Multimedia Research for Response and Management of COVID-19 and Future Pandemics

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Coronavirus Disease 2019 (COVID-19) has been affecting most of the countries and impacting almost every aspect of people's lives. More than one hundred million confirmed cases and two million deaths have been reported due to COVID-19 as of February 2021. While our society suffers an unanticipated epidemic, researchers and engineers have developed various technologies to manage this global emergency. Specifically, multimedia tools, techniques, and applications have been developed and played essential roles in facilitating the recovery, resilience, and management of COVID-19, including pandemic status monitoring and impact prediction, enhancing public awareness and telehealth, etc. However, there are many challenges that require further investigation and research to better manage COVID-19 and prepare for future pandemics.

COVID-19 is caused by a highly contagious coronavirus known as SARS-CoV-2, which makes it very difficult to control its spread. Hence, policies, such as quarantine, lockdowns, mask mandates, etc., are put in place to prevent the rapid dissemination of the virus by limiting in-person contacts and exposure to the virus. Multimedia tools and techniques also play important roles in the response and management of COVID-19. For example, most of the people obtain knowledge regarding COVID-19 and self-protection from multimedia data including video, image, etc. Meanwhile, researchers have been trying to develop advanced multimedia techniques and tools to address challenges in the response and management of COVID-19 and preparation for future pandemics.

In addition to understanding COVID-19, it is also critical to make the general public aware of the status of the pandemic. Scientists and research institutions have collaborated to develop tools to deliver information about COVID-19 to the general population and make them easy to understand. Thematic maps are publicized as one of the easiest ways to comprehend the disease's spatial spread, which has been essential to educate people and instruct life-saving decision-makers.[1] Similarly, images, videos, and texts are produced and shared via social media, such as Twitter and YouTube, to educate citizens by explaining information and knowledge about COVID-19, pandemic, transmission, and self-protection methods. However, it has been found that information shared on the Internet can be false or misleading, and 25% of most-viewed YouTube videos regarding COVID-19 contain nonfactual contents.[2] Understanding the validity and reliability of the information spread over the social network and the Internet becomes a serious problem to be resolved. While identifying fake news and false information in social media has been studied by many researchers,[3] the current system usually fails to identify nonfactual information regarding a new topic. So, further research is in high demand to develop a system that can keep tracing the new concepts on the Internet and determine whether the information in the multimedia contents is factual according to the most updated knowledge.

Another challenge of a multimedia system is to monitor and understand the pandemic situation and the efficacy of policy execution. For instance, videos as well as the GPS sensor data can be utilized and analyzed to determine whether the social distancing policy has been followed by the general public.[4] Meanwhile, public opinion and resident emotional status regarding the implemented and anticipated government policy can be helpful for the policymaking, which can also be inferred from the texts and discussions in

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the social media data.[5] However, most of the aforementioned analyses utilize single modality data, and the interrelationships among different modalities are greatly underestimated. Information from different modalities, which often complement each other, can be fused to better understand the pandemic situation. In addition, the causality between various concepts, which are usually observable in one of the modalities, can be revealed.

Artificial Intelligence (AI) technologies, specifically machine learning and deep learning, allow us to predict the future trends based on the observed data. Integrating AI with multimedia data, such as texts and images regarding COVID-19 from the social media, allows the researchers to predict whether an existing policy will be accepted by the general public and how effective it can be before being implemented. Multimedia analytics tools can utilize multimodal data and predict the impacts of various policies on the COVID-19 transmission to help government officials make decisions.[6] Furthermore, to provide a rapid analysis of the virus's geospatial spread, the aforementioned multimedia data needs to be accessed and processed within a short time constraint, which calls for the development of high-performance computing and data streaming techniques to deliver the information to the policymaker and the general public in a timely manner.

Multimedia technologies have also contributed to mitigating the impact of COVID-19 on people's lives by telehealth services and online education, which ensures immediate patient diagnosis and education but reduces in-person communications. However, there remain many challenges to address in telehealth and distance education. For example, telehealth sessions may negatively affect the relationship between the patient and the healthcare professional by removing the personal connection that can be established face-to-face.[7] Some of the barriers can be solved by virtual reality (VR) and augmented reality (AR). Telehealth in VR has proven successful in cases of cognitive rehabilitation,[8] while VR/AR environments have shown to improve the effectiveness and efficiency of learning.[8] Meanwhile, these services can be further empowered by AI techniques using multimedia data collected in VR/AR environments. The patient's mental state and cognitive progress can be better perceived by analyzing voice and video footage of the eyes and body language,[9] and the learning status can be estimated based on the multimodal data collected in these environments.[10] Although many advancements have been made to improve the quality of services, there are still large amounts of work in the concept of remote health and education applications.

In conclusion, multimedia researchers have developed advanced tools and techniques for the recovery, resilience, and management of COVID-19. However, more investigations and research in multimedia should be performed to address many open questions in all phases of multimedia analysis, including data acquisition, data analysis, result validation, data visualization, etc., which could provide a promising future to better respond and manage COVID-19 and future pandemics.

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