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COVID-19 Lifeguard: A Compact Wearable-IoT (W-IoT) System for Health Safety and Protection of Outgoers in the Post- Lockdown World

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Abstract— **Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which has spread worldwide, creating an unprecedented pandemic situation. Due to rapid spreading, the pandemic forced several nations to impose lockdown for isolating the population and new policies of quarantine were adopted. After the government eased the restrictions, the most prominent challenges faced by daily commuters (employees or students) include maintaining a safe distance from others, regular sanitization, and washing hands, wearing masks and face shields, contact tracing, etc. It is quite difficult to practice social distancing and always use hand sanitizer when using public transport or at the workplace and people do not have a track of their temperature, heart rate, and oxygen saturation level. Though it is ideal to avoid traveling, when necessary some factors need to be considered such as personal hygiene, contactless interaction, disinfection, and monitoring important health parameters. Given this, we aim to develop an IoT-enabled compact wearable system including all essential features like an electronic face mask, an automatic sanitizer dispenser, and a Temperature-SpO2 monitoring wearable to avoid any physical touch and discomfort and alert the nearby doctors about irregularity in any parameter through the GSM module. The results of the software simulation of the system and the web-scraping using Python software to extract coordinates of containment zones are discussed in the paper.**

Keywords—COVID-19 guard, electronic face mask, automatic sanitizer dispenser, health monitoring wearable, Internet of Things.

I. INTRODUCTION

The year 2020 has been challenging for the entire world due to the novel coronavirus disease. The virus that caused the COVID-19 outbreak is known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). COVID-19 spreads when an infected person is in close contact with another person as small droplets and aerosols containing the virus can spread from an infected person's nose and mouth or sometimes also via contaminated surfaces. Infected people can transmit the virus to another person up to two days before they show symptoms, as can people who do not experience changes. Its symptoms include fever, severe cough, fatigue, breathing difficulties, loss of smell and taste, and in some cases hypoxia (insufficient oxygen saturation levels). The first known human infections were in Wuhan, China, and the human-to-human transmission was confirmed by the World Health Organization and Chinese authorities by 20 January 2020 [1].

The entire world has suffered both economically and mentally due to the pandemic, which caused several deaths. As of 31st March 2021, there were 580,327 active cases and 162,959 deaths in India. The weekly epidemiological report by WHO reveals a 10% increase in new cases by 16th March 2021 and a fatality rate of nearly 2.2% [2]. It prompted radical loss in the economy while affecting the health and social life of millions of individuals. There was a huge negative impact on employment, healthcare facilities, manufacturing of essential goods, business, cultural life, relations with peers and family members, education, etc. Traveling, and meeting people were restricted leading to mental distress and unhealthy practices while affecting interpersonal communication. Moderate exercise, respiratory and hand hygiene, wearing a mask, and taking immunity-boosting medicines prescribed by AYUSH Ministry was advised by the health ministry to stay preventive against this worldwide pandemic [3].

But as the situation is getting under control, the restrictions are being lifted and more people are traveling daily for work or education. For example, the Maharashtra government allowed offices to reopen with 30% staff in September 2020, and gradually, almost everyone has gone back to physical attendance [4]. Restarting daily activities with the fear of the disease has been tough, but adopting healthy practices can help prevention. The new normal life has blended with sustained use of face covers, gloves, disinfectants, etc. For the safety of the public, the government has installed sanitizer dispensers and temperature sensors at public places and advised to do the same to all the organizations. Since the COVID-19 cases are rising from March 2021 in Maharashtra, the Mumbai civic has made it mandatory for home-quarantined patients to have a pulse oximeter, digital thermometer, and use face masks, gloves, sanitizer, etc. [5]. However, it is almost impractical to keep all the surfaces disinfected at all times and record the body temperatures of coworkers /students in big companies or institutions. While many are struggling to cope with these challenges, there are some useful solutions provided for the prevention and detection of the disease using electronics and embedded systems. Some of the most popular applications include electronic masks, pulse oximeters, virus-free masks, and thermal imaging cameras to detect the temperature, automatic sanitizer dispensers, biosensors for coronavirus detection in patients, drones to spray disinfecting chemicals, 3D printed hands-free door openers, wearable patches for real-time monitoring of body parameters. Our work is focused on developing a wearable IoT device for health safety, protection, and risk management system. It includes an electronic face mask, automatic sanitizer dispenser, wearable for health monitoring, and alert on coming in touch with any surface. The guard will also be used to integrate with the Arogya Setu application and inform the nearby doctors if there is any abnormal change in the user's important body parameters. The survey of the work related to the use of embedded systems for health monitoring and Covid-19 prevention has been carried out and discussed in the next section of the paper.

II. Literature Survey

There have been numerous research work on health monitoring using embedded technology. Compact and simple devices are used by everyone at home such as electronics blood pressure monitors, glucose meters, heart rate wearable watches, etc. The disease outbreak has made a significant contribution to extending this research. The work reported in [6-8] shows an IoT-based health monitoring system using various sensors to measure body parameters and some designs have the provision to send an alert in an emergency. It is good in a way but has a limitation of alerting only to the individual. The system implemented in [9] has overcome the limitation using an OP App with a heart rate and SpO2 detector that stores data on a cloud server which the doctors can view. Similarly, in [10-12], the work proposes android mobile applications and cloud computing to allow real-time location tracking for emergencies using the internal GPS and various other sensors with Bluetooth module. However, Bluetooth technology has the problem of signal reflection so finding the exact distance may be difficult.

