

COVID-19 Pandemic: A Brief Review on How Computer Science and Information Technology Can Help Shape the Future of Food Safety

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Received: September 22, 2021; **Accepted:** September 29, 2021; **Published:** October 02, 2021

Citation: Pellegrini M (2021) COVID-19 Pandemic: A Brief Review on How Computer Science and Information Technology Can Help Shape the Future of Food Safety. *Clar J Infect Dis Ther* 02(01): 86–90.

Abstract

The COVID-19 pandemic is affecting all businesses and the food industry in particular, posing new challenges for the next future. In a short time, industry had to deal with new plans and protocols in order to reduce the risk of exposure to the coronavirus ensuring that employees remain healthy. This meant introducing distancing measures, updating Personal Protective Equipment (PPE) requirements, wiping down surfaces and equipment on a regular basis and adapting delivery procedures. In addition to issues that are affecting all businesses, food industry has and will have additional challenges to deal with. People will always need to eat and so safe, high quality food must still be produced and provided to customers.

Food safety represents the primary concern of all manufacturers, but this should now encompass actions to slow down, as much as possible, the spread of the coronavirus. Even though there is no evidence that the virus can be transmitted via food or food packaging, there is evidence that it can remain viable on certain surfaces for a longer period. The present paper reports a brief review on how the profitable combination of computer science and information technology can help shape the future of food safety.

The literature review has been conducted by considering scientific contributions and official resources published by the main international governmental organizations and technical institutions. Some of the cited sources include World Health Organization (WHO), Food and Agriculture Organization (FAO), International Telecommunication Union (ITU) and the Institute of Electrical and Electronics Engineers (IEEE). As the COVID-19 pandemic is unprecedented and still ongoing around the world to date, the literature review was limited to contributions published no more than two years ago.

Information and communication technology (ICT) and computer science applications are already present in industry. Despite this, the challenges the world will have to face in the next future to stem the spread of the COVID-19 pandemic require further interdisciplinary and synergistic efforts. In this framework, technology can play a key role in help shaping the future of industry and food safety in particular.

Introduction

The COVID-19 disease is having an unprecedented worldwide impact in health and socioeconomic terms; according to data provided by Johns Hopkins University [1], by 2020, September 21, the number of global cases

passed 31 million with more than 960,000 deaths. Furthermore, the pandemic is certainly having an unprecedented impact also on food systems. This is what ITU, the United Nations' specialized agency for ICT, reported on its online resource ITU News [2].

WHO declared COVID-19 disease a public health emergency of international concern on 2020, January 30 [3]. The 2020 edition of the Global Report on Food Crises (GRFC) [4], published on 2020, April 20 as the result of a joint, consensus-based assessment of acute food insecurity situations around the world, describes the worldwide scale of acute hunger. GRFC-2020 provides an analysis of the drivers that are contributing to food crises across the globe, and examines how the COVID-19 pandemic might contribute to their perpetuation or deterioration. When comparing the 50 countries taken into account in both the 2019 and the 2020 reports, the population in crisis rose from 112 to 123 million. This reflected worsening acute food insecurity in key conflict-driven crises and the growing severity of drought and economic shocks. Around 183 million people in 47 countries were classified in stressed conditions, at risk of slipping into crisis or worse. As stated by Antonio Guterres, Secretary-General of the United Nations (UN) and reported on GRFC-2020 [4], the upheaval that has been set in motion by the COVID-19 pandemic may push even more families and communities into deeper distress.

Even before COVID-19 began to affect food systems and agricultural livelihoods, the 55 countries and territories that are home to 135 million people were already facing acute food insecurity [2, 4]. Such people are in need of urgent humanitarian food and nutrition assistance and are the most vulnerable to the consequences of this pandemic as they have very limited or no capacity to cope with either the health or socioeconomic aspects of the shock. Rising levels of food insecurity and lack of access to healthcare are likely to increase malnutrition rates. On the food supply side, movement restrictions necessary to contain the spread of the virus will disrupt the transport and processing of food and other critical goods, increasing delivery times and reducing availability of even the most basic food items [4].

Conclusions of GRFC-2020 state that, given the unprecedented nature of COVID-19 crisis, taking rapid collective action to pre-empt its impact on food security and food systems is of paramount importance and urgency. In particular, anticipatory actions have to be undertaken to safeguard the livelihoods of the most vulnerable people and related agri-food systems to protect the critical food

supply chain. Early actions for mitigation include, among others, expanding near-real time, remote food security monitoring systems to provide up-to-date information on the impacts of the outbreak on food security and livelihoods, health, access to services, markets and supply chains [4].

In this framework ICT, applied computer science and artificial intelligence (AI) will support sustainable development worldwide and in particular can play a key role in help shaping the future of food safety. The aim of the present work is outlining how state-of-the-art and trends of such technologies could be useful for the whole agri-food sector.

Survey Methodology

As the coronavirus pandemic is unprecedented, the present work aimed to review scientific contributions and official resources published no more than two years ago.

ICT and AI are already helping in agriculture and food engineering [5]: picking vegetables, controlling pest infestations, soil and crop health monitoring and predictive analysis are only a few examples. Improving food traceability as well as the efficiency that can be gained through robotics, automation and digitization in supply chain logistics are some of key requirements for the near future of food safety. Indeed, notwithstanding the essential role of farm, factory and food workers, it is recognized that any human interaction with the food value chain, at least in the context of a virus, presents some risk [2].

COVID-19 is a respiratory illness and the most recent advice from the WHO [6] is that current evidence indicates that the primary transmission route of COVID-19 virus is through person-to-person contact and through direct contact with respiratory droplets generated when an infected person coughs or sneezes. There is no evidence to date of viruses that cause respiratory illnesses being transmitted via food or food packaging. Coronaviruses cannot multiply in food; they need an animal or human host to multiply. The virus can spread directly from person-to-person when a COVID-19 case coughs or sneezes, producing droplets that reach the nose, mouth, or eyes of another person [7].

