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# Suraksha: Low Cost Device to Maintain Social Distancing during CoVID-19

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***Abstract*—On the 11th of March 2020, the World Health Organization (WHO) affirmed COVID-19, a pandemic, in response to more than 1,00,000 confirmed cases globally in more than 100 nations and the persistent danger of spreading further. Presently, there's no remedy or vaccine for COVID-19. The only way to curb its menace is taking precautionary measures, as advised by the health experts. Social distancing, that is maintaining a minimum distance of 1 to 1.5 meter between two individuals, is one of the foremost proactive measures advised by WHO. This paper presents a smart wearable device, Suraksha, that can be worn while travelling outside and will help maintain social distancing. The user will be able to rely on this device's alerting mechanism without having to constantly worry about their surroundings. It is a simple device which is easy to use and is built using basic electronic components. The device is also capable of integrating with the health applications over Bluetooth and support contact tracing.**

***Index Terms*—Social Distancing, Smart Device, CoVID-19, Personal Safety, Contact tracing**

## I. Introduction

The Coronavirus that infects the respiratory system is from a family of viruses that range from the common cold virus to the MERS Corona virus [1]. As per the World Health Organisation (WHO) [2], the first case was reported in China on 31st December 2019. The outbreak was declared as a public health emergency which led to international concern on 30th January 2020. On March 11, 2020, as per the WHO report [3], in over two weeks' time span, the number of cases of CoVID-19 outside China and the west had increased thirteen-fold and the number of affected countries tripled. With more than 1,18,000 cases in 114 countries and 4,291 deaths, CoVID-19 is spreading alarmingly [4]. Many upcoming technological advancements have been made to fight against CoVID-19 as done by S. Vijayaraghavan and Puthenveettil, N. [5], where an aerosol box for the patients to protect healthcare workers from contracting SARS-CoV-2 infection. As they say, "Prevention is better than Cure", it is aptly suitable in the current scenario. The best way to prevent the spread of this infection is to avoid being exposed to the virus by maintaining good personal hygiene, frequent hand-washing with soap, covering the mouth while coughing and sneezing and social distancing. As per health experts, social distancing can be a viable measure to curtail the spread of COVID-19 [6]. Technology and innovation can be effectively utilised to help maintain social distancing. Our proposed system "Suraksha" (means safety in Sanskrit) is a wearable device capable of detecting the movement between individuals and warn them if they are not maintaining a safe distance.

Technology and innovation can be effectively utilised for maintaining the imperative distance as per social distancing standards. The proposed system uses a wearable device, capable of detecting the movement between individuals and triggering an alarm in the event of close proximity between the individuals. The Suraksha device helps the user in maintaining a minimum physical distance from people and objects by sounding a buzzer alarm and LED whenever anyone comes within close proximity of the user. The proposed device is built using simple electronic components which makes it affordable and easy to carry around. The paper is organised as the following: Section II briefly describes the state of the art and other similar works. Section III explains about the proposed system. The methodology used to design the proposed system is detailed in Section IV. Section V explains about the design and architecture of the proposed system. In Section VI implementation of the system is discussed and the paper is concluded in section VII.

## II. Related Works

Narinder Singh Punn, Sanjay Kumar Sonbhadra and Sonali Agarwal [7] propose a deep learning-based system for computerizing the work of observing social distancing using surveillance video. The proposed system utilizes an object detection model to isolate people from the background and a deep sort approach for tracking the individuals identified as carriers, with the assistance of bounding boxes and assigned IDs. Cong T. Nguyen and Yuris Mulya Saputra [8], present fundamental background about social distancing as well as effective technologies that can be used to facilitate the social distancing practice.

Dr.Tinku Joseph and Dr.Mohammed Ashkan Moslehi [6] mention that in the view of pulmonologists from different nations affected by COVID-19 joined hands to frame this consensus on prevention and treatment aspects of this disease. In this paper, it also states that sometimes Coronavirus from animals infect individuals and spread further via community spread such as with SARS-CoV, MERS-CoV and now with this COVID 19. The virus that causes COVID-19 is designated severe acute respiratory syndrome corona virus 2 (SARS-CoV-2); which was previously referred to as 2019-nCoV. The Social Distancing Reminder System [9] makes use of two Ultrasonic sensors connected to the Arduino to detect close objects, but the disadvantage with this system is that the mean detection range of an ultrasonic sensor is from $15^0$ to $30^0$. So it can only detect $60^0$ combined, which is ineffective.

