China’s AI Strike Force on COVID-19

Wilson Kia Onn Wong  
CTBC Business School, Tainan, Taiwan

Abstract

Purpose – This paper examines the methodical and highly efficacious manner in which China deployed its comprehensive AI (artificial intelligence) strategy to significantly stymie the spread of COVID-19 across the country.

Design/methodology/approach – This study deploys a case-study approach, supported by the literature on existing and emerging AI and related technologies.

Findings – The onset of the COVID-19 pandemic has revealed to the world the remarkable progress China has made in AI and its accompanying ecosystem. More importantly, this outlier event demonstrates the surgical, hybridised manner in which China has utilised these emerging technologies in containing its spread (i.e. “AI Epidemiological Targeting”) and set itself on the path to unleashing their full potential (i.e. “AI Symbiosis Paradigm”). Nonetheless, China still needs to harness its rapidly advancing AI prowess in identifying COVID-19’s pathogenesis and developing a proven vaccine.

Originality/value – This study presents a pioneering effort to analyse the deployment of AI and its ecosystem in the “war” against COVID-19.

Keywords COVID-19, Artificial intelligence and big data, Data edge, Pathogenesis and proven vaccine

Paper type Research paper

1. Introduction

Since December 2019, COVID-19 (also known as novel coronavirus), a new virulent and highly transmissible strain of coronavirus has purportedly spread from China’s Hubei province to over 100 countries, triggering a worldwide pandemic (Duddu, 2020) [1]. By 15 March 2020, COVID-19 had infected over 150,000 people with fatalities in excess of 5,000 globally (Bloomberg, 2020a). The virus, which was detected ravaging the denizens of Wuhan, the capital city of Hubei province, triggered an unprecedented mobilisation of resources from Beijing to quell the spread of this virulent strain. Despite the considerable death toll it has exacted (largely in Hubei province), the Chinese authorities have managed to rein in the spread of the virus by early March 2020; by 6 March, China reported only 99 new cases a day, significantly lower than the 2,000 a day recorded earlier in mid/late February (Qin, 2020). This dramatic reduction was to a large extent made possible by the effective deployment of AI (artificial intelligence) and big data technologies. Before the COVID-19 pandemic, AI was a largely academic discussion, with the media positing breathlessly on its boundless potential. It took an unfortunate shock to an increasingly complacent global system (with 2003’s “Severe Acute Respiratory Syndrome” (“SARS”) outbreak a distant memory) to fully demonstrate the immense life-saving potential of AI augmented by sophisticated “Big Data” analytics.

Given the strident discussions on AI’s game-changing nature, it is easy to forget that AI has relatively humble origins (Lee, 2018). In a classical sense, it is fundamentally about programming computers to replicate human intelligence. However, with the advent of increasingly powerful microchips and Internet technologies (i.e. wireless, fifth generation mobile telecommunications (5G)) over the past two decades, there is an increasing (and frightening) prospect of these computers evolving their own form of intelligence; a “real” intelligence that exceeds the confines of mere mimicry, with an ever-increasing potential to surpass that of their human creators (Warwick, 2012); the emergence of 5G is potentially...
revolutionary, as it is expected to connect an increasingly expanding global network of autonomous vehicles, sensors and robots (i.e. the “Internet of Things”) through cutting-edge AI (Araya, 2019); China, not the US, is the global pioneer in 5G with the country having built 160,000 5G base stations across China, with potential network coverage and capacity in over 50 cities (Rahim, 2020). Moreover, it has become an article of faith amongst those in the commanding heights [2] that whoever unties the “AI Gordian Knot” [3] would dominate the 21st century. China’s palpable ambition to dominate this AI future, backed by overwhelming financial might, makes it the leading contender in this race and seemingly inevitable victor (Britannica, 2019; Lee, 2018). This belief is further entrenched by numerous Western media reports that relentlessly assert China’s eventual victory in this AI race, owing to its ready access to incontestably endless pools of data generated by its burgeoning e-commerce industry. AI is basically about mimicking human behaviour (perhaps eventually surpassing it); thus, access to significant volumes of data on human behavioural patterns (e.g. consumer spending patterns) would invariably expedite AI development. It is for this reason alone that many consider data the “black gold” of the 21st century (The Edge Singapore, 2019). Moreover, to manage and exploit this relentless avalanche of data, increasingly sophisticated “Big Data” [4] techniques such as predictive analytics are being used to anticipate events before they eventuate (Mayer-Schönberger and Cukier, 2013).

