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China's Use of AI in its COVID-19 Response

CSET Data Brief

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Introduction and Summary

Xi Jinping has made artificial intelligence a primary focus of China's innovation and high-tech development since 2012. Policies released under his leadership touch on various aspects of AI, from military applications to manufacturing, ecological preservation, and healthcare. High-level guiding policies like the 2017 "Next Generation Artificial Intelligence Development Plan" (新一代人工智能发展规划) call for increased AI usage in the development of intelligent medical care and health and elder care systems.[1]

The emergence of COVID-19 in December 2019 has amplified these efforts, as Chinese companies of all sizes across AI-related sectors have developed and retooled AI systems for epidemic control and prevention. The State Council's June 2020 White Paper, entitled "Fighting COVID-19: China in Action," states that China has "fully utilized" artificial intelligence to not only research, analyze, and forecast COVID-19 trends and developments, but also to track infected persons, identify risk groups, and facilitate the resumption of normal business operations.[2]

This CSET data brief summarizes findings from a March 2020 report entitled "Example Applications of Digital Health Technology for Epidemic Prevention and Control (Third Phase)" (数字健康技术病情防空应用案例集（第三期）), published by the China Academy of Information and Communication Technology (中国信息通信研究院; 中国信通院; CAICT)—a think tank under the PRC's Ministry of Industry and Information Technology (工业和信息化部; MIIT). The CAICT paper is a compilation of selected news reports from WeChat and official Chinese state-run media sources, company press releases, and academic journals highlighted by CAICT's Center for Research on Medical and Health Big Data and Networks (医疗健康大数据和网络研究中心) for their contributions during the COVID-19 outbreak. This issue brief offers a high-level assessment of the types of AI technologies used to fight COVID-19 and the key players involved in this industry, according to CAICT assessments.

The tools and systems described in the CAICT report appear to address technological and logistical pandemic response challenges, including difficulties in case-by-case investigation, prevention, and control for "grassroots" case investigators;[3] patient rehabilitation tracking and management;[4] tracing close contacts of sick individuals; epidemic-related misinformation; medication consumption problems; supply mismanagement; and overworked doctors and understaffed hospitals.

Key findings from this analysis include the following:

- The artificial intelligence work described in the CAICT report spans across several AI-related fields, including surveillance, medical imaging, robotics, and human-computer interaction.
- Companies included in the CAICT report range from large-scale, state-owned enterprises to newer, smaller firms. Both types of companies receive similar praise for their efforts in epidemic prevention.
- In addition to prioritizing AI in hospital and medical settings, China is working to incorporate AI healthcare tools into business and everyday life as a means to find safe solutions for returning to full functionality in the post-COVID-19 era.
- Most AI-related epidemic prevention and control work highlighted in the CAICT report takes place in larger cities—primarily in Wuhan, where the outbreak emerged.
- Three highlighted companies are on the U.S. Department of Commerce Bureau of Industry and Security's (BIS) Entity List: Yitu Technology, CloudMinds, and iFlytek.

This brief focuses on a section of the CAICT report examining use cases of artificial intelligence combating COVID-19. It presents an analysis of the technologies highlighted under five categories: surveillance, public health monitoring, medical imaging, robotics, and human-computer interaction, explored in depth below. These categories were chosen based on an assessment of the technologies presented by CAICT. It also examines the underlying commercial ecosystem.

Surveillance

Already a prominent tool in Beijing's toolkit, surveillance technology has played an important role in China's handling of COVID-19. This has involved efforts to observe and track sick individuals as well as monitor vascular conditions and body temperature. The key entities highlighted by the CAICT report that provided surveillance-related AI tools are:

Key Players

4Paradigm (第四范式) is a Beijing-based startup founded in 2014 by former Baidu employees. It focuses on AI and machine learning software to improve efficiency for companies/organizations via "mitigation learning."[5]

Potevio (北京普天) is a Chinese wholly-owned state-owned enterprise focused on information and telecommunications technology. It was founded in Beijing in 1991.[6]

Airdoc is a Beijing-based company focused on AI and machine learning solutions for the healthcare industry. It was founded in 2015.[7]

Beijing SEEMMO Technology (北京深晶科技) is a Beijing-based company founded in 2012. It specializes in image analysis technology via computer vision.[8] The Chinese language version of its website claims customers have included the Public Security Bureaus in Tongxiang (Zhejiang), Xinxiang (Henan), Linyi (Shandong), and Xi'an (Shaanxi).[9] The English language version appears to have been shut down as of June 2020.

