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A Compact Wearable Smart Tag for Monitoring Social Distancing in Pandemic Circumstances

Priyanshu Rudra Pal[1], Joysree Debnath[2], Dhriti Rudrapal[3], Debarshita Biswas[4]

Student, Electronics & Communication Engineering, ICFAI University Tripura, Tripura, India [1,2]

Assistant Professor, Electronics & Communication Engineering, ICFAI University Tripura, Tripura, India[3,4]

Abstract: In the context of recurrent outbreaks of infectious diseases, protecting public health has emerged as a paramount concern. The smart tag is a small, wearable device expertly engineered to provide safe spacing between individuals in congested settings. The system integrates an Arduino Uno microcontroller, an ultrasonic sensor, an LED, and a buzzer to establish an efficient proximity alarm system. The ultrasonic sensor quantifies the distance between humans. And if an individual encroaches upon the designated unsafe range, the device promptly activates alarms via visual (LED) and audio (buzzer) messages. This allows users to quickly implement corrective actions in order to maintain a sufficient amount of space between themselves and others. The system is designed with portability, cost-effectiveness, and a lightweight construction in mind. This makes it very accessible for everyday use in a wide range of contexts, including schools, hospitals, businesses, and other public spaces. It has the potential to greatly reduce the risk of illness transmission by promoting awareness and adherence to social distancing practices. This Social Distancing Smart Tag combines technical innovation with public safety in order to provide a proactive and realistic strategy for preventing sickness. This initiative serves as an example of the intersection of innovation and societal demands, addressing current public health challenges through the use of technology that is both accessible and dependable.

Keywords: Arduino Uno, Ultrasonic sensor, Social distancing, Smart tag, Microcontroller**.**

I. INTRODUCTION

The significance of maintaining physical distance to reduce pathogen transmission is underscored by the repeated epidemics of infectious diseases in contemporary civilization. The COVID-19 pandemic has underscored the importance of social separation as a preventive strategy to reduce the transmission of infectious diseases. Despite the existence of numerous awareness campaigns, a significant number of individuals fail to comply with the established distance protocols in public spaces. The Social Distancing Smart Tag system is a cutting-edge, technology-based method that is intended to ensure the safe maintenance of physical distance [1]. The tag is configured to function as a wearable device, similar to an ID badge, that is capable of identifying individuals in close proximity and alerting the user when the minimal safe distance (e.g., 1–2 meters) is exceeded. The Social Distancing Tag provides a pragmatic and innovative approach to alleviating the effects of the pandemic. The purpose of this portable device is to provide users with immediate notifications when secure distances are breached, thereby assisting them in maintaining social separation. The device utilizes an Arduino Uno microcontroller and an HC-SR04 ultrasonic sensor to continuously monitor proximity, notifying users of any safety distance violations through the activation of an LED and alarm.

The Social Distancing ID Card is a lightweight, affordable, simple device that is easy to carry and operate. This gadget is highly effective for ensuring safety and reducing the risk of disease transmission. It is very useful in crowded environments such as schools, offices, and hospitals. The project demonstrates the application of innovative concepts to address societal challenges while prioritizing health security through the integration of modern technology with a fundamental, user-friendly design. The World Health Organization (WHO) [2] and other global health groups have advised that it's highly vital to stay away from other people when there are illness outbreaks. This rule has been found to dramatically limit the transmission of diseases. But making sure that people always follow it in crowded and prominent locations. Wearable technology has becoming more popular since it might assist people stay safe distances.

Subrahmanyam et al. developed a prototype device that facilitates social separation with a solution based on Ultra-Wide Band (UWB) wireless technology [3]. The prototype emits a warning signal when the distance between individuals falls below the designated threshold. In the event of a protocol break, the user is alerted via an LED. The authors preferred UWB due to its superior signal strength relative to Bluetooth. A study conducted by Sultana et al. developed an ID card system using proximity sensors and utilizing real-time data analytics. The system can track individual proximity, issue alarms, and pinpoint high-risk zones during pandemic scenarios. Essential factors encompass data privacy, user approval, and compatibility with current infrastructures [4]. An alert device proposed by AbuAli [5], consisting PIR sensor to keep individuals at a safe distance from one another. Deshmukh et al. designed a smart ID card for daily transactions in a collegiate setting, facilitating social separation during the Covid-19 pandemic. The study sought to diminish social

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connection among individuals through touch or physical contact [6]. In a similar study found in the literature, developed a prototype to uphold social distancing in public venues such as schools, colleges, and organizations. This prototype will notify the user if an individual enters the designated area. By utilizing a sensor, the user can sustain an acceptable distance while engaged in work [7].

