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Safe Distance Protection Badge

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Article Information

ABSTRACT

The past two years have changed the world completely. COVID-19 definitely taught us the importance of social distancing. It is still difficult to understand how much of a distance one should maintain and whether we're maintaining it with these sudden changes. The Social distancing and covid protection badge come in use for these such situations. In situations like public events where strangers need to maintain a distance, the device can provide consistent guidance without people having to police themselves or each other. This could be useful in schools, museums, recreational facilities, or workplaces. It uses basic technology and can be put together using low cost readily available components. This communication occurs very quickly and so can be thought of as nearly instantaneous.

KEYWORDS: Social distance, Radio Frequency communication, embedded application, collision avoidance

1. INTRODUCTION

The project aims to help people maintain social distancing to avoid the spreading of COVID-19. In some public places and surroundings, people easily forget to maintain a safe distance. This device could help remind them. We designed a wearable and portable badge that warns the users if they enter another user's safe social distance by using ultrasonic sensors and RF waves.

We, the students of AISSMS's Institute of Information Technology, Pune have proposed a system that consists of badges that are connected via a RF network to maintain social distancing and alert the users on breaking the rule.

In our project, we are basically concentrating on the following applications such as:

- Provide guidance at public events where everyone needs to maintain social distancing.
- To use in schools, museums or workplaces.
- It is helpful in crowded places like public transport facilities and airports.

Hence, a device that prompts the user to maintain distance in a crowd is a solution.

1.1. OBJECTIVES

- Primary objective is to implement social distancing between people by using low cost and minimal infrastructure.
- Design a device to ensure a crucial safe distance of 2mtr between two or more people
- Build at least two prototypes so that we can test how they work in sync.
- Synchronize between the devices, thereby creating a RF network.
- Prompt the user via the piezo buzzer and vibration motor if the time between the sender and receiver RF signals is less than 6ms.
- The device should be compact, portable, wireless, and rechargeable.

2. LITERATURE SURVEY

"Enabling and Emerging Technologies for Social

Distancing: A Comprehensive Survey and Open Problems" presented by the University of Technology Sydney [1] (2020) Focuses on Social Distancing dos and don’ts and different emerging technologies to tackle this problem. This paper outlines the new technologies that have emerged as a result of the COVID – 19 Pandemic. The Paper also suggests technologies that could be further improved and innovated upon such as Crowd Detection and Health Monitoring Systems.

IEEE Paper on "Wearable Social Distancing Detection System," presented at IEEE International RF and Microwave Conference [2] (2020) reviews the hardware and testing of a Wearable Social Distancing Device that aims to alert the user to maintain a safe distance of at least 1m by sounding an alarm and also displaying the distance on a LCD; it achieves this by using an Ultrasonic Sensor. The disadvantage of such a device is that only the user will be alerted and not the people around him/her. We aim to address this issue by proposing to create a device, using similar hardware, that would be carried by all individuals at an event. Also, the wireless communication would be handled by the devices between themselves; hence, less room for error.

“The Contactless Badge" designed IR - Thermometer Evaluating Temperature [3] (2020) says that their device consists of two functions mode Physical Distancing and High-temperature alert mode. When observed thermal change is noticed in a comparison of the ambient temperature in the surrounding mode1 is activated and performs the function of alert defined in the section processing of input.

"Performance analysis of the nRF24L01 ultra-low-power transceiver in a multi-transmitter and multi-receiver scenario," SENSORS IEEE [4] (2011) suggests the nRF24L01+ Transceiver Module is inexpensive, reliable, has a low current consumption during transmission (Reception won't be used in the project) and has the highest data transfer rate. As for the range, 5 – 10 m is more than sufficient for the successful implementation of the project.

IEEE Paper on “Smart Cap for Prevention of contagious diseases and Social Distancing using Arduino” [5] (2021) This paper reviews the various advantages of a device called the Smart cap. It uses a GSM module for working. The cap is useful to maintain a safe distance between two people and thereby reduce the spread of airborne diseases.

The major disadvantage of this device is that it is heavy. It is a lot to carry in place of a regular cap due to the circuit inside. We aim to address this problem by building a more compact device that is lightweight and can be worn on the arms or around the neck.

Hence, from the above survey of the popular RF Modules, which have proposed a system consisting of badges connected via RF channel available, the nRF24L01+ Module is found to be apt for the application of this project.

