Pandemic Control in Smart Cities

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Introduction

COVID-19 is a highly contagious viral, it not only changed people's lifestyle in a short time period but also shows many benefits of the functions of smart cities. According to Fan Youshan, the General Manager of China Electronics Technology Group Corporation, he mentioned that the goal of a "new smart city" is "people first", efficient and precise management, sustainable development, open information sharing, and a safe network environment. Overall, the most important thing is improving residents' standard of living. During the COVID-19, we see smart city functions affect a lot of parts of city operation. Governments use facial recognition system, Health QR Code and sensors tracking COVID-19 infectors' movements for predicting high-risk areas. The sensors are used to collect data for our virus transmission model so we can minimize the spread of COVID-19 and safely return to our previous lifestyle.

Current Problems and Restructuring Suggestions for Smart City Construction: A Case Study on Fight against COVID-19 in Several Chinese Cities

COVID-19 is a highly contagious viral, it not only changed people's lifestyle in a short time period but also shows many benefits and weaknesses of the functions of smart cities. According to Fan Youshan, the General Manager of China Electronics Technology Group Corporation, he mentioned that the goal of a "new smart city" is "people first", efficient and precise management, sustainable development, open information sharing, and a safe network environment. Overall, the most important thing is improving residents' standard of living. During the COVID-19, we could see smart city functions affect a lot of parts of city operation.

Jinan's "City Brain" collects and analyzes data for essential living resources and medical supply to achieve rational distribution. At the same time, the system could use these data to analyzes the where is the highly contagious area and have some prevention in hospitals and communities in time.

Besides using the resource information analysis to do the prediction, the Jinan government also uses "Traffic Brain" to exact identify car information for tracking the movements of people infected. Furthermore, the "Traffic Brain" could detect population density in specific areas and sound an alarm to law enforcement.

Beijing government encourages people to use the application named WeChat that could help residents solving some financial problems, such as extend the loan, claim insurance, and so on. Meanwhile, the Beijing Public Transport Group provides a customized service that could find the best bus lines for each user. This action can reduce the number of users in public transportation then decreasing the risk of infection.

Beijing Medical Association created an online platform call "Online Doctor Consultation Platform of Beijing for Pneumonia Infected in COVID-19". This platform could release patients' anxiety and give more new treatment recommendations timely; that also avoid cross-infection in clinics.

Now "Health QR Code" is country-wise using in China; regulatory authority can easily recognize people's health status by code's color. And the application "Property Management Assistant", use face recognition technology and cloud access control helping property manager prevent unauthorized access to the community. For education, many schools started online education, some of them use online meeting applications and others use the television platform.

Shortcomings and limitations of the smart city also have been shown up during the pandemic. The smart city system lacks facing epidemic outbreaks' preparation. At beginning of the COVID-19, some smart cities didn't seasonable to update the data collection style, which causes duplication of work and lack of cooperation. These reasons lead to time-wasting and didn't control the spread area at first.

The improvements of smart cities should from two sides, the first is updating the whole system from a top-level goal, and the second is fixing the specific problem from basic. Just like the COVID-19 case, a smart city improves work efficiency, reduces the number of staff involved in high-risk occupations for COVID-19, avoids manual transmission data error, saving time, and prevents large outbreaks in the local area partly. However, we need to update the personal data collection system, the traffic flow tracking system, the online health care system, and the resource allocation system collectively.

The purpose of a smart city is to improve residents' quality of life, ensuring public security, and preventing potential risks. Through the COVID-19 crisis, designers need to focus on the effects of digital governance, preparing for and responding to emergencies, and design functions more from the actual demand side.

Utilizing Smart City Cyber-Physical Infrastructure for Tracking and Monitoring Pandemics like COVID-19 with the ICCC as the Nerve Centre

While the ongoing COVID-19 has posed significant challenges to many cities around the world, the virus is also driving the development and improvement of smart cities. The Indian government has applied the ICCC system for smart cities to track gatherings of people in order to control the development of the virus, prevent large-scale outbreaks, and better respond to potential problems.

The Indian government has enabled ICCC systems in several smart cities, which are connected to the Internet of Things and work together to manage and monitor the city. One of its functions is to use surveillance cameras in the city to detect crowd gatherings on time, target them, inform the relevant authorities, and deploy law enforcement officers to evict them. This system effectively reduces the exposure time of law enforcement officers in high-risk areas and can target crowd gathering places promptly, improving the efficiency of law enforcement officers.

