Mobile Applications for COVID-19: Benefits, Technologies and Future Research Opportunities

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Abstract – The SARS-CoV-2 (COVID-19) pandemic has emerged as one of the greatest problems of the 21st century worldwide. Efforts to fight this pandemic require a global co-operation and a multidisciplinary approach. An application of information and communication technologies (ICT) to a great degree contributes to fighting the pandemic as these technologies are one of the key services that assist patients, researchers, health institutions and other interested parties in different activities in an effort to fight the pandemic and its consequences. The present paper presents the features of certain mobile applications (apps) that are being used for different purposes such as: tracking patients, COVID-19-related warnings, keeping tracks of statistical data, organising life and business, etc. Aside from presenting the features of a certain number of applications, a review of technologies used for the development of these applications will also be presented. Furthermore, the paper addresses certain challenges that come along with the mobile technologies applications and offers suggestions for future research.

1. Introduction

To prevent spreading of the pandemic caused by COVID-19 has become one of the major priorities of a great number of governments, economic and political communities, as well as numerous other institutions and researchers worldwide. In order to find adequate methods and solutions that can aid in supressing the spread of the virus, it is necessary to co-operate on the global level. Therefore, it is important to face the COVID-19 challenges from an interdisciplinary perspective [1]. This implies an application of different technologies and methods to fight the pandemic. The aim of the present paper is to present features of some of the already developed mobile applications that have proven as an essential tool in the fight against the COVID-19 pandemic. Aside from the description of their features and usefulness, in further text the technologies used for their development will be presented. After a thorough research into these technologies, in this paper we will provide certain guidelines for future research that are related to the potentials and possible advancement of the already developed applications.

The purpose of different applications is to aid state governments, healthcare systems, patients and population in general to fight one of the greatest problems of our time. There are different ways in which these applications aid in supressing the spread of the virus and help people live through the pandemic [2], [3], [4], [5]. By means of using official applications controlled by authorised institutions, it can be ensured that no false information is being spread. These applications have an important role in connecting the key health services and informing the population about the procedures necessary for them to protect their and other people’s health.

Keywords – COVID-19, coronavirus, pandemic, mobile applications, mHealth, health monitoring, contact tracing
findings indicate that mobile applications are successful for the prevention, management, treatment, or follow-up of COVID-19 [6].

Aside from the applications authorised by state institutions, in most cases there is also a co-operation between different countries in order for an efficient co-ordination mechanism to be established. For instance, in EU countries, a great number of applications have been developed together with a common platform that promotes these applications. Since the COVID-19 pandemic is a global issue, the European Union presented a solution for communication between national applications in the fight against the coronavirus [7]. In some countries, a great number of applications has been developed such as in India, for instance, where there have been over 40 applications registered so far [8]. Some of these applications are simple applications used for getting informed about the number of infected persons in a certain area, whereas other applications possess a great number of features, including self-check tests on the presence of the virus. Numerous applications scoop data from the World Health Organization (WHO) which offers guidelines and materials necessary for learning about prevention, tracking the pandemic, details about the distribution of the virus and statistics.

Most of the applications are addressed to citizens but there are some applications dedicated to the authorities and medical staff [4]. Aside from their purpose and features, applications may differ in terms of the regions and areas they cover in terms of data and limitations of access for different users and technologies they use. Therefore, the most of applications have different characteristics related to: features, platforms, languages, and country-context related features [2]. For instance, some of the applications have been developed as web platforms, whereas others are intended for mobile phones based on Android and iOS operative systems. They are based on different technologies such as GIS (Geographic Information System), IoT (Internet of Things), machine learning, etc. For instance, paper [9] compares some applications for COVID-19 taking into account: emerging technologies such as IoT, Drones, AI, Blockchain, and 5G. Therefore, information and communication technologies play an important role in fight against the COVID-19. For that reason, in this paper we will present different possibilities for the development of applications’ different features by means of implementing the aforementioned technologies.

The paper is structured in the following manner: the second part presents a review of a certain number of the already developed applications, their features and possibilities. The third part of the paper sums up the main objectives and features of mobile applications. The fourth part consists of a review on the most frequently used technologies used to tackle Covid-19 challenge. The fifth part consists of the concluding remarks and suggestions for future research and development of mobile applications.

2. Review and Examples of Mobile Applications

Mobile applications are one of the key tools in the fight against the spreading of the COVID-19 pandemic. Figure 1. presents key merits of mobile applications for fighting the COVID-19 pandemic. Numerous applications have been developed with the objective of easing access to medical information, important contact information about hospitals and other institutions. In this way, these applications make it easier for people to locate the nearest hospitals for treating coronavirus, centers for collecting swabs and laboratories. In addition, numerous applications contain information about the best practices for patients while providing information about steps required to be taken in the case of an onset of symptoms.

A great number of mobile applications allows access to statistical data about the number of persons infected in a certain area. The data are retrieved from different sources such as reports of different state authorities, medical institutions, international organisations, etc. A great number of applications uses the WHO as a source to provide an insight into the statistics, recommendations and contact persons for the fight against the pandemic, whereas the recommendations and guidelines are based on the recommendations by the WHO. These data allow for making certain decisions such as travelling restrictions, closing certain locations, lockdown, etc. In this way, the spreading of the virus is being controlled and chances of infection reduced.
Certain applications have been developed as to enable tracking and control of symptoms by means of a continuous interaction with patients and other people. For instance, some applications provide a user’s guide for evaluating on whether a potential contact with the virus has been made.

In addition, certain applications help in geolocating patients. However, an implementation of these applications is conditioned by means of legislation and privacy protection regulations in a certain region. Therefore, the European Commission has ensured that all the national application in member states are to be developed in accordance with the defined standards and guidelines [7].

As an alternative, applications can be developed to display locations of active cases on the map without identifying patients. A great benefit of this option is that locations of persons in isolation can be easily tracked. These pieces of information can help in restricting movement in the zones where potential clusters have been identified. There is a wide range of other possibilities such as the possibility to inform an authorized body in the case the established quarantine protocol has been breached.

Furthermore, the geo-locating option may be used for locating the closest testing centres, medical treatment and medication procurement. The information on the display of locations with infected persons can be inserted in different ways. The applications developed by official institutions of individual countries are mostly based on the official reports by hospitals. However, there are applications based on the information provided by patients themselves, which