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THE ROLE OF INTERNET OF THINGS (IoT) TO FIGHT AGAINST COVID-19

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***Abstract*—The Internet of Things (IoT) has become a new topic of research in various scientific and corporate fields, particularly in healthcare, in recent decades. The IoT revolution transforms new healthcare services by the inclusion of scientific, political and environmental prospects. It progresses from traditional to specialized healthcare systems, making it easier to identify, treat and manage patients. COVID – 19 has developed into a pandemic that spread around the globe. Day and night, scientists and engineers are working to produce a vaccine, develop additional research equipment and improve surveillance. Using contactless equipment is one of the critical factors to reduce the spread. To prevent the transmission of the coronavirus IoT can be used. That is an interconnection between the Internet and electronic devices. Devices are sensuous and recordable as well as can watch and respond. In this article, we discussed Covid-19 literature, monitoring techniques and proposed an IoT model to help mitigate the transmission of Covid-19.**

Keywords—Internet of Things (IoT), COVID -19, Healthcare, Monitoring

I. INTRODUCTION

IoT is an advanced technology that can combine all intelligent objects without any human intervention within a network. More quickly, any device connecting to the Internet can be an IoT device for further tracking or data transmission[1][2]. IoT has gained rigorous experimental field as a current research subject in a wide range of educational and industry disciplines, primarily in healthcare. The Internet of Things revolution reconstructs modern medical systems by integrating technical, economic, and social opportunities. This system is better than traditional healthcare systems and is beneficial for patients treatment, monitoring, and diagnosis. In the healthcare system, IoT is rapidly has become powerful technology in which lower costs, improved service quality and improved user experience can be achieved[3]. Due to its wide-ranging capacity for monitoring, identification and authentication, and data analysis, IoT growth in universal health care is predicted to boost from 70 billion USD in 2020 to 189 billion USD in 2025[4].

The worldwide problems faced by coronavirus is the world's biggest emergency for human health. This problem has a significant impact on human health. As of March 2021, 31 million individuals with an estimated death toll of about 960,000 were affected by COVID-19 cases, according to the World Health Organization (WHO) last report. Symptoms typically such as flu are important for early diagnoses, like sore throat, cough, and fever. COVID-19 formation takes approximately 1 and 14 days. Unexpectedly, a corona disease transmitting to others might be a patient without any symptoms.

It is possible for all individuals to be quarantined. This illness's recovery time often differs and depends on the age of the patient, health complications, etc., but it might take about 6 to 41 days on average [4]. Although this infection can quickly be transmitted compared to similar diseases in the coronavirus community, many attempts are continuous and a lot of research is being done to reduce its propagation. IoT technology has shown in this situation that it is a simple, safe and effective way of dealing with the disease outbreak COVID-19.

The purpose of this analysis is to evaluate in four phases, including early diagnosis, monitoring, quarantine and after recovery and finally, proposed IoT based model for COVID - 19 monitoring, controlling and IoT-based solution. Early detection of disease may lead to less transmission of viruses, leading to improved health care for virus-infected patients[5].

The number of infections with COVID-19 can also be reduced by quarantining or suspected cases and imposing locks. In addition, the tracking of returning symptoms and the potential infectivity of these recovered cases will help track COVID-19 patients after recovery.

The main contributions of this paper can be summarized as;

- A brief overview of IoT and AI technology are explained.
- This article proposes a patient's Room Door model that will be opened or closed with a specific sound pattern with an IR sensor attached with the Arduino UNO board.
- Possible future directions and research challenges are discussed

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The rest of the paper is organized as follows. Section 2 provides a detailed literature review. Section 3 presents the role of AI and IoT in the perspective of COVID-19. The proposed IoT model is presented in section 4, along with its components and features. Finally, section 5 concludes the work.

II. LITRATURE REVIEW

The use of the Internet of Things (IoT) to supply health services has received a lot of attention in the literature.

