have developed an Automated Facemask Dispenser Using Arduino UNO R3.

The primary way of transmission of the COVID-19 disease is through close contact, respiratory droplets, and touching surfaces that are frequently touched by other people namely, railings, doorknobs, and tables (World Health Organization, 2020). Since the pandemic started, facemasks showed a pivotal role in preventing the disease. It is one of the best methods and the cheapest to slow the spread of not only COVID-19 but also other existing viruses (UNICEF, 2020). The Department of Health of the Philippines still requires the use of facemasks up to this day, especially in closed and crowded places. Wearing a facemask won't completely protect us from harmful viruses that can be transmitted airborne such as respiratory diseases. Everything we touch is at risk of contamination since we are battling an invisible infectious disease. Wearing a facemask is easily done and so forget it. People are not used to wearing face masks before going outside, thus there is a high possibility of forgetting facemasks. In addition, facemasks can be fragile and break easily. In doing so, buying an alternative still consists of contamination as in some other stores, they are the ones giving the facemask manually which is considered counted as cross-contamination and the proper hygiene can't be proven. Facilities such as offices, schools, hospitals, and public bathrooms are shared which means the chances of transmission of diseases are high. Despite the fact that many of these facilities are practicing proper hygiene, health protocols, and sanitation by providing hygiene kits, the way of accessing facemasks in public facilities can cause cross-contamination, especially in public places where the sanitation of each individual is not monitored. The effectiveness of the use of masks depends on the general public's behavior in handling face masks (Kellerer & Matthias, 2021).

To live in the world is to adapt constantly. A year after the COVID-19 pandemic emerged, we have suddenly been forced to adapt to the 'new normal': work-from-home setting, parents home-schooling their children in a new blended learning setting, lockdown and quarantine, and the mandatory wearing of face masks and face shields in public (Corpuz, 2021). With the new normal, one of the things that are implemented is to wear a facemask when going outside. Masks should be used as part of a comprehensive strategy of measures to suppress transmission and save lives; the use of a mask alone is not sufficient to provide an adequate level of protection against COVID-19 (WHO, 2020). Continuing to practice and wearing a facemask as a routine will slow and prevent the contact of the virus from being transmitted. With the addition of the facemask being enclosed in a dispenser, the level of effectiveness and protection of the facemask is high as it is guaranteed that it was not contaminated.

Having an Automated Facemask Dispenser is not only for the COVID-19 virus, as it is not the only respiratory disease. There are numerous respiratory diseases that can be transmitted through droplets and other possible ways that can be contagious and having this Automated facemask dispenser at offices, facilities mostly at the hospital will ensure the safety and prevention of contamination. Making sure to prevent all of this from happening, having an automated facemask dispenser in your house, and in public places will keep us protected from any diseases that are transmissible. Even in the future, this automated facemask dispenser was beneficial for the prevention of various infectious diseases. This study produced an automated face mask dispenser that minimizes contact and reduces contamination. Instead of random people manually grabbing a facemask from its container, the automated dispenser was providing a facemask with less contact. It provides a relatively safe and effortless way to maintain basic personal hygiene and protect individuals reaching any viral diseases. Additionally, it ensures that the face masks were not touched by many individuals before someone makes use of it.

Statement of the Problem - This study aims to produce an Automated facemask dispenser using Arduino Uno R3 to provide a relatively safe and effortless way to maintain basic personal hygiene and protect individuals from reaching any viral diseases. Specifically, the study will seek to answer the following questions: (1) What is the level of effectiveness of the Automated facemask dispenser in terms of accuracy & precision, and convenience? (2) Is it effective to use the dispenser housing, and Ultrasonic sensor in minimizing contact and preventing cross-contamination? (3) Do the following factors have an impact on the ultrasonic sensor’s recognition rate in the circuit in terms of location, hand size, and distance from the ultrasonic sensor? (4) Is there a significant relationship between the recognition rate of the ultrasonic sensor and the distance of the hand?

