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SOCIAL DISTANCING CAP

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ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has led to a dramatic loss of human life worldwide. Social distancing (means keeping a safe space between yourself and other people) is the need of the hour to avoid transmission of the disease. To counter this situation, this "Social Distancing Cap" is built using an Arduino, a servo motor and an ultrasonic sensor. It uses the ability of the ultrasonic sensor to measure obstacle distances by sending and receiving ultrasonic waves that reflect back from the obstacle (surrounding people in this case). This device will enable us to know if someone's coming closer to us from any direction and will alert us to maintain the required distance through the means of a buzzer sound. It has a second feature which ensures that we avoid touching our face when the cap is ON.

Keywords: Social Distancing, Coronavirus, Ultrasonic Sensor, Arduino Uno, Servo Motor.

I. INTRODUCTION

The WHO (World Health Organization) has declared the coronavirus disease 2019 as a pandemic. This corona virus has spread worldwide and caused a major breakdown in every aspect of human life. A coordinated effort is needed by everyone to reduce and stop the further spread of this deadly virus. The transmission rate is quite high and the number of cases is rising each day. Here is a graph depicting information about the affected countries and the total number of confirmed cases they have as on 18th November 2020.

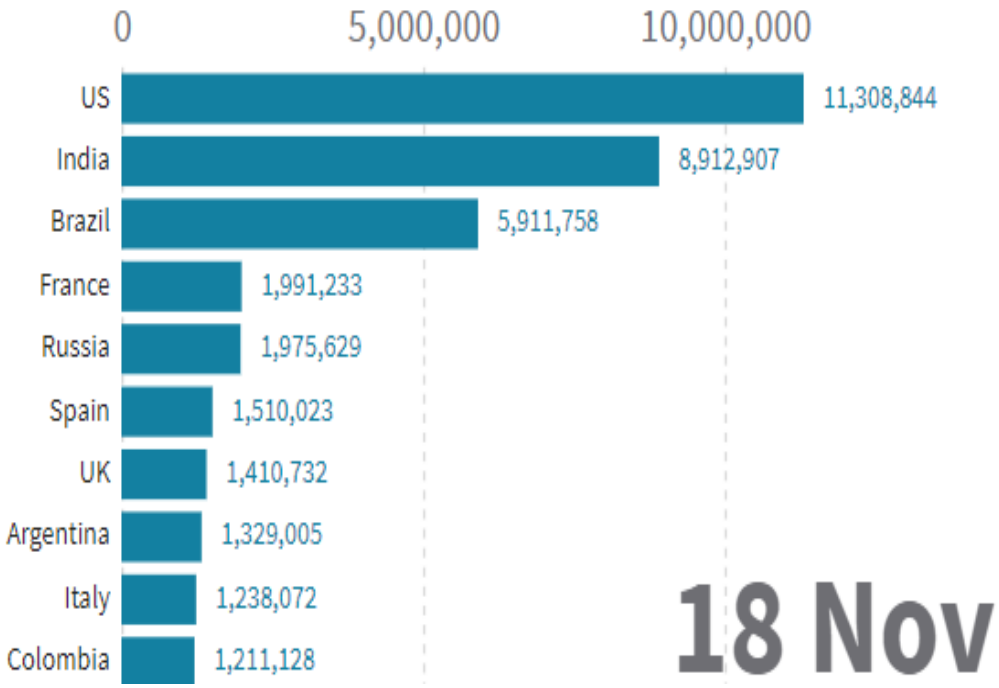

Figure 1: Spread of cases of covid-19 across various countries.

The data shows, India is the second most affected country in the world right now. With no lockdown or restrictions and everything open, the number of cases is not reducing. It is unavoidable to go out and hence it is necessary to take the required precautions. Given below is the graph giving details about the rise in cases that are reported cases, reported deaths, daily new surge in cases and mortality rate in India as on 16th November 2020.