Usak et al. carried out a systematic review of the application of IoT in health care systems. A discussion of the main problems of using IoT to deliver health care was also included in that article and classification of the examined work in the literature[6]. A hybrid IoT safety and health monitoring system was proposed by Wu et al. The goal was to make outdoor safety a priority. The system is divided into two layers: one collects user information and the other aggregates that information over the Internet. Wearable devices were employed to capture environmental safety indications and the user's health symptoms [7]. Hamidi investigated the authentication of IoT smart health data to secure the privacy and security of patient data. A biometric-based authentication technology was proposed in the paper [8]. Inspired by the literature, Rath and Pattanayak designed a smart healthcare institution in urban areas employing IoT devices. In the VANET zone, issues such as patient safety, security, and prompt treatment were explored. Simulators such as NS2 and NetSim [9] were used to evaluate the proposed system. Based on the relevant research, Darwish et al. suggested a CloudIoT-Health paradigm, which blends cloud computing with IoT in the health domain. The paper discussed integration problems as well as new CloudIoT-Health trends. Technology, communication and networking, and intelligence are the three levels of these difficulties [10]. Zhong and Li investigated how college students were monitored throughout their physical activities. The study focused on a PARM (Physical Activity Recognition and Monitoring) model that requires data pre-processing. Several classifiers were tried and discussed, including decision trees, neural networks, and SVM [11]. Din and Paul presented a smart health monitoring and management architecture based on the Internet of Things. There are three layers to the architecture: (1) data generation and processing from battery-operated medical sensors, (2) Hadoop processing, and (3) application layers. Because the sensors' batteries had a limited capacity, the researchers used an energy-harvesting strategy including piezoelectric devices linked to the human body [12]. Otoom et al. created a prototype for real-time blood sugar regulation based on the Internet of Things. The optimum insulin dose was determined using ARIMA and Markov-based statistical models [21]. From Bluetooth Low Energy, Ma et al.[13] have provided state-of-the-art technology for wearable sensor-based healthcare systems (BLE). Low-energy sensor technologies, such as BLE devices, they claim, allow wearable healthcare solutions to be employed without regard to location due to their portability. BLE is also the first wireless communication technology for wearable healthcare devices that fulfils interoperability, electronic compatibility, secure data transmission, low-power operation, direct communication with cellular, and internet infrastructure, according to Mukherjee et al. [14]. Adhikary et al.[15] suggested a low-power transmission system that uses BLE as a protocol for data communication between sensors in the wristband and the smartphone to monitor heart activity via electrocardiogram (ECG) signals. They created a system that could detect an ECG signal from the arm with great accuracy, with a health-rate calculation error rate of less than 10% compared to a typical system. Through BLE connection, an android application was created to display sensor data in real-time. Winter et al. [16]presented a study that used biosensors implanted in a wearable device to detect early sickness warning systems that track elders' activity patterns. They discovered that no large-scale wireless Photo Plethysmo Gram (PPG)-based Heart Rate(HR) monitoring system had been deployed for long-term real-world application in their research. Ferrero [17] offered a healthcare service that uses devices to inspect and monitor the patient's heart state to prevent heart disease. The system was developed in multiple phases, the first of which is data acquisition utilizing non-invasive wireless sensors, the second of which is a sensor gateway that stores data on the server, and the third of which is a warning system in the event of abnormal conditions in a patient. Third, cloud computing will be utilized to store and monitor patient data and provide web services for healthcare applications. Finally, applications for smartphones or tablets will be utilized to display data on the patient's health state. The data generated by the developed threshold value determination technique proved to be accurate and adequate. Y. Mittal et al. [18] developed a voice-controlled smart home that could be simply and inexpensively deployed using an IoT connection. It also required very little training and maintenance. They indicated that wireless technologies could be employed to improve performance even more. On the other hand, their method suffers from authentication lockout and distance issues; the closer the user is to the sound device, the better the system is. Furthermore, the proposed mobile application system can address the issue of distance, which demands users to be within a specified distance of the microphone. A. Ismail et al. [19] devised a technique that was a hybrid of SVM and other algorithms that are hard and time-consuming to implement. They suggested a system that does not require a large amount of corpus training to train the speech recognition process and instead requires a predetermined dictionary that comprises the basic voice commands and their templates, unlike the other techniques. The system can automatically match template commands with user commands using a supervised machine learning method based on a predetermined vocabulary with the controlling speech commands. A smart home data set, SVM alone, and the hybrid system were all used to test the suggested model. In addition to applying the hybrid model for voice recognition, the suggested SVM-DTW provides a straightforward and easy technique to integrate SVM and DTW and matches DTW templates for a speaker verification system. The suggested SVM-DTW for managing and accessing smart home equipment has various advantages. Dong et al. [20] proposed a medical system for monitoring people's health. They collected data such as HR during daily life in order to recommend a healthier lifestyle. Hunkin et al. [21] presented a wearable device for mental health

difficulties that uses a wireless connection and various sensors for human bodily measurements to provide users with real-time alerts and advice via cellphones. A. Heryana [22] offered a healthcare service that uses wearable gadgets to detect cardiac disease. They created a system that is divided into phases, starting with non-invasive wireless sensors and moving on to a sensor gateway that stores data and is equipped with an alerting system solely for abnormal circumstances in patients. The third phase involves leveraging cloud computing to manage patient data storage so that they can utilize the service to monitor their heart health. The fourth step is a tablet and smartphone application for tracking health conditions and measures.