Abhiruchi Passi and Devdutt [10] explain another social distancing technique. It is an ID card based system which is similar to the previously mentioned technique, as it uses the same Ultrasonic sensor to detect distance between individuals. However, here ,there is only one sensor ,which makes the device portable and convenient but limits the detection range of objects. The Vision Based Social Distancing Monitor designed by Rahul Khanna [11] is about a sophisticated system which is based on computer vision. This system makes use of a Raspberry Pi camera to detect human beings and then makes a virtual box around each person. The system detects whether a person is maintaining social distance with other individuals or not based on the intersection of boxes. This system, however, has many drawbacks.

To begin with, the components used in this system are very expensive making it less affordable. The system is based on monitoring other individuals and not for helping maintain one's own distance with others. This doesn't help anyone as the person himself won't know whether he is maintaining social distance or not. This system can be easily manipulated as the image detection system is fairly new. Another disadvantage is that the data can easily be misused hence it requires high security. Lastly the system is not portable. Applications like the Aarogya Setu [12] requires a smartphone which may not be affordable by all and one has to be registered to be able to track potential CoVID-19 positive cases. On the contrary, our device is simple, easy to use and portable that is powered by a battery. The SPACEband [13] requires the user to install an application, which needs a smartphone, internet connection and a working bluetooth module. It detects other people in its vicinity only if they are also using the band.

The bio-bubble band [14] used for the Indian Premier League (IPL) cricketers, makes use of bluetooth technology for detecting people around the user. However, in this case the individual's transmitter and receiver signal from the Bluetooth module can easily be jammed by the means of network interference. Also, on the event of charging the mobile or the band, there are chances of false alarm.

The Suraksha device is built using simple electronic components which makes it easy to carry around and affordable. When compared to other devices discussed, the Suraksha device is different and better in a way as it uses PIR sensors which detects Infrared radiations(change in temperature) in the surroundings. Moreover, the Suraksha device has a 360 degrees coverage range. Most other devices that use ultrasonic sensors end up detecting inanimate objetcs in the surroundings and do not have a wide detection range.

## III. Proposed System

The motivation for the work comes from the need to create a device that helps people maintain distance from others during the spread of communicable diseases such as COVID-19, using present day technology and innovation. The device can effectively be utilised for maintaining the minimum physical distance as per the social distancing standards by alerting the user if anyone is detected in close range to them.

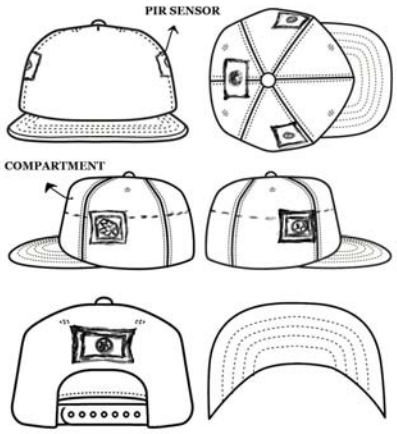


Fig. 1. Proposed Model of Suraksha Device

The design is based on a person individually, so they can know if they have maintained social distance using the buzzer and the led also, the proposed system is a cheap, efficient and portable way to help people maintain social distance. The proposed system would consists of a wearable device as shown in figure 1, capable of detecting close movement between individuals and triggering an alarm in the event of close proximity. The sensor detects the infrared radiation emitted or reflected from objects and the micro-controller is programmed with a certain sensitivity limit up to which the sensor detects infrared radiation. This way, if any person in close proximity to the sensor, the alarm is triggered accordingly. The device makes use of smart sensors. A smart sensor takes input from the physical surroundings and uses built-in compute resources to perform predefined functions upon detection of specific input and then process data before passing it on as shown in figure 3. The wearable device consists of PIR motion Sensors, Buzzer, LED, Battery, Switch, Jump Wires and a micro controller with a built-in Bluetooth and WiFi module.

Our proposed solution makes use of PIR sensors which detects humans and animal bodies and not arbitrary objects. The detection range of PIR sensors is comparatively larger,

