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The Creation of a Face Mask Detecting Alarm System with the Use of Raspberry Pi as a Component

Dr. Julie Ann B. Real, Mark Raphael D. Dela Cruz, Marcus Joshua E. Fortes, Elijah Arielle M. Soriano, Jasser Penzen L. Reyes, Raphael Gio C. Tiangco, Justin Bien R. Felicitas

***Abstract*— The use of face masks proves to be one of the key factors in lowering the airborne transmission rates of the COVID-19 and influenza viruses. In Qatar, mask regulations were implemented as a means of ensuring that the general population wore facemasks all the time (Ministry of Public Health, 2020). However, some people either refuse to wear facemasks or wear them improperly (Scheitle & Corcoran, 2021). Authoritative figures, such as medical and security personnel, were then tasked with upholding facemask mandates in public spaces as a way to ensure that the public would wear facemasks all the time. It leads to the main objective of this study, which is to make a Face Mask Detecting Alarm System (FMDAS) with the use of the Raspberry Pi as the main component. The results showed that the FMDAS device can detect if a person is wearing a face mask properly, as it gives a person a grade from 0–100% based on how the face is covered. In addition, it can detect up to seven people at once and has a maximum range of detection of a person's face of up to 1.5 m from the device. Findings also revealed that the FMDAS device can be a reliable and convenient way of monitoring the proper use of face masks without creating an unnecessary workload for medical staff and security personnel, thus creating a stress-free and consistent way of lessening the spread of COVID-19 and influenza viruses in Qatar.**

***Index Terms*—Alarm System, COVID-19, Influenza, Face Mask, Raspberry Pi**

Dr. Julie Ann B. Real, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Mark Raphael D. Dela Cruz, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Marcus Joshua E. Fortes, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Elijah Arielle M. Soriano, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Jasser Penzen L. Reyes, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Raphael Gio C. Tiangco Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar
Justin Bien R. Felicitas, Senior High School Department/ Research Development Accreditation and Publication Office/ Philippine School Doha/ Doha, Qatar

I. Introduction

The recent pandemic caused by the COVID-19 virus and its variants has caused a change in the day-to-day lives of everyday citizens, with varying effects. The global economic sector has taken a heavy toll, with many businesses failing. Apart from the disease itself, the pandemic brought with it a slew of additional issues, such as social isolation, continual cleanliness of everything, and the usage of face masks to prevent COVID-19 transmission everywhere (Wang, 2021). Due to the COVID-19 virus evolving and developing numerous versions that require different remedies than previously, COVID-19 is no longer the sole problem that civilization is dealing with. Thus, the practice of social distancing and constant sanitation of everything, as well as the practice of using facemasks, is prolonged, resulting in the continuous cycle of these daily hassles.

Mask regulations in public settings were then implemented as a means of ensuring that the general population wore face masks all of the time. In the year 2020, 175 countries will have made it compulsory to wear facemasks in public transport, shops, and crowded places (Brooks, 2021). Qatar has made wearing masks mandatory in all public establishments, and failure to do so may result in a fine (Ministry of Public Health, 2020). The implementation of facemask usage, along with other safety protocols, has decreased the number of COVID cases. This further cemented how important the implementation of facemasks in public areas is.

The use of facemasks, especially in low-virus abundance areas, proves to be a key strategy. Others were then tasked with upholding these mask mandates in public spaces as a way to ensure that the public would wear facemasks all the time, thus not halting any progress on everyday activities (Piątkowski & Walkowiak, 2022). Facemasks must be worn appropriately to provide the best measure of safety for all, especially inside, such as in stores, cinemas, and theaters. Security guards can only handle a certain number of commonly encountered objects. Without the presence of an authoritative figure, people would not feel obliged to follow these mask mandates. Mask mandates are only as effective as how they are enforced by authoritative figures and how people themselves obey the mask mandate rules.

Common reasons for not wearing facemasks are that they cause discomfort and can have negative effects, such as rashes and acne. The most common concerns expressed are related to physical discomfort and negative effects. Political beliefs also factor into people not wearing masks, as some

people believe that mask mandates infringe upon one's liberty, while others believe that wearing masks is effective in preventing the spread of COVID-19 (Lu He et al., 2021).