In response to the outbreak, Chinese state and non-state entities have stepped up efforts to provide hospitals and local authorities with AI-based surveillance technology, seeking to improve monitoring and tracking of sick individuals in medical and non-medical environments.

- 4Paradigm partnered with Nanjing Hospital and the Northern Jiangsu People's Hospital to achieve more accurate and efficient transmission source-tracing. According to CAICT, the team used machine learning technology to build a "data-driven coronavirus transmission digital twin (数字孪生) system," combined with patient information, to monitor and trace possible transmission sources.[10]

- 4Paradigm's AI solution for epidemiological deduction and virus source tracing allegedly improves population coverage and screening accuracy, helping find and "cut off" sources of outbreaks. 4Paradigm also claims to use AI to "enrich existing rule-based models for prevention and control screening, further improving population coverage."[11]
- According to CAICT, Beijing-based Potevio's (中国普天) "AI Close Contact Catcher" (AI密接捕手) utilizes a convolutional neural network (CNN) by means of "cross-camera pedestrian re-identification technology ("行人夸镜头重识别技术")—allowing them to search large amounts of video footage.[12]
    - CAICT claims that, relying on a single photo of a pedestrian target, the "AI Close Contact Catcher" can "efficiently and accurately retrieve and identify a target individual from a vast amount of video surveillance images, then depict trajectories in space and time."[13] This eliminates the need to monitor multiple surveillance screens for long periods of time.
    - Among its many capabilities, the CAICT report notes that Potevio's system uses pedestrian detection and position redetermination technology without relying on facial features. It can reportedly discover "unauthorized abnormal behaviors" by quarantined individuals and carry out real-time warning.[14]

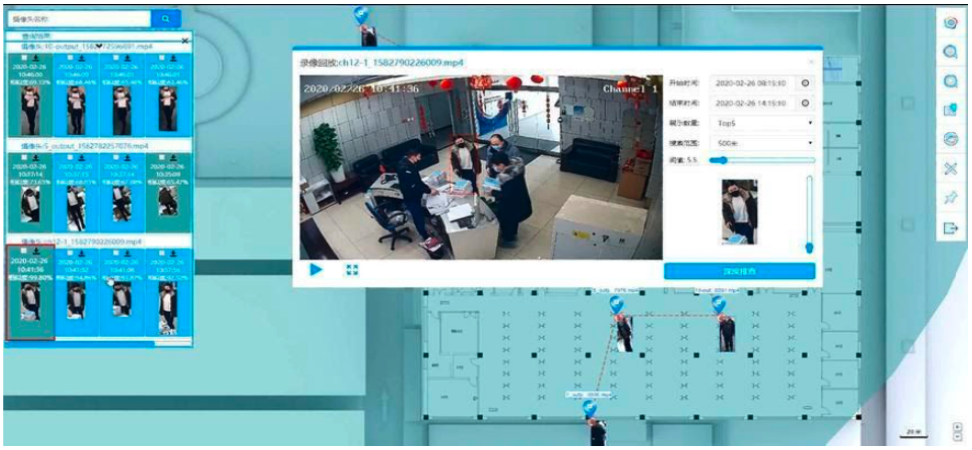

Figure 1: Potevio's "AI Close Contact Catcher." Source: CAICT[15]

A different type of intelligent surveillance applications is illustrated by companies such as Airdoc and Beijing SEEMMO Technology that have produced intelligent devices that monitor and sense vascular conditions and body temperature, in conjunction with video surveillance and facial recognition technology, as part of their efforts to combat COVID-19.

- Due to state-owned Jiangsu Sunshine Group's (江苏阳光集团) position as a key industry leader in textiles, garments, biotech and pharmaceuticals, medical devices, and more, according to CAICT, the company needed to remain open throughout the epidemic in order to produce personal protective equipment (PPE). Sunshine Group therefore partnered with AI medical care solutions provider Airdoc to carry out case-by-case risk analysis of its employees before returning to work.[16]
- CAICT claims Airdoc's solution uses intelligent devices, including retinal scanners and AI sensors, to assess employees' vascular condition, body temperature, heart rate, breathing, and other data, alongside data on employees' recent behavior, to quickly and effectively review the risks of employees returning to work.[17]
- Beijing SEEMMO Technology (北京深晶科技), which is based in Zhongguancun,[18] developed THOR, an intelligent temperature measurement and early warning system that employs high-precision body temperature cameras alongside intelligent facial detection, target tracking, and facial recognition algorithms to "automatically take and record the temperatures of people at all access monitoring points, without contact or sensation."[19]
- SEEMMO CEO Chen Ruijun (陈瑞军) claims that the system can take the temperatures of 100 people per minute, and that it is already being deployed in communities, parks, campuses, subways, bus stations, airports, and other crowded public areas.[20]

