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The Making of Self-Disposing Contactless Motion-Activated Trash Bin Using Ultrasonic Sensors

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Abstract:- The spread of viruses continues with the presence of surfaces containing harmful pathogens, posing a prevalent risk of indirect contact transmission. This study aimed to address transmission concerns through the creation of a Self-Disposing Contactless Motion-Activated Trash Bin with the integration of ultrasonic sensors for definite motion detection. A quantitative experimental research design was used to systematically gather data on the parameters of distance, detection time, and weight capacity of the device. The results of the study proved the feasibility of utilizing ultrasonic sensors as a main component in creating a self-disposing contactless trash bin. The device possessed the capability of detecting motion up to 60 centimeters, and as early as 0.47 seconds. Its self-disposing feature has also been deemed functional, with a weight of 1 to 3 kilograms. This study strived to contribute to the burgeoning field of smart waste management by offering a tangible solution that addresses the escalating demand for efficient and contactless waste disposal methods. By bridging technological innovation with pressing societal needs, this study emphasized the potential of sensor-driven solutions in shaping a more sustainable and hygienic future. Based on the findings,the device can detect motion within a fair range, function in less than a second, and self-dispose effectively. It is recommended to use materials of higher quality to enhance and refine the operating process of the self-disposing contactless motion-activated trash bin.

Keywords:- *Contactless Trash Bin; Sanitation,; Self-Disposing, Technology; Ultrasonic Sensor; Waste Disposal System.*

I. INTRODUCTION

While the world has slowly transitioned back to normal due to the alleviation of the coronavirus spread through vaccines, there remains an increased and present risk of infectious diseases everywhere and every day. Indubitably, viruses, bacteria, parasites, fungi, and others alike are still alive and looming around the world, being transmitted through various ways—one in particular, “indirect contact transmission.” (Higuera, 2017). After recent contact with a potentially infected individual or contaminated material, harmful microorganisms may remain on a contaminated surface, leaving a harmful trace of infection for the next person to be in contact with (Seventer et al., 2017; Real, 2022).

Transmission of viruses occurs when an individual touches their eyes, nose, or mouth after being in contact with a contaminated surface or object . These contaminated surfaces are often in public places such as malls, recreational parks, or fitness centers. The risk of transmission is prominent as the use of necessary facilities such as trash bins is imminent. The threat of transmission is present from the surface of the trash bin down to its very contents. Research indicated that the main form of viral transmission often derives from exposure to respiratory fluids containing virus wastes lingering in objects such as used tissue papers, which when disposed of, are often in contact with the surface of the trash bin (California Institute of Technology, 2019). As a result, the contaminated waste could leave a smear on the surface of the trash bin, making it unsanitary for use. In the study demonstrated by Ogawa et al. (2023), contactless trash bins increased the transparency of waste weight and volume generated by residents, allowed the possibility of polluters’ pay principle adoption, and increased collection efficiency due to more accurate task distribution based on the waste content detected by the sensors. Moreover, the study responds to the global practice of smart waste collection technologies.

Waste disposal management is an essential factor in the containment of viruses and bacteria. Exposure to infectious pathogens and improper waste management increases the risk of disease transmission for sanitary workers, patients, and the population (Das, 2021). Poor application of sanitary measures and negligent waste management increases the risk of hazardous viral transmission into society. With a properly structured system of waste management and uncontaminated public facilities, the swiftness of infectious transmission could be reduced.

Ultrasonic sensors are predominantly utilized in technology. It is often integrated into the safety features of modern vehicles—in particular, the proximity sensors at the rear side of a car as an anti-collision system. Ultrasonic sensors are capable of detecting types of disturbances within their proximity by emitting ultrasonic sound waves (Arun Francis, 2019). Through these properties of ultrasonic sensors, used as an independent variable, the study has made its dependent variable, the Self-Disposing Contactless Motion-Activated Trash Bin. The Ultrasonic Sensor has been used by numerous researchers to sense the movements of the objects as they approach. An Arduino board with the help of an Ultrasonic Sensor has helped Buachoom et al. (2019) in their study of simple harmonic motion. In their

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study using ultrasonic sensors, the researchers have been able to display the records of distances.