The objective of this study is to create a Face Mask Detecting Alarm System (FMDAS). It is a device for workers to reduce the unnecessary workload that comes with having to check whether people are wearing masks every day. The Face Mask Detecting Alarm System can distinguish between those who are wearing and those who are not wearing their masks. The workload that comes from monitoring face-mask-wearing customers is then lowered for the workers. The device produces a sound that serves as a signal that a person is not wearing a mask. Afterward, a voice tells the unmasked citizen to put on a mask.

Facemasks are highly useful in public spaces like schools and offices where there are lots of people. This is particularly crucial in schools due to several factors, including children's susceptibility to illness and their potential unwillingness to wear masks out of discomfort or lack of familiarity with the idea. In addition, they are unaware of the negative consequences of not wearing a mask (Tingley, 2021; Park et al., 2020).

The Raspberry PI was used as the primary component in an AI-based smart device that detects whether or not a person is wearing a facemask and sends an alarm message via a mobile application (Teboulbi et al., 2021; Baluprithviraj et al., 2021). The only difference is that the FMDAS device shows results in real time and has an alarm system that alerts authorized personnel to advise people to wear masks properly.

The Raspberry Pi serves as the device's main component, with the webcam and speaker serving as sub-components. The Raspberry Pi is utilized since it can run many applications and do complex calculations, making it useful in the coding process. The Raspberry Pi has been increasingly taken up by biologists, in the laboratory, the field, and the classroom, and across a wide range of disciplines (Jolles, 2021). Raspberry Pi has also recently seen an increase in usage by scientists and biologists, whom they use Raspberry Pi to create surveillance devices that monitor plant and animal behaviors (Robinson, 2021). The Raspberry Pi is also connected to the webcam to process the image and to the speaker that produces a sound to notify people to wear a mask.

II. Research Questions

The objective of this study is to make a Face Mask Detecting Alarm System with the use of a Raspberry Pi as a component. Specifically, this research aims to answer the following questions:

- How far is the distance can the Face Mask Detecting Alarm System detect in terms of meters?
- How many people can the Face Mask Detecting Alarm System detect under one condition?
- How accurate is the Face Mask Detecting Alarm System in identifying if a facemask is properly worn?

III. Methodology

This study utilized the quantitative experimental design of research. Experimental research is the type of research that aims to determine “cause and effect” relationships of defined variables under controlled conditions, create products with certain materials, create comparisons between two specific products, and test the feasibility and/or effectiveness of products (Tanner, 2018). The relationship between the independent and dependent variables was tested through the hypothesis. In this study, the Raspberry Pi is the independent variable and the Face Mask Detecting Alarm System is the dependent variable. The quantitative method was used to organize the experiment properly and ensure that the right type of data is 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 demonstrate an outcome and has an advantage in finding accurate results.

A. Research Locale

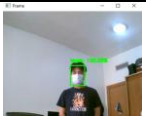
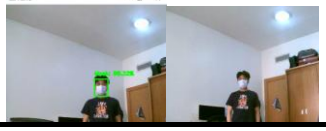
The research study was conducted in Bin Mahmoud, Al Reem Street, Al Qayed Building A. This location was chosen as it was a very accessible point for all researchers due to the presence of a nearby metro station. Furthermore, the materials and equipment needed are all present at this location which would make the creation of the Face Mask Detecting Alarm System faster and more efficient

IV. Results

The objective of this study is to make a Face Mask Detecting Alarm System with the use of a Raspberry Pi as a component. Below are the results and interpretation of the data that were collected from the assembly and testing of the Face Mask Detecting Alarm System (FMDAS).

1.) The distance can the Face Mask Detecting Alarm System detect in terms of meters

Table I
The Distance at which the Face Mask will be detected

Trial	Distance(m)	Pictures
First Trial of Measurement	0.5m	 (SUCCESSFUL)
Second Trial of Measurement	1.0m	 (SUCCESSFUL)
Third Trial of Measurement	1.5m	 (SUCCESSFUL)
Fourth Trial of Measurement	2.0m	

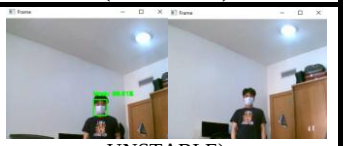
		(UNSTABLE)
Fifth Trial of Measurement	2.5m	 UNSTABLE)
Sixth Trial of Measurement	3.0m	 (FAIL)

