Robots in a contagious world

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Abstract

Purpose – This paper aims to show how robotic technology is being used to combat the COVID-19 pandemic.

Design/methodology/approach – Following a short introduction, this discusses the role of robots in the following COVID-related applications: disinfection, checking human temperature, monitoring public places, delivering food and other items, food preparation and personal interactions by telepresence. It concludes with a brief discussion.

Findings – Robots are playing diverse and vital roles. They have helped to reduce the chances of spreading the infection by reducing inter-personal contact; freed-up medical professionals by conducting certain routine teaks; assisted and speeded-up the provision of food and medical supplies; monitored public places; informed the public of the need for social distancing; and allowed those in isolation to remain in contact with friends and family.

Originality/value – This provides a timely account of the use of robots in efforts to ameliorate the impact of the COVID-19 pandemic.

Keywords Robot, Coronavirus, COVID-19, Pandemic

Paper type Technical paper

Introduction

The present COVID-19 outbreak which is sweeping the world is the latest in many pandemics that have occurred since antiquity. During the past century, around 500 million people became infected with Spanish Flu between 1918 and 1920 with an estimated 20–50 million fatalities and Asian Flu was responsible for 1.1 million fatalities between 1957 and 1958. However, the present pandemic is unique in being the first truly global event to have occurred since the advent of robotic technology.

A key strategy in restricting the spread of any contagious disease is minimising inter-personal contact, and this approach is presently being adopted by many of the world’s nations. Here, robots are playing an important role by de-manning a number of key tasks and conducting other vital functions. This article aims to illustrate the role that robots are playing in the present pandemic.

Robots for disinfection

Disinfection is a vital function in several scenarios but is generally a manual process which can bring operators into close proximity with hospital patents or members of the public. Several companies are now producing and developing robots that can overcome this problem and some examples are discussed below.

In 2014, a group of Danish hospitals identified the need for a far more effective way of reducing infection rates and led to collaboration between bacteriologists, virologists and hospital staff with Danish service robot manufacturer Blue Ocean Robotics. The resulting mobile robot, the UVD Robot (Figures 1 and 2), is now produced by UVD Robots which was founded in 2016 by Blue Ocean. It uses high intensity UV-C light with a wavelength of 254 nm to kill bacteria and viruses and effectively limits the spread of coronavirus without exposing front-line hospital staff to the risk of infection. It is battery-powered and can move at 5.4 km/h and with an operating time of 2–2.5 h, it can disinfects 9–10 rooms from a single charge, taking around 10–15 min/room. It weighs 140 kg and can be recharged in three hours. The first robots were shipped to hospitals in China in late February 2020 following an agreement between medical supplies company Sunay Healthcare Supply and UVD

Figure 1 The UVD robots

Source: Sychem

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Robots. Through Sunay’s partners in China, the robots will be deployed in all Chinese provinces at more than 2,000 hospitals.

Similar robots, the Sunburst UV Bots, are being used in Singapore and are produced by local company PBA Group. More than 200 will be rolled out in shopping malls and the health care and transport sectors by the end of this year. The first will be deployed at a shopping mall at Northpoint City and then more at other malls owned by Frasers Property Retail. It uses lidar for navigation and can detect when people are too close and automatically shuts off its UV lamp. It can operate for around 2.5h on a single charge and is able to self-navigate to the charging stations. The company ultimately plans to deploy over 500 units in Malaysia, Thailand and Hong Kong. In March 2020, the infection isolation area of the Third People’s Hospital of Hubei Province in China officially unveiled the mobile ARIS-K2 robot (Figure 3). Produced by Chinese robot manufacturer Youaizhihe Robot Technology, it has a high-definition visible light camera and a thermal camera that can identify people and measure their body temperature. Below the cameras, six UV lamps emit 270 µW/cm² of UV light, capable of killing more than 99.9% of viruses and bacteria within a six-metre radius within 10 min. During the day, the robot automatically cruises around the main entrance and exit of the hospital to detect people with abnormal body temperatures, and at night, it automatically implements a UV disinfection programme in the hospital’s outpatient, emergency and infection isolation areas.