Seminal contributions have been made during the pandemic to detect, trace and prevent Covid-19. Some authors have proposed the use of thermo-vision cameras, voice detectors, a framework using Artificial Intelligence and machine learning to diagnose and assess the CT scan images, mobile applications to alert safe distance and trace contacts, etc. The work done in [13-15] involves low-cost wearable medical devices for detecting and tracking symptoms of COVID-19 and tracks the quarantine subjects in real-time. It uses headsets and mobile phones for peak detection of the respiration rate and intensified cough and hence can be considered feasible. The work in [10] has demonstrated an 'active mask' that senses airborne particles and makes intelligent decisions to reduce their concentrations. It has a controller to generate mist spray and is connected via an application that alerts charging and decontamination of the mask.

The paper [16] presents a wearable device Suraksha to help people maintain social distancing which detects motion in 360^{o} up to 1.5m. The device can adapt to various surroundings by adjusting the sensitivity of the PIR sensor. By adding a temperature sensor, the user can be alerted if their temperature is not normal. Similarly, the IoMT-based wearable EasyBand proposed in [20] helps to maintain social distance and the user is alerted about the contamination zone. In [17], the system integrates a wearable IoT node with a smartphone app to collect a user's health parameters and notifying in real-time using ML. It uses a Radio Frequency (RF) distance-monitoring method to notify about social distancing and a voice coughing detector to monitor the user's voice and coughing severities. But RF method comes with the limitation of distance range and may be harmful to some patients/elders.

Although results appear consistent with prior research, they are limited to specific areas such as detection, tracing, or prevention. The issue of safety, sanitization, health monitoring, and alerting the doctors is not resolved by a single integrated system. Mobile applications have been proposed for storing individual's data and alerting but informing the individual of any physical touch or contact with an infected person is not mentioned. Electronic masks are designed with mist sprays and air purification mechanisms, however, they don't help with the discomfort and difficulty in breathing. The proposed health monitor wearable doesn't serve the purpose of automatic sanitization alert and dispensing it when in touch with any plane. Hence, from the survey, it can be summarized that no proper consolidates system is designed to monitor the health, physical contact alert and disinfect the individual, alert the concerned authorities if symptoms exist, and prevent cross-infection. The organization of the rest of the paper is as follows:- In section III the problem is overviewed and the objective of the work is discussed. Section IV consists of the design and implementation of the system for each component. The results are discussed in section V and section VI consists of the conclusion drawn. Acknowledgment and References arementioned in sections VII and VIII respectively.

III. Objective of Work

A. *Problem Overview*

According to a recent survey of the Hindustan Times, 36 lakh commuters are using Mumbai's suburban train network each day after its services were opened up to the general public in February 2021 [18]. Post-lockdown has been tedious for everyone, especially those traveling to work daily. The challenges could be summarized as follows:

- It is hard to follow social distancing norms when using public transport or at public places.
- People have to keep sanitizing their hands and washing them frequently, and taking out the bottle/spray every timewhile moving is quite inconvenient.
- Face masks, shields, and gloves need to be worn for long hours causing discomfort and breathing difficulties.
- While in local transport, there is no way to avoid touching surfaces or people even if being cautious.
- The body temperature, heart rate, and oxygen saturation

levels have to be monitored regularly.

- It is not possible to switch to private transport because of the rising traffic, and even closed air-conditioned transport is not advised.

Any noticeable change in the body parameters is not alerted to the nearby healthcare centers so that immediate action can be taken to prevent the infection from spreading.

Many new technologies and wireless devices have been developed to prevent the spread. Many mobile applications have been invented for contact tracing and informing citizens of infected patients nearby. Hence, our research focuses on using IoT technology to provide protection and avoid any kind of discomfort during traveling or working.

B. *Objective of Work*

Considering the problem of commutation and traveling in the post lockdown world, wherein the things are in a recovering phase, we propose a compact Wearable and IoT-enabled (W-IoT) System: COVID-19 Lifeguard that can be easily used while going out. The features included in this system are listed below:

1. Wearable Electronic Mask with the provision of air ventilation in it.
2. Beep alert to the user when he repeatedly comes in contact with different surfaces and Wearable Sanitizer Dispenser.
3. Monitoring Essential Parameters like Temperature, HB-SpO2, that are likely to get changed when a person gets infected.
4. SMS Alert System in which the user will set an emergency contact number to which a message will be sent if the health parameters are not normal.
5. SMS Alert to the user when he steps in a containment zone.
6. Integrating the System to the Server/Cloud by using Open Source IoT- ThingSpeak.

IV. DESIGN AND IMPLEMENTATION

The overall design of the COVID-19 Lifeguard is discussed in this section.

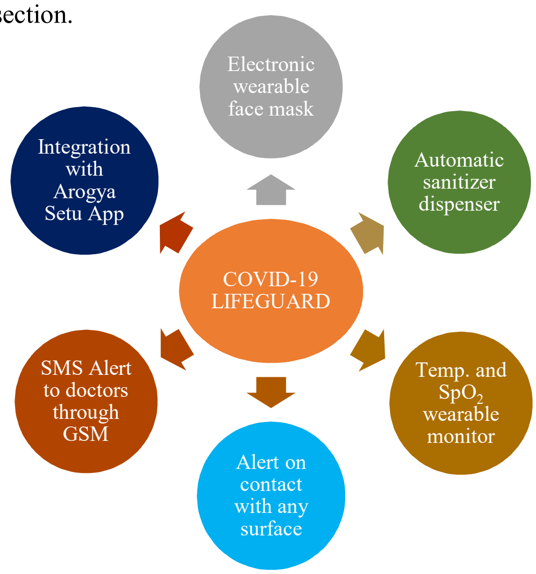


Fig. 1 Components of Lifeguard.