The sheer efficacy of AI and “Big Data” in alleviating the ravages of global pandemics was palpable with the relentless onset of COVID-19. China has assiduously deployed these technologies extensively across the country in a race to arrest the spread of the virus. Despite earlier criticism of China’s slowness in sharing the extent of the COVID-19 spread across Wuhan (the epicentre), there is no denying China’s dogged determination to eradicate its spread in the early months of 2020, with the full resources of the state supporting this campaign (Cyranoski, 2020). This highly effective campaign comprised the rapid deployment of supercomputing, facial recognition and data analytics technologies. This unfortunate pandemic has demonstrated to the world how an unprecedented combination of existing and emerging AI (includes surveillance and drones) and data analytics platforms by China could prove invaluable in arresting the rampant spread of a deadly virus. From both an epidemiological [5] and societal standpoint, this successful mass-scale hybridisation of various technologies (this paper calls such a hybrid framework “AI Epidemiological Targeting”) could prove to be the “holy grail” in tracking unfolding epidemics before they evolve into full-blown pandemics. This hybridised “AI Epidemiological Targeting” (as coined in this paper) strategy is simply a confluence of ideas and technologies “whose time has come” (quoting Victor Hugo), as it harnesses the power of existing and emerging AI, surveillance and data analytics technologies and exploits their capabilities on a massive scale in a China undergoing the ravages of COVID-19 (Hugo, 2017). However, China’s “AI Epidemiological Targeting” strategy is much more than a hybridisation of disparate existing and emerging technologies, a capability which most developed nations possess. Through the following segments, this paper makes the argument that China is now on the way in achieving seamless integration of these seemingly different technologies (i.e. supercomputers, drones, data analytics, deep learning, 5G, robots, computer vision, AI-powered diagnostic equipment, temperature scanners, smart helmets and facial recognition technology) and harnessing the potential to untie the “AI Gordian Knot”. China’s “AI Epidemiological Targeting” enables its massive state machinery to effectively track and limit COVID-19’s community spread, facilitate swift and accurate diagnoses of possibly infected patients and efficaciously implement necessary quarantine orders and lockdowns.

This paper calls this seamless integration of technologies the “AI Symbiosis Paradigm”, as this integration could create a pattern-recognition, self-learning (the operative word) positive loop (made possible by deep learning [6]) which significantly strengthens the capabilities of each individual technology; the “AI Symbiosis Paradigm” is fundamentally about various
interacting technologies leveraging on the self-learning capabilities of deep learning to evolve a multitude of problem-solving strategies with virtually no human interference (Goodfellow et al., 2016). It is easy to forget facial recognition gear is at best a “smart camera”, if not for its ability to connect to computer databases, drones and data analytics platforms augmented by deep learning. Moreover, smart helmets worn by Chinese police are now capable of not only detecting hundreds of suspected infected COVID-19 individuals rapidly but also enabling them to effectively identify and track these people (facilitated by extensive databases), limiting the risk of community spread (You, 2020). Facial recognition technologies, drones and high-tech helmets are amongst the nodes in this symbiotic value chain, whose capabilities are augmented through their constant interaction (i.e. symbiosis) and the deployment of deep learning, that enables these respective nodes, directed by intelligent algorithms (devoid of human intervention), to become increasingly more intelligent through self-learning capabilities, resulting in a value chain that is continuously enhancing its robustness (see Section 3, AI enabled tracking). The “AI Symbiosis Paradigm” makes the argument that the seamless integration of these technologies offers a level of precision, scenario planning and superior decision-making, previously unheard of. It is much more than the “Internet of Things”, as the latter considers only smart devices connected to the Internet, capable of garnering information, analysing it and offering a course of action. Thus, the “Internet of Things” does not adequately capture the true spirit of this rapidly advancing AI era, which is possibly on the verge of delivering a “Superintelligence”; Oxford University philosopher, Nick Bostrom asserts that “Superintelligence” is any intelligence that significantly surpasses the cognitive abilities of Homo sapiens in almost every aspect (Bostrom, 2014). Having said that, the sheer cognitive prowess afforded by the “AI Symbiosis Paradigm” would not be possible without the thorough grounding laid by the “Internet of Things”.

