DESIGN AND PROTOTYPE DEVELOPMENT OF A LOW-COST FACE TOUCH PREVENTION WEARABLE FOR COVID19

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ARTICLE INFO	ABSTRACT
Received: Revised: Approved:	*In preventing the spread of the Coronavirus, one of the protection measures for everyone is to avoid touching their eyes, nose and mouth, as advised by the World Health Organization (WHO) in their website. Viruses are easily picked up by our hands after touching many surfaces on daily basis. Once it is contaminated, our hands can transfer the virus to our eyes, nose or mouth where the virus can easily enter our body. The aim of this research is to develop a commercialized low-cost wearable called the Cov19-donttouch that alerts people from touching any parts of their face. The device is designed to mimic a choker or a brooch or a detachable device that will be placed near the neck area to sense the hand movement and will vibrate when a person is trying to touch their face. Cov19-donttouch uses low-cost motion detection sensor and vibrating motor as its main components. Through induction, the motion detection sensor detects human body movement (in this project: hand) and sends trigger to the buzzer that is connected to a sensor output pin. The sensor works well under one's shirt or hijab for hand movement detection. The development of the device is achieved as Cov19-donttouch is a stand-alone wearable device where it does not need smart phones or smart watches to function. The device is equipped with battery as its power supply. All the components are encapsulated in a case produced using the 3D printer. Filament ABS is chosen for its durability and versatility as these are very important aspects since the device will be worn outside. ABS provides strength and higher temperature resistance. The Cov19-donttouch device will be placed on the neck to mimic a choker and it performs its intended function well.*
KEYWORDS	

INTRODUCTION

The World Health Organization (WHO) repeatedly explains how avoiding face touching is one of the keys to avoiding getting infected by the COVID-19 virus. Unfortunately, most face touching is done subconsciously, and it has been a habit formed earlier on, making it difficult to break. Research by Yen Lee et al. in 2015 showed that people touch their face, on average, 23 times per hour that is, once every 3 minutes. 45% were touching their eyes, nose, and mouth, which means that people are frequently and unnecessarily exposing themselves to the risk of infection.

In many situations, face touching is a recurrent habit that has implications on hand hygiene. It is the unavoidable act to not touch our face due to involuntary response, since it started in the womb, or as a method of communication on daily basis. The research conducted by Nicas M (2008.) as displayed in Figure 1 has shown that the average total contact rate per hour was 15.7.

Since the pandemic, many creative designs are created that are supported by living and practicing them. A family doctor from Ohio, Dr. Will Sawyer has created Henry the Hand, a website to encourage children to practice a safe habit of not touching their eyes, nose, and mouth. This is because the body's mucous membranes are very vulnerable to infections. An idea that suggested wearing woolly gloves to prevent face-touching is not so reliable as gloves may port the virus too. Frequent handwashing and sanitizing using sanitizer that contains more than 70%-alcohol can also help lower the chances of catching the virus on our hands.

To train people to avoid touching their faces, researchers from around the world are having a hard time coming up with a solution. Mike Bodge, Brian Moore, and Isaac Blanken Smith use Artificial Intelligence (AI) to prevent people from touching their faces by developing a new web-based app, donttouchyourface.com. Through the app, it learns the user's behavior patterns via a webcam and warns the user by sending an alarm sound if their hand is near the face area. Kim Binsted, a professor at the University of Hawaii has taken it upon herself to produce a solution. Binsted thought of developing an app that not only trains us but also helps us avoid touching our faces. This app is supported on FitBit devices and buzzes every time your hand comes in close contact with your face. Joseph Toles et al. built Immutouch, a smartwatch that vibrates if someone touches his/her face. Immutouch apps let users train themselves using some hardware. The app requires you to calibrate your smartwatch with your smartphone for data training. Other developments related to this research have also been conducted but most of the work is applying Machine Learning, and app development that work with smart devices as mentioned by Sara Mageit (2020).
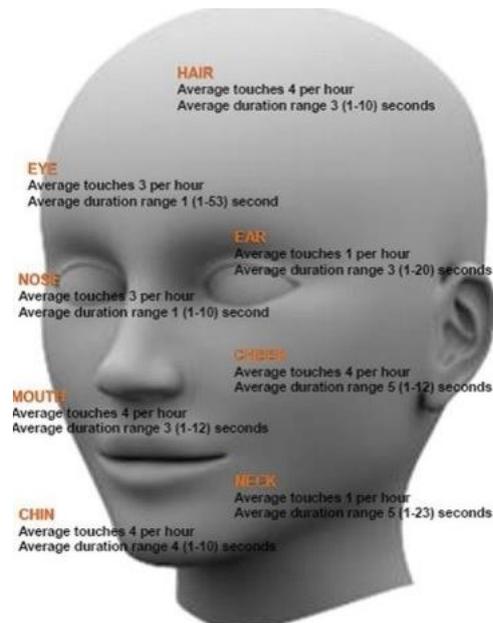
Figure 1. Hand-face touch total contact rate per hour