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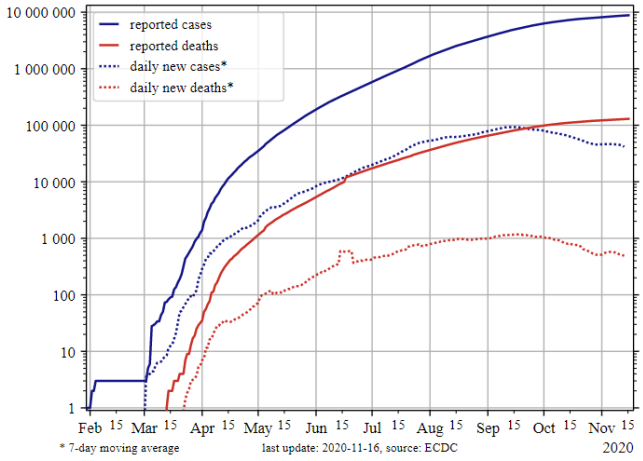

Figure 2: COVID-10 in India.

Generally, this virus is transmitted when an infected person comes in physical contact with others, or when a healthy person uses goods used by the infected person (indirect contact with infected person). Usually, the family members of the infected person are at higher risk. Also, the healthcare workers treating the patients are at risk so the wear PPE kits. Preventing its transmission can only be achieved by everybody coming along to do so. Measures to prevent it are:

1. Perform hand hygiene frequently with an alcohol-based hand rub if your hands are not visibly dirty or with soap and water if hands are dirty.
2. Avoid touching your eyes, nose and mouth.
3. Respiratory hygiene must be practiced using the method of putting your bent elbow on your mouth while coughing or sneezing.

4. A person should be wearing a mask if he/she has respiratory symptoms.
5. Maintaining at least 2 meters of distance from individuals with symptoms related to covid.

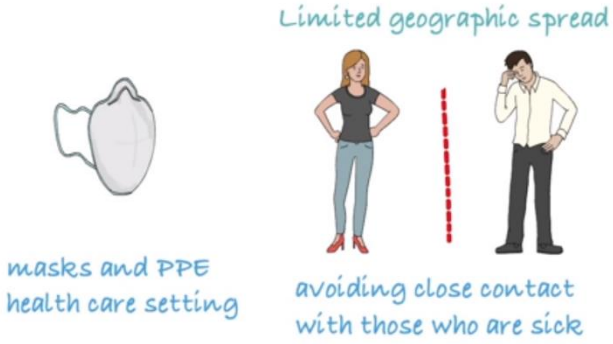

Figure 3: Social Distancing

By taking in view the need of maintaining social distancing whenever you are in public, we decided to create a "Social Distancing Cap" which can alert us when required. It is important to keep everyone safe from this brutal pandemic since we have to do our jobs and other work anyhow.

This cap will help to maintain a certain distance from people around you and we will be forewarned about our surroundings. This cap will be the ideal solution to maintain social distancing.

II. METHODOLOGY

Components to be used for this device are as follows:

Arduino UNO R3

The Arduino Uno R3 is an open-source microcontroller. It has the Microchip ATmega328P microcontroller. The board is containing multiple digital and analog I/O pins that can be used to interface the microcontroller with many other components. There are 2 different ways to power this microcontroller:

- with the help of USB cable or
- by using an external 9-volt battery

The software used for programming this microcontroller is the Arduino IDE. Programming language used can be C or C++ as per convenience.

Figure 4: Arduino UNO

HC-SR04 Ultrasonic Sensor

The HC-SR04 ultrasonic sensor works using SONAR (Sound Navigation and Ranging) technology to calculate the distance of an object just like the bats do using echolocation. It is highly accurate with the range of 2 cm to 400 cm with a resolution of 0.3cm. This sensor is not affected by sun rays or black objects, but, soft material like fabric is difficult to spot.

Figure 5: HC-SR04 Ultrasonic Distance Sensor

The operating voltage is 5V and the working current is 15mA. It works for an angle of 15 degree.

The duty cycle of the trigger pulse is 10μS for this ultrasonic sensor. When the sensor is triggered, it generates eight acoustics (Ultrasonic wave bursts) and initiates a time counter. As soon as the reflected (echo) signal is received by the sensor, the timer stops. The output of the ultrasonic sensor is a high pulse with the same duration as the time difference between transmitted ultrasonic wave bursts and the received echo signal.

Mini Servo Motor

A servo motor can rotate with great precision. It is used to rotate an object at specific angles. It runs through a servo mechanism.

Servo motor can be rotated from 0 to 180 degrees. The degree of rotation can be controlled by applying electric pulse of proper width. It is controlled using a PWM (Pulse Width Modulated) signal which is sent from a microcontroller which in this case is an Arduino UNO.

