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DEVELOPMENT OF AUTOMATED SANITIZING ROOM

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ABSTRACT

Internet of Things is a revolutionary domain that has the caliber to impact our lives and bring significant changes to the world. Several IoT applications have been envisioned to facilitate data driven and smart application for the user. Smart City and Intelligent Transportation System (ITS) offer a futuristic vision of smart, secure and safe experience to the end user, and at the same time efficiently manage the sparse resources and optimize the efficiency of city operations. However, outbreaks and pandemics like COVID-19 have revealed limitations of the existing deployments, therefore, architecture, applications and technology systems need to be developed for swift and timely enforcement of guidelines, rules and government orders to contain such future outbreaks. This work outlines novel architecture, potential use-cases and some future directions in developing such applications using Smart City and ITS.

KEY WORDS —Smart City, Intelligent Transportation System, COVID-19, Social Distancing, IoT, Artificial Intelligence, Digital Twin, Big Data, Cyber Security.

1. INTRODUCTION

The COVID-19 pandemic has engulfed the world with a large portion of the population infected. These staggering numbers highlight various opportunities in existing technologies and infrastructure to contain the spread of this highly contagious virus. The impact of Corona virus is both global and unpredictable. Also, the supply chain shock it is causing will most definitely and substantially cut into the worldwide manufacturing revenue of US $15 trillion currently forecasts for 2020 by global tech market advisory firm. The lack of an approved medicine to cure this disease presses the need for prevention and mitigation mechanisms to minimize the spread. Social distancing measures, including country wide lock-downs, travel prohibition, quarantining hotspots, and limiting customers at essential businesses, are slowly restricting the spread of the virus. It is paramount, in such critical situations, to implement swift mechanisms, and various agencies work in coordination to limit the spread of the disease.

It is expected that broad range of situational intelligence and automated targeted response is needed throughout the community to ensure the safety of people and assets, with an aim to lower the fatalities and minimize impact on the economy.

However, even in the cities where strict social distancing guidelines were issued to limited movement, it has been noticed the technology can play a role in enforcing such restrictions. In the United States, New York, San Francisco, New Orleans, and Philadelphia ranked as the most vulnerable specifically in terms of health risks. These large cities are vulnerable due to high population density and higher use of public transportation, according to the report. Also, about 61% percent of New York City residents commute using public transportation.

This initiative includes research, projects and data sharing in areas such as infrastructure and technology, smart energy and water, and Intelligent Transportation System (ITS). Another prime example is Smart America, a White House Presidential Innovation Fellow project with the goal to research smart city related topics such as ITS, Smart Manufacturing, Healthcare, Smart Energy, and Disaster Response. Although many cities are taking the initiative of turning into smart cities, there are many challenges that need to be addressed. To be effectively prepared for future outbreaks and enforce protocols, it is expected that smart cities and ITS technology will host a range of data driven services together with deployed sensors to not only help in enforcing community wide social distancing measure but also assist in early detection of such outbreaks. This article focuses on proposing a novel architecture along with several use-cases which can be developed to create a smart city and ITS inspired data driven system which can help to enable and enforce community distancing measures during pandemics and high impact low frequency (HILF) events.

2. METHODOLOGY

The presented research work discusses a smart epidemic tunnel that can assist an individual in immediate disinfection from COVID-19 infections. The authors have presented a sensor-fusion-based automatic sanitizer tunnel that detects a human using an ultrasonic sensor from the height of 1.5 feet and disinfects him/her using the spread of a sanitizer spray. The presented smart tunnel operates using a solar cell during the day time and switched to a solar power-bank power mode during night timings using a light-dependent register sensing unit.

In the wake of the coronavirus outbreak, a sensor-based disinfectant tunnel has been designed and developed for the benefit of Symbiosis students, faculty and staff. It has been installed at the entrance of the Symbiosis Institute of Technology (academic buildings) to disinfecting the person passing through the academic buildings. It sprays a disinfectant that has the capability to kills 99.999% of viruses, bacteria, fungi, molds and spores within 10 s. This smart tunnel prevents further spread outspread of Covid19/SARS Cov-2. The area inside the tunnel is 3.28 m2 (2 1.64 m) with a height of 2.5 m so that an individual can easily stand and rotate his body for disinfection. Pipelines fitted with V6 brass nozzles are installed inside the 1 cm dia PVC pipeline. A 0.25 HP pump and pressure control valve (manual) have been used to spray disinfectant solutions from the tank having a capacity of 50 liters. An audio-based proximity sensor with a buzzer and a relay circuit has been fixed to monitor the disinfection process automatically.