Researchers have been developing wristbands that could vibrate, for example, the donttouchyourface app to help people to keep their hands off of their faces. However, those inventions required the use of smart platforms. For instance, the Immutouch (wristband) needs the smartphone to train the data of hand movement. On top of that, the device needs to be calibrated before one can start using it, whereas the donttouchyourface and JalapeNo app uses Machine Learning technology to make the idea work. These advanced inventions are time-consuming and costly. It is hoped that our invention could be released soon and worn during this pandemic to help reduce the number of people getting infected with the COVID-19 virus.

Although the wristband invention is great and advanced in so many ways, it is lacking in terms of practicality. The standard advice is to wear your watch on your dominant hand or both hands if push comes to shove. This is seen as impractical especially since it is costly while the wearer looks weird wearing a watch on both hands.

Aside from that, the above invention also limits its function. The machine learning/data training for hand movement applies to our own hands, but it is better if the device could also vibrate if someone else's hand comes in close contact with our face.

Thus, it is necessary to develop a practical yet simple device at a low cost as it is expected to benefit a lot of people. The Cov19-donttouch development outlines a systematic approach to prioritizing a cheaper yet functional device desired by the customers.

RESEARCH METHOD

The concepts of Cov19-dontouch prove uncomplicated design which required only several electronic components. Various detection sensors can be used for movement detection such as ultrasonic sensors, passive infrared sensors, microwave sensors, etc. In furtherance of producing an accurate result in motion detection, different type of sensors is used at one time studied by O.Urfaliglu et al. (2008), Scott (2009), Ching et al. (2011), Gopal et al. (2013), Yogesh et al. (2018), Jun Gong et al. (2018) and Ozella et al. (2019).

For this project, a simple sensor, IR proximity sensor is used for its simplicity and accuracy as mentioned by William et al. (2013), Chong Wang et al. (2009), and Renesas (1999). The sensor is used especially for human hand detection where humans produce infrared radiation or as known lower frequency of an electromagnetic wave. The radiation reflection will be processed by a comparator component that can trigger an alert to the user directly.

Motion sensors can operate in specific beam focus to a certain degree. Therefore, the sensor can penetrate through a specific material wall instead of being made from metal where infrared sensors are classified as electromagnetic radiation. The output will switch from low-value voltage to the maximum voltage (3.3V) once the sensor detects any movement. The output can be anything such as a buzzer, vibrator, or light indicator (LED) to notify the user. To attain the efficient result, a mini disc vibrating motor was chosen as this output notification shows a significant signal to alert users. Moreover, the parameter of vibrator motor torque can be adjusted to suit users' sensitivity by placing the resistor (100Ω -1kΩ) in series.

The sensor's detection range is also adjustable. The sensor is embedded with a potentiometer that allows the selection of resistance values to be set at minimum and maximum values. Reducing the potentiometer value resulting a reduction in range detection. The range required is depending on the situation where the provider can set the fixed range or the user able to set their appropriate range.

All components are encapsulated in a small casing with the dimension within 3.5cm x 3cm x 3cm made by filament ABD. As the project aims to develop a working commercial low-cost device, the components are properly chosen to meet the purposes. IR proximity sensor, vibrating motor, and 3V coin battery are the main components used in the project. Ender 6 3D printer with filament ABD is used for the casing.