Medical Imaging

The application of AI to medical imaging is an active area of research and application in globally; thus, it is unsurprising that CAICT has chosen to highlight how various companies are applying AI to deal with various medical imaging challenges related to COVID-19. Prominent companies working in this field include the following:

Key Players

Beijing Infervision Technology (北京推想科技有限公司) is a Beijing-based late firm founded in 2015. It uses deep learning technology and computer vision to help diagnose cancer and other diseases.[21] As of March 2020, the company claims to have expanded service beyond China to include North America, the Asia-Pacific, and Europe.[22]

Beijing Kunlun Medical Technology (CuraCloud; 北京昆仑医云科技有限公司) is a Beijing-based international medical AI R&D company focused on developing software for medical devices.[23] It was founded in 2016.[24] The company also maintains an office in Seattle.[25]

Keya Imaging (科亚医疗)[26] is a Beijing and Shenzhen-based company focused on utilizing AI to improve medical imaging. According to its official website, Keya Imaging researchers have earned advanced degrees from U.S. universities, including Yale, Cornell, Duke, and the University of North Carolina,[27] and its advisors have connections to the Chinese Ministry of Health and the Johns Hopkins Hospital.[28]

United Imaging (上海联影医疗科技有限公司) is a Shanghai-based firm founded in 2010 that focuses on developing medical imaging diagnostic products.[29] The company maintains connections with several branches of the Chinese Academy of Sciences, including those in Shanghai* and Shenzhen.[30] It also maintains R&D centers in Cleveland, Houston, and Concord, CA.[31]

Yitu Technology (依图科技) is a Shanghai-based firm that specializes in AI technologies for industrial applications. It was designated a member of China's "National AI Team" in 2019.[32] Founded in 2012, its facial recognition technology has been deployed by large Chinese firms, including China Merchants Bank.[33] In October 2019, Yitu was added to the U.S. Department of Commerce Bureau of Industry and Security (BIS) Entity List.[34]

Chinese firms are working to develop new software solutions for detecting and monitoring COVID-19 cases by incorporating AI software into medical imaging technology. Most of the AI-based imaging technologies mentioned in the CAICT report claim to utilize lung CT scans to assist radiology

* United Imaging has visited and/or partnered with CAS' Shanghai Institute of Biochemistry and Cell Biology, Shenzhen Institutes of Advanced Technology, and the Shanghai Institute of Advanced Research.

departments with the speed and efficiency of diagnostics. However, the system developed by United Imaging appears to go further by aiming to improve the experience for both patients and doctors.

- Beijing Infervision Technology developed software that can look for symptoms and features associated with COVID-19 in CT scans. Infervision's algorithm can allegedly "spot characteristics of COVID-19, as distinct from other respiratory infections, in lung images..."[35] The software has been deployed to 34 hospitals across China, including the Zhongnan Hospital at Wuhan University.[36] The report quotes Professor Xu Haibo (徐海波), Chair of the Zhongnan Hospital Department of Radiology, as saying the software "has helped overworked medical staff screen patients and prioritize those most likely to have COVID-19 as key screening targets for further examination and testing."[37]

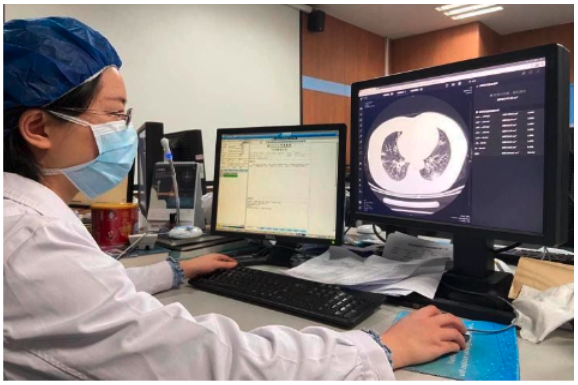

Figure 2: Infervision software in use at Zhongnan Hospital. Source: CAICT[38]