Table I shows how far the Face Mask Detecting Alarm System can detect in terms of meters. In the first trial, a person wearing a facemask standing 0.5m away from the Face Mask Detecting Alarm System (FMDAS) was able to be detected by the machine. In the second trial, a person wearing a facemask standing 1m away from the Face Mask Detecting Alarm System (FMDAS) was able to be detected by the machine. In the third trial, a person wearing a facemask standing 1.5m away from the Face Mask Detecting Alarm System (FMDAS) was able to be detected by the machine. In the fourth trial, a person wearing a facemask standing 2m away from the Face Mask Detecting Alarm System (FMDAS) was able to be detected by the machine, however, it was unstable. In the fifth trial, a person wearing a facemask standing 2.5m away from the Face Mask Detecting Alarm System (FMDAS) was able to be detected by the machine, however, it remained unstable. In the sixth trial, the Face Mask Detecting Alarm System (FMDAS) was not able to detect a person wearing a facemask standing 3m.

As shown in the table, the device can stably detect a facemask for distances of 0.5m, 1m, and 1.5m. Reaching 2.0m and 2.5m, the device is still able to detect the mask, however, it is unstable. When it reached 3m the device had already failed to detect the face mask. A possible reason for the fact that the device could only detect up to 2.5m is because of the type of object detection used, which is a webcam. Although this kind of method can run in real-time, it usually struggles with dealing with small objects due to the difficulty of handling smaller input image sizes (Shen et al., 2019).

2.) Number of people the Face Mask Detecting Alarm System can detect under one situation

Table II
The number of people the Face Mask Detecting Alarm System can detect

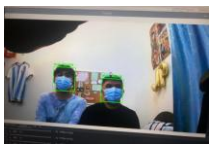
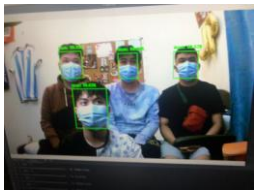
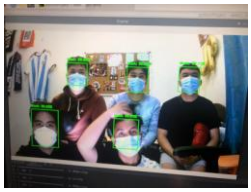
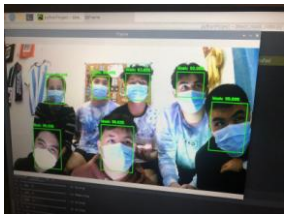
Trials	Number of People	Pictures
First Trial of Measurement	1	 (SUCCESSFUL)
Second Trial of Measurement	2	 (SUCCESSFUL)
Third Trial of Measurement	3	 (SUCCESSFUL)
Fourth Trial of Measurement	4	 (SUCCESSFUL)
Fifth Trial of Measurement	5	 (SUCCESSFUL)
Sixth Trial of Measurement	6	 (SUCCESSFUL)
Seventh Trial of Measurement	7	 (SUCCESSFUL)
Eight Trial of Measurement	8	 (FAIL)

Table II shows the number of people that can be detected by the Face Mask Detecting Alarm System under one situation. In the first trial, one person was able to be detected by the Face Mask Detecting Alarm System. In the second trial, two people were able to be detected. In the third trial, three people were able to be detected. On the fourth trial, four persons were able to be detected. On the fifth trial, five persons were able to be detected. On the sixth trial, six persons were able to be detected, and on the seventh trial, seven persons were able to be detected by the Face Mask Detecting Alarm System. However, on the eighth trial, it was a failure only identifying 3 masks out of 8. The Face Mask Detecting Alarm System can detect more than six individuals.

As presented in the table above, the device can successfully detect up to 7 people. The results show that the device is not capable of detecting all masks from the past 7 participants. The lighting in the room proved to be an issue when testing the Face Mask Detecting Alarm System's ability to detect the masks of the participants. Illumination as a factor progressively worsened the performance in face identification under incongruent lighting conditions (Lim et al., 2022).