Significance of the Study - With an automated face mask dispenser, people can now wear a more sanitary mask, lowering their risk of contracting viruses. Therefore, this study can give benefits the following: First for the DWCSJ, through this study, it is the researchers’ first concern to support the well-being and health of all locally, which is the reason we are glad to offer an answer to protect your youngsters and understudies. To ensure the safety of both students and teachers at the school, our brand-new Face Mask Dispenser is the ideal solution. Our dispensers for face masks come preloaded with individually sealed masks that are simple to mount. Our dispensers for face masks can be placed in classrooms, in front of teachers' lounges, and in other locations. Students are also reminded to always wear their masks by these dispensers, which also let them swap out their old masks for new ones whenever they see fit. Second, in public places, additionally, wearing a facemask in this day and age has become a habit. The automatic facemask dispenser will help control the spread of infectious diseases, which is important to ensure safety. Restocking and monitoring inventory levels will be quicker and easier with the face mask dispensers. They can rest assured that face masks will be readily available for those who come into contact with their organization due to the high capacity and quick and easy access. The researchers' product's novel design was demonstrated in this study. This can serve as a reference for future researchers' projects. Future researchers can utilize this product to assist them in resolving project-related issues. This product can connect them to information sources.

Scope and Delimitation of the Study - The automated facemask dispenser using Arduino Uno R3 aims to develop a touchless automatic dispenser that minimizes contact and reduces contamination. This study aims at maintaining basic personal hygiene and protecting individuals from reaching any viral diseases in a relatively safe and effortless way. This research was conducted at various public and private schools in San Jose Occidental Mindoro throughout the academic year 2022-2023. The scope of this study was limited to Divine Word College of San Jose students. Some calculations, assumptions, and selections were made in consideration of a proper and realistic design.

2. Methodology

Research Design - The researchers used an applied experimental research design to produce an Automated Facemask Dispenser using Arduino UNO R3, particularly how its components work together to generate an effective face mask dispenser. There was a control group and an experimental group, with the experimental group being the only one to receive the manipulation according to Simkus (2018). The applied experimental research design is a type of experimental design having a practical objective, such as a solution to a real-world problem (Driskell et al., 2014). The effectiveness of the facemask dispenser's contactless action to access the facemask was assessed by the researchers using this design. Additionally, the researchers determined whether the dispenser's construction is adequate to shield the facemask from contamination.

Research Process; Stage 1 Preparation and Gathering of Materials - This project requires modernized technological materials to produce an innovative and effective product. The researchers chose the most accurate and expensive materials to do so. These materials were ordered online and stored in San Jose Occidental Mindoro. To complete the main product of our experiment effectively. Here is the list of materials needed to create an Automated Facemask Dispenser Using Arduino Uno R3 (Mellis, 2023; Rawal, nd.) For the Dispenser housing:

Figure 1 Gluing Materials

Figure 2 Plywood

B. For the automation:

Figure 3 Arduino Uno

Figure 4 Ultrasonic Sensor

Figure 5 Servo motor

Figure 6 Wirings

Figure 7 Battery

Figure 8 LED

The researchers made use of an Arduino Uno R3 as the primary component for the automation of the product. The ultrasonic sensor also was used to detect an object in dispensing the facemasks. In order for the automation of the product to function properly the researchers will use Mini Gear Servo, Wiring, Battery, and LED to enable the project to work properly while some of the gluing materials will be used to connect the cardboard and other tools. The researcher also used cardboard for the sanitation of the dispenser housing to enclose the facemask. The researchers made sure to follow the rules and protocols before buying the tools and conducting the research.

Stage 2: Building and Developing the Product - a. Assemblage of Materials for Automated Facemask Dispenser Using Arduino UNO R3; b. Attaching each material for dispenser housing; c. Using Arduino Uno R3 for automation of the product; d. Connecting all components to Arduino Uno R3 properly; f. Encoding the program

Figure 9. Actual Product of Automated facemask dispenser using Arduino Uno R3

Stage 3: Experimental Stage - The researchers evaluated the Ultrasonic Sensor if precisely programmed. They test the duration of the Ultrasonic Sensor and how quickly it responds when it senses an object. Also, they do the experiment if the design of the facemask dispenser housing is convenient and meets the goal to reduce direct contact with the facemasks. Lastly, the researchers tested the durability and effectiveness of the automated facemask dispenser.