- Similar to Infervision's software, Beijing Kunlun's "Smart Pneumonia Diagnostic Assistance System" has been utilized to detect pneumonia using lung CT scans. Kunlun's software, jointly designed by Kunlun subsidiary Keya Imaging, was donated to hospitals in Hubei, Guangdong, Sichuan, Shandong, and other areas.[39]
- Along the same lines, Yitu Technology established their "Intelligent Evaluation System for COVID-19" that can allegedly perform "quantitative analysis, efficacy evaluation, and prognosis" for COVID-19 related lesions in chest CT images. The system launched at the Shanghai Public Health Clinical Center; since coming online on February 21, the CAICT report states that it has served 93 percent of confirmed COVID-19 patients in Shanghai. The report also claims that Yitu's system is the industry's first AI-based imaging product for the intelligent assessment of coronaviral pneumonia.[40]

- United Imaging, meanwhile, rolled out its "United Imaging Temporary Hospital CT Emergency Radiology Department," which CAICT calls a "rapid, flexible, and intelligent full-process radiology department."[41] It reportedly reduces the infection risk for doctors by allowing contactless CT scanning, and has been deployed at multiple locations across Wuhan.[†]

Robotics

Many companies across China are working to minimize human exposure to COVID-19 by using robots instead of humans in high-risk areas. CAICT chose to highlight Chinese firms that are not only deploying their robotics technology within hospitals and medical facilities, but also utilizing robots to improve efficiencies in monitoring the pandemic. The firms discussed in the CAICT report are as follows:

Key Players

Wuzhu Technology (五竹科技有限公司) is a Tianjin-based enterprise founded in 2017. It specializes in software development, robotics, and artificial intelligence.[42] Very little information exists in open sources about this company; however, it does appear to have participated in exercises orchestrated by the China's Artificial Intelligence Industry Alliance (AIIA; 中国人工智能产业发展联盟).[43]

TMiRob (上海钛米及其人股份有限公司) was founded in Shanghai in 2015.[44] It focuses on developing medical robots.[45]

CloudMinds (达闼科技) is a Beijing-based robotics company founded in 2015, with a secondary location in Santa Clara, CA that closed in January 2020.[46] In May 2020, CloudMinds was added to the BIS Entity List for "engaging in activities contrary to the national security or foreign policy interests of the United States."[47]

AUBO Robotics (遨博智能科技有限公司) is a developer of lightweight collaborative robots.[48] Founded in Beijing in 2015, the company's website

[†] The "United Imaging Temporary Hospital CT Emergency Radiology Department" has been deployed at the the Jianghan Temporary Hospital located at the former Wuhan International Conference and Exhibition Center, as well as temporary hospitals at Wuhan's Hongshan Stadium, Hanyang International Expo Center, and the Tazihu Sports Center.

claims that it is "China's first national high-tech enterprise dedicated to the research and development of independent and controllable collaborative robots," and that it has "presided over the formulation of national standards for collaborative robots."[49] In 2014, AUBO opened a research facility in Knoxville, TN, originally under the name Smokie Robotics. The company was formerly located at the University of Tennessee Research Foundation Business Incubator and, in 2018, moved to a new facility on the University of Tennessee's Cherokee Farm Innovation Campus.[50]

Keenon Robotics (上海擎朗智能科技有限公司) is a Shanghai-based enterprise founded in 2010. It focuses on the development of indoor unmanned distribution robots, according to its website.[51]

Shanghai Mumu Robot (上海木木机器人技术有限公司) is a developer of domestic service robots founded in 2014.[52] Mumu Robot is a member of the China Mobile Robot Industry Alliance (中国移动机器人 (AGV) 产业联盟).[53]

The CAICT report describes how Chinese robotics firms are working to incorporate their intelligent robotics products into the domestic healthcare industry to combat COVID-19. Robots are being used to provide everything from disinfection services and fever screenings to contactless meal deliveries.

- Wuzhu Technology developed "epidemic robots" (病情机器人) to "help grassroots organizations make large-scale improvements" in curtailing the COVID-19 outbreak by utilizing self-learning AI technology that allows for, 1) policy announcements to be made to entire populations; 2) case-by-case investigation of entire populations; 3) regular closed-loop tracking of patient groups; 4) social sampling surveys; and 5) automated data collection and analysis for medical institutions.[54]
- The CAICT report notes that the Langfang City (Hebei) Health Commission utilized Wuzhu Technology's epidemic robots to assist in creating a health hotline number to survey individuals in the area about symptoms and travel history. The system was also deployed by the Guangzhou branch of state-owned China Unicom to create a telephone call-back using big data-based intelligent voice technology. This joint solution by Wuzhu and China Unicom was rolled out to health commission and sub-district offices in the Baiyun and Conghua districts of Guangzhou.[55]