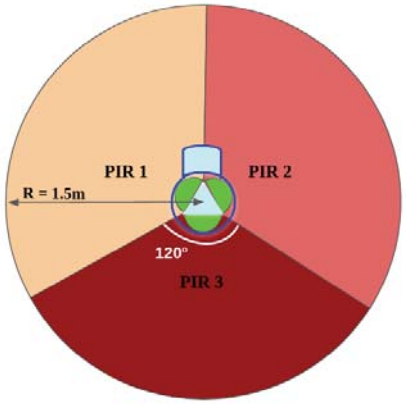


Fig. 2. Coverage Range of the Proposed System

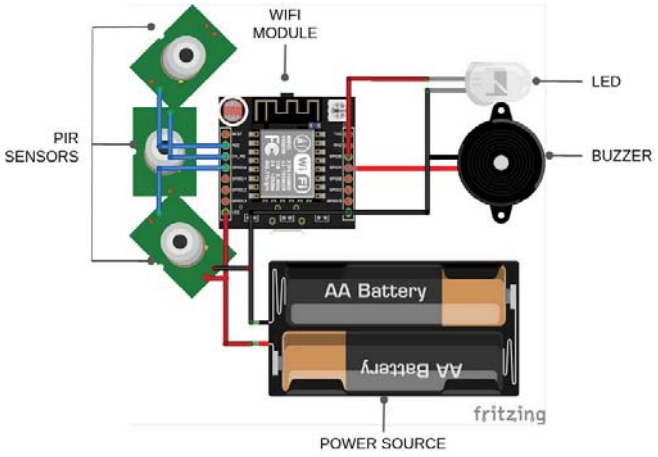


Fig. 3. Block diagram of Working

which is about $120^0$, hence, by using three sensors and in the right angle, it enables the device to help cover $360^0$ as shown in figure 2 of seamless social distancing [15].

The hardware components used in the making of the device are discussed below:

- **NodeMCU:**
  NodeMCU ESP32 development board has a Espressif ESP32 [16], 32 bit microprocessor with on board WiFi and Bluetooth. This development board is capable of connecting with other Bluetooth devices such as mobile phones and exchanging data. The development board also provides interfaces to connect other peripherals such as buzzer and LED.
- **Power Source:**
  A battery is a source of energy which provides a push (voltage) of energy to get the current flowing in a circuit. It supplies power to the entire circuit. The complete system is powered using a pair of lithium ion 18650 batteries through a battery management system. There is a built-in voltage regulator present in PIR sensors, it is powered by any DC voltage from 4.5 to 12 volts, typically 5V is used [17]. Hence for this reason a 5V battery has been chosen.
- **LED Bulbs:**
  COM-09590 - It is a very basic 5 mm LED with a red lens. It has a forward voltage of 2.0V and a rated forward current of 20 mA. The LED alerts the user by blinking when people are detected by the PIR sensor.
- **Passive Infrared Motion Sensor:**
  Passive Infrared (PIR) Sensor, the passive word indicates that the PIR Sensor does not generate or radiate any energy for detection purposes [18]. Its sensitivity can be adjusted to get smaller or larger sweep range. The three PIR Sensors detect movement in the surroundings within the range.
- **Buzzer:**
  Piezoelectric buzzers - It is an audio signalling device. The buzzer alerts the user if anyone comes within the range of the PIR sensor.

TABLE I
APPROXIMATE PRICE OF THE PROPOSED SYSTEM

| S.No | Component Name | Purpose and Specifications | Price (INR) |
|---|---|---|---|
| 1 | NodeMCU | Manage the complete system onboard WiFi and Bluetooth 32bit dual core processor 12 bit ADC and GPIO | 700 |
| 2 | PIR sensor | Detects the human movement 5V supply voltage, 120 degree coverage | 300 |
| 3 | Buzzer | To alert the user and other people 5V 80dB | 50 |
| 4 | LED | To notify the user 1.5V | 5 |
| 5 | Li ion Battery | To power the complete system 5V 2000mAh with BMS | 400 |
| | | Total cost (INR) | 1455 |

Table I shows the approximate cost of the proposed system. It can be seen that the prototype system costs around Rs. 1455. The price is in the affordable range for a normal person. The price can be brought down further when mass producing the product.

## IV. Design Methodology

Our intention from the beginning was to make a portable, light-weight, easy to use and efficient system to help maintain social distancing as it is by far the best means to stay safe. Further, a few different concepts which were not coherent are initialized. The first one being the use of Ultrasonic Sensors instead of the proposed passive infrared sensors, which have only 30 degrees range. It detects every inanimate object in its vicinity, giving false-positive results every time the user gets too close to an object. Using too many Ultrasonic sensors to achieve 360-degree implementation makes the system more complex, bulky and inefficient. The Passive Infrared Sensor, on the other hand, recognizes only living objects within its range which is about 120 degrees, substantially higher than the Ultrasonic sensor. This is exactly what is apt for our required system, and hence the choice of making use of ultrasonic sensor was ultimately ruled out.

Next, a system had to be made with these components for which a wide range of ideas are proposed, for instance, making an Armband or a belt which the user could wear comfortably. These ideas were, however, ruled off as they had a high risk of detecting the user's own body, like the arms while wearing an armband would be in close contact to their body, giving false alerts to the user. The belt was also ruled off, as making use of many PIR sensors to cover 360-degree range would make it very bulky and inconvenient. The final design idea that has been intended to proceed further was a headgear, which could be worn and removed at the user's convenience. Moreover, the headgear would be very spacious and can have different compartments, easily encompassing the device's components and still having enough space to fit onto the user's head. Taking all this into consideration, the proposed system was subsequently designed.