Stage 4: Observation and Data Gathering Procedure - The researchers used a self-constructed questionnaire to determine the acceptability and effectiveness of the automated facemask dispenser for the 15 respondents that are randomly selected to test the product. Upon the approval of the research instrument, the researchers formally sent a letter to their adviser for their consent to conduct the study and the request to get the email address of the respondents to facilitate the research instrument and interviews. To validate their responses from the instrument, the researchers conducted a structured interview with selected respondents. The copies of the questionnaires were given to the subject teacher for validation purposes. After validation, if the items were adequate enough to collect data, were objective and not biased, and all of items were relevant to the research problem, the copies of the questionnaires were then distributed personally by the researcher to the respondents. The surveys were retrieved on the same day after they tested the product. The results of the questionnaire retrieval copies were tallied. The data was then analyzed and interpreted using the most applicable statistical approaches.

Statistical Treatment of the Data - The researchers used frequency distribution for descriptive analysis. The tallied results from the retrieved questionnaire were put on a graphical representation. This was to verify the effectiveness of Automated facemask dispensers using Arduino Uno R3 for maintaining the basic personal hygiene of the users. The experimental design was used by the researchers in this study entitled Automated facemask dispenser using Arduino UNO R3 particularly how its components work together. This study used a control group and an experimental group, with the experimental group being the only one to receive the manipulation according to Simkus (2018). The effectiveness of the facemask dispenser's contactless action to access the facemask was assessed by the researchers using this applied experimental research. Additionally, the researchers determine whether the dispenser's construction is adequate to shield the facemasks from contamination. The researchers also used Pearson’s r correlation coefficient formula in identifying the significant relationship between the distance of the hand from the ultrasonic sensor and the duration of time for it to be detected.

3. Results and Discussions

Table 1 below shows the tabulated evaluation of the respondents’ view on the performance of the Automated Facemask Dispenser in terms of accuracy, precision, and convenience. Out of 15 respondents who tested the product, they strongly agree that the facemask dispenser hands out one face mask at a time with a weighted mean of 3.6. Furthermore, with a weighted mean of 3.73, the respondents strongly agree that the dispenser is convenient to use and is ideal for public places. According to reports, the most likely reason for developing numerous bacterial infections in public health settings including hospitals, clinics, schools, and nursing homes is poor hand hygiene practices (Lee et al., 2020). This Automated Facemask dispenser is ideal for public places as it requires no human contact to access a facemask. Additionally, it controls the overuse and underuse of the product as the experiment showed a highly positive result in terms of the frequency of the dispensing machine.

The tabulated results of the respondents' assessments of the Automated Facemask Dispenser's efficacy and usability are shown in Table 2. Out of 15 respondents, a weighted mean of 3.86 indicates that they strongly agree that the Ultrasonic sensor is functioning and can detect the hand of the person. Secondly, a weighted mean of 3.60 strongly agrees that the face mask dispenser helped to lessen the contact in obtaining the face mask. Therefore, the ultrasonic sensor played a vital role in lessening the contact as it is the sensing component for the dispenser to operate which also supports the results of the findings on the result above.

Table 1

Mean level of effectiveness of Automated Facemask Dispenser

Indicators	Frequency				Overall		Percentile Rank
	4	3	2	1	Weighted Mean	Descriptive Equivalent	
The face mask dispenser hands out one face mask at a time.	9	6	0	0	3.6	Strongly Agree	2
The dispenser is convenient to use and ideal for public places	12	2	1	0	3.73	Strongly Agree	1
Overall Weighted Mean					3.67	Strongly Agree	

Descriptive Equivalent: 4- 3.26- 4.00 (SA), 3- 2.51- 3.25 (A), 2- 1.76- 2.50 (DA), 1- 1.00- 1.75 (SDA)

Table 2

Mean level of effectiveness of the Automated Facemask Dispenser

Indicators	Frequency				Overall		Percentile Rank
	4	3	2	1	Weighted Mean	Descriptive Equivalent	
The face mask dispenser helped lessen contact in obtaining a face mask.	12	3	0	0	3.60	Strongly Agree	2
The Ultrasonic sensor is functioning and can detect the hand of the person.	13	2	0	0	3.86	Strongly Agree	1
Overall Weighted Mean					3.73	Strongly Agree	