- Several Chinese robotics companies have deployed their intelligent robot systems to help with more menial tasks. TMiRob and CloudMinds developed intelligent robots that have been providing services, such as mobile disinfection, materials distribution and recycling, fever screenings, and isolation ward services. The CAICT report states that TMiRob as of March 2020 had already introduced 60 disinfection robots into hospitals in Hubei Province and across China. In addition, CAICT claims that more than 100 Keenon Robotics' meal delivery robots have been deployed at key hospitals in Hubei, Shanghai, Beijing, Chongqing, and other locations.[56]
- Shanghai Mumu Robot has allegedly deployed dozens of its "Noah Robots" (诺亚物流机器人) across Wuhan. The CAICT report notes that the Noah Robots at Wuhan Asia General Hospital have been divided between operating rooms, the pharmacy, the central supply room, and the anesthesiology department to provide logistical support.[57]

Figure 3: Noah Robot assisting a doctor during COVID-19
Source: China S&T Daily[58]

Human-Computer Interaction

Throughout the COVID-19 outbreak, human-computer interaction has sought to reduce transmission, not only between doctors and patients, but also throughout Chinese society. In the months following the outbreak's peak, we may continue to see the deployment of HCI-oriented technologies across China, both within and outside medical establishments.

Key Players

Beijing Unisound Information Technology (北京云知智能科技股份有限公司) was founded in 2012 and focuses on intelligent voice technology.[59]

iFlytek (可达讯飞) is a partially state-owned[60] Chinese company founded in 1999 out of Hong Kong University of Science and Technology. iFlytek is also a member of China's "National AI Team."[61] In October 2019, iFlytek was added to the BIS Entity list.[62]

Futong Dongfang Technology (北京富通东方科技有限公司) is a Beijing-based software and equipment company founded in 2003 by Hong Kong-based Futong Technology Development Holdings.[63]

Yunji Technology (北京云迹科技有限公司) is a Beijing-based firm established in 2014. It specializes in robots and big data processing.[64]

The majority of HCI-based technologies recognized in the CAICT report appears to center around intelligent voice systems, as these allow for increased efficiency in hospitals and less human contact with commonly-used surfaces that may harbor germs. However, other intelligent HCI systems are being used to provide medical analyses to lessen the burden on overworked medical staff.

- Several Chinese firms have launched intelligent voice systems to assist in COVID-19 control and prevention. Beijing Unisound's "intelligent voice-based electronic case system" has been deployed across COVID-19-designated hospitals in Xiamen, Guangxi, Beijing, and other areas.[65] Similarly, iFlytek developed the "e-chart" (电子病历) intelligent voice entry system to assist the Wuhan Keting temporary hospital. The system uses speech recognition and semantic understanding to allow doctors to orally dictate medical case records.[66]

- Futong Dongfang created the Intelligent Guidance product—an AI engine that applies accurate and intelligent medical consultation guidance services to improve efficiency in hospitals. The system claims to use natural language processing, cognitive computing, and application microservices architecture; it has been going through pilot testing in Beijing.[67]
- Apart from medical establishments, Yunji Technology has developed contact-free voice-controlled elevators that require passengers to scan a QR code and open an app to summon an elevator by voice on their phones and select a floor. According to the head of Yunji, the app uses IoT and voice interaction technology.[68]

Conclusion

China's prioritization of healthcare-related AI will continue beyond the scope of COVID-19; therefore, further analysis of these developments is required. Meanwhile, as the world continues to grapple with the pandemic, some of the technologies cited by CAICT should act as inspiration for other high-tech firms, as many appear to provide necessary services such as assistance for healthcare professionals, improved efficiency in hospitals, and precautionary measures for returning to normal business operations. However, policymakers, entrepreneurs, and tech firms worldwide should pay attention to the cases discussed in this report that may present issues associated with misuse of personal data, surveillance and privacy, and dual-use capabilities. Furthermore, the fact that the aforementioned companies have been highlighted by CAICT is noteworthy in itself, as it may suggest a stronger relationship with the PRC government now and going forward.

There are also notable gaps in the evidence provided by CAICT. The CAICT report does not comment on the surveillance work of larger Chinese firms, such as Alibaba and its Health Code tracker app, that have received significant coverage in Western media. Furthermore, although the report briefly touches AI that may appear to violate privacy issues as presented in the Potevio case, it does not include more prominent cases such as Xiaomi's "smart doorbell"-like device that can allegedly notify local officials when individuals break self-assigned quarantine.[69] Therefore, it is important to acknowledge that the information presented by CAICT is not all-inclusive and may avoid more controversial companies and technologies.

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