This system employs the Internet of Things for health monitoring and prevention of spreading the disease by daily travelers. Fig.1 depicts the basic components of all the elements of the system.

COVID-19 lifeguard has six parts – design of electronic face mask, automatic hand sanitizer dispenser, health monitoring wearable, alert system on coming in contact with any surface, integration with Arogya Setu App for containment zone alert, and module for SMS alert to doctors. Each of these is discussed below.

A. *Electronic Face Mask (for proper Air Ventilation)*

The design of the low-cost face mask involves an air purification filter to prevent the airborne pathogens and infectious aerosols from entering the respiratory tract and a motor-controlled fan to circulate the air. The motor is controlled using a button so that the fan (for air circulation) can be switched ON/OFF when desired. This helps to prevent the spreading of the disease while avoiding any discomfort while using continuously. Fig.2 shows the block diagram of the mask.

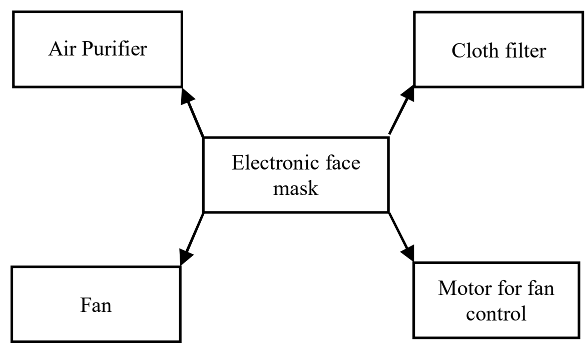


Fig. 2 Electronic mask components.

B. *Health Monitoring Device*

The block diagram of the wearable device is shown in Fig.3. The system has three sensors: A heartbeat detection sensor, a temperature sensor (LM35), and a touch sensor. The push-button will be attached either to the wrist or near the heart of the person wearing it. As soon as the button is pushed the sensor will count the heartbeat, and the current heartbeat, as well as the total heartbeat for one minute, will be depicted on LCD Display. Also, the temperature sensor will sense the temperature of the person which will eventually be displayed on the LCD Display. The touch sensor will glow the LED when the person comes in contact with any surface.

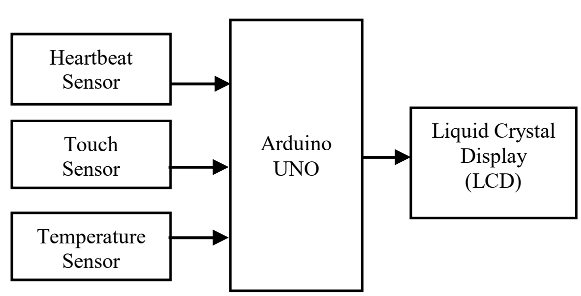


Fig. 3 Health Monitor Wearable

C. Automatic Sanitizer dispenser

Fig.4 shows the basic block diagram of the design. It includes an infrared obstacle sensor having a transmitter and receiver pin. The OUT pin is connected to the transistor BC547 which is further connected to the relay circuit with a diode.

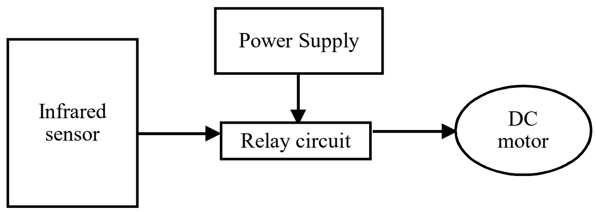


Fig. 4 Automatic hand sanitizer dispenser.

The flowchart in fig.5 shows how the design works. After initializing the system, when the input is high (sensor detects hand), the circuit completes and the motor rotates. Hence the sanitizer is dispensed without touching the device.

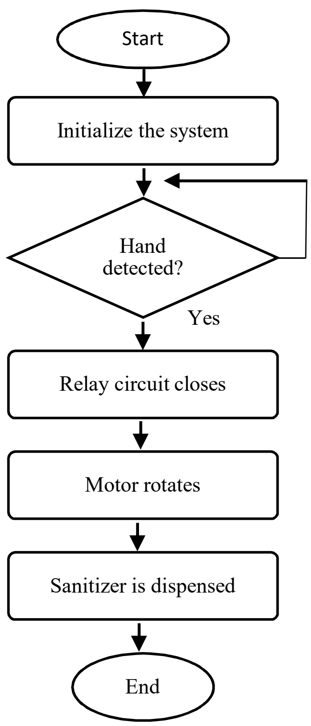


Fig. 5 Flow chart.

D. SMS alert system

The block diagram of the alert sending system is shown in Fig.6. The health monitoring wearable device is connected to the GSM modem for sending SMS to the doctor in case of an emergency. The health monitoring parameters are constantly monitored and have a specified range. Since, the symptoms of COVID-19 include variation in body temperature, oxygen saturation level, and heartbeats, these could be used for early diagnosis. If the parameters cross the normal range, immediately an alert is sent to the user as well as the nearby doctor/health care center so that treatment can be made available.