Existing literature demonstrates the importance of social distancing during pandemic outbreaks and the need for a smart alerting device that can potentially restrict further spreading of such viral diseases. While designing such a smart device the selection of components are very important. Research highlights the efficacy of ultrasonic sensors, particularly the HC-SR04, in proximity detection due to their precision and cost-effectiveness. These sensors have been widely used in a variety of applications, from robotics to safety devices. Paired with the versatile and user- friendly Arduino Uno microcontroller, they enable the development of a smart system for monitoring distance. Studies on similar devices demonstrate that incorporating visual and auditory alerts, such as LED lights and buzzers, enhances user awareness and ensures timely response to unsafe proximity. The Social Distancing Smart Tag builds upon these findings by combining the HC-SR04 sensor and Arduino Uno in to a light weight, wearable solution. By providing instant alerts through an LED and buzzer, it empowers individuals to take proactive steps to maintain distancing. This study not only addresses existing challenges in public health but also contributes to the growing body of literature on accessible, cost-effective technology for disease prevention and safety.

II. MATERIALS (HARDWARE AND SOFTWARE)

A. Arduino Uno

Arduino UNO is a user friendly microcontroller board, as illustrated in Fig. 1. Arduino released the first version of their most basic USB board. It is considered to be a powerful board that may be used in a variety of applications. The Arduino UNO board was designed by Arduino.cc [8]. The Arduino UNO is a common board inside the Arduino platform. The system is built on an ATmega328P microprocessor. It includes a power plug, a USB interface, an ICSP header, 14 digital pins, and 6 analog input pins. It can be programmed using an Integrated Development Environment that supports the C and C++ languages. It is applicable to a wide range of applications that incorporate sensors, actuators, LEDs, motors, and similar components.

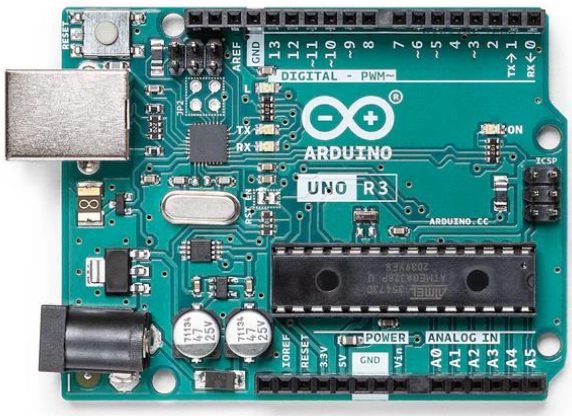

Fig. 1 Arduino Uno Microcontroller [8]

It is compatible with a wide range of modules and shields that can improve its capabilities. In contrast to other boards, such as the Arduino Mega, it is easier for consumers to operate. The board is equipped with electronic components such as shields and other devices, as well as analog and digital input/output pins (I/O).

B. HC-SR04 Ultrasonic Sensor

The parts of an ultrasonic sensor is shown in Fig. 2. The HC-SR04 consists of a pair of ultrasonic transducers. One of them is a transmitter that converts electrical signals into ultrasonic sound pulses with a frequency of 40 kHz. The other one acts as a receiver, detecting the pulses that are being broadcast. The receiver generates an output pulse with a width that is proportional to the distance of the object in front of it once it has received these pulses. With a precision of 3 millimeters, this sensor has outstanding non-contact range detecting capabilities, spanning from 2 centimeters to 400 centimeters (which is approximately 13 feet). Due to its operation at 5 volts, it may be directly linked to an Arduino or any other 5V microcontroller.