Descriptive Equivalent: 4- 3.26- 4.00 (SA), 3- 2.51- 3.25 (A), 2- 1.76- 2.50 (DA), 1- 1.00- 1.75 (SDA)

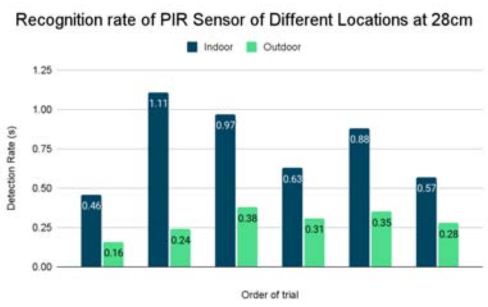

Figure 10: Recognition rate of Ultrasonic Sensor of different locations at 28cm

The researchers conducted an experiment to find out how the location of the ultrasonic sensor can affect its detection rate. For each location, indoor and outdoor, the researchers conducted a total of 6 trials of the hand detection rate of the ultrasonic Sensor at 28cm. The results of the trials measured in seconds are shown in Fig. 10.

Table 3

Average recognition rate of Ultrasonic Sensor of different locations at 28cm

Location (hand with a distance of 28cm)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Mean
Outdoor (30℃)	0.16s	0.24s	0.38s	0.31s	0.35s	0.28s	0.29s
Indoor (28℃)	0.46s	1.11s	0.97s	0.63s	0.88s	0.57s	0.77s

The table 3 shows the data of the recognition rate of the ultrasonic sensor at different locations namely, indoor and outdoor with the hand at a distance of 28cm. When the ultrasonic sensor was placed outdoors at a 30 degrees Celsius temperature, an average value of 0.29s was obtained by the researchers. The average value of 0.77s was obtained indoors with a 28 degrees Celsius temperature, conversely. Furthermore, air temperature contributes the greatest impact on the detection and recognition rate of Ultrasonic Sensors as supported by Gabriel and Kuria (2020). At higher temperatures, the speed of sound increases. The sound waves travel faster backward and forward from the object. As a result of this experiment, the researchers have concluded that the Ultrasonic Sensor has a faster recognition rate when placed outdoors at higher temperatures.

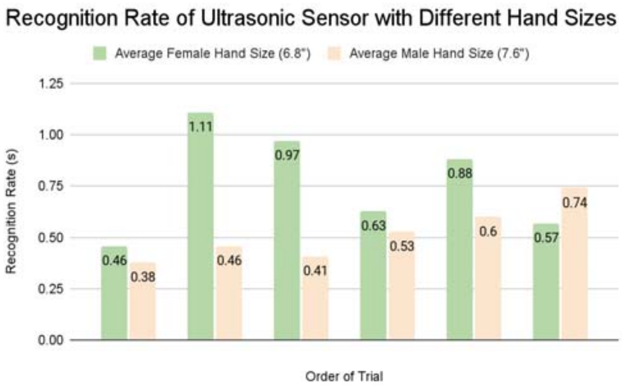

Figure 11: Recognition rate of Ultrasonic sensor at different hand sizes at 28cm

Figure 11 shows whether the hand size affects the recognition rate of the Ultrasonic Sensor. Two people participated in this experiment. A female with an average female hand size of 6.8” and a male with an average hand size of 7.6” (Healthline, 2019). Both participants waved their hands at a 28cm distance from the Ultrasonic Sensor with each having a total of 6 trials.

Table 4

Average recognition rate of Ultrasonic Sensor for people with different hand size

Hand Size (with a distance of 28cm from the Ultrasonic Sensor)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Mean
7.6”-Average Male Hand Size	0.38s	0.46s	0.41s	0.53s	0.60s	0.74s	0.52s
6.8”- Average Female Hand Size	0.46s	1.11s	0.97s	0.63s	0.88s	0.57s	0.77s

Table 4 reveals the result from the data gathering with a total of 6 trials for each participant and the calculated mean as well. For the female participant, an average of 0.77s was recorded. On the other hand, an average of 0.52s was recorded from the male participant. This shows that the hand size of an individual is a factor that can cause a slight delay in the recognition rate of the Ultrasonic Sensor. Ultrasonic Sensors can detect larger objects at longer distances greater than smaller targeted objects (Senix Corporation, n.d.).