III. Role of AI and IoT in helping out COVID-19 patient during the self-quarantine phase

We are facing the pandemic of COVID-19 since 2020. We are still fighting against it. While vaccination has arrived, it will still take time for the population to be vaccinated. Bharat Biotech has developed COVAXINTM, India's indigenous COVID-19 vaccine, in partnership with the Indian Council of Medical Research (ICMR) - National Institute of Virology (NIV)[23]. Corona Virus is spreading out from one people to another. So, it is advised to be in self-quarantine for the COVID patient. Being in quarantine is not an easy task. Everything has to be made available to corona patients without directly coming into contact. Remote monitoring has to be also done.

When they are in the quarantine phase for at least 2 weeks, they have to be in strict monitoring without direct contact. So here comes the role of AI and IoT. These techniques have the speciality of performing the task without human intervention. So we can make use of various IoT and AI-enabled devices that can do our work without human intervention[24].

Following are some examples that are working out these days:-

3.1 IoT

In this pandemic, IoT devices are acting as a boon in fighting against Corona Virus by providing Contact-less equipment and system for the treatment of infected patients. It also helps in the reduction of spreading the virus through contacts. These devices help set up a new-normal working environment by adding such contact-free devices for attendance, sanitization, body-temperature monitoring, etc. These are now widely get adopted in offices, warehouses, hospitals etc. In addition, facial recognition-based products such as the delivery of touch-free pills and touch-free heartbeat assessment are advantageous features for hospitals.

2.1.1 Locating the Corona Virus-infected entities

As per the study conducted by the Massachusetts Institute of Technology (MIT), it can help epidemiologists identify people who have come across infected patients by superimposing geographic information systems (GIS) on mobile IoT results. The technology can track patients having high risk possibility of being infected and provide the health care staff with valuable data.

2.1.2 Connected Thermometers

Linked thermometers are used in hospitals to monitor the body's temperature and record any differences in real-time. These systems accept and relay real-time data from patient using the sensors to a nurse's station for continual monitoring with the aid of an IoT Access Controller.

The data collected from more than a million linked thermometers were used to produce daily maps showing that high fevers are rising in US counties. In addition, a team of product experts have developed a contactless fever detection device in India that uses AI-based thermal imaging to remotely read the skin temperature of any person moving through the camera range.

2.1.3 Smart Wearable

Researchers at the IIT-IstitutoItaliano di Tecnologia have developed sensorized suits to track various physical records of the human body and notify patients when their body temperature rises by more than 37.5 degrees [25]. In addition, bracelets and rings synchronized with Artificial Intelligence techniques are being used in China to continuously monitor vital human body parameters, including temperature, heart rate, and blood oxygen levels.

2.1.4 IoT Buttons

A new invention in IoT is IoT Button that is used at many hospitals in Canada. It is used to deploy any facility rapidly and send warning messages to management for any type of cleaning or maintenance problem.

3.2 Artificial Intelligence

Nowadays, AI is the possible field for seeking solutions in the fight against pandemic in medical advances. It is being used for data dashboards, timely notifications, social control, and medical diagnosis & therapy in the current domain.

3.2.1 Patients Monitoring and Hospital Visitors using AI

Due to the pandemic, many hospitals worldwide are implementing AI and IoT blended devices to monitor the patient and decrease the spread of the virus through contacts by providing contact-free techniques and devices. To determine the fever conditions of a visitor, Camera-embedded facial scanners screen hospital visitors and analyze facial attributes and do the thermal scanning of visitors. These solutions are frequently used these days to provide treatment at an unparalleled pace for thousands of infected patients. Chinese technologists recently developed a no-contact infrared sensor system to locate people with fever, even in crowds[26].

3.2.2 Remote monitoring

Remote surveillance is another important type of AI technology that medical amenities bring about to protect the staff and monitor patients extensively, even from remote

locations and hospital dormitories. For example, a sensor technology that is once positioned under the patient's mattress can examine the heart rate, respiratory rate, and body movement of the patient under observation in the treatment of patients with high priority COVID.

3.2.3 COVID voice detector

Technology researchers are deploying AI resources to distinguish infected people by analyzing the sound of their cough, how they breathe and the way they talk for determining if that person is having COVID-19 diseases or not.