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Fig. 2 HC-SR04 [9]

C. Buzzer

A buzzer is a type of acoustic device that transforms audio signals into sound waves. It appears as seen in Fig. 3. It is mostly utilized for signaling or alerting. Depending on the design and application, it can generate musical tones, flute sounds, buzzers, alarms, electric bells, and various other noises. It comprises two pins: positive and negative. The positive terminal is denoted by the '+' symbol or a longer terminal [10]. The negative terminal is represented by the symbol "-", and it is connected to the GND terminal. This terminal works at a voltage of 5 Volts.

Fig. 3 Buzzer [10]

D. LCD with I2C module

An I2C LCD display comprises two primary components: an HD44780 character LCD and an I2C LCD adaptor. Character LCDs are specifically engineered to exhibit letters, numerals, and symbols. A 16×2 character LCD can display 16 characters per line, with a total of two lines. The LCD Module consists of 16 pins connected to the 16 corresponding pins of the I2C Interface device [11]. The module is then connected to the Arduino board via the four extra pins (GND, Vcc, SDA, and SCL) through the I2C interface.

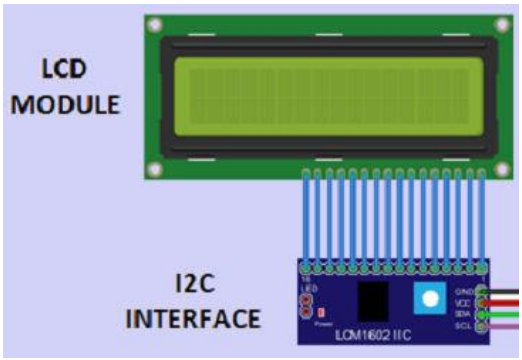

Fig. 4 LCD module with I2C Interface [11]

The other basic components used in the system include LED, resistor, veroboard, connecting wires etc.

E. Arduino IDE software

The IDE Arduino IDE (Integrated Development Environment) serves as a platform for composing, compiling, and uploading code to Arduino controllers. This software is compatible with Windows, MacOS, and Linux operating systems. The IDE provides a simple interface for creating and editing code, and it is easy to use even for beginners. Fig. 5 shows

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Fig. 5 Arduino IDE platform [12]

III. METHODOLOGY (CIRCUIT DIAGRAM AND WORKING)

The present implementation uses Arduino Uno, three ultrasonic sensors, one LCD screen, buzzer and LED indicator. The detailed component list is given in Table I.

Table I Component details

Name	Quantity	Component
Arduino Uno	1	Arduino Uno R3 Microcontroller Board
PIEZO1	1	Piezo
D2	1	Green LED
DIST Ultrasonic sensor: DIST1, DIST2, DIST3	3	Ultrasonic Distance Sensor (4-pin)
U5	1	MCP23008-based, 32 (0x20) LCD 16 x 2 (I2C)

The study is initially carried out in Tinkercad [13] simulation tool. The Tinkercad project and corresponding circuit diagram is given in Fig. 6 and Fig. 7, respectively. Later on, the practical prototype is implemented using the hardware components.