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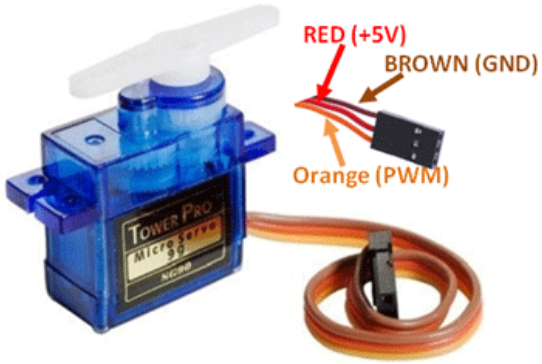

Figure 6: Servo Motor SG90

Servo motor checks the pulse in every 20 ms. The pulse of 1 ms width can rotate the servo to 0° , 1.5ms can rotate to 90° (This is the neutral position) and 2 ms pulse can rotate it to 180° . Here also, the working voltage is 5V (Volts) and its operating speed is 0.1s/60°.

Buzzer

A buzzer is used here as a signaling device, which are generally used in alarm devices and timers. The rated voltage of the buzzer used is 6V while the operating voltage is 4-8V DC for a rated current of less than 30mA

Figure 7: Buzzer

An Arduino generates an oscillating signal as required by the passive buzzer. The signal is emitted at one of the digital pins. But, the arduino can only provide up to about 40mA of current on each of its pins so, to limit the current a resistor is used so that the microcontroller is not overloaded.

If a high value resistor is used, it will reduce the current but will also reduce the volume of the sound. Value of the resistor is set according to the required volume, device and specific buzzer. Even a potentiometer can be used to control its volume.

3S-12V, 10A -18650 Lithium Battery Overcharge and Over-Current Protection Board

It is a protection module for 3-series-cell lithium-ion rechargeable batteries and includes a very high-accuracy voltage detector and a delay circuit. It automatically cancels protection after fault conditions are removed. It has protection function of overcharge, over-discharge, short circuit and over-current protection. It is suitable for lithium battery pack of 11.1V, 12V & 12.6V

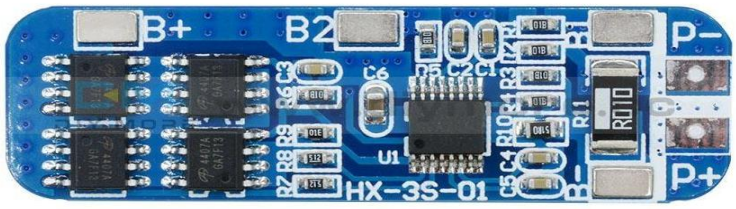

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Figure 8: Lithium Battery Overcharge and Overcurrent Protection Board

The charging voltage of this board is 12.6 V ~ 13V and the maximum operating current is of 6-8A

Rocker Switch

The Single Pole Single through is an on or off switch. It is used to connect or break the connection between two terminals of the switch. These are used to switch the power supply of the circuit.

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Figure 9: Rocker Switch

Also known as toggle switch, this switch has two contacts one is input and other one is output. These switches have different ratings for different kinds of loads, like Inductive load, lamp load, and motor load has the current ratings of 3.5A, 1.8A and 2A respectively.

III. MODELING AND ANALYSIS

The proposed system works basically using an ultrasonic sensor controlled using an arduino. The ultrasonic sensor measures the distance of the obstacles which are present in front of the sensors, the microcontroller (Arduino) sends a trigger signal to the ultrasonic sensor so that it generates ultrasonic sound waves and when the obstacle reflects it, the echo is received by the sensor.

The microcontroller calculates the time signal into distance using the following formula:

$$Distance\ (cm) = \frac{echo\ pulse\ width\ (uS)}{58}$$

$$Distance\ (inch) = \frac{echo\ pulse\ width\ (uS)}{148}$$

Since the calculated distance is the total distance travelled from the ultrasonic emitter to the object—and back to a receiver—it is a two-way trip. The actual distance can be determined by dividing this total distance by 2. Ultrasonic waves travel at the speed of 343 m/s at room temperature of 20^0 C. The distance between the object and the sensor is half of the total distance travelled by the ultrasonic wave. The following equation is used to calculate the distance of an object placed in front of the sensor:

$$distance = \frac{time\ taken\ x\ speed\ of\ sound}{2}$$

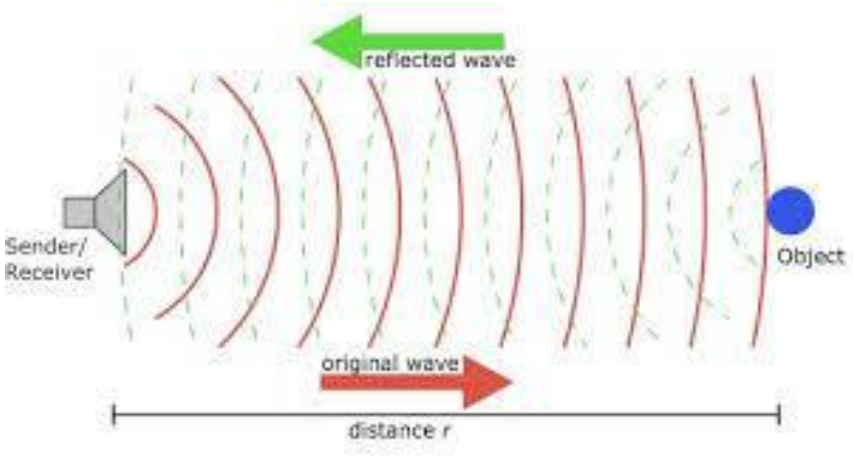

Figure 10: Distance travelled by ultrasonic wave

Since it is required that the ultrasonic sensor covers the complete surrounding, it has to be placed on the top of a servo motor. Servo motor works simultaneously with the ultrasonic sensors. This servo motor expects to

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receive a pulse signal from the microcontroller every 20ms (milliseconds) and the length of the pulse decides to what degree motor will turn.

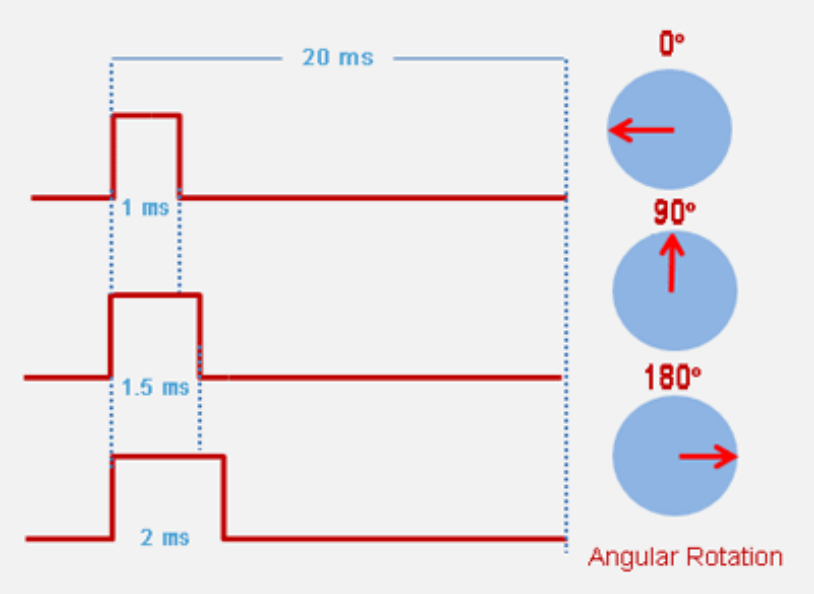

Figure 11: Electric pulse width for rotation of servo

Whenever the ultrasonic sensor detects an obstacle, a signal to the buzzer is sent by the microcontroller. As already described under the buzzer section, this buzzer uses a resistor to limit the current through it. A typical 16Ω buzzer can be driven directly from an IO pin by using a 100Ω to 200Ω series resistor. This will give an average current of about 10-20mA which is less than the current rating of the digital pin of the microcontroller.