The project is adopting The Waterfall Model - which is a chronological design process where one process will be executed starting after completing the previous process and is seen as flowing downwards. The approach is a typical engineering design. The process started with problem identification, proposed solution, and component specification identification. As the aim of the project is to produce a low-cost wearable, thus identifying suitable component are very crucial. Thus, the mechanical design parameters such as size and weight, are limited by the electrical component specification. All components are encapsulated in a compact size casing were suitable to wear. A vibrator motor is chosen as the device output can generate vibration to alert users and able to produce a buzzing sound simultaneously. Nevertheless, the device should be monitored frequently especially on its output strength and power consumption to ensure the reliability and quality of the wearable.

As shown in Figure. 2, the main component for cov19-dontouch is an active IR (Infrared) proximity sensor which able to detect the presence of hands. In a more specific context, an IR proximity sensor uses a pair of infrared emitting and receiving tubes to emit infrared towards the obstacle surface and received the reflection surface. A comparator LM393 is embedded together in this IR proximity to determine whether the reflective surface meets the distance required. The effective distance detection capability of the IR proximity sensor is within 2cm to 30cm and 3.3V to 5V for operating voltage. Therefore, the appropriate range sensing has been identified for Cov19-dontouch by adjusting the IR proximity sensor potentiometer. The appropriate range has been done for this project to differentiate the movement of a human's hand from other obstacle objects nearby.
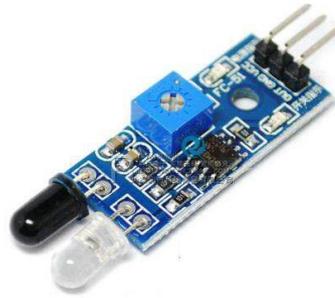
Figure 2. IR proximity sensor

The detection angle should be considered as this device will be placed nearby to human's face and the IR proximity sensor focused beam is limited to 35º. Thus, the sensor will be detected in front of the human's face to avoid any unwanted obstacle object from the other angle. A mini disc vibrating motor is an output component to produce a vibrate and buzz sound. This vibrating motor considers a mini size of 10mm x 2.7mm and weighs 0.9gram roughly. The operating voltage is between 2V – 5V respective to the current draw which is compatible with the power supply of the Cov19-dontouch.

Syirrazie et al. (2017) mentioned proximity sensor placement is one of the critical parameters that need full attention. Placing the sensor in the wrong place (resting back) will result in no detection or motion detected all the time. Even if the sensor is positioned correctly (resting front) we would be expecting different results depending on the angle of the windows of the lens opening. As shown in figure 3, the detection area is dependent on the lens window opening.
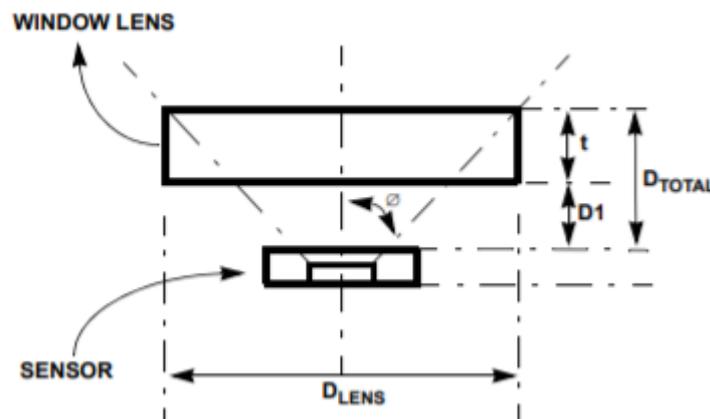

Figure 3. Flat windows lens

The design of Cov19-donttouch comprises two main components: an IR proximity sensor and a vibrating motor. 3V coin battery is used as a portable power supply. IR Sensor is connected to the battery via pin 3, and to the ground via pin 1. Pin 2 of the sensor is connected to the +ve pin of the vibrating motor and was switched by a transistor component to trigger the input and output once the sensor detected the motion. The resistor 1kΩ has been placed in the circuit to reduce the current drawn to attain an appropriate torque output of the vibrating motor, while the -ve pin of the vibrating motor is connected to the ground.

A slide switch is added to the circuit to manually activate/deactivate the circuit; therefore this switch can reduce the battery power consumption if the user is not wearing it.
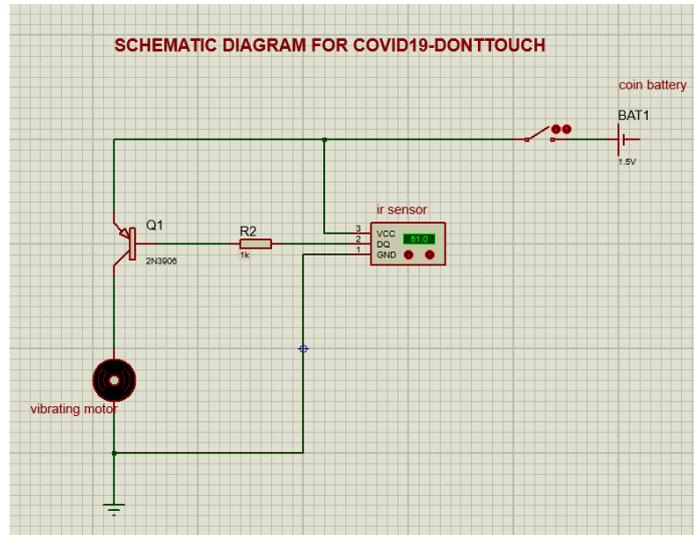

Figure 4. Circuit Diagram

RESULT AND DISCUSSION

The detection range sensitivity of the proximity IR sensor is adjustable to suit the application of a device. The output voltage on the IR transmitter influences the IR sensitivity range. The output voltage can be controlled by issuing different resistance values. Table 1 shows the range detection result. The device can detect the distance between 3 to 30 cm.

Table 1: Range Detection Result

Analog Voltage Output (V) (approx.)	Distance to Reflective Object (cm)
0.02	0.0
3.00	3.3
2.72	4.0
2.35	5.0
2.00	6.0
1.75	7.0
1.55	8.0
1.40	9.0
1.25	10.0
1.05	12.0
0.95	14.0
0.80	16.0
0.75	18.0
0.65	20.0
0.5	25.0

0.45	30.0
0.38	35.0
0.3	40.0

The beam focus for the sensor is sufficient to fit a certain area, especially in front of the user's face. Then, the distance for obstacle detection range has been adjusted to a 15cm maximum range which is suited to a distance before the user's hand touches the face. IR proximity sensor is the most appropriate choice in terms of range detection distance and the detection angle. These are very important parameters to consider in avoiding any unwanted reflective signal from other objects.

All the components are encapsulated in a supporting case that is produced using a 3D printer. Filament ABS is chosen for its durability and versatility as the device will be worn outside. ABS provides strength and higher temperature resistance researched by Muhammad Aminur et al. (2020) and Ranvijay et al. (2018).

Cov19-donttouch will be placed on someone's neck (mimic a choker). The device performs its intended function well. The device vibrates when it detects a hand movement. The battery is replaceable when it drains.

CONCLUSION

This research aims to design a functional low-cost wearable device called the Cov19-donttouch that could vibrate or buzz when the user brings their hand near the face. This device will be worn around the neck as a choker or used with a special lanyard or pinned/clipped onto the collar of the shirt of the wearer. Thus, if the wearer tries to touch their face with their hands, the device will then vibrate or buzz to alert the wearer about it. This device will operate on a coin battery which is very light in weight. Since the user will be wearing the device around the neck area, this device is relatively small, light, and safe so as not to distract or harm its wearer.

As most of the device's development related to face-touching focus on a wristband, this project offered a choker-like wearable. To juggle between left or right hand, enhance the chance of face touching. A suitable range detection of 15cm is chosen after considering many factors such as late alarming and false object detection. The device is also embedded with a small vibrator to alert the user when the hand is close to the face. Some researchers would prefer sound or LED as auditory and flashing alerts, this project opted to use a buzzer since it boosts more alert impact to the user.

In conclusion, the device is successfully developed and meets its objective to produce an easy-operated, commercial low-cost wearable that helps to refrain people from touching their faces.

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