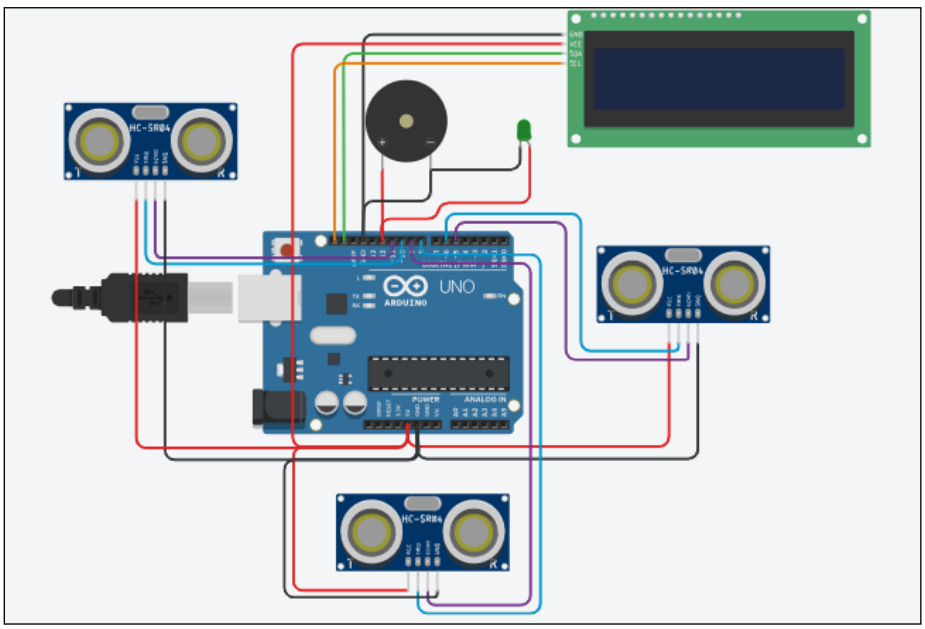

Fig. 6 Tinkercad simulation of social distancing smart tag

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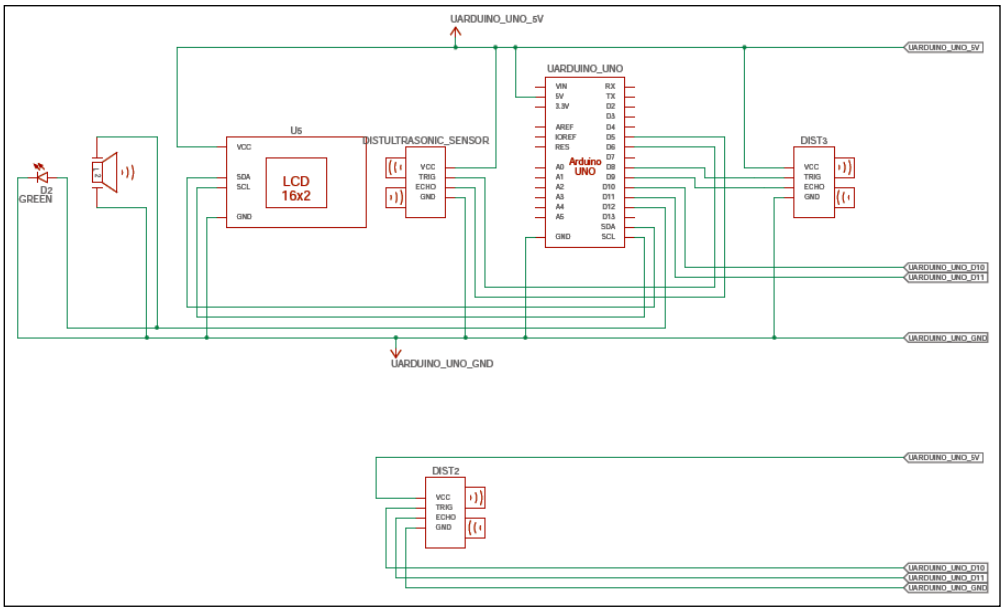

Fig. 7 Circuit diagram

The ultrasonic sensors measure the distance of the object appearing in any direction and Arduino will continuously analyse the distance. Three ultrasonic sensors are placed on the system such that, the objects appearing in any direction (360 degree) can be traced. Each sensor collects the distance of the object in its range and compares with the distance safety value defined in the program. When the object comes too close, an alarm sound is produced. For the present study two meters distance is kept as the threshold level and if the measured distance becomes less, the Arduino will turn on the buzzer. The study is about social distancing to reduce the speed of communicable diseases. The objective is to activate the buzzer to signify a minimal distance between two individuals and to provide an alert if the allowable distance is exceeded.

The system performed well in both simulation and hardware; the results are satisfactory. When the person wearing the social distancing smart tag goes very close (less than two meters) to any other person, buzzer turns on and the exact distance displays on the LCD screen.

IV. CONCLUSION

The Social Distancing ID Card is a simple yet effective innovation to promote safe practices in workplaces and public areas. By using low-cost technology, it allows for real-time tracking and warns users when they are in an unsafe area. This lowers the risk of disease transmission. This system, if widely adopted, can become a critical tool in managing pandemics and safeguarding public health.

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