## V. System Design and Architecture

During quarantine,it is needed to maintain a distance of at least 1-1.5 m from people and in public places. But sometimes the human brain does not remember this. So, a smart solution called Suraksha Device is proposed in this research work. It is a smart wearable device which can be used for maintaining social distancing.

The HC-SR501 PIR motion sensor is used for measuring the distance from the body to the object. And this measured signal by the PIR motion sensor is sent to the microcontroller. The program/ code to manipulate the input values from the sensors is uploaded in the microcontroller. The condition implemented in the code is that when the distance is greater than 1.5 m, the electric buzzer starts blowing. And on the other side if the distance is less than 1.5 m the electric buzzer will not blow as shown in figure 4.

The system architecture consists of three PIR motion sensors which would be connected to the NodeMCU ESP32 module through jump wires. As discussed earlier, PIR sensor, buzzer and LED are connected to the NodeMCU ESP32 development board. The PIR sensors detect motion in close proximity of the user, which can be adjusted by changing the sensitivity of the PIR sensors. Upon detection of motion, the LED light would glow and the buzzer would make a beeping noise as shown in figure 4, thereby alerting the user that he is not maintaining a minimum physical distance with other individuals. An alert is also sent to their mobile phone application through Bluetooth. This data can be used by the contract tracing applications to get an accurate level of closeness and time duration of close contact. A work flow diagram is shown in figure 2

The device will be powered by a 5V Li-ion battery, making the system easy to carry around. The device makes use of a slide switch to avoid any waste of energy. Since the whole design is made to be as compact as possible to fit inside a cap, a compartment is made in the cap to accommodate all these parts and be seamless to someone whether or not he/she is wearing the cap.

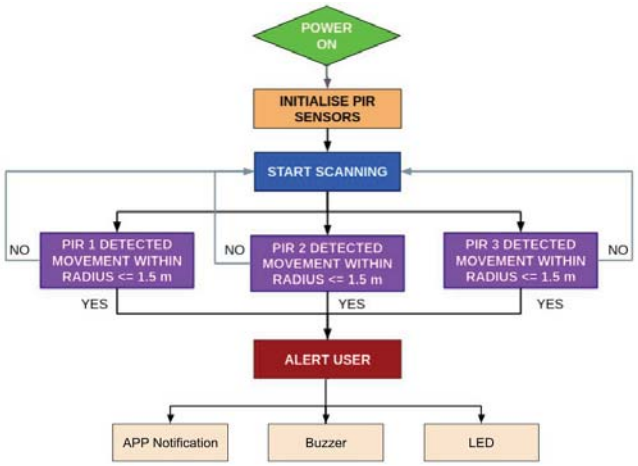


Fig. 4. Flowchart of proposed system

TABLE II
Test cases of the Suraksha device

| Movement | Detection Range (cm) | Notification |
|---|---|---|
| Person 1 | >150 | OFF |
| Person 2 | <=150 | ON |
| Person 3 | >150 | OFF |
| Person 4 | <=150 | ON |
| Person 5 | <=150 | ON |
| Person 6 | >150 | OFF |

## VI. System Implementation and Results

With the administration finding ways to contain the spread of the novel corona virus, it is our obligation to follow the advice in letter and spirit. Innovation and technology can assume a critical job in encouraging social distancing, which is a powerful method of forestalling CoVID 19. A straightforward, yet simple to wear gadget, will help the community everywhere, in battling against the novel corona virus by maintaining the minimum physical distance. This way, even in such times where there is an added fear of contracting the virus in a pandemic such as COVID-19 people don't have to constantly worry about their surroundings as they can rely on this device to alert them. Test results are tabulated in table II. If any person comes within the range of radius of 1.5m from the user, the Buzzer and LED will turn ON.

The scan response time of the PIR sensors is 1s. The loop will exit after 1 second. The Suraksha device is capable of alerting the user of their surroundings at anytime and anywhere. The device is more preferable as the user need not worry about registering/creating an account or even installing an app in their mobile phones to be aware of their surroundings at all times.

## VII. Conclusion and Future Work

The Suraksha device is a gadget built with an intention to help people in maintaining the minimum physical distance also called social distancing in times when there is a widespread fear of catching contagious diseases. This device, which is

basically a "cap", can be worn by anyone, anywhere as it is reliable and easy to use. As of now, the effective management of power distribution within system has not been assessed yet.