In the USA, San Antonio-based Xenex produces the LightStrike UV disinfection robot. This mobile robot uses a patented system based on a pulsed xenon UV source operating at 200–315 nm which can deliver up to 4,300-times more germicidal pathogen-killing UV intensity than conventional UV-C mercury vapour sources and can disinfect an entire patient room in 20 min. These robots have been deployed in more than 500 hospitals worldwide in the USA, the UK, Italy and other countries in continental Europe, South America, Asia, the Middle East and Africa. These numbers are increasing daily, according to the company. Although the cost is $125,000, the company estimates that this translates to about $2 to $8 per room depending on the number of rooms used in each day.

Liquid disinfectants are being dispensed by robots in Hong Kong. In March 2020, the MTR Corporation, Hong Kong’s rail transport operator, announced the deployment of mobile robots to conduct deep cleaning and decontamination in train compartments and stations. Dubbed the VHP Robot (Figure 4), they arose from a joint project between MTR and Avalon Biomedical (Management) Ltd., a Hong Kong biotechnology company, and operate by spraying vapourised hydrogen peroxide onto surfaces. The operator can configure the robot to operate automatically by pre-setting the floor plan of the designated area, or remotely control it with a mobile device from a distance of up to 20 metres. It takes about four hours to complete the cleaning of an eight-car train when operating in automatic mode.

Based in Shanghai, Keenon Robotics has recently modified one of its mobile delivery robots so as to conduct sterilisation tasks in Chinese hospitals. In contrast to other devices, it features both UV and hydrogen peroxide sterilisation techniques. Weighing 70 kg, it has a liquid capacity of 1.5 litres, a maximum speed of 2.2 mph and an eight-hour operating time from its rechargeable, 48-volt battery.

**Figure 2** A UVD robot operating in an ICU

**Figure 3** The ARIS-K2 robot at the Hubei third people hospital outpatient hall

Source: Sychem

Source: Youaizhihe robot technology
Several different wheeled and tracked robot platforms which have been equipped with tanks containing liquid disinfectants have been deployed in Chinese cities. These are often modified versions of robots aimed at other applications such as crop spraying. They have been used to disinfect outdoor areas in Hangzhou, Wuhan, Shenyang and many other cities and are mostly remote-controlled from a phone or tablet.

**Monitoring human temperature and people in public places**

Human temperature is widely used as an indicator of infection, and many measurements are being made with hand-held instruments during the present pandemic. However, this is time-consuming and potentially exposes the operators to infection and robots equipped with temperature monitoring technology are being deployed, particularly in China. An example is the 5G-powered patrol robot manufactured by Guangzhou Gosuncn Robot Company. These mobile robots are equipped with five high-resolution cameras and IR sensors capable of scanning the temperature of ten people simultaneously within a radius of five metres. They can also determine whether people are wearing masks and if a high temperature or the absence of a mask is detected, the robot sends an alert to the relevant authorities. They have been deployed in airports and shopping malls in cities which include Guangzhou, Shanghai, Xi’an and Guiyang. In another example, Chinese robot manufacturer CloudMinds in collaboration with China Mobile, has donated and sent 5G-enabled temperature measuring and inspecting robots to Wuhan Tongji Tianyou Hospital, Wuhan Union Hospital and Shanghai Sixth People’s Hospital which allow medical staff to measure patient temperature while reducing the chance of infection from direct contact. The company has also donated robots to clean and disinfect spaces and deliver medicine within quarantined areas in these hospitals. During the peak of the epidemic in China, authorities were carrying out large-scale, remote human temperature measurement in apartment complexes through the use of drones equipped with thermal imaging cameras.

The mobile Aimbot robot from Shenzhen-based UBTECH Robotics is playing a vital role in monitoring children returning to schools in China following the prolonged absence due to COVID-19. At the school gates of two middle schools, the Kunming No.3 Middle School and Kunming Dianchi Middle School in Yunnan province, students are now being greeted by an Aimbot robot rather than a human. Using IR sensing technology, the robot takes their temperature and checks if they are wearing their face mask correctly, thereby helping the school authorities to monitor the students and reducing cross-infection risks. The Aimbot can measure a person’s temperature at a distance of up to 3.5 metres and monitor up to 15 people simultaneously. It has also been used to monitor people’s temperatures and determine whether a mask is being worn at a fever clinic at Shenzhen Third Hospital. It can also assess the density of people in a given area, allowing it to vocalise a reminder for people to keep a safe distance from each-other. UBTECH’s humanoid Cruzr robot is being used as the first point of contact for the Shenzhen Hospital’s quarantine and outpatient areas where it invites visitors to approach it for information, an initial symptom diagnosis and even a live consultation with a medical professional through the remote video function. Like Aimbot, Cruzr can detect if a visitor is not wearing a mask and can vocalise a reminder, as well as broadcasting health recommendations, guidelines and information updates. By conducting these front-line functions and allowing medical personnel to focus on more urgent tasks, Cruzr is able to reduce the risks faced by staff as they assess and triage visitors entering the hospital.