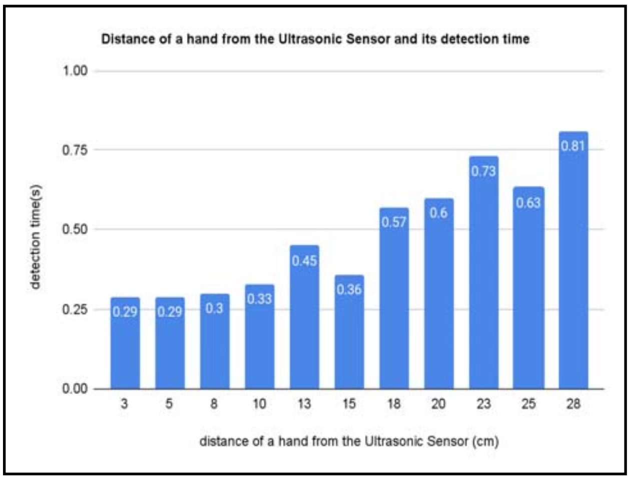

Figure 12: Distance of a hand from the Ultrasonic sensor and its detection time

Using Pearson's Correlation Analysis, the researchers determined whether the distance of the hand affects time for the Ultrasonic sensor to detect and dispense a facemask. The researchers conducted a test on how the hand's distance from the Ultrasonic Sensor would affect the time it takes to detect it. In Figure 12 a hand that is 28cm away from the Ultrasonic Sensor will be detected in 0.81 seconds. Conversely, a hand at a distance of 3 cm will be detected in a shorter time, about 0.29 seconds.

Table 5

Person's r Sample Correlation Coefficient

Indicators	*x*	*y*	*df*
distance of a person from the Ultrasonic Sensor (cm) (x)	1	0.95	13
distance of detection (s) (y)	0.95	1	0.441

Legend: x- distance of a person from Ultrasonic Sensor (cm) y-distance of detection (s)
**Significant at p< 0.05

The result of Pearson's r sample correlation coefficient was shown in Table 5, it shows that there is a very high positive correlation between the distance of the hand from the ultrasonic sensor and the time it takes to be detected, moreover, since the computed value of 0.95 is greater than the critical value of 0.441, the researchers reject the null hypothesis and accept the alternative one. Therefore, there is a significant relationship between the distance of a person from the ultrasonic sensor (cm) and the duration of detection (s). The findings show that if the value of x or the distance between a hand and the Ultrasonic Sensor increases, the time it takes for the Ultrasonic Sensor to detect the hand also increases. Ultrasonic sensors operate by delivering sound waves at a frequency that is unrecognizable to humans. The distance is then calculated based on the amount of time needed to wait for the sound to be reflected back (Cook, 2018). Hence, nearer objects are detected for a shorter amount of time.

4. Conclusions

Following the overview of results, the following conclusions were made; It is proven that the automated face mask dispenser is convenient to use in public places and does dispense one facemask at a time. The Ultrasonic sensor is operational and can detect the person's hand. Effective in minimizing contact and reducing contamination providing a relatively safe and effortless way to maintain basic personal hygiene and protect individuals from any viral diseases. The researchers concluded that the elements affecting the ultrasonic sensor's recognition rate were the hand size, the placement, and the distance from it. There is a very high positive correlation between the distance of the hand from the Ultrasonic Sensor and the time it takes to be detected.

Recommendation **-** Based on the results of the experiments, the researchers suggest calibrating a sensor by exposing it in the first 5 seconds of the sketch to the highest and lowest inputs that you want to monitor, resulting efficiently in accurately and precisely dispensing facemasks, which leads to the conclusion that they are practical and ideal for public spaces. The researchers recommend weekly maintenance to maintain basic personal hygiene and protect individuals from any viral diseases. Based on the researchers' observation, the placement of the ultrasonic sensor affects its recognition rate. The researchers recommend the change of the ultrasonic sensors located in the under part of the dispenser housing. The researchers recommend the use of LED lights for notification if the ultrasonic sensor can recognize it. To future researchers, the researchers recommended that the dispenser's supply capacity to be increased.