First, city surveillance cameras capture the movements of people installed by the city planning department. Especially in some locations where crowds tend to gather, such as shopping malls, restaurants, and stations. If there are no surveillance cameras in these places, then the surrounding business owners or residents are encouraged to use their smartphones to capture the gathering events. They can upload them to the government's cell phone software to report the crowd gathering events to the relevant departments.

Next, the video analysis software defines parameters to analyze the number of people in the video footage and send an alert to the ICCC system when the number of people in the footage exceeds a predetermined value. The ICCC system displays the details of the time and location of the crowd gathering event, and at the same time, sends an alert to law enforcement.

Finally, law enforcement dispatches patrol officers to disperse the crowd or take other actions based on the content of the alert.

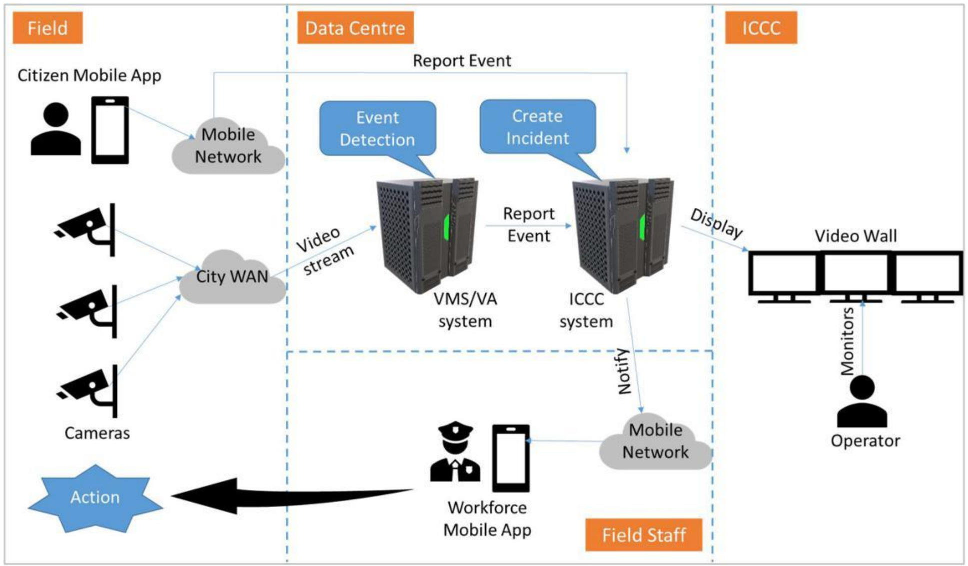

Fig. 3. Technical architecture of lockdown tracking and monitoring. [2]

The advantage of this is that it only focuses on the gathering of people. The system does not take and store photos of the participants individually, avoiding the possibility of invading personal privacy. The reporting feature allows more people to participate in the fight against COVID-19, and the remote filming and uploading of videos avoid the opportunity to come into contact with others.

The Indian government has also used the ICCC system to create the Quarantine Centre Surveillance System, which uses facial recognition to track suspected infected persons, domestic and international travelers.

First of all, smart city municipalities install surveillance cameras at airport security checkpoints and various quarantine centers. The system captures photos of people and stores their data, that including names, addresses, health conditions, and so on.

Furthermore, the surveillance cameras in various places in the city are used to track and monitor the people who need to be quarantined and to update the images in the face recognition data system in real-time.

Finally, the content of the face recognition system is used to compare with the video stream from the surveillance cameras in the smart city. Once a quarantined person is found to be outside, a warning would be sent to the authorities.