3. BLOCK DIAGRAM

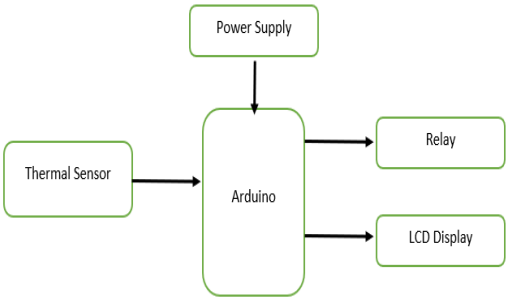


Fig 3.1 System Design

A smart epidemic tunnel is a customized solution designed to fight against the current pandemic situation and to disinfect individuals using an automatic sanitization spray. The presented system can be placed outside public places such as a hospital (especially in ICU for the safety of medical staff), vegetable markets, bus stop, airport, housing societies, railway station, industries, shopping mall, educational institute, post-office, bank, hotels and many more.

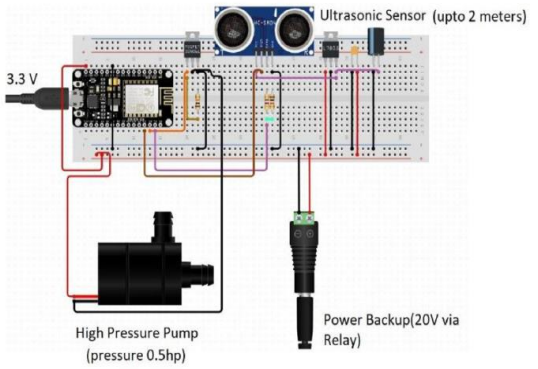
4. DESIGN AND EXPERIMENTAL SETUP

A smart epidemic tunnel is a customized solution designed to fight against the currentpandemic situation and to disinfect individuals using an automatic sanitization spray.The presented system can be placed outside public places such as a hospital (especiallyin ICU for the safety of medical staff), vegetable markets, bus stop, airport, housingsocieties, railway station, industries, shopping mall,

educational institute, post-office,bank, hotels and many more.

The necessity of a smart epidemic tunnel

Recently, fellow researchers have made efforts in implementing a cost-effective pandemictunnel to disinfect humans from COVID-19-like infections. In this study, an IoT-based



sensor fusion assistive tunnel has been presented, which can disinfect an individual from thepossibility of coronavirus infections. The major contributions of the presented PWP system

are as follows:

- An IoT-based sensor fusion assistive framework has been proposed to do real-time

detection of individuals temperature.

- The presented smart tunnel can prevent or disinfect an outsider who is entering aparticular building or a premise from COVID-19 infection possibilities. Furthermore,it has also been observed that the presented sensor-fusion based mechanism candisinfect a person in a time of span of just 5 s.
- The presented smart epidemic tunnel can function using solar energy during theday and it functions using a solar power bank at night time.
- In the end, web and mobile interface has been designed to provide daily, weekly andmonthly reports of the counts of individuals, along with in-out timestamps andpower usage reports.

The investigation results validate the performance evaluation of the presented smartepidemic tunnel mechanism. The presented smart epidemic tunnel is embedded with anintelligent sanitizer sensing unit which stores the essential information in a cloud platformsuch as Google Firebase. Thus, the proposed systemfavours society by saving time and helpsin lowering the spread of coronavirus. It also provides daily, weekly and monthly reports ofthe counts of individuals, along with in-out timestamps and power usage reports.

5. LAYERED DESIGN OF SMART TUNNEL

It is an IoTbasedsensor-fusion assistive technology designed for the safety of Symbiosis students,staff, workers and visitors. The detailed circuit design of the presented IoT-based sensorfusionassistive technology for COVID-19 disinfection (smart epidemic tunnel). Thepresented layered design contains five layers:

(1) Sensing layer;

(2) Networking and communication layer;

(3) Cloud service layer;

(4) Data processing layer; and

(5) Application layer.