3.) The Accuracy of the Face Mask Detecting Alarm System in identifying if face mask is properly worn

Table III
The Accuracy of the Face Mask Detecting Alarm System in identifying if face mask is properly worn

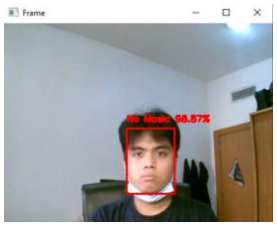
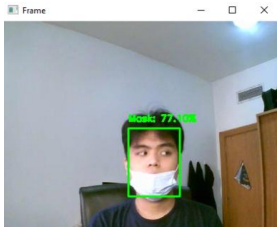
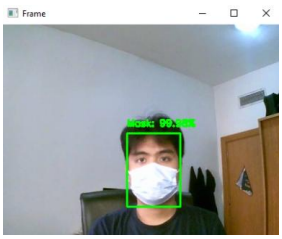
Trials	Percentage	Pictures
No Mask	95 – 99%	
Mask Covering the mouth	70 – 90%	
Full-covered mouth and nose	97 – 99%	

Table III shows the percentage used in identifying the accuracy of the face masks being worn. This was tested in several trials wherein a face mask was not worn by a person, a face mask covered the mouth only, and a face mask covered the mouth and nose. In the first trial, when the device detected a person not wearing a face mask, their face where put in a red square with a 95–99% number on it, indicating that that person is not wearing a face mask. In the second trial, when a person was covering only his mouth with the mask, the device put the person's face in a green square and identified their face as only 70-90% covered. In the last trial, when a person fully covered his mouth and nose, the device put the person's face in a green square and identified their face as 97-99% covered. The alarm is triggered when the device detects that the person is not wearing a face mask to remind the person to put on a face covering to stop the spread of any virus. The use of face coverings helps reduce the risk of infection by 70% (Center of Disease Control and Prevention, 2021).

V. Results

The spread of COVID-19 and other flu diseases, such as fever, sore throat, headache, and asthma, has disrupted the lives of people due to the need to practice safety precautions like maintaining social distance and wearing masks properly. The latter proved to be a challenge for people, as some found it unnecessary and did not believe that it helped in preventing the spread of COVID-19 and other kinds of viruses (Anderson, 2022). Some people also find wearing a mask to be uncomfortable. These factors cause people to wear masks improperly or not at all, thus increasing the chance of spreading COVID-19 and other kinds of viruses. Wearing a facemask that only covers the mouth still leaves one vulnerable to catching the virus, as the nose is one of the key entry points for COVID-19 and other flu-related viruses (Chapman, 2020). In Qatar, mask regulations were implemented as a means of ensuring that the general population wore facemasks all the time (MOEHE, 2020). This then causes the need for people like medical staff and security personnel to check if people are correctly wearing facemasks, causing an unneeded amount of extra workload.

The Face Mask Detecting Alarm System (FMDAS) aims to lessen the workload of people as it scans the faces of people and checks if they are wearing a face mask or not. When the device detects that the person is not wearing a facemask properly or is not wearing one at all, an alarm sounds to alert the person to fix or wear their facemask.

This study proves that the Raspberry Pi can be a component in the Face Mask Detecting Alarm System (FMDAS). Based on the trials and tests, it has a maximum range of detecting a person's face up to 1.5 meters and can detect up to seven people at once under one situation involving proper lighting of the setting as well as a high placement of where the camera is placed at around 1.7m above ground to be able to capture the faces of the average adult (Schappi, 2022). Furthermore, the results also showed that the FMDAS device can detect if a person is wearing a face mask properly, as it gives a person a grade from 0–100% based on how the face is covered.

Findings revealed that the FMDAS device can be a reliable and convenient way of monitoring the proper use of face masks without creating an unnecessary workload for medical staff and security personnel, thus creating a stress-free and consistent way of lessening the spread of COVID-19 and influenza viruses in Qatar.

For COVID-19 and flu-related safety protocols, a Face Mask Detecting Alarm System can be used. Although originally used for thermal purposes, this type of tool is commonly seen in airports, malls, or areas with large gatherings to measure temperature, which is a reflection of body heat. The Face Mask Detecting Alarm System is very useful for both thermal and mask detection. It can be a reliable and convenient way of monitoring the proper use of face masks without creating an unnecessary or excessive workload for medical staff and security personnel, thus creating a stress-free and consistent way of lessening the spread of COVID-19 and influenza viruses in Qatar.

To enhance the effectiveness and efficiency of the FMDA device, it is recommended to add internal storage or a better microSD card to boost the speed of the device. It is also suggested that the camera be placed near entrances and at eye level rather than high up, where it may have difficulty

detecting faces. Further, it is strongly suggested that the device be placed in a bright area and that people form a line for the camera to have an easier time detecting faces.

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