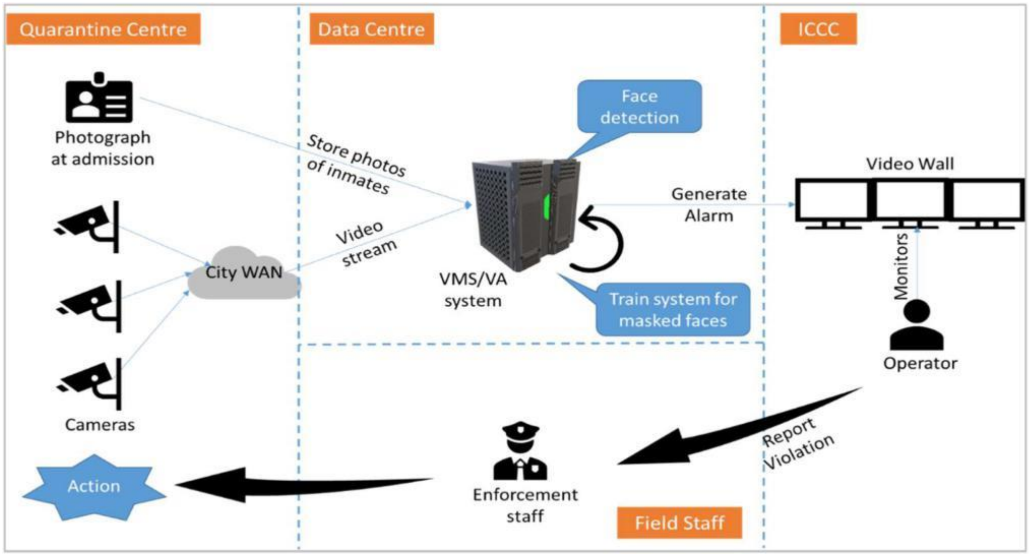

Fig. 5. Technical architecture for quarantine monitoring. [2]

As has been noted, this system is very good at preventing and controlling the spread of COVID-19. It also effectively predicts the path of virus transmission, allowing authorities to prepare for the possibility of a potential disease outbreak. Not only that, but the tracking of COVID-19 infected people has also improved the sensitivity of the face recognition system, from full-face recognition at the beginning to implementing identification of the monitor only from the exposed area outside the mask.

Leveraging AI and Sensor Fabrics to Evolve Smart City Solution Designs

We have got to a stage in technology where sensors and robots are taking over a lot of our tasks and helping us monitor trends in our daily lives. While we use technological devices every day, we generate a lot of data that we can use to create new machines and platforms. The main purpose of sensors is to be able to work with an application so the system design would have to follow the three guidelines that the design should be able to be built upon, it should provide an interface for all the monitoring purposes and should have a full structure. So basically, it should be a system design that can be used in various models around the city to collect data.

The smart city program incorporates different types of sensors. There are sensor system designs across the cities for the autonomous cars to function with a lower probability of errors. The infrastructure and buildings are equipped with sensors to gather data about weather and climate. Optical wiring is used to provide street lighting. The parking transactions can also be monitored by sensors as well as the neighborhood bulletin boards. These devices go hand in hand with platforms that track aggregation and correlation.

This article includes an example of Barcelona smart city. They have added more than 1000 sensors around the city to monitor the activities of the citizen. They generate about 8 GB data from the city every single day. The parking spots that are not occupied are located by the sensors. The energy monitoring generates more than 3 MB data, noise is about 578 KB, urban lab is about 153 KB, garbage collection is about 480 KB and parking spots is about 615 KB every day.

A similar system is the drones which can capture GPS data as well as video footage to track and monitor and they are being used for more commercial activities now. For example, in movies we can see the use of drones to take ariel shots and record data from a different view. Drones are now equipped with Infrared, Lidar, Ultrasonic and other such sensors to capture data that can be used to include in software algorithms.

However, there are still improvements that need to be made for the sensor technology in smart cities. Even though we have the data collected from the sensor technology, to become a fully smart city we still need to develop the systems and analytic models to filter the data and integrate them into our cities.

System Design of Safety Road Network in Urban Morphology Prevention During COVID-19 Based on Digital Simulation Technology

The first case of COVID-19 was reported and since then the number of cases has been increasing with an exponential growth. Through Urban Morphology and Digital Simulation Technology we can gather the data collected through sensors and utilize them in our virus transmission models. "Urban morphology is the study of the form of human settlements and the process of their formation and transformation." The study of building a town or a city is called urban morphology.

In this article we use Grasshopper/ELK to replicate the topographical areas that we need to monitor and track. Then we use the collected data to form relationships between the population in a certain area and the traffic road network to come up with a pandemic prevention model.

The virus transmission model is basically based on the number of cases in the initial stage and the amount of people that have been infected. The time that it takes to infect others is also included in the model.