5. References

Bababelle, M., Bello, M., Umar, A., Shehu, A., Bello, D., & Abdullahi, F. (2022). A look at the different types of servo motors and their applications. *Sarcouncil Journal of Engineering and ComputerSciences,1*(2),4-9.

Cook, J. (2018). Ultrasonic Sensors: How they work (and How to use them with Arduino). *Arrow*. https://www.arrow.com/en/research-and-events/articles/ultrasonic-sensors-how-they-work-and-how-to-use-them-with-arduino

Corpuz, J. C. G. (2021). Adapting to the culture of 'New Normal': an emerging response to COVID-19. *Journal of Public Health, 43*(2), 344-345.

Driskell, J. E., King J., & Driskell, T. (2014). Chapter 20- Conducting applied experimental research. Laboratory Experiments in the Social Sciences (Second Edition), pp. 451-472. https://doi.org/10.1016/B978-0-12-404681-8.00020-0

Department of Health (2023). https://www.gmanetwork.com/news/topstories/nation/870023/doh-logs-2-109-new-covid-19-cases-active-tally-rises-to-15-891/story/

Gabriel, M. M., & Kuria, K. P. (2020). Arduino UNO, ultrasonic sensor HC-SR04 motion detector with display of distance in the LCD. *International Journal of Engineering Research & Technology, 9*(5), 936-942.

Devan, P. D., Gokul, R., Dharun, S., & Thirudhakshin, T. (2022). Automatic Facemask Vending Machine. 8(1), 990.

Healthline. (2019). What’s the Average hand size for Men, Women, and Children? https://www.healthline.com/health/average-hand-size

Kellerer, J. D., Rohringer, M., & Deufert, D. (2021). Behavior in the use of face masks in the context of COVID-19. 38(19), 862-868. https://doi.org/10.1111/phn.12918

Lee, L.Y., Lam, E.P., Chan, C.K., Chan, S., Chiu, M., Chong, W., Chu, K., Hon, M., Kwan, L., Tsang, K., Tsoi, S., & Wu, C. (2020). Practice and technique of using face mask amongst adults in the community: a cross-sectional descriptive study. *BMC Public Health, 20*, 948. https://doi.org/10.1186/s12889-020-09087-5

Madyun, A. (n.d). Everything you need to know about facemask. UNICEF. https://www.unicef.org/sudan/everything-you-need-know-about-face-masks

M. Bal, & R. Abrishambaf (2017). A system for monitoring hand hygiene compliance based-on Internet-of-Things. *2017 IEEE International Conference on Industrial Technology (ICIT),* Toronto, ON, Canada, pp. 1348-1353. https://doi.org/10.1109/ICIT.2017.7915560

Mellis, D. A. (2023). Building an Arduino on a Breadboard. https://docs.arduino.cc/hacking/hardware/building-an-arduino-on-a-breadboard

Moss, M. (2023). 75 years of who: The world health assembly considers what’s next for the global health agency. https://unfoundation.org/75-years-of-who-the-world-health-assembly-considers-whats-next-for-the-global-health-agency

Kellerer, J. D., Rohringer, M., & Deufert, D. (2021). Populations at Risk Across the Lifespan- *Case Studies, 38*(5), 862-868. https://doi.org/10.1111/phn.12918

Raja, D. (2015). Servo motor control using Arduino. https://circuitdigest.com/microcontroller-projects/arduino-servo-motor-control-code-and-circuit

Rawal, A. (n.d). Arduino Uno Pin Functions. https://www.thegeekyway.com/arduino-uno-pin-functions/

Senix Corporation (n.d.) https://senix.com/faqs/

Simkus, N. (2018). Compound-specific carbon isotope compositions of aldehydes and ketones in the Murchison meteorite. https://doi.org/10.1111/maps.13202

UNICEF (2020). https://l.facebook.com/l.php?u=https%3A%2F%2Fwww.unicef.org%2Fsudan%2Feverything-you-need-know-about-face-masks