There are devices which cannot detect motion in all the directions, whereas the proposed device can detect motion in $360^0$ up to 1.5m. This way the user need not worry about their surroundings at all times.

This 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 increases or decreases from our average normal body temperature. The sensor that could be used for this is MAX30205 Human Body Temperature Sensor [19]. The IoT part comes into picture as it has been attempted to make the NodeMCU ESP32 board communicate with a mobile device via Bluetooth, a basic mobile application can be created to send notifications based on the signals from the ESP32 module.

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## REFERENCES

[1] D. R. Dhaya. (2020) Deep net model for detection of covid-19 using radiographs based on roc analysis. [Online]. Available: https://www.irojournals.com/iroiip/V2/I3/03.pdf

[2] W. H. O. Disease Outbreak News. (2020) Pneumonia of unknown cause – china. [Online]. Available: www.who.int/csr/don/05-january-2020-pneumonia-of-unkown-cause-china

[3] D. T. A. Ghebreyesus, "Virtual press conference on covid-19 – 11 march 2020," in *Virtual press conference on COVID-19 – 11 March 2020*, W. H. Organisation, Ed. The address of the publisher: World Health Organisation, 3 2020, p. 17.

[4] S. P. K. et al., "Understanding the pathogen evolution and transmission prevention measures:recent findings on molecular interventions towards covid-19 therapeutics via hints from the past," 2020. [Online]. Available: https://www.amrita.edu/publication/understanding-pathogen-evolution-and-transmission-prevention-measures-recent-findings

[5] S. Vijayaraghavan and N. Puthenveettil, "International pulmonologists's consensus on covid-19," vol. 64, no. 10, 2020.

[6] D. M. A. M. Dr. Tinku Joseph, "International pulmonologists's consensus on covid-19," vol. 322, no. 10, pp. 2–6, 2020.

[7] S. A. Narinder Singh Punn, Sanjay Kumar Sonbhadra, "Monitoring covid-19 social distancing with person detection and tracking via fine-tuned yolo v3 and deepsort techniques," *Annalen der Physik*, vol. 322, no. 10, pp. 891–921, 2020.

[8] N. V. H. N.-T. N. T. V. K. B. M. T. D. N. N. D. T. H. T. X. V. E. D. S. C. B. O. Cong T. Nguyen, Yuris Mulya Saputra, "Enabling and emerging technologies for social distancing: A comprehensive survey," *Physics and Society*, pp. 1–2, 2020.

[9] U. Parts. (2020) Social distancing reminder system. [Online]. Available: https://maker.pro/arduino/projects/social-distancing-reminder-system

[10] D. M. R. Abhiruchi Passi, "Manav rakshak: Device to help maintain social distancing," vol. 9, pp. 2–3, 2020.

[11] R. Khanna. (2020) Vision based social distancing monitor. [Online]. Available: https://www.hackster.io/rahulkhanna/vision-based-social-distancing-monitor-2a6f8a

[12] G. o. I. National Informatics Centre, Ministry of Electronics Information Technology. (2020) Aarogya setu. [Online]. Available: https://www.aarogyasetu.gov.in/

[13] (2020) Spacebands. [Online]. Available: https://www.spacebands.co.uk/

[14] (2020) Bio-bubbles with bluetooth band. [Online]. Available: https://indianexpress.com/article/sports/ipl-bubble-bluetooth-bands-to-enforce-distancing-others-rooms-out-of-bounds-6571625/

[15] M. L. L. C. A. A. Hanumanthaiah, D. Arjun and A.Gopinath, "Integrated cloud-based smart home with automation and remote controllability," *International Conference on Communication and Electronics Systems (ICCES)*, 2019.

[16] S. S. R. C. Y. P. H. K. N. B. Sai Shibu, A. Hanumanthiah and J. V. S. Pavan., "Development of iot enabled smart energy meter with remote load management," *IEEE International Conference on Computational Intelligence and Computing Research (ICCIC)*, pp. 1–4, 2018.

[17] D. Knuth. (2015) Testing and playing with pir sensors (motion sensor). [Online]. Available: https://www.tweaking4all.com/hardware/pir-sensor/

[18] T. P. V. R. Sujay Narayana, Venkatesha Prasad, "Pir sensors: characterization and novel localization technique, madhuri iyer, sripad s. kowshik," *IPSN '15: Proceedings of the 14th International Conference on Information Processing in Sensor Networks*, p. 142–153, 2015.

[19] M. Integrated, "Human body temperature sensor," Maxim Integrated Products, Inc, 2016. [Online]. Available: https://datasheets.maximintegrated.com/en/ds/MAX30205.pdf