5.1 SENSING LAYER.

The sensing layer consists of a variety of sensing units such asultrasonic sensing unit, LDR sensing unit modules, NodeMCU microcontroller unit and a0.25 HP booster pump. Furthermore, this layer also contains a solar cell and a solar powerbank. The sensing layer is responsible for detecting individual entering the smart epidemictunnel and disinfect them using a sanitizer spray for 10 s. In addition to this, this layerconsists of a solar cell that provides a solar energy-based power backup to all the sensingunits and also operates a 0.25 HP booster pump in the day-time. At night time, the LDRsensing unit switches the smart epidemic tunnel in a solar power-bank based power mode.Again, in a day-time, the presented smart epidemic tunnel receives the required power fromthe solar cell.

5.2 NETWORKING AND COMMUNICATION LAYER.

The networking and communication layer

for establishing interfaces between a sensing layer, networking and communicationlayer, an MQTT broker architecture, Google Firebase and Web and mobile interfaces.The MQTT protocol assists smart epidemic tunnel in transmitting the count of humans

who have entered a tunnel through the day and night, along with their in-outtimestamps on a Google Firebase database.

5.3 CLOUD SERVICE LAYER.

The cloud service layer is responsible for storing the in and outtimestamp values of all the individuals who have entered the smart tunnel in the day andnight timings. Furthermore, it also stores the counts of the number of individuals who haveaccessed tunnel in a particular building or a premise. The cloud platform used in thepresented systemis an open-source Google Firebase database.

5.4 PROCESSING LAYER.

The processing layer is responsible for fetching data from aGoogle Firebase cloud computing platform via an MQTT broker architecture andprocesses the received in and out time stamps values and the number of individualswho have entered the smart epidemic tunnel during day and night. This layer alsogenerates a variety of daily, weekly and monthly reports which contain in and outtimestamps and the counts of individuals who have accessed the tunnel. The processeddata has been sent to the application layer for further analysis.

5.5 APPLICATION LAYER.

The application layer consists of a graphical user interface (GUI)-based web and mobile interface which provides daily, weekly and monthly updates of thenumber of individuals who have accessed the smart epidemic tunnel during the day or nighttimings. The application also provides various graphical representations that can beforwarded to the security control roomfor further analysis.

6. WORK FLOW

The presented smart tunnel starts functioning when anindividual enters the tunnel. Whenever an individual enters the presented smart epidemictunnel, it sprays a sanitizer solution (made up from a mist of sodium hypochlorite) todisinfect an individual who is entering a particular building or a premise from the outsideand might have been in contact with a COVID-19 suspect.

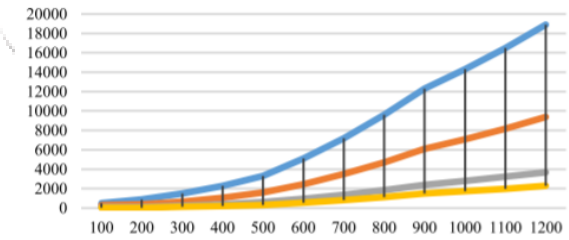
TIME IN	TIME OUT	SPRAY PER PERSON	UNIT IN AMPERE	POWER COMMAND
9.00am	5.00pm	100ml for 10 sec	0.022	2.2
9.00am	5.00pm	100 ml for 20 sec	0.04	4.4
9.00am	5.00pm.	100 ml for 30 sec	0.045	6.6

Table 3.1 Timestamp and power command report

The investigation results validate the performance evaluation of the presented smart epidemic tunnel mechanism. The presented smart epidemic tunnel is embedded with an intelligent sanitizer sensing unit which stores the essential information in a cloud platform such as Google Firebase.

Thus, the proposed system favours society by saving time and helps in lowering the spread of coronavirus. It also provides daily, weekly and monthly reports of the counts of individuals, along with in-out timestamps and power usage reports.