Nonetheless, there is the argument China’s comprehensive and highly effective mobilisation of resources, in its “people’s war” on COVID-19, is only possible within a highly-centralised autocratic political system (Xinhua, 2020a). Examples of the Chinese system’s highly efficacious nature would include the remarkable ability to build two temporary (nonetheless relatively well-equipped [7]) hospitals (i.e. Huoshenshan and Leishenshan hospitals) in less than two weeks (starting in late January 2020) to provide a whopping 2,600 beds, and the deployment of 33,000 medical staff from across China along with the capacity to swiftly utilise universities, convention centres and high schools as 13 temporary hospitals (McDonald, 2020; Mai, 2020); a January 2020 Lancet editorial describes China’s mobilisation of resources as such “No other country could mobilise resources and manpower at such speed” (The Lancet, 2020). The alleged weakness of this top-down model would be its lack of transparency. But in the onset of a global pandemic, this unimpeded decision-making model is arguably the right model for the time. Within relatively laissez-faire Western societies such as the US, such aggressive and efficacious measures would be near impossible to implement within the same time frame (Mai, 2020).

2. AI-augmented supercomputing
China has leveraged on its progress in AI and supercomputing to arrest the spread of COVID-19 within its borders through expeditious and accurate diagnosis, a critical first step before efforts to finding a cure (Peckham, 2020). At China’s National Supercomputer Centre in Tianjin, the Tianhe-1[8] computer’s AI system has the capacity to shift through hundreds of images generated by “Computed Tomography” (CT) and generate a diagnosis in approximately ten seconds. Moreover, Tianhe-I’s AI system was created, based on a significant city model with a population in excess of 11 million and 198 communities. The sheer speed of this AI system is illustrated by the fact that it would take an experienced physician about 15 minutes to go through the 300 images generated by a CT scan, while it
could complete the same task in approximately ten seconds with an 80% (and improving) accuracy rate (outperforming standard COVID-19 toolkits and human radiologists). The results would then enable doctors in COVID-19 afflicted areas, particularly those with a shortage of test kits or experiencing a sudden spike in infections, to swiftly distinguish those afflicted with the novel coronavirus from those with common pneumonia or the flu. Beyond providing “mere” diagnosis, Tianhe-1’s AI system is sufficiently intelligent to advise doctors on the next course of action and even directing them to specific parts of the lungs to treat, leveraging on the prior experience of physicians who have treated COVID-19 patients (Peckham, 2020; Chen, 2020). Similar AI-augmented diagnostic systems have been emerging across China, revealing the significant strides the country has made in the field. For instance, the Damo Academy, Alibaba’s premier cutting-edge research facility, has developed an AI diagnostic system capable of detecting novel coronavirus cases with a superlative degree of accuracy of 96%. Even smaller firms such as Infervision, a Beijing start-up, have developed a comparable diagnostic system with an accuracy of 95%. Infervision’s deep learning system has learned from thousands of cases (and rising), even encompassing early cases from Tongji hospital in Wuhan; this system is now deployed across 34 hospitals in China (Chun, 2020; Mak, 2020).