These activities are still in the early stages, with researchers collecting data such as recording the speech and coughing of people to decide which one is infected. Then, it determines and predicts the outcome when these data are feed into AI algorithm (machine learning and deep learning programming algorithm).

3.2.4 India battles COVID-19 with AI

As India started fighting against COVID-19, many AI and technology start-ups have come forward to help in this fight. For example, a robotics start-up in India has proposed its robots for screening and diagnosing the people that collect vital information such as the patient's name, their symptoms are shown, and validation without contact such as temperature controls. The diagnostic robot, which interacts with a doctor in a remote location through video chat, will concentrate on people who have a high body temperature or show signs of the virus[27][28]. We are in a situation when COVID-19 viruses are affecting our life and lifestyle as well, AI and IoT can find out devices to trace and track the COVID-19 hostiles.

These technologies have resulted in a delicate balancing act between the need to combat the virus and the competing need to protect people's privacy. Thus, while it is critical to make efforts to combat the pandemic, it is also crucial to keep the use of such resources to a minimum, both in terms of purpose and time, and to uphold individual rights to privacy, non-discrimination, the security of journalistic sources, and other freedoms[28].

IV. EXISTING SYSTEM

We are very much novice to this quarantine system. There is an excellent chance of new techniques to be developed in this field by the researchers. In the existing system, people cannot be fully isolated from the outside world during quarantine. They are not able to be in no contact. The people, who would help them, also have to keep safe themselves. Whenever someone comes to help the quarantined person by bringing some food items, food, vegetables, medicine, or help due to some emergency, they will have to enter the house. Especially, door and window knobs of the patient's room get most contaminated. This can contaminate the visitor also.

4.1 Proposed Model

In the proposed model, we have designed a patient's Room Door that will be opened or closed with a specific sound pattern. This will be a Touch-Free Gate. If we can open or close the gate without touching them, we can keep other visitors safer because there is more chance of a virus present at the gate knob while entering or exiting the room. Ultrasonic Sensor gates are also available in the market now, but that sensor is opened for anyone who wants to enter the room. This sound pattern sensor gate will be opened only for those authorized people who knows the sound pattern for unlocking the patient's room.

4.2 Working Principle of the proposed model

During COVID-19 disease suffering, it is advisable to stay away from the patient. The patient should live in complete isolation. But sometimes, it is required to go to the patient for medicine or food supply. So it is necessary to make more things contact-less and security enabled so that unwanted person do not come in contact.

So this sound pattern sensor-enabled gate will be opened only for those who are very important to meet to patient. This gate is opened when a specific sound will be generated near the door, such as a five times clap and one whistle.

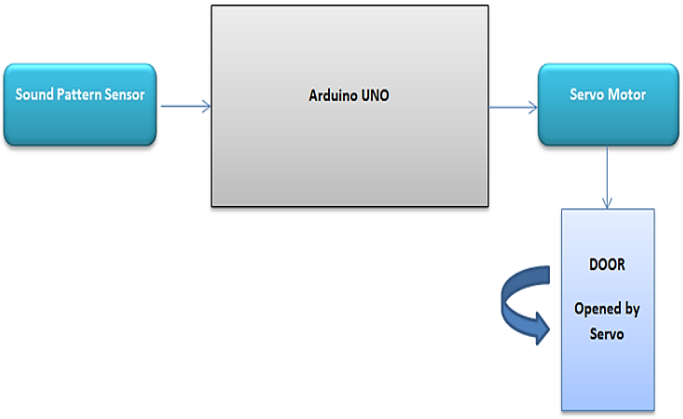

Fig. 1: Block Diagram Showing the basic hardware connectivity of the model

Figure 1 is showing the block diagram of our proposed model. This diagram is showing the connectivity of various components of the model. The sound pattern sensor is connected to the input pin and the servo motor is connected at the output pin. The sound sensor will take the sound pattern as input and will send an input signal to Arduino UNO. Then Arduino will send the signal to the output pin, which is connected to the Servo motor. As a response, the Servo motor will be rotated and it will open/close the gate.

4.3 Algorithm for Model

1. Whenever a sound pattern is generated near the Sound sensor, it will detect the sound pattern and send the input signal to Arduino.

2. **If** (the sound pattern matches the security Sound pattern)

   Then Arduino will send a signal to the output pin and Servo Motor will be rotated to open/close the door automatically.

Else

The door will not be opened / closed.