COST AND TIME ANALYSIS



6.1 FINDINGS

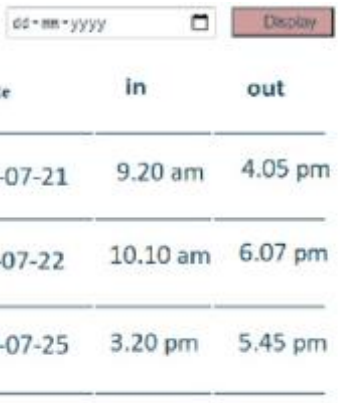
The major findings of this study are as follow:

_ The presented smart tunnel can prevent or disinfect an outsider who is entering a particular building or a premise from COVID-19 infection possibilities within 10 s.

_ The presented smart epidemic tunnel can function using solar energy during the day, and it functions using a solar power bank at the night time. This functionality has been provided by an LDR sensing unit placed in a tunnel.

_ Furthermore, the tunnel has been designed in such a way that it can also disinfect a disabled person sitting in a wheelchair or a person riding a bike.

_ In the end, Web and mobile interface has been designed to provide daily, weekly and monthly reports of the counts of individuals, along with in-out timestamps and power usage reports. In the future, an AI-based tunnel can be designed which can detect face-masks and provide auto-thermal scanning of the individuals to protect them from coronavirus like infections.

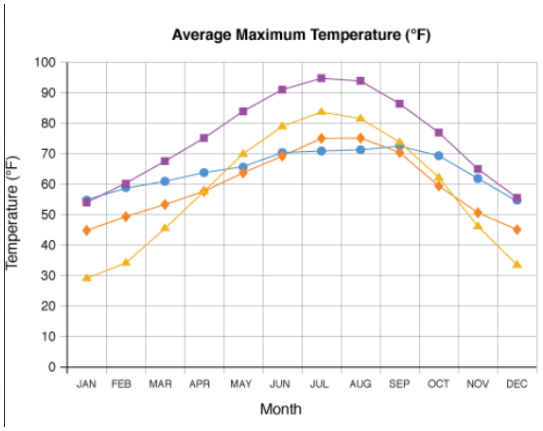


6.2 MOTOR SPECIFICATION

For motors spinning heavy objects, much more powerful motors must be used. The maximum current specification of a motor is the maximum amount of current that a motor can withstand passing through it without being damaged or destroyed. So, the maximum current is a power restraint that circuit designer must make sure is not exceeded. It is the 230v 1 hp motor. Right Angle gear motor is also called Worm Gear motor, 90°Gearbox motor, it is a DC motor with Right Angle Gearbox, the gearbox output direction is 90° (Right Angle) with DC motor input. This kind of gearbox is designed change the motor's output direction, to fit some special space requirements.

MOTOR SPECIFICATION

- RPM - 1500
- STARTING TORQUE – 25Nm
- MAXIMUM CURRENT- 220V-240V



7. CONCLUSION

In the undertaken study, an IoT-based sensor fusion assistive framework has been proposed to do real-time detection of individuals from a distance of 1.5 m. The presented smart epidemic tunnel starts functioning when a human id detected by an ultrasonic sensing unit equipped in a tunnel. After an individual is detected, the nozzles placed in a tunnel spray a sanitizer solution (made up from a mist of sodium hypochlorite) to disinfect an individual who has entered the tunnel. Sodium hypochlorite is a widely used component of bleaches in a variety of clean in solutions such as water purification systems. The presented system has been designed as per the requirement of Symbiosis Institute of Technology, Pune. The presented smart epidemic tunnel has been designed from portable structures, which are made up of PVC and steel materials. The major findings of this study are as follow: The presented smart tunnel can prevent or disinfect an outsider who is entering a particular building or a premise from COVID-19 infection possibilities within 10 s. The presented smart epidemic tunnel can function using solar energy during the day, and it functions using a solar power bank at the night time. his functionality has been provided by an LDR sensing unit placed in a tunnel. Furthermore, the tunnel has been designed in such a way that it can also disinfect a disabled person sitting in a wheelchair or a person riding a bike. In the end, Web and mobile interface has been designed to provide daily, weekly and monthly reports of the counts of individuals, along with in-out timestamps and power usage reports. In the future, an AI-based tunnel can be designed which can detect face-masks and provide auto-thermal scanning of the individuals to protect them from coronavirus like infections.

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