The analytical prowess of these systems is expected to improve even further over time, with increasing amounts of “quality” data being fed to the system. The quality of the data matters, as reflected in the cliché IT adage “Garbage In, Garbage Out”; simply put, inaccurate data along with data that is steeped in bias could undermine attempts to develop sophisticated AI systems (e.g. machine learning systems) (S&P Global, 2019). In this context, China has a history of being plagued by low quality and sometimes fraudulent data; some Chinese officials have been known to fabricate economic statistics to advance their careers; the governments of China’s Inner Mongolia autonomous region, Liaoning province and the Tianjin municipality have all confessed to fabricating their economic data between 2017 and 2018 (Leng, 2019). Despite the tremendous human and economic toll exacted by COVID-19, it has compelled China and the rest of the world to strengthen our existing AI systems to better deal with the next global pandemic; as British wartime Prime Minister, Winston Churchill famously remarked: “Never let a good crisis go to waste”. And strengthening the quality of data is a critical first step. Chinese medical professionals seem to have taken this to heart, as they have made considerable effort towards upgrading the Tianhe-1’s AI system, which underperformed initially. But with an increasing critical mass of accurate and relevant data, the diagnostic and forecasting performance of the AI system subsequently improved by leaps and bounds (Chen, 2020).

3. AI-enabled tracking
Chinese government algorithms have reached a level of sophistication capable of estimating the probability that a given neighbourhood or individual has been exposed to COVID-19, giving contact tracing [9] a high degree of precision. This involves matching smartphones locations to areas known to have infected individuals or groups. With this capability, Chinese authorities have been able to surgically deploy limited medical resources; for instance, officials were able to accurately apply tests for the novel coronavirus to high-risk subjects identified by AI algorithms. China’s robust AI capabilities have enabled the authorities to enforce a watertight lockdown on Hubei province (Wuhan is its capital), a sizeable landmass with approximately 60 million people; guards at train stations and other checkpoints determine whom to let through, based on colour codes highlighted on mobile phones (green, yellow or red colours indicate a person’s health status [10]) (Kupferschmidt and Cohen, 2020).

This Orwellian but efficacious capability is facilitated by the enabled GPS on smartphones, which provides a thorough and precise record of the user’s itinerary.
In the US and Europe, privacy laws prevent local authorities from collecting this data. However, China has no such privacy constraints in place, with telecom providers freely using locational data for advertising (Knight, 2020). Ironically, a seemingly draconian and highly invasive political culture vis-à-vis that of the liberal West is now proving tremendously more effective at arresting the spread of a deadly pandemic and saving countless lives in the process; by late March 2020, the number of COVID-19 related deaths in Italy (6,820 deaths) had surpassed that of China’s (3,285 deaths), as the former did not execute its lockdown with the highest stringency (BBC, 2020; Braithwaite and Ruotolo, 2020).

Moreover merging computer vision [11] with sophisticated algorithms has also enabled the Chinese authorities to arrest the spread of COVID-19 at an impressive pace. By deploying Chinese tech titan, Baidu’s AI system (combines cameras equipped with computer vision and infrared sensors to predict people’s temperatures in public areas), local authorities are capable of screening up to 200 people per minute and detecting their temperature. This unique AI flags anyone who has a temperature above 37.3 degrees (with a margin of error within 0.05 degrees Celsius) and is currently being used in Beijing’s Qinghe railway station (Dickson, 2020; Feng, 2020). This temperature scanning ability has also achieved an unprecedented level of mobility in China, a capability triggered by the onslaught of the novel coronavirus. For instance, police officers in China are wearing smart helmets capable of automatically scanning people’s temperatures as they patrol the streets. These high-tech helmets, capable of scanning the temperatures of 200 people in a minute, are equipped with infrared sensors that trigger an alarm if someone within a five metre radius has a fever. Further, the helmet’s sophisticated facial-recognition technology could display the person’s personal information (i.e. name, address) on a virtual screen within (You, 2020; McNiece, 2020).