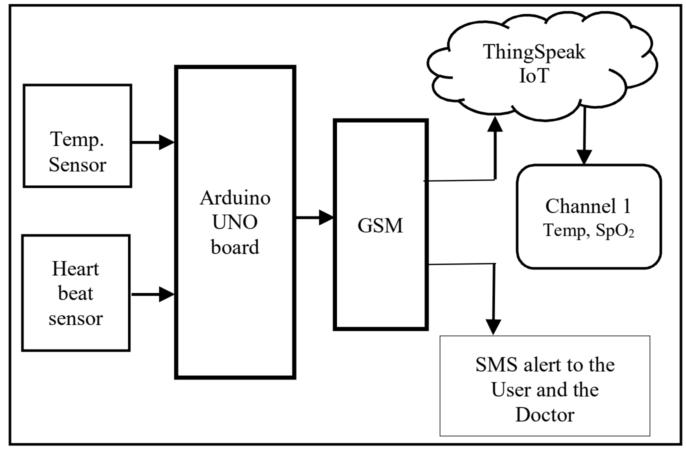


Fig. 6 Block Diagram of SMS alert system.

The data is uploaded on the ThingSpeak site, which is an open-source IoT analytics platform service. ThingSpeak is used because it enables live data sources to be combined, visualized, and analyzed in the cloud. Users can upload data from their devices to ThingSpeak, which allows them to create real-time illustrations of live data and send alerts. The data can be easily stored and monitored using channels and web pages. It has the facility to send SMS/e-mail using the ThingHTTP application. This will ensure that the person is examined within a few hours and proper medical treatment is given.

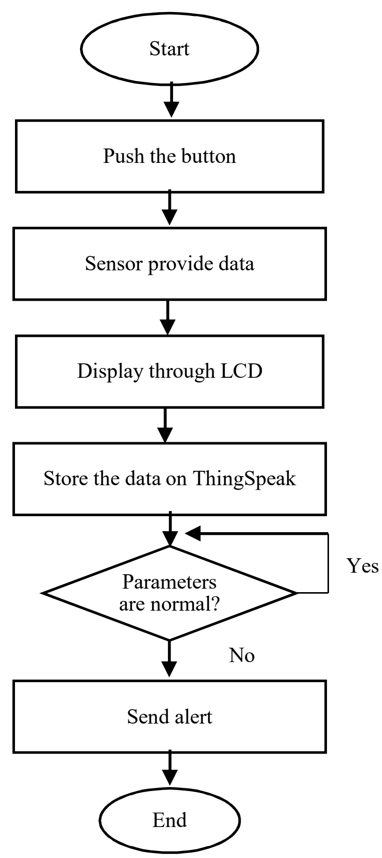


Fig. 7 Flow chart for health monitoring system.

The entire flow chart of the health monitoring wearable device and sending alert is shown in Fig.7. The alphanumeric LCD (LM016L) shows the values and these can be easily stored through the internet for ease of control. If the values displays are normal, the device goes into a standby mode, and hence, a user can check the temperature and heartbeat whenever and wherever desired.

E. Touch alert

When traveling or at the workplace, social distancing needs to be followed and it is advised to sanitize the hand whenever a person comes in contact with any surface. Hence, there is a touch sensor in the wearable that will beep when a person comes in contact with some surface/other people a maximum number of times (4-5) set in the system. This will remind the person to disinfect his hands using the sanitizer.

F. Integration with Arogya Setu App

The block diagram of the GPS-based alert about the containment zone is given in Fig. 9. The App uses your location to know if the area you are around come under the infected areas of the database and also needs an activated Bluetooth to determine if you have been within six feet from the infected person [19]. For the integration of the Arogya Setu App with our system, we scrapped the data from the Arogya Setu app using Python. Web scrapping is an automated process which allows user to retrieve data from a website.

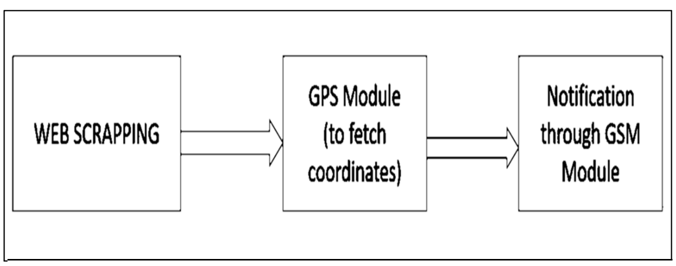


Fig. 8 Web Scraping.

Thus, by web-scraping the containment zones of various states in India were obtained. The scrapped data was converted to a text file and then was loaded into the Arduino IDE from where it was fed to the GPS (Global Positioning System) module where it was processed to know whether that coordinates fall in the containment zone of that specific place or not. The message after processing was then delivered to the person through the GSM MODULE.

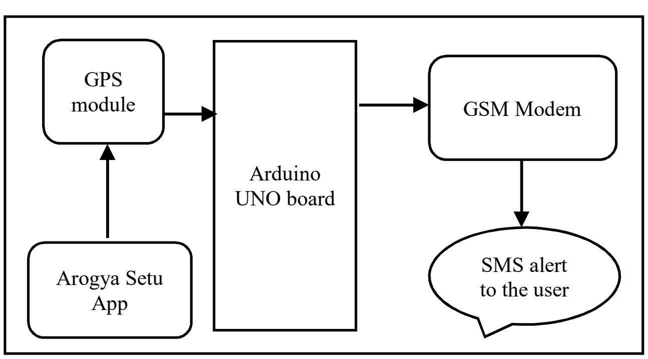


Fig.9 GPS and GSM based location alert.