The Arduino is powered using a lithium battery overcharge and over current protection board. This board comes with a USB port and makes the design rechargeable. It comes with 3 Li-ion rechargeable batteries of 3.7V each and are connected to the board in the configuration given below-

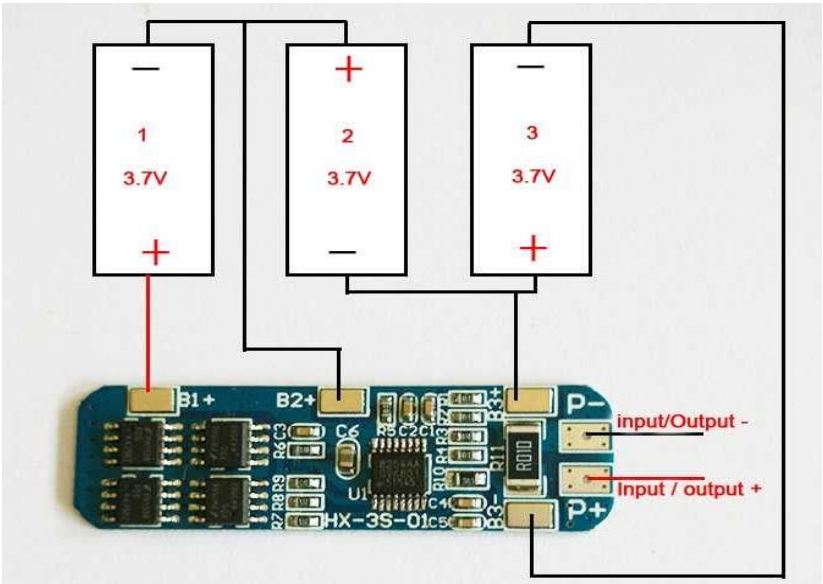

Figure 12: Cell configuration connected with board

The load is connected to the P+ and P- terminals. In this case the load is the Arduino uno (Microcontroller) board. Also, across these two terminals we will connect a charging USB port to charge those lithium batteries. The supply from the overcharge and overcurrent protection board to the Arduino board is controlled using an SPST rocker switch.

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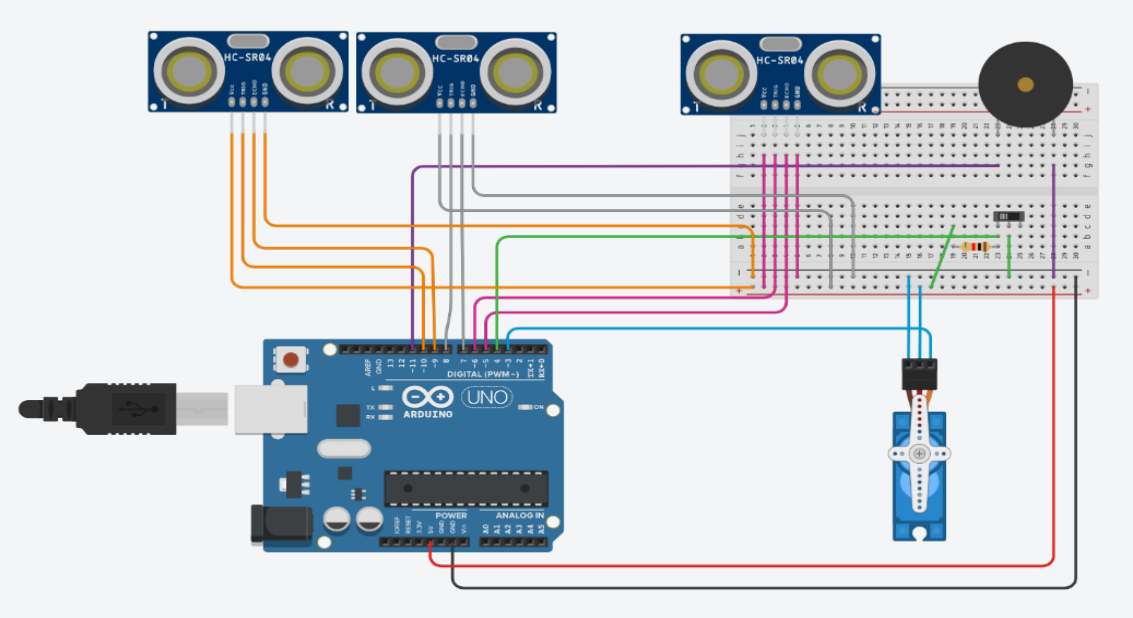

Figure 13: Simulation of main circuit

On simulating the circuit, it worked as designed. Ultrasonic sensor 1 and 2 are going to be fitted on the top of the cap. When these sensors detect a human obstacle within a range of 2-100 cm, the buzzer gives an alert signal. These two sensors are placed further on the top of the servo motor which rotates for 180 degree such that both the sensors on the top of it covers the surrounding 360 degrees. Ultrasonic sensor 3 is placed on the brim of the cap facing downwards so that it can detect a hand when it gets nearer, in the range of 0-15 cm, the buzzer gives an alert.