Without outlier events such as COVID-19, the world may not have realised the significant strides China has made in AI, surveillance and data analytics technologies. To most observers, it is painful to contrast China’s sophisticated (albeit highly invasive) handling of the novel coronavirus vis-à-vis that of the US (the acknowledged global technological superpower) which stumbles even in finding the most basic materials (e.g. protective masks for healthcare professionals and ventilators needed to keep infected patients alive) needed to deal with this pandemic (McNeil, Jr., 2020). Consequently, the US has the greatest number of confirmed COVID-19 infected patients in the world, exceeding 140,000 (by the time of this article) and rising (Johns Hopkins University, 2020). To be fair, China’s medical infrastructure was also deeply stretched in the early days of COVID-19 (around January 2020), particularly in Wuhan, the country’s novel coronavirus epicentre (Hollingworths, et al., 2020). But through a combination of seemingly draconian lockdown measures augmented by a highly-sophisticated “AI Epidemiological Targeting” strategy, China quickly clamped down on the daily new infections. The “AI Epidemiological Targeting” strategy is not flawless, as its modus operandi is rooted in detecting COVID-19 symptoms but some carriers could be asymptomatic. As of 30 March, China has placed 1,541 people infected with the novel coronavirus but who do not exhibit symptoms under careful scrutiny; the actual number of such individuals is feared to be much larger (Bloomberg, 2020b); despite the relative sophistication of Chinese COVID-19 scanners and diagnostic equipment, it, like any other test, is not 100% accurate (Johnson, 2020). As evidenced in the following chart, the number of newly confirmed COVID-19 cases fell precipitously from a high of 2,641 in mid-February 2020 to a low of 31 by end March 2020 (Xinhua, 2020c). Of the 31 newly confirmed cases on 29 March 2020, only one was a locally transmitted case. These newly reported confirmed cases also indicated an improvement from the previous day, which recorded 45 cases (National Health Commission of the PRC, 2020a, b) (see Figure 1).
4. Rise of the drones

The relentless coverage of the deadly capabilities of militarised drones (particularly in the form of US-military air strikes) by global media outlets has perhaps obscured the life-saving potential of this emerging technology (Warrell, 2020). China, through this unfortunate pandemic, has showcased its immense disaster management and life-saving capabilities. Owing to the highly infectious and deadly nature [12] of COVID-19, some Chinese firms have started deploying autonomous technologies (i.e. drones) for contactless delivery, discharging disinfectants and the execution of basic diagnostic functions. For instance, Shenzhen-based Pudu Technology, which makes robots for the catering industry, has customised its technology and installed them in more than 40 hospitals across China to assist medical staff in delivering meals to patients (minimising exposure to patients and the possibility of infection) (Jakhar, 2020). Similarly, Qianxi Robotic Catering has also installed robots capable of preparing food for medical workers in Wuhan. Moreover, these robots are capable of removing trash, ensuring stricter hygiene standards in stressful periods, ravaged by an on-going pandemic. More sophisticated deployments of autonomous technologies are demonstrated by another Shenzhen-based MicroMultiCopter, which has used aerial drones to transport medical samples and conduct thermal imaging (Jakhar, 2020, Demaitre, 2020). To prevent further COVID-19 infections, Chinese tech companies such as XAG, an agricultural drone maker, has customised its drones (originally designed to disperse pesticides) to spray disinfecting chemicals in public spaces and on epidemic prevention vehicles commuting between novel coronavirus impacted areas (Yang and Reuter, 2020).
Moreover, drones, equipped with loudspeakers [13], have been used to admonish citizens wandering outdoors without protective face masks and disperse crowds, in the Chinese authorities’ concerted efforts to stem the spread of COVID-19 (Winsor, 2020). Despite the Orwellian overtones, China has leveraged its capabilities as the world’s largest drones maker [14] with great effect, ensuring that its citizens do not flout public health safety regulations; across many Chinese cities, regional authorities have made it compulsory to wear mask in public spaces (Lindberg and Murphy, 2020). Whilst such high-tech public shaming methods could possibly be appreciated (or at least tolerated) in the midst of a global pandemic, the problem lies with dialling back such measures when normalcy returns. Even if such seemingly intrusive measures are not dialled back, it may not matter much to the Chinese public, which unlike citizens in the West, have long grown accustomed to mass surveillance (Strittmatter, 2019).