3. End.

4.4 System Architecture

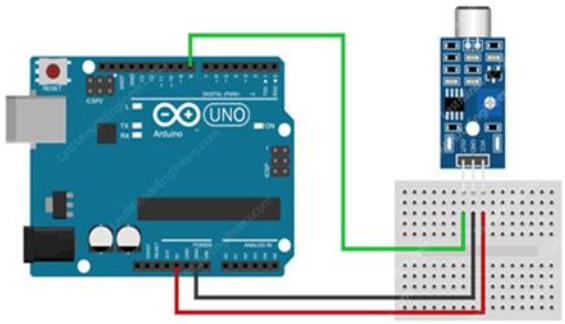

Fig. 2: Showing Connectivity between the sound sensor and Arduino UNO.

Figure 2 is showing connectivity between the sound pattern sensor and Arduino UNO. We can use a sound sensor in our proposed system, a small board combining a microphone (50Hz-10kHz) with some processing circuitry for converting Sound-Waves into electrical signals.

This electrical signal is embedded to onboard LM393, High Precision Comparator, to digitize it and is available at OUTPUT pin [3]. Figure 3 is showing a typical sound pattern sensor.

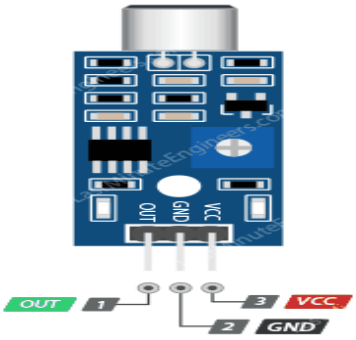

Fig. 3: Sound pattern sensor

IV. System Coding

This proposed system needs a code using Arduino Software that can be uploaded to Arduino UNO Board and then code is executed for the proper functioning of the proposed model.

sketch_jun19a | Arduino IDE 2.0.0-beta.5

File Edit Sketch Tools Help

Arduino Uno

sketch_jun19a.ino

```
#include<EEPROM.h>
#include<Servo.h>

#define patternLenth 5
#define patternInputTime 10000
#define sensitivity 80
#define margin 100
#define sw 7
#define servoPin 3
#define openGate 0
#define closeGate 180
long slot[patternLenth+1];
int pattern[patternLenth];
int flag=0;
int acceptFlag=0;
int knok;

Servo myServo;

void setup()
{
  pinMode(sw, INPUT_PULLUP);
  myServo.attach(servoPin);
  myServo.write(180);
  Serial.begin(9600);
}

void loop()
{
  int i=0;
  if(digitalRead(sw) == LOW)
  {
    Serial.println("Start");
    delay(1000);
    long stt= millis();
    while(millis()<(stt+patternInputTime))
    {
      int temp=analogRead(A0);
      if(temp>sensitivity && flag==0 && i<=patternLenth)
      {
        delay(10);
        flag=1;
        slot[i++]=millis()-stt;
        //Serial.println(slot[i-1] - stt);
        if(i>patternLenth)
        break;
      }

      else if(temp == 0)
      flag=0;
    }

    long stp=millis();
    Serial.println("Stop");
   // Serial.println(stp-stt);
    for(int i=0;i<patternLenth;i++)
    {
      knok=1;
      if(slot[i+1]-slot[i] <500 )
        pattern[i]=0;
      else
```

```
        pattern[i]=1;
        Serial.println(pattern[i]);
      }

      if(digitalRead(sw) == 0)
      {
        for(int i=0;i<patternLenth;i++)
          EEPROM.write(i,pattern[i]);
        while(digitalRead(sw) == 0);
      }

      else
      {
        if(knok == 1)
        {
          for(int i=0;i<patternLenth;i++)
          {
            if(pattern[i] == EEPROM.read(i))
            {
              Serial.println(acceptFlag++);
            }

            else
            {
              Serial.println("Break");
              break;
            }
          }
        }

        Serial.println(acceptFlag);
        if(acceptFlag >=  patternLenth-1)
        {
          Serial.println(" Accepted");
          myServo.write(openGate);
          delay(5000);
          myServo.write(closeGate);
        }
        else
          Serial.println("Rejected");
      }

      for(int i=0;i<patternLenth;i++)
      {
        pattern[i]=0;
        slot[i]=0;
      }
      slot[i]=0;
      acceptFlag=0;
    }
```

Fig 4: Code for Proposed Model

Fig 4 is showing the coding for applying this contactless door lock and unlock pattern. This is the need of today's society. During this Covidien Era, contactless equipment usage has been highly increased. So this is beneficial for health and security too.