V. RESULTS OF SOFTWARE SIMULATION OF THE SYSTEM

To date, the circuit design and the simulation using Proteus 8 Professional are completed; which is discussed in this section. The programming was done in Arduino IDE version 1.8.13. The results are discussed as follows: -

A. Electronic Face Mask (for proper Air Ventilation)

The basic circuit for the low-cost electronic face mask consists of a DC motor that will rotate the fan as shown in Fig. 10. A switch is used to control the motor so that the user can switch it ON/OFF as desired.

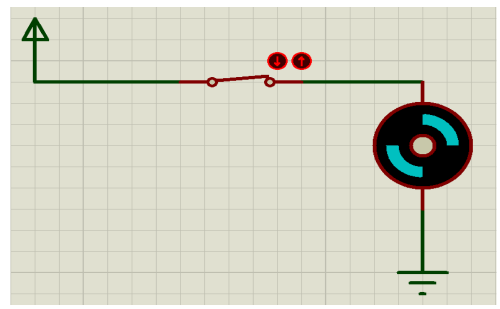


Fig. 10 Electronic face mask basic circuit.

B. Simulation for health monitoring device

The circuit diagram and results of the health monitoring device have been shown in Fig. 11. The device has a heartbeat sensor, a temperature sensor (LM35), and a capacitive touch sensor. LM35 sensor is widely used to measure the ambient temperature but by forming a suitable metallic contact with the human body, it can also be used to measure the body temperature. For the simulation purpose, the temperature was kept at 27^0C.

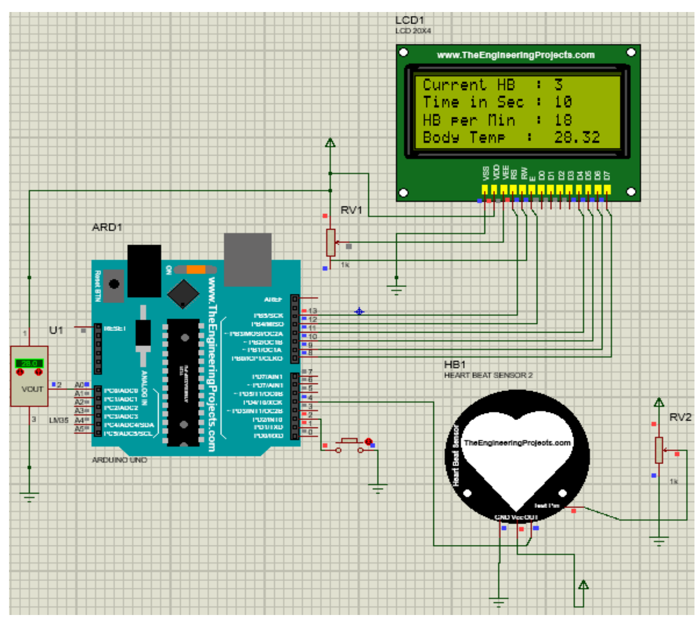


Fig. 11 Health monitoring device.

The heartbeat sensor works on a push button and the user can push the button to count the heartbeats and generate the heartbeat per minute rate. The LCD will show the temperature, time in seconds, and the heartbeat rate. Through this information, the user can analyze his/her parameters regularly.

C. Circuit for automatic sanitizer dispenser

The simulation of the automatic sanitizer dispenser is shown in Fig. 12.

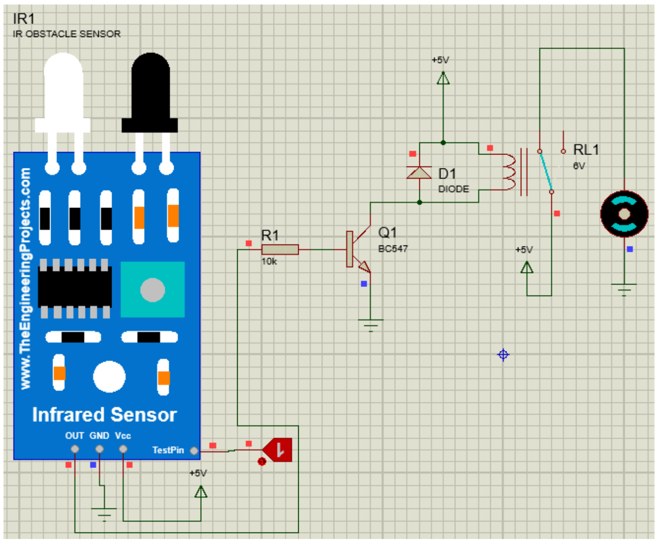


Fig. 12 Sanitizer dispenser circuit.

A logic high pulse is given to the IR sensor (high indicates the presence of a human hand). On giving a high pulse, the relay circuit through the transistor closes. An input voltage of +5V is given to the relay and the motor runs when the circuit closes. A small tank/bottle of sanitizer is attached to the wrist band so that when the motor runs the sanitizer is dispensed on the user's hands. This makes it easier to disinfect hands as other surfaces or items are not touched or the user does not have to remove the bottle from the bag/pocket to sanitize while traveling.