5. Conclusion
The emergence of the global pandemic COVID-19 has provided an extensive albeit costly (considering both the significant death toll and economic devastation) case study on how AI and its accompanying ecosystem (e.g. deep learning, facial recognition software, drones and data analytics) could be deployed in large scale crisis management. China has, to a large degree, emerged as a leader in this regard (Obeidat, 2020). By contrast, the US, home to Silicon Valley (the world’s technology Mecca) has stumbled comparatively, having surpassed China as the epicentre of this devastating pandemic, with confirmed infections rising into the six figure region (Johns Hopkins University, 2020). By mid-March 2020, only a mere 11,000 people in the US had been tested for COVID-19, (nearly two months after the first confirmed case in the country), with the novel coronavirus having spread across 2,000 counties in the country (Pilkington, 2020; Ingraham, 2020). Conversely, by early March, Chinese tech companies such as BGI, through its “Huo Yan” laboratory solution (combines high-tech detection and diagnosis) were running 50,000 daily tests (with the capacity to increase to 80,000) across 12 Chinese cities (BGI, 2020).

The COVID-19 pandemic has unquestionably revealed to the world the significant strides China has made in AI, a progress made possible by its sizeable data pool. Researcher and venture capitalist, Lee Kai-Fu has argued that China enjoys a distinct “data edge” over the US, as it generates more data (includes behavioural pattern indicators such as consumer spending) than the US through its considerably more robust digital economy. This “data edge” is exemplified by the fact that China’s mobile payments overwhelmingly exceed that of the US by a factor of 50; China is the world’s largest e-commerce market with annual transaction values exceeding US$1 trillion (Allied Wallet, 2019). Further fuelling this “data edge” is the lack of privacy concerns amongst the 800 million-plus Internet users (98% access the web through their mobile phones) in China who generally seem not to mind trading their private data for convenience (McCarthy, 2018; Webster and Kim, 2018). However, China’s detractors often forget that Internet surveillance is quite commonplace, even in the US. There is relatively minimal public outrage, as the American public is often blissfully unaware of this intrusion. In the US, the National Security Agency (NSA) worked closely for over a decade (between 2003 and 2013) with US telecommunications giant, AT&T to scrutinise the vast amount of Internet traffic (includes billions of emails and wiretapping of Internet communications at the United Nations headquarters) passing through the US. This government intrusion was only uncovered through the whistle blowing efforts of former NSA contractor, Edward Snowden (Angwin et al., 2015).

Despite the technological brilliance of China’s high-tech campaign to eradicate COVID-19, it is still some distance from achieving its full potential. The recurrence of COVID-19 in Beijing in June 2020 is indicative of the gaps in this strategy and the need for continuous
vigilance of a coronavirus whose pathogenesis we barely understand. If we do not understand COVID-19’s pathogenesis (i.e. the root of the virus), it would be extremely difficult to stay ahead of the curve with regard to treating this coronavirus and developing a suitable vaccine. Despite the scientific community’s limited knowledge on COVID-19, China, through its highly effective high-tech strategy, has managed to contain this second wave of COVID-19 infections within three weeks with no fatalities (Campbell, 2020). Notwithstanding the setback (i.e. the second wave of COVID-19 infections in Beijing), the increasing deployment of AI in the development of COVID-19 vaccines has undeniably greatly expedited the chances of eradicating this particular strain of coronavirus, with human clinical trials (using AI-designed vaccines) being carried out in Australia in early July 2020 (Clinical Trials Arena, 2020). If China wishes to maintain its lead in spearheading global efforts to eradicate COVID-19, it would do well by dedicating more resources for developing a proven vaccine through the application of its vast AI capabilities.