Several robot manufacturers are rapidly modifying existing robotic platforms to meet the temperature sensing needs associated with the pandemic. For example, PAL Robotics’ humanoid ARI robot can be equipped with a thermal camera to detect patient temperatures and the company’s TIAGo robot now has a version fitted with a thermal imager that takes remote temperatures from groups of people.

Aerial and terrestrial robots are being used to monitor people in public places in countries with social distancing or isolation...
rules. In Singapore, Spot, a four-legged “robotic dog”, produced by Boston Dynamics is being used to patrol a park to encourage locals to continue social distancing. Remotely controlled and equipped with cameras it can estimate how many people are congregating. It regularly plays a recording reminding anyone within earshot of the country’s lockdown rules, saying “Let’s keep Singapore healthy. For your own safety and for those around you, please stand at least one metre apart. Thank you”. Officials in Singapore have also deployed 30 drones to count the numbers of people visiting parks.

China and many European countries are using drones equipped with speakers and recorded messages for broadcasting to the public and MicroMultiCopter Aviation, located in Shenzhen, has deployed over 100 drones in many Chinese cities to patrol areas and observe crowds. The drones were also capable of identifying people who were not wearing masks in public spaces and can be used with loudspeakers to broadcast announcements. Likewise, in Spain, Kuwait and the UAE, drones equipped with loudspeakers were used to broadcast messages, urging residents outside to “go home”. In California, Florida and New Jersey, officials have used drones to get messages to homeless communities and warn people to stay apart and respect physical distancing rules.

Delivering food and other items

Food delivery robots have been operating for some years in a number of towns and cities in Europe and the USA and in the present environment they offer the critical advantage of minimising inter-personal contact, thereby reducing the chances of spreading infection. US-based Starship Technologies has been offering robotic delivery services in the UK and the USA with its battery-powered, six-wheeled robot (Figure 8) since 2018. The robot has a payload capacity of 10 kg and can travel for around 10 miles between charges. The company reports a surge in demand in its services since the COVID outbreak and has doubled its fleet of robots in Milton Keynes to 70 in the past few weeks. In March 2020, it announced that it was offering a free delivery service to those employees of the UK’s National Health Service living within its operating area and stated that they had completed 100,000 autonomous deliveries in the town.

Silicon Valley start-up Nuro recently began delivering groceries in the Houston area in partnership with grocery giant Kroger with its R2 autonomous robot (Figure 9), which travels at speeds up to 40 km/h and can transport some 190 kg. The robots are also ferrying food, personal protective equipment, clean linen and other supplies to workers at two facilities in California: the Event Centre in San Mateo and the Sleep Train Arena, both having been converted into field hospitals to handle the overflow of patients who have contracted COVID-19.

Founded in 2016 and based in Beijing, ZhenRobotics produces the six-wheeled RoboPony delivery robot. This has a capacity of 30 kg and can operate for up to 16 h on a charge from its lithium-ion battery. It features an internal UV source to disinfect items in its compartment and is being used by major Chinese retailer Sunin.com Group Ltd. to deliver food and other items to households in Nanjing affected by the COVID outbreak. According to the company, orders have grown
threelfold since the outbreak began and is planning to produce 90 more units to meet demand. Also in China, conventionally powered, driverless vehicles produced by Beijing-based White Rhino Zhida Technology are delivering fresh food to 2,700 residents in Beijing and medicines and other vital supplies to Wuhan Fangcai Hospital.