Technology like contactless trash bins has been the subject of multiple studies in the past years. According to Kinshuk et al. (2023), contactless trash bin systems serve as an efficient and environmentally responsible solution that advances waste management procedures by limiting the spread of bacteria and odors. Moreover, Azman et. al's (2021) study expressed that traditional recycling bins often hold extreme amounts of germs, bacteria, and viruses. Hence, the researchers of the study proposed a touchless garbage bin to prevent the further spread of health-harming microorganisms. According to these studies, contactless trash bins offer a more promising and convenient way to improve waste disposal in public areas. Although contactless trash bins such as the Automatic Hands-Free Stainless Steel Trash Can by Amazon, Automatic Bathroom Trash Can by Yoccrov, and iTouchless Sensor can already exist in the market, these devices are often made with expensive materials with additional premium features such as an odor filter, that can add up to a higher overall cost, making the trash bins inaccessible and unaffordable to people unable to purchase these high-end trash bins.

The major difference in this study's Self-Disposing Contactless Motion-Activated Trash Bin is the significantly lower cost, the use of ultrasonic sensors instead of infrared sensors which is used by the Automatic Bathroom Trash Can by Yoccrov, and easy accessibility to the materials used in this study. Moreover, this study has incorporated additional features, such as a hand sanitizer dispenser and a self-disposing system to prevent overflow within the trash bin.

This study benefits the Philippine School Doha, Qatar, and Philippine communities, as well as future researchers. The findings of this study will acquaint the community of students, teaching, and non-teaching staff of Philippine School Doha with the potential virus transmission by contaminated objects and the importance of hygienic and sanitary practices. The chances of contracting such diseases can be diminished through proper acknowledgment of precautionary measures regarding waste disposal. This study could aid Qatar and Philippine communities by encouraging the use of contactless bins instead of regularly used bins in indoor, everyday settings, such as schools and households to encourage a habit of observing hygienic health measures. Moreover, future researchers may use this study as a reference to titles related to contactless trash bins, motion-activated devices, or any related product that may serve a greater purpose in ensuring health safety.

II. RESEARCH QUESTIONS

The objective of this study was to construct a Self-Disposing Contactless Motion-Activated Trash Bin using ultrasonic sensors. This research paper aimed to answer the following questions:

- What is the maximum distance the ultrasonic sensor from the Self-Disposing Contactless Motion-Activated Trash Bin can detect?
- What is the average time of detection of the ultrasonic sensor?
- What is the maximum weight the self-disposing feature of the Contactless Motion-Activated Trash Bin can contain?

III. METHODOLOGY

This study utilized the experimental design of research. Experimental research is a scientific method in performing research where independent variables are applied to dependent variables to observe their effect on the latter. (Zubair, 2022). In this study, the ultrasonic sensors were the independent variables and the Self-Disposing Contactless Motion-Activated Trash Bin was the dependent variable. The quantitative method was used to organize the experiment properly and to ensure that the right type of data was available to answer the research questions as clearly and efficiently as possible. It is necessary to use this method because it provides a high level of control over the variables that demonstrates an outcome and has an advantage in finding accurate results.

A. Research Locale

The research study was conducted in Philippine School Doha in Doha State of Qatar, specifically in the Messameer Area (Zone 56), Al Khulaifat Al Jadeeda Street (St. 1011). The research was done at this location due to the facilities present that enable the researchers to make their product.

B. Research Procedure

The following procedure shows the step-by-step process of how to make a Contactless Motion-Activated Trash Bin with the use of ultrasonic sensors.

➢ *Ensuring the Protection and Maintaining Safety:*

- Wear personal protective equipment such as safety goggles, safety gloves, safety shoes, and a laboratory coat while performing the procedures below to avoid hazardous conditions.

➢ *Preparing the Inner Bin:*

- Use a container that can fit inside the trash bin, adjust the size as necessary to maximize the volume that the bin can hold.
- Attach a hook using zip ties or a glue gun, to the lower part of the inner bin, in order to hold onto the door when self-disposing.
- Drill and screw a set of free moving wheels to the bottom of the inner trash bin, in order to make the self-disposing process easier and smoother.