As already stated, the nRF24L01+ module is ideal for our project due to its transmission properties and all the specifications that we need. While opting for the same we also surveyed various other components for RF transmission. This information is given in Table 1. Table 2 shows the approximate cost of the main modules and components used.

Components	Frequency	Range(m)	Data Rate
Generic	433MHz	15-25	4 kb/s
nRF24L01+	2.4GHz	5-10	1-2 kb/s
RFM95W	868MHz	200-300	37.5 kb/s

Table 1. Survey of RF module

Component	Rate	Quantity	Price
Arduino Nano	320/-	2	640/-
nRF24L01+	270/-	2	540/-
HC-SR04 Module	140/-	2	280/-
Beeper	70/-	2	140/-
Total:			1640/-

Table 2. Cost of Components

3. METHODOLOGY

We recognized the Social Distancing issue and began our research on the subject. During the Literature Survey, we came across a crude device using an Ultrasonic Distance Sensor that alerts the user via a beeper when social distance is disobeyed. This device sparked the inspiration to build a more reliable and compact device, capable of communicating with other devices, thereby forming a network.

We decided to make use of Radio Waves as the system needs to be near-instantaneous. After a thorough market survey, we selected the nRF24L01+ Transceiver Module among the other RF Modules available. Referring to articles, we concluded that the Receiver Transducer de-soldered from the HC SR-04 Module would serve efficiently as the RF receiver. We also decided to use the versatile ATmega-328p microcontroller as the main unit. For prototyping, we concluded that the Arduino Nano R3 board would be apt as it is compact and versatile. In the prototype version, we build two devices on the breadboard. We synchronized the nRF module and ultrasonic receiver to establish a network and determine whether social distancing is maintained or not.

After successfully testing the prototype shown in Fig. 1, we proceeded to create a custom build version for our badge. The main challenges we had were :

- To make the design compact and portable
- It should be rechargeable and wireless

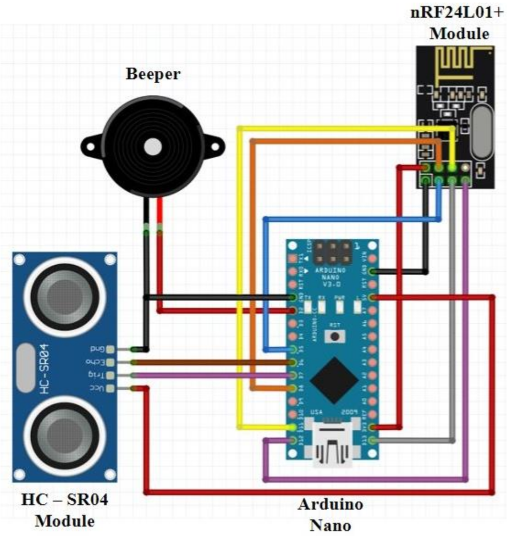

Fig.1. Prototype design

3.1 ARCHITECTURE

In order to address these problems, we opted for a SMD(Surface-Mount Device) design PCB to reduce the size. We also choose a 1000Mh 3.7v LiPo battery which takes approximately 1 hour to charge. The PCB is a two-layer PCB design scheme comprising 0805 SMD components to make the board as compact as possible. 10x2 male headers are used for ICSP. THT components include the Beeper, the Ultrasonic Receiver, and the nRF Module. Fig. 3 shows the complete SMD build PCB that is our proposed social distancing badge.

The custom circuit design consists of the following primary blocks:

- Microcontroller Block – It consists of a ATMega – 328p as well as an external 16MHz crystal oscillator.
- Power Block – It consists of Adjustable and 3V Voltage Regulators for providing steady voltage to the components.
- Battery Charging Block – It consists of a Micro USB port and a LiPo Battery Charging IC along with LEDs to indicate the charging status.
- RF Block – This mainly consists of the nRF24L01+ module and its related connections with the Microcontroller.
- ICSP Serial Communication Block – It consists of pin headers for serial communication.

All the SMD components are used because the resister and capacitors of package 0805 or battery charging and voltage regulator ICs of the SOT23 package chosen are really small which reduces the size of the badge. We used lead-free solder paste by using the sand reflow soldering method and heating it up to 160 degrees Celcius. Fig. 2 shows the software flowchart stating the working code.