Cargo-carrying drones are also playing a vital role in delivering both food and medical supplies. In China, Antwork drones have transported medical samples and quarantine materials between Xinchang County People’s Hospital and Xinchang County’s Disease Control Centre. As a result, a journey that would have taken 20 min by ground transport took only six, thereby cutting delivery time by more than half. In Anxin County’s series of semi-isolated islands, routine grocery deliveries typically required three modes of transport: goods were shipped to a pier, ferried to each island and then distributed by foot. When counter-virus measures suspended the ferry service, driving could take more than two hours to cover the 100 km journey, but as e-commerce company JD Logistics deployed its drone fleet, several drone delivery corridors were put in place, replacing the drive with a 2 km flight that could be completed in just 10 min.

Food preparation

Several food preparation robots have been developed in recent years and although many have been viewed as little more than a gimmick, the present pandemic has demonstrated their value by minimising the chances of food contamination during preparation and serving and reducing inter-personal contact. An example is the fully un-manned, robotic food preparation station, developed by Qianxi Robotic Catering, a subsidiary of Chinese property giant Country Garden. It is able to prepare 36 meals every 15 min and can satisfy at least 120 diners in an hour. Several units have been donated to Wuhan, capital of Hubei Province in central China, where medical workers on the frontline of the COVID outbreak are struggling to secure regular meals due to the city being in lockdown and where doctors and nurses are reportedly missing canteen hours when on call or responding to medical emergencies. Outside Hannan Red Cross Hospital in Hunan, where isolation wards and temporary treatment centres have been set up, the robot is serving traditional brown rice clay-pot casserole dishes for free. The robots are running for 24 h/day and ensure that medical workers in the region are able to eat whenever they need.

Telepresence robots

Telepresence robots are playing a role in two COVID-related applications: providing quarantined hospital patients and care home residents with remote access to friends and family and allowing healthcare workers to evaluate, monitor and treat patients from a safe distance. This latter use has proven to be particularly beneficial in the many situations where hospital workers lack adequate personal protection equipment.

An example is the Temi robot (Figure 10) produced by Robotemi, a company founded in 2016 with headquarters in New York, an R&D lab in Tel Aviv and a manufacturing facility in Shenzhen, China. While not originally designed for dealing with a medical emergency, it has now been modified to include a thermometer, a thermal camera and a sink which allows employees to wash their hands. It is equipped with four wheels and uses lidar, cameras, proximity sensors and an IMU for autonomous navigation and collision avoidance and features human–robot interaction capabilities through speech recognition and far field voice technology, natural language processing, speech-to-text and text-to-speech engines. It is equipped with a ten-inch tablet with a touch/display screen and connectivity is via Bluetooth and Wi-Fi. The robots autonomously move between patients and can provide remote video consultations with doctors and can also deliver medicine.
and take temperatures without a human having to be in the same room as the patient. In Israel, the robots are being used in the Sheba Medical Centre to monitor quarantined patients while maximising staff safety and in South Korea, they are used in elderly care facilities and public spaces to monitor the infection and prevent its further spread. In Hong Kong, China and South Korea, it has been deployed in nursing homes, allowing families to communicate with residents through video calls.

In Italy, at the Circolo Hospital in Varese, a wheeled telepresence robot dubbed Tommy is being deployed at the bedside of COVID patients in the ICU, including those on a ventilator, to monitor blood pressure and oxygen saturation. The robot is equipped with a tablet and a microphone, allowing communication between the patient and medical staff outside the ICU. Its use has minimised contact between health workers and infected patients, and most importantly, it has reduced the demand for personal protection equipment which has been in very short supply.

**Discussion**

The rapid spread and lethal consequences of the present COVID pandemic has taken the world by surprise. However, the realisation that robotic technology can assist in ameliorating its impact has been equally rapid and all manner of robots, both standard and modified to meet specific needs have been deployed. These have helped to reduce the chances of spreading the infection by reducing inter-personal contact through automation, freed-up medical professionals by conducting certain routine tasks, assisted and speeded-up the provision of food and medical supplies, helped to inform the public of the need for social distancing and allowed those in isolation to remain in contact with friends and family.

Because of the speed of the pandemic’s spread there has been no time to plan a comprehensive robotic deployment strategy and uses have very much been on an *ad hoc* basis. However, in the fullness of time, there will be opportunities to evaluate successes and limitations and plan for the future. Just as the Fukushima reactor meltdown highlighted the need for greatly improved disaster response robots and catalysed the DARPA Robotics Challenge, perhaps the COVID outbreak will stimulate funding for and targeted developments in robots for pandemic assistance.

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