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➢ *Preparing the Trash Bin:*

- Disassemble the trash bin from the lid;
- On the lid, drill two holes that match the size and shape of the Ultrasonic sensor on the right of the front of the lid;
- On the right side of the lid, make a long vertical hole that matches the pump of the hand sanitizer;
- Place the lid back into the trash bin;
- Inside the lid, attach the hand sanitizer using glue, to perfectly match the hole with the pump;
- Drill 4 holes on the right side of the body of the trash bin, in order to insert the wires from the container later on;
- Cut out the entirety of the front side of the body of the trash bin;
- Reattach the front side to the body of the bin using a hinge that will be drilled and screwed into the right side of the bin, and to the front side of the bin for it to be accessible;
- Drill a hole into the right side of the door where it will be later used to connect the servo motor horn to the door.
- Drill two holes next to each other below the first hole, then add a zip tie through the holes then tighten when it forms a loop inside the bin. This will be used to pass through a hook then pull the inner bin.

➢ *Preparing the Arduino Uno, Breadboard, and Batteries:*

- Prepare a container with a lid to store the stated parts;
- Drill holes in the container that match the positions of the holes in the trash bin, in order to assort the wires from the container to the trash bin later in the process;
- Connect the 9v Battery to the 9v Snap Connector and connect to the 3.5mm port in the Arduino Uno;
- Glue the Arduino Uno and 9v Battery to the inside of the container
- Insert 6 AA Batteries into the 6 AA Battery Holder, and connect the wires to the positive and negative bus strips of the breadboard
- Glue the 6 AA Battery Holder and Breadboard to the inside of the container
- Wait for the items to dry
- Attach the container to the right of the trash bin

➢ *Preparing the Ultrasonic Sensor:*

- Near the top half of the front, right of the bin, place the first Ultrasonic Sensor using glue while making sure the pins face down;
- Wait for it to dry;
- On the back, top half of the inside of the bin, place the second Ultrasonic sensor on a 45 degree angle using glue;
- Wait for it to dry.

➢ *Preparing the Servo Motor:*

- For the servo motor of the lid, attach the servo motor near the hinge of the lid with glue, and wait for it to dry
- Connect the servo motor horn to the hinge of the lid using a small pin or wire
- For the servo motor of the sanitizer, attach the servo motor beside the sanitizer with glue, and wait for it to dry
- Connect the servo motor horn to the pump of the sanitizer using a small pin or wire
- For the servo motor of the self disposing function, attach the servo motor to the right side of the bin, near the movable front cover
- Connect the servo motor to the door by using a zip tie that goes through the horn of the servo motor, and through the drilled hole made earlier

➢ *Connecting the Wires:*

- Connect the wires from the VCC nodes of the Ultrasonic Sensors to the negative terminal of the Breadboard
- Connect the wire from the Trig node of Ultrasonic Sensor A to the PD9 node of the Arduino Uno
- Connect the wire from the Echo node of Ultrasonic Sensor A to the PD8 node of the Arduino Uno
- Connect the wire from the Trig node of Ultrasonic Sensor B to the PD11 node of the Arduino Uno
- Connect the wire from the Echo node of Ultrasonic Sensor B to the PD10 node of the Arduino Uno
- Connect the wires of the Ground nodes of the Ultrasonic Sensors to the positive terminal of the Breadboard
- Connect the wire from the 5v node of the Arduino Uno to the negative terminal of the Breadboard
- Connect the wire from the second Ground node of the Arduino Uno to the positive terminal of the Breadboard
- Connect each of the brown wires of the Servo Motors to the positive terminal of the Breadboard
- Connect each of the red wires of the Servo Motors to the negative terminal of the Breadboard
- Connect the orange wire of the Servo Motor for the lid to the PD7 node in the Arduino Uno
- Connect the orange wire of the Servo Motor for the sanitizer to the PD6 node in the Arduino Uno
- Connect the orange white wire of the Servo motor for the disposing to the PD5 node in the Arduino Uno

➢ *Programming the Arduino Uno:*

- Connect a data cable to the Arduino Uno.
- Connect the other end of the data cable to a laptop.
- Run the Arduino IDE software.
- Input the program.
- Verify the inputted program.
- Upload the inputted program to the Arduino Uno microcontroller using the USB cable.