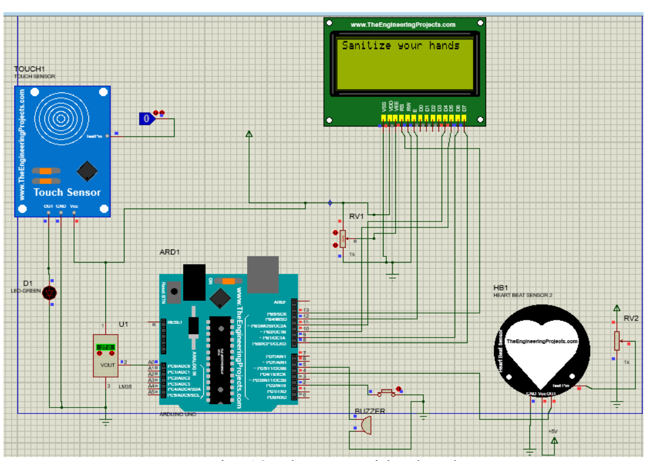


Fig. 13 Alert to sanitize hands.

The wearable device also has a timer for a buzzer which will give a reminder for sanitization. Every two hours, the user will be notified through the device to sanitize his/her hands to prevent contamination. The message as shown in Fig. 13 will be displayed on the screen and the buzzer will buzz for two seconds.

D. Simulation for SMS alert using GSM

The simulation is done using a GPS module and SIM900D (GSM module). The GPS module shares the exact coordinates of the user. In the real time implementation, along with the coordinates, the name of the location will also be included in the SMS. The SMS is sent to the emergency mobile number of the doctor saved in the phone. The simulation is done in Proteus using the virtual terminal to display the SMS. The results are shown in Fig. 14.

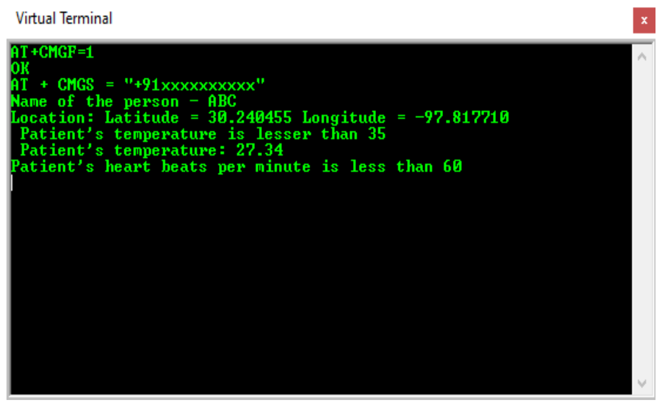


Fig. 14 SMS alert to the doctor.

The results show that if the temperature of the user is less than 35^0C or greater than 38^0C and the heart beats per minute are not in the range of 60-100, then the SMS containing the location coordinates, exact location of that individual and his health parameters are sent to the doctor. This will help in early diagnosis and the user can get the treatment quickly.

E. Circuit for touch alert

The circuit of the wearable device with touch alert is shown in Fig.15.

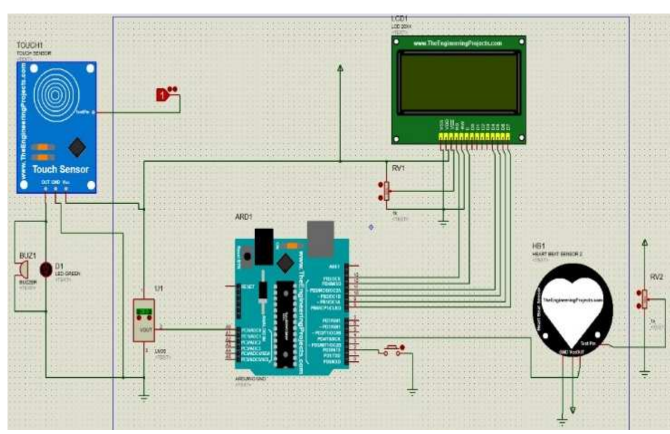


Fig. 15 Wearable device with touch alert.

The wearable device also has a touch sensor so that the LED on the corner of the device will glow and the buzzer will buzz when the person comes in contact with a surface/another person. This will make the user aware so that the disinfection through sanitizing the hands can be done.

F. Simulation of integration with Arogya Setu App

The circuit diagram for a wearable device with a GSM module and its integration with Arogya Setu App is shown in Fig.16.

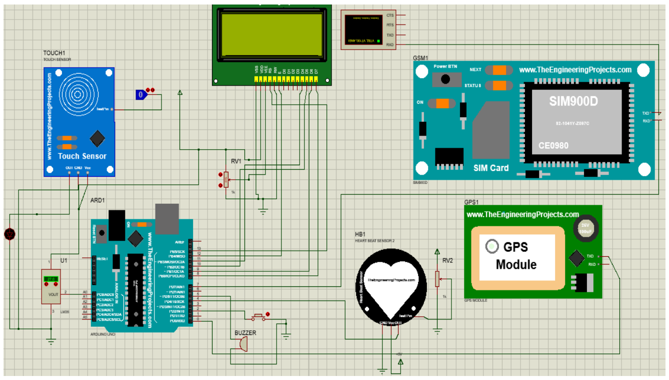


Fig. 16 Containment zone alert.

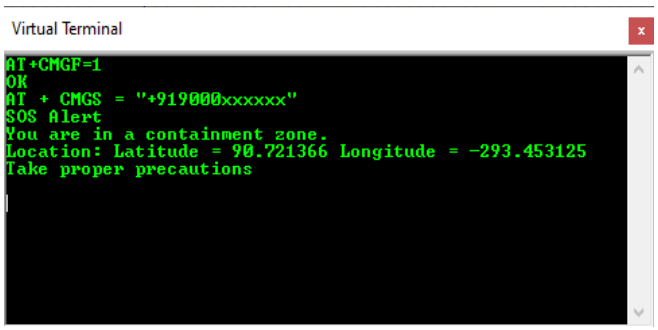


Fig. 17 Containment zone alert.