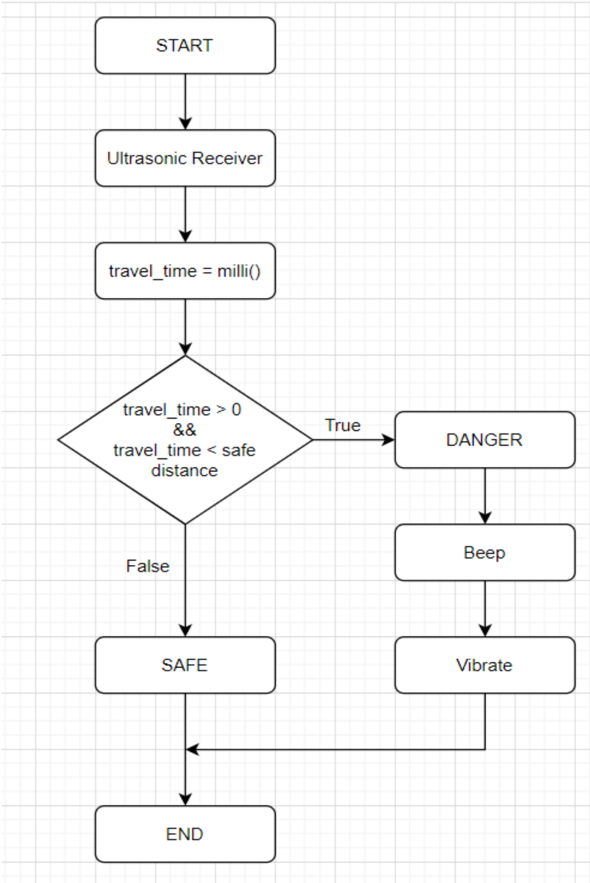

Fig. 2. Software flowchart

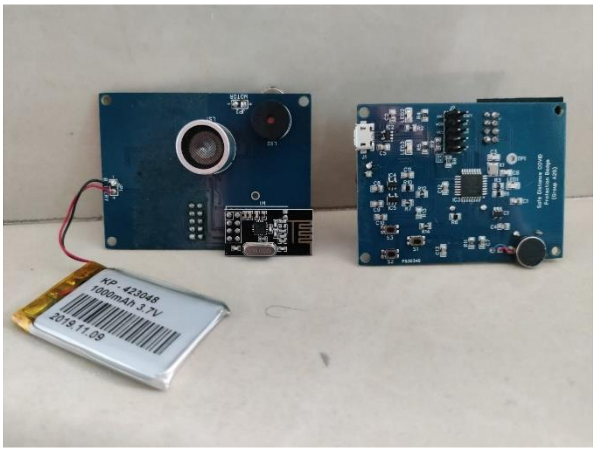

Fig. 3. Social Distancing portable badges

4. RESULTS

- In a space, where our system is employed, a device know as the 'sender' sends an RF packet to all other devices in its vicinity, that is in the radio frequency range. It then waits for an ultrasonic ping. The device that receives the RF packet and is closest to the sender responds with an ultrasonic ping immediately.

- The ping from the closest badge to the 'sender' reaches first. The 'sender' device measures the time taken from RF signal sent and an ultrasonic ping received. If this duration is less than approximately 6ms, then we know that the user is closer than 2m. The nRF sends an alert by activating the buzzer and vibration motor.
- Each device in the channel becomes a 'sender' at a random time interval to ensure the RF channel is shared. In this way, every user has distance measurements to keep a safe distance.
- The device is able to charge a LiPo battery and show the charging status accordingly. This is shown in Fig. 4.

Fig. 4. Battery charging circuit

5. CONCLUSION

Various devices for social distancing have been proposed to date. The Safe distance Badge proposed in this paper uses the Radiofrequency channel and ultrasonic ping, to communicate between devices and to determine whether they are practicing social distancing at a minimum 2m distance. After successful implementation of the proposed badge, the model will be able to sense distance and alert the user via buzzer and vibration. Thus helping the crowd to reduce the spread of covid via contact. One of the goals we achieved in our design is to minimize the component count and reduce the size to make the badge portable and also rechargeable. The onset of the COVID – 19 Pandemic has given rise to various new technologies so as to enable humankind to adjust to the "new normal", and many new areas and aspects are yet to be explored. Such as the integration of our badge with the Arogyasetu app. Our model can also be used in electric vehicles in the future.

6. REFERENCES

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