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➢ *Organizing the Wires:*

- Gather the sets of wires using tape.
- Attach the wires throughout the trash can using tape.

IV. RESULTS

This study aimed at creating a Self-Disposing Contactless Motion-Activated Trash Bin using Ultrasonic Sensors. The section below presents the results and interpretation of the data obtained from assembling and testing the device, wherein the three main research questions were to be answered, such as maximum distance of the trash bin, average time in opening of the trash bin, and maximum weight of the self-disposing feature.

A. Maximum Distance the Ultrasonic Sensor from the Self-Disposing Contactless Motion-Activated Trash Bin Can Detect

Table 1: Motion Detected by the Contactless Trash Bin on Varying Distances

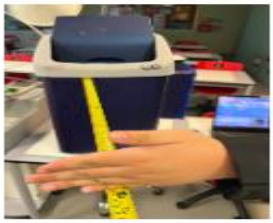
Trial	1	2	3	4
Photos				
Distance	15cm	30cm	45cm	60cm
Result	Detected	Detected	Detected	Detected
Average			**37.5cm**	

Table 1 shows the motion detected by the Self-Disposing Contactless Motion-Activated Trash Bin at varying distances. For this test, a self-retracting metal ruler was used to record the maximum distance at which motion was detected. The distance used for each trial was in intervals of 15. In the first trial, the distance of the user's hand was 15 centimeters away from the sensor and it was successfully detected. In the second trial, the distance measured was 30 centimeters and the user's hand was detected. Motion was also detected on the third and fourth trials with distances of 45 centimeters and 60 centimeters respectively. Ultimately, the ultrasonic sensor can detect motion to an average distance of 37.5 centimeters.

Based on the data given, the distance at which the Self-Disposing Contactless Motion-Activated Trash Bin triggers is successful to a distance of 60 centimeters. Findings from a similar study showed that their trash bin detects the movement of objects or people at a distance of 40 cm (Abidin et al., 2022). This means that the varying results for the distances that the ultrasonic sensors detected are subjective based on the programming of the sensors. Ultrasonic sensors send and receive pulses to transmit information about an object's proximity. It sends out a 40 kHz ultrasonic pulse, meanwhile, it can detect a range as far as 3 meters (Aman & Soni, 2018).

B. Average Time of Detection of the Ultrasonic Sensor

Table 2: Detection Time of the Contactless Trash Bin

Trial	1	2	3	4	5
Photos					
Time	0.80 seconds	0.60 seconds	0.47 seconds	0.73 seconds	0.47 seconds
Average			**0.61 seconds**		

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Table 2 shows how long it takes before the contactless motion-activated trash bin detects motion from the user depending on the time in which motion is detected. In this test, the tool utilized was a stopwatch and the time interval used for each trial was in seconds. In the first trial, the time in which the user's hand was detected was 0.80 seconds. In the second trial, the user's hand was detected at 0.60 seconds. As for the remaining trials, three, four, and five, the motion was detected at 0.47 seconds, 0.73 seconds, and 0.47 seconds consecutively.

Based on the data given, the average time at which the Self-Disposing Contactless Motion-Activated Trash Bin successfully triggers due to motion pickup is 0.61 seconds. In comparison to other studies that made use of the same ultrasonic sensor, the results of their trials significantly differ from ours. One of which is a study conducted by Prasojo et al (2020). The results of their trials involving detection time are fairly quicker than this device as on average, the time at which their device, Fire Fighter Robot, can detect motion from the user, is 0.23 seconds. The difference in terms of performance of the ultrasonic sensor in both devices is caused mainly by program execution and the response of the sensor itself.