Notes
1. Coronaviruses refer to viruses that have particles exhibiting crown-like characteristics (i.e. corona means crown in Latin), and they cause respiratory illnesses with varying degrees of severity ranging from the common cold to deadly pneumonia. The family of coronaviruses includes COVID-19, SARS and MERS (Middle East Respiratory Syndrome) (Auwaerter, 2020). For COVID-19, the common signs of infection encompass dry cough, fatigue, fever, headache, nausea, shortness of breath, sputum production, myalgia or arthralgia and sore throat. In severe COVID-19 cases, the infection could result in pneumonia, kidney failure and even death (WHO, 2020a, b).
2. Russian leader, Vladimir Putin puts it succinctly: “Artificial intelligence is the future, not only for Russia, but for all humankind. It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world” (RT, 2017).
3. In 333 BC, Alexander the Great cut the intractable “Gordian knot” with his sword. This supposedly resulted in the expression “cutting the Gordian knot”, which meant a direct and spirited solution to an intractable problem (Britannica, 2019). In this paper, the problem at hand would be the creation of AI, a challenge of unrivalled technological complexity. The cutting of this “AI Gordian Knot” would grant the promethean capacity to change the world in every aspect of our lives from economics to warfare.
4. Big data refers to data encapsulating greater variety, which outpours in increasing volumes at ever-increasing speeds (Oracle, 2020).
5. Epidemiology is the study of the genesis and determinants of diseases, bringing together teams of physicians, statisticians, laboratory scientists, epidemiologists and public health professionals (Centers for Disease Control and Prevention, 2020).
6. Deep learning enables computers to develop complex concepts, using relatively simpler concepts as a base. Large data sets are often required to facilitate deep learning (Goodfellow et al., 2016).
7. These hospitals have isolation units, ventilation systems and infrared scanners (McDonald, 2020).
8. Built in 2010, the Tianhe-1 Supercomputer is China’s first petaflop computer. Being petaflop means the supercomputer is capable of conducting at least one quadrillion calculations per second (Xinhua, 2020b).
9. Contact tracing involves identifying and monitoring individuals who have been in close contact with those infected by a virus (WHO, 2020).
10. Green suggests that the person is fine while yellow indicates that the individual had contact with the infected and has yet to complete two week quarantine. Red indicates that the person was confirmed with COVID-19 or exhibiting symptoms and waiting for the diagnosis (New Zealand Herald, 2020).
11. Computer vision refers to the deployment of computer systems to describe our physical world in terms of images and illustrate its characteristics (i.e. colour distributions, illumination and shape).
The perception of physical characteristics which we, human beings, perform easily is a complex and error-prone task for computers (Szeliski, 2011).

12. An infected COVID-19 victim infects between 2 and 2.5 others, a reproduction rate that is approximately twice as high as seasonal flu, which generally infects 1.3 new people for each patient (Biggerstaff et al., 2014). Currently, COVID-19 has an estimated mortality rate of at least 10 people per thousand infected (1%) while the seasonal flu has a much lower rate of one per thousand infected (Huang, 2020).

13. These high-tech drones not only have loudspeakers but also come replete with high-definition zoom lenses, thermal sensors and chemical spray jets for disinfecting entire areas (Liu, 2020).

14. The 360 drone manufacturers (includes the world's largest drone maker, DJI) housed in China’s drone capital, Shenzhen, account for 70% of the world’s civilian drones (Kesteloo, 2020).

References


**Corresponding author**
Wilson Kia Onn Wong can be contacted at: wilsonwong@ctbc.edu.tw