This model was used when the SARS outbreak occurred, but it has some flaws. It doesn't really account for some of the attributes that is required. There have been a lot of improvement in the virus propagation models after that. The SI model consists of two categories, one that is the susceptible individual and the other is the infectious individual. The SIS model is based on the SI model but adds a situation where the infected individuals that have recovered go back to the susceptible category again. In the SIR model the recovered and immunized individuals are separated into another group. The SIRS model shows that the individual who has recovered or immunized loses their immunity with a certain probability. The SEIR model introduces the exposed state which includes the possibility of an individual to be in contact with the person who has the virus but be asymptomatic.

The use of Rhino and Grasshopper allows for the collection of the data that we can use to simulate the population flow and take necessary actions to reduce the crowding of a certain location. We can map out the start and end routes of individuals who have been infected with the virus.

The M-SEIR model is an advancement of the SEIR model. The M-SEIR model is an improved SEIR model that takes into the categories from the SEIR model and adds couple more attributes. In this model, the population is divided into Susceptible which is denoted by S, exposed which is denoted by E, Infectious (I), Recovered (R) and Hospitalized. There are two levels of quarantine areas that the group is divided into. The level 1 quarantine area includes people who are susceptible, exposed, infectious, and recovered. This area needs more monitoring because there is a larger chance of spreading the virus. In level 2 quarantine area, the individuals who are suffering with the symptoms and need to be hospitalized are kept. This allows for less spread of virus because they do not have contact with a lot of the other groups.

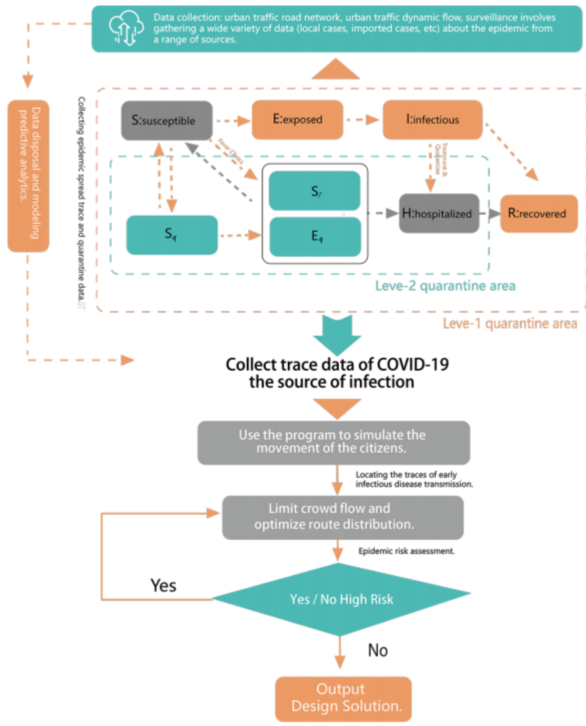

Figure 12. M-SEIR urban epidemic prevention model

The simulation with the Grasshopper and the Rhino platforms for the COVID-19 pandemic surge in San Francisco shows the start and end pathway of the people who have been infected. This can further be used to incorporate into smart cities to prevent the spread of virus.

 

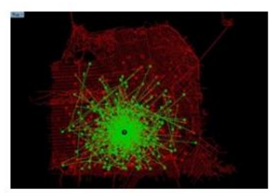

Figure 15. Distribution of COVID-19 in the United States [19] Figure 16. Distribution of COVID-19 cases in San Francisco. [19] Figure 17. Simulate the starting and ending points of the activities of potentially infected people in San Francisco

Conclusion

The improvements of smart cities should from two sides, the first is updating the whole system from a top-level goal, and the second is fixing the specific problem from basic. Just like the COVID-19 case, a smart city improves work efficiency, reduces the number of staff involved in high-risk occupations for COVID-19, avoids manual transmission data error, saving time, and prevents large outbreaks in the local area partly. However, we need to update the personal data collection system, the traffic flow tracking system, the online health care system, and the resource allocation system collectively.

The purpose of a smart city is to improve residents' quality of life, ensuring public security, and preventing potential risks. Through the COVID-19 crisis, designers need to focus on the effects of digital governance, preparing for and responding to emergencies, and design functions more from the actual demand side.

In conclusion, with the use of movement path tracking technologies and the urban morphology model we can prevent the spread of pandemics in smart cities.

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