C. Maximum Weight the Self-Disposing Feature of the Contactless Motion-Activated Trash Bin Can Contain

Table 3: Weight Capacity of the Self-Disposing Feature

Trial	1 (1 kg)	2 (2 kg)	3 (3 kg)	4 (4 kg)
Photos				
Result	Successfully Disposed	Successfully Disposed	Successfully Disposed	Unsuccessfully Disposed

Table 3 shows the maximum weight the self-disposing function of the contactless motion-activated bin can handle. The self-disposing function operates in a way that the inner bin is pulled by the hook attached to the door that automatically opens once the ultrasonic sensor inside has been triggered by a certain level. For the test, the tool utilized was a weighing scale that contained increments of 1 kilogram that was added per trial. In the first trial, the total weight of 1 kilogram was successfully disposed of by the trash bin. In the second trial, the total weight of 2 kilograms was successfully disposed of by the trash bin. In the third trial, the total weight of 3 kilograms was successfully disposed of by the trash bin. In the fourth trial, the trash bin failed to smoothly dispose of 4 kilograms worth of weight.

Based on the results of the assessment, the self-disposing feature of the Self-Disposing Contactless Motion-Activated Trash Bin is effective in carrying a maximum weight of 3 kilograms. The trials show that the Self-Disposing Contactless Motion-Activated Trash Bin is more suitable for indoor settings, containing typical everyday wastes such as paper, food scraps, and simple garbage. However, The Self-Disposing Contactless Motion-Activated Trash Bin enforces a timely response to waste accumulation as compared to similar works that only monitor the trash bin's waste level through an alert function. A study conducted by Samann (2017) utilized a similar feature, monitoring the waste level of the trash bin and notifying its fullness through a mobile application. The immediate disposal of the Self-Disposing Contactless Motion-Activated Trash Bin contributes to preventing overflow, which may create an unsanitary situation with filthy trash lying in the surroundings. Moreover, overflow of trash bins may exude an unpleasant smell and spread harmful diseases and illnesses (Ravale, 2017).

V. CONCLUSIONS

The risk of transmission becomes prevalent due to the presence of surfaces where pathogens grow and cultivate. These harmful microorganisms, such as the coronavirus, may be transmitted indirectly by contact from contaminated objects to bodily surfaces like the face. This kindles the importance of observing sanitary measures that reduce the containment and spread of pathogens in all environments.

Hence, the researchers designed a contactless product for disposal with additional functions, a self-disposing system to avoid overflow, and a hand sanitizer feature to strengthen the protection of health and hygiene. This research strived for a favorable outcome relying on the distance from where the motion is. The duration of time was evaluated before the Contactless Motion-Activated Trash Bin detected the motion. Finally, the maximum weight the device can dispose of with its self-disposing feature was analyzed.

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Based on the outcomes of the study, the Self-Disposing Contactless Motion-Activated Bin can suitably function after detecting motion from 15 centimeters to 60 centimeters, establishing a safe distance from the waste situated in the bin to reduce exposure. Furthermore, the Self-Disposing Contactless Motion-Activated Trash Bin can detect motion and promptly perform its activities as early as 0.47 seconds. The self-disposing feature of the Self-Disposing Contactless Motion-Activated Trash Bin functions effectively carrying a weight of 1 kilogram to 3 kilograms, making it suitable for indoor, small-scale settings. In conclusion, the Self-Disposing Contactless Motion-Activated Trash Bin is effective for contactless waste disposal.

Students, future researchers, and benefiting communities are advised to use materials of higher quality to strengthen durability and enhance the overall performance of the product. It is recommended to have additional space inside the actual trash bin dedicated to the electronic materials such as the Arduino Uno, the breadboard, and the respective wiring. If the space cannot be provided inside the trash bin and must be placed outside, it is recommended to have an enclosure for the electronic materials that can be easily accessed. It is also advisable to connect the power supplies to a switch for convenience of turning off and on. As for the total weight that the trash bin can handle, it is recommended to use a stronger servo motor that can handle additional weight and ensure a smooth self-disposing process. Lastly, it is best to remove the breadboard by soldering the wires together, and by assorting and adding an insulator to the wires to remove the possibility of wires being unplugged, and to avoid messy wiring.

Moreover, future researchers may utilize this study as a reference to titles related to contactless and motion-activated devices. It is advised to use larger bins to create more room to contain trash and avoid cramping inside with the other components. Aside from the hand sanitization and self-disposing feature, the researchers suggest improving the product by incorporating more features useful to those who are to use it.

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