V. Facts and Figures

Various surveys show that the use of contactless gadgets and devices has been increased worldwide. People have started to give priority to touch-free devices in their day to day lives. So this need has increased the use and innovations of contact-less things. When the term contact-less is used, then we cannot escape from IoT. Fig 5 below shows the survey data of various countries showing the increase in the use of devices for contactless e-commerce.

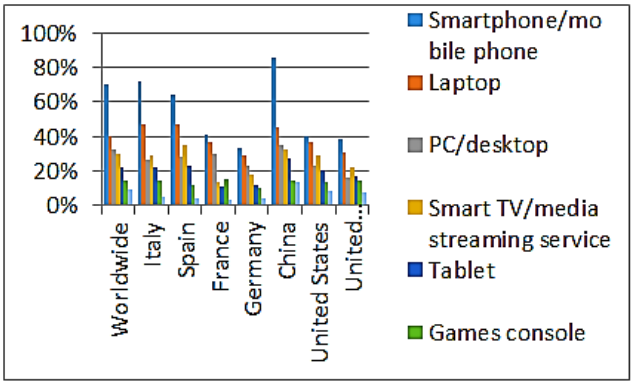

Fig 5: Worldwide increase in use of devices for contactless means

Another survey shows that the contactless payment has been increased and the e-commerce facility has been boosted during this pandemic.

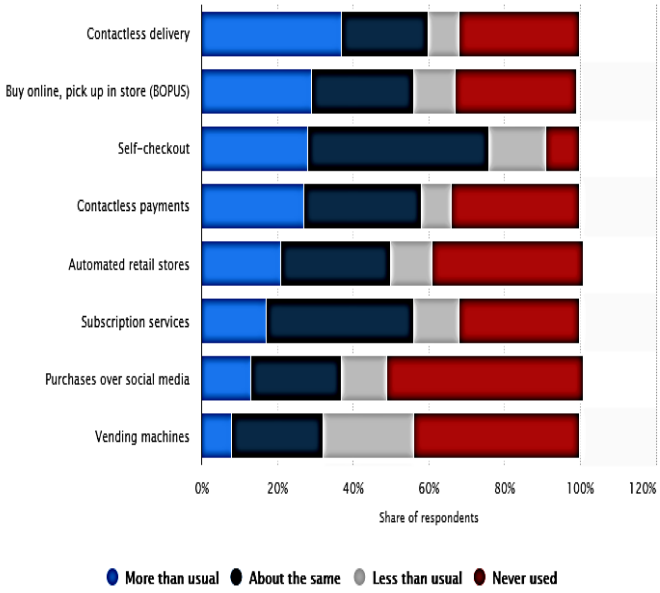

Fig 6: In US, shopping method has been changed during the pandemic

In Fig 6, it is clear that the shopping manner used traditionally has been affected due to this epidemic. Everyone is moving toward contactless approaches. Thus, in this paper, the focus has been given to use contactless doors for protection from COVID-19 spread.

VI. Discussion

In this proposed model, we have tried to minimize the risk of direct contact of the door gate knob as the proposed model system opens the door with a specific sound pattern.

So, there is no need of touching the door while opening or closing. As the COVID-19 pandemic has infected many worldwide, every country is trying to find such systems with less contact/no-contact mechanism applied for various works. Most of the new research in this field is in the primary implementation phases as the COVID-19 pandemic is new to this world.

This proposed model aims to give an idea about minimizing the risk of contact at doors that are frequently accessed so that the infection spread of this disease through surface contact of door knob can be minimized.

In future, various sensors can be added to the gate for adding more security constraints to this proposed model. Therefore, this model is completely scalable.

V. Conclusion

The COVID-19 pandemic has had a wide-ranging effect, including healthcare, banking, politics, economics, and education. In the management of the post-COVID-19 environment, IoT will play a significant role. IoT's core functions will enable proper execution of various applications, such as communication control, emergency recovery, patient knowledge exchange, electrical governance, supply chain management, online learning, citizenship maintenance. IoT can provide patient-centred resources such as personalized therapy, monitoring, diagnosis, and real-time patient/health surveillance anywhere, at any time, with the assistance of AI-based medical facilities and healthcare experts. The use of IoT with smart sensors will help alert the individual and maintain the social distance in the healthcare system. In the proposed model, a patient's Room Door will be opened or closed with a specific sound pattern. This will be a Touch-Free Gate. The proposed model will be helpful to protect an individual from COVID-19 and reduce the impact of community transmission.

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