Importing Libraries

```
import pandas as pd
```

Reading Libraries

```
df = pd.read_excel('/contamination.xlsx')
```

```
list(df)
['Unnamed: 0', 'Unnamed: 1', 'Unnamed: 2', 'Unnamed: 3']
```

Renaming Columns

```
df.columns =['District', 'State', 'Contamination','Coordinates']
```

```
df[0:10]
```

	District	State	Contamination	Coordinates
0	NaN	NaN	NaN	NaN
1	South Andamans	Andaman And Nicobar Islands	Red Zone	11.7401° N, 92.6586° E
2	Nicobars	Andaman And Nicobar Islands	Green Zone	11.701° N, 92.6886° E
3	North And Middle Andaman	Andaman And Nicobar Islands	Green Zone	11.65971° N, 93.1766° E
4	Kurnool	Andhra Pradesh	Red Zone	22.2587° N, 71.1924° E
5	Guntur	Andhra Pradesh	Red Zone	23.0225° N, 72.5714° E
6	Krishna	Andhra Pradesh	Red Zone	28.4595° N, 77.0266° E
7	Chittoor	Andhra Pradesh	Red Zone	27.4595° N, 75.0266° E
8	Spsr Nellore	Andhra Pradesh	Red Zone	28.4595° N, 77.0266° E
9	West Godavari	Andhra Pradesh	Orange Zone	28.4595° N, 76.0266° E

Fig. 18 (a) Results for Web Scraping.

For the integration of the Arogya Setu App with the system, the data is scraped from the Arogya Setu app using Web Scraping in Python and the containment zones of various states can be obtained. The Python algorithm shown in Fig. 18(a), (b), and (c) gives the exact location from the coordinates scrapped from the website. The data is converted into the text file and is loaded into Arduino IDE from where it is fed to the GPS Module. The message is then delivered using the GSM Module if the person is in the containment zone. Fig.16 shows the SMS alert that the user receives when he/she enters a containment zone. This creates awareness about taking more precautions and practicing social distancing.

```
df1 = df. dropna()
```

```
df1[0:10]
```

	District	State	Contamination	Coordinates
1	South Andamans	Andaman And Nicobar Islands	Red Zone	11.7401° N, 92.6586° E
2	Nicobars	Andaman And Nicobar Islands	Green Zone	11.701° N, 92.6886° E
3	North And Middle Andaman	Andaman And Nicobar Islands	Green Zone	11.65971° N, 93.1766° E
4	Kurnool	Andhra Pradesh	Red Zone	22.2587° N, 71.1924° E
5	Guntur	Andhra Pradesh	Red Zone	23.0225° N, 72.5714° E
6	Krishna	Andhra Pradesh	Red Zone	28.4595° N, 77.0266° E
7	Chittoor	Andhra Pradesh	Red Zone	27.4595° N, 75.0266° E
8	Spsr Nellore	Andhra Pradesh	Red Zone	28.4595° N, 77.0266° E
9	West Godavari	Andhra Pradesh	Orange Zone	28.4595° N, 76.0266° E
10	Y.S.R.	Andhra Pradesh	Orange Zone	28.4595° N, 77.5555° E

Graphical Representation to understand the dataframe

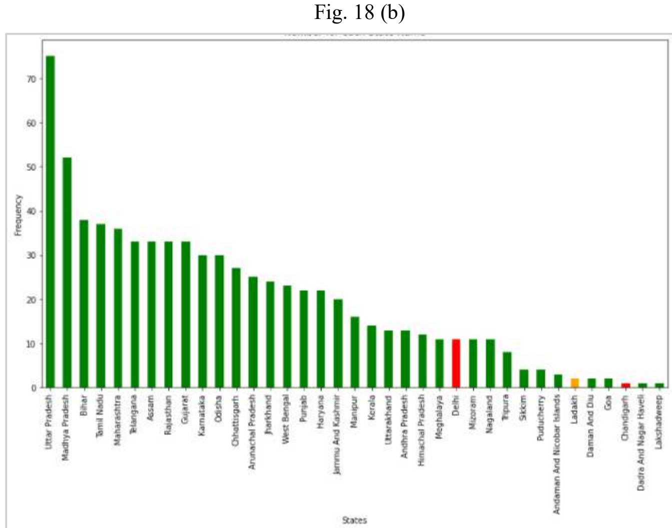
```
import matplotlib.pyplot as plt
```

```
ind_col_map = {
    "Red Zone": "red",
    "Green Zone": "green",
    "Orange Zone": "orange"
}

unique_comb = df[["State","Contamination"]].drop_duplicates()
name_ind_map = {x:y for x, y in zip(unique_comb["State"],unique_comb["Contamination"])}
```

```
c = df['State'].value_counts().index.map(lambda x: ind_col_map[name_ind_map[x]])
```

```
ax = df['State'].value_counts().plot(kind='bar',
                                    figsize=(14,8),
                                    title="Number for each State Name", color=c)

ax.set_xlabel("States")
ax.set_ylabel("Frequency")
plt.show()
```

Fig. 18 (b)




```
print("The received co-ordinates from the device is: 26.9124° N, 75.7873° E ")
print("...checking the contamination zone from the dataset")
df1.loc[df1['Coordinates'] == '26.9124° N, 75.7873° E', :]
```

```
The received co-ordinates from the device is: 26.9124° N, 75.7873° E
...checking the contamination zone from the dataset
```

	District	State	Contamination	Coordinates
508	Jaipur	Rajasthan	Red Zone	26.9124° N, 75.7873° E

Fig. 18 (c)

Thus, from this we get to know that the received co-ordinates from the device falls into RED ZONE of the Contamination Region in Jaipur - Rajasthan. Hence, the user will be alert and will take necessary precautions while moving through the containment zone.