A button is controlled using the microcontroller such that when its' state is 0, both the top and front sensors will work. When the state of this button changes to 1, then only the front sensor works.

IV. RESULTS AND DISCUSSION

After simulation of the main circuit, the complete circuit is then connected according to the circuit diagram given.

As mentioned above, we add a charging circuit to give a DC power source to the Arduino UNO in the final design.

Now this circuit is placed on the cap after being assembled, Steps involved are-

- A rectangular cardboard piece is pasted on the servo motor place blades so that 2 ultrasonic sensors can be placed facing outwards on it.
- This servo motor is then placed on the top button of the cap using a glue gun
- The Arduino board is stitched to the back side of the cap
- The charging protection board with rechargeable cells is pasted on the right side of the cap while the mode changing switch is on the left side of the cap
- On the front brim of the cap, the third ultrasonic sensor with the face protection feature is supported with another rectangular piece of cardboard.

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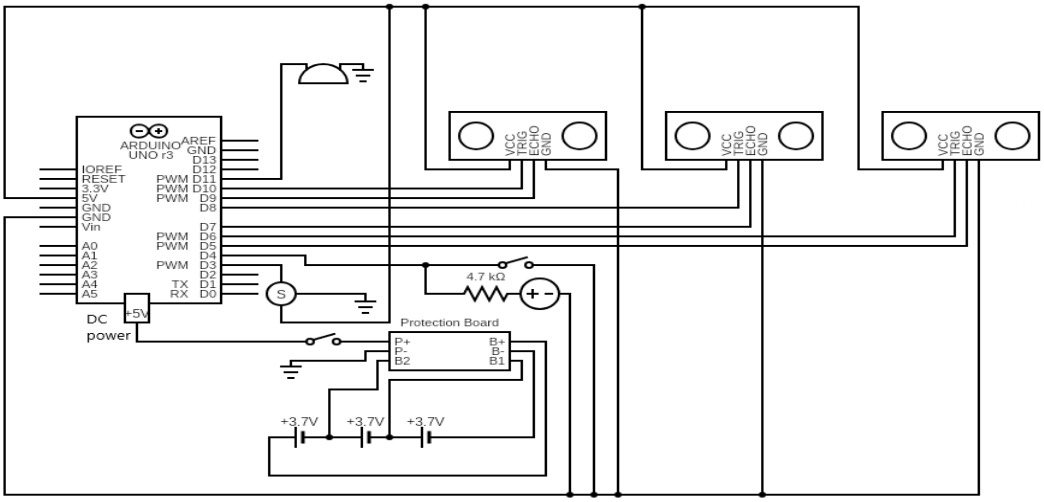

Figure 14: Complete circuit diagram

V. CONCLUSION

We realized that it is very essential to make something which is important to keep people away from each other as well as from this deadly disease. Now as a result of this project, we will be able to keep a safe distance from people in the crowded places, in the offices/ classes and any public places. The Arduino controls the range of the Ultrasonic sensor which is 50-150cm in outdoor mode and 0-20cm in indoor mode. The Ultrasonic sensor detects anything which comes between the range. This Social Distancing Cap activates the buzzer to alarm the person wearing the cap that someone is near so that we maintain social distancing. This is a practical design which can be made better with modifications. Addition of thermal sensor can add to this systems application by detecting the temperature of the person wearing it and alerting the person when it increases above 99 ˚C. Also, to measure the temperature of people around the person wearing social distancing cap, Infrared temperature sensors can be used, which calculate the temperature of a body from a distance by detecting that person infrared energy. Thermal sensors for detecting only humans are widely used in house automation systems. They can be used in this cap for more precision in detecting human presence whether stationary or in motion. Adding features to the cap can increase its weight but, future is all about miniaturizing objects. This social distancing is helpful not only in the time of a pandemic but in general, it will help to maintain a hygienic environment. When we are watching everyone getting sick and dying, we should keep all the precautions possible, this is just one of those attempts to make social distancing simpler.

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