Alternatively, as the respiratory droplets are too heavy to be airborne, they land on objects and surfaces surrounding the infected person. It is possible that someone may become infected by touching a contaminated surface, object, or the hand of an infected person and then touching their own mouth, nose, or eyes. This can happen, for instance, when touching door knobs or shaking hands and then touching the face [7].

Recent research evaluated the survival of the COVID-19 virus on different surfaces and reported that the virus can remain viable for up to 72 hours on plastic and stainless steel, up to four hours on copper, and up to 24 hours on cardboard [8]. Then, it is imperative for the food industry to reinforce personal hygiene measures and provide refresher training on food hygiene principles to eliminate or reduce the risk of food surfaces and food packaging materials becoming contaminated with the virus from food workers.

Results

Properly disinfecting public spaces can help stop the spread of coronavirus protecting workers' health but if cleaning crews do not wear appropriate PPE, they themselves are at risk for infection. PPEs such as masks and gloves can be effective in reducing the spread of viruses and disease within the food industry, but only if used properly [7]. A disinfecting robotic arm that uses an ultraviolet (UV) light sanitizer to clean contaminated areas is being perfected at University of Southern California in Los Angeles [9]. Cameras mounted on the robotic arm help the operator, located away from the contaminated area, to navigate the robot. The robot scans the surroundings also using infrared (IR) radiation to determine their depth and then builds a 3D model of the area. Using a gripper, the robotic arm is able to open drawers and closets, and manipulate objects to perform a thorough sanitization of hard-to-reach surfaces.

Thermal imaging cameras represent a fast, contactless, and reliable method to detect a fever, a common symptom of COVID-19. IEEE members are working on projects that aim to improve the technology used in these cameras so they can be used in public spaces and commercial buildings to provide fast individual screenings to help stop the spread of the virus. Thermographic cameras

used in the healthcare field must meet specific standards. For example, the screening technology must have a measurement accuracy of ± 0.5 °C; several manufacturers of such cameras are not following those requirements. Then, software is being developed to help cameras meet technical standards required by the healthcare industry [10]. The cameras have infrared temperature sensors and motorized focus, which are controlled by the software's system operator. The temperature sensors detect electromagnetic waves from the person and the motorized focus allows the camera's operator to zoom in and out.

A team of researchers at Thailand's National Electronics and Computer Technology Center has built a temperature-screening system that can examine up to nine people at a time. More places are screening people so the ability to scan several at once could eliminate waiting lines [11]. The system combines a visible camera and a thermal imaging camera. It is equipped with features such as light detection and ranging (Lidar) remote sensing methodology and facial recognition [12], which can be used with or without a facial covering, to determine where a person is standing in the camera's field of view. The system also uses an algorithm that compensates for distance shift that happens with traditional thermal-imaging-based temperature scanners. Distance shift occurs when several individuals being checked are not at the same measuring distance, leading to a fluctuation in temperature measurements. Measurements from the Lidar and other inputs are used to compensate for variations in distance between an individual and the scanner.

AI has been employed against infectious diseases having the ability to rapidly track, analyze, and diagnose various infectious processes in real time [13]. The ability of AI technology to augment decision-making processes is due to the speed of pattern recognition and the robust amount of data that are digested and analyzed for optimal outcomes.

Augmented reality (AR), an interactive experience where real objects are enhanced by computer-generated perceptual information, has been widely used as an instructional tool to help the user to perform the task in real world conditions [14]. Recent advancements in AR have helped assisting operators in industrial safety applications in a control room environment by providing extra information in the decision making process [15].

AI, Internet of things (IoT) and the resulting massive amount of streaming data, often referred to as Big Data, are having a disruptive role in food quality assessment (using sensor fusion), food safety (using gene sequencing and block chain-based digital traceability), agriculture (including intelligent farm machines and drone-based crop imaging), and finally supply-chain modernization [16].

Mixed reality (MR) is a hybrid reality where real and virtual objects are merged to produce an enriched interactive environment [14]; in 2019, software taking advantage of AR and MR has been used to monitor pathogens such as *Salmonella* and *Listeria* on surfaces in factories more efficiently than paper-based monitoring methods [17]. Software taps AI to identify areas inside manufacturing plants where bacteria could be present and grow. This information is then uploaded to a cloud-based task management system; it can also be presented in real time through a MR headset, allowing the user to track and add information whilst walking the factory floor. Following the COVID-19 outbreak, such software has been updated for tracking the virus on surfaces with the same accuracy and efficiency demonstrated for other pathogens [18].

Conclusion

ICT, AI and in general computer-based solutions will drive technology in helping food and beverage producers protect their employees and plants against COVID-19 contamination by detecting and tracking the virus on surfaces as well as body temperature to identify a fever.

However, since there are dangers embedded within the adoption of any digital technology, the current pandemic is liable to make these dangers worse. Security issues, for example, still plague the massive amounts of data generated online every day. As ICTs are clearly central to the many ways people will respond to the COVID-19 crisis, how to best safeguard the data such technologies produce will hinge on the answers to three main questions: what is too important in our every-day life to take place online? Who will protect data that needs to be stored and shared for contact tracing? Who will be held liable if such new data is left vulnerable, stolen or exploited?

Future directions in the response to the COVID-19 pandemic will also have to take into account human-technology relationship as the latter is mediated by the political and institutional context in which technology is implemented.

Acknowledgement

The author would like to acknowledge healthcare workers on the frontlines of battling coronavirus disease worldwide.

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