VI. CONCLUSION

In this paper, an IoT-enabled compact wearable system is developed for the safety and protection of people traveling daily for work or education. The implementation conveys that this system is beneficial in monitoring the necessary health parameters of the user along with provision for disinfection and touch alert. The results obtained show that through the GSM module, the nearby doctor can be notified if the individual's body parameters (temperature and heart rate) are abnormal. If the user is in a containment zone, then an alert is sent through SMS. The method of Web Scraping is implemented to find the containment zone location. Hence, this Lifeguard could be used by any commuter post-COVID-19. Future work involves the implementation of the system in hardware.

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VIII. REFERENCES

[1] Indranil Chakraborty, Prasenjit Maity. "COVID-19 outbreak: Migration, effects of society, global environment and prevention" *Science of the Total Environment*, vol.728, 2020.

[2] Available: https://www.who.int/publications/m/item/weekly-epidemiological-update---16-march-2021. Article: Weekly Epidemiological Update on Covid-19 – 16 March 2021. Last accessed 17th March, 2021, 9:45.

[3] Rastogi S, et.al. "COVID-19 pandemic: A pragmatic plan for ayurveda intervention" *Journal of Ayurveda and Integrative Medicine*, vol. 12, no. 3, April 2020.

[4] Available: https://indianexpress.com/article/india/maharashtra-announces-unlock-4-guidelines-whats-allowed-whats-not-6577750/. Article: Unlock 4.0 Guidelines. Last accessed 15th March 2021, 13:50.

[5] Available: https://www.timesnownews.com/ mumbai/article mumbai-bmcissues-fresh-covid-guidelines-use-of-masks-gloves-mandatory-for-patientsunder-home-quarantine/740088. Article: Use of masks, gloves mandatory forhome-quarantined patients in Mumbai. Last accessed 16th March, 2021, 16:15.

[6] Muhammad Irmansyah, et.al. "Low Cost Heart Rate Portable Device for Risk Patients with loT and Warning System" *International Conference on Applied Information Technology and Innovation*, 2018, IEEE, April 2019.

[7] S. Pinto, J. Cabral and T. Gomes, "We-care: An IoT-based health care system for elderly people," *2017 IEEE International Conference on Industrial Technology (ICIT)*, 2017, pp. 1378-1383.

[8] Chao Li, et al. " The IoT-based heart disease monitoring system for pervasive healthcare service" *International Conference on Knowledge Based and Intelligent Information and Engineering Systems*, 2017, vol.112,pp. 2328-2334.

[9] Sivapriya Natarasan, Dr.Pavithra Sekar. "Design and Implementation of Heartbeat rate and SpO2 Detector by using IoT for patients" *International Conference on Electronics and Sustainable Communication Systems 2020*, IEEE, August 2020.

[10] Emre Oner Tartan, Cebrail Ciflikli. "An Android Application for Geolocation Based Health Monitoring, Consultancy and Alarm System" *International Conference on Computer Software & Applications*, June 2018. IEEE. Vol. 2.

[11] J. Mohammed, et al. "Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing," *2014 IEEE International Conference on Internet of Things (iThings), and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom)*, 2014, pp. 256-263.

[12] Al-khafajiy, M., Baker, T., Chalmers, C. *et al.* "Remote health monitoring of elderly through wearable sensors." *Multimed Tools Appl*, 2019*,* vol.78, pp. 24681–24706.

[13] Radovan Stojanović, et al. "A Headset Like Wearable Device to Track COVID-19 Symptoms" 9th *Mediterranean Conference on Embedded Computing (MECO)*, 2020, IEEE, July 2020.

[14] V. Singh,et al. "IoT-Q-Band: A low cost internet of things based wearable band to detect and track absconding COVID-19 quarantine subjects," *EAI Endorsed Transactions on Internet of Things,* 2020, vol. 6, no. 21, p. 163997.

[15] Rohan Reddy Kalavakonda, et al. " A Smart Mask for Active Defense Against Coronaviruses and Other Airborne Pathogens" *IEEE Consumer Electronics Magazine 2020*. Vol. 10.

[16] Sashmita Raghav, et al. "Suraksha: Low Cost Device to Maintain Social Distancing during COVID-19" *2020 4th International Conference on Electronics, Communication and Aerospace Technology*, IEEE, December 2020.

[17] Seyed Shahim Vedaei, et al. " COVID-SAFE: An IoT-Based System for Automated Health Monitoring and Surveillance in Post-Pandemic Life" IEEE Access, October 2020. IEEE. Vol. 5.

[18] Available: https://www.hindustantimes.com/cities/mumbai-news/36-lakh-people-using-local-trains-in-mumbai-daily-since-february-1-101613626966387.html. Article: 36 lakh people using local trains in Mumbai daily since February 1. Last accessed 26th March 2021, 17:43.

[19] Surbhi Sharma, et.al. "Current treatment protocol for COVID-19 in India" *Sensors International*, vol. 1, no. 3, Jun 2020.

[20] A. K. Tripathy, et al. "EasyBand: A Wearable for Safety-Aware Mobility During Pandemic Outbreak," in *IEEE Consumer Electronics Magazine*, 2020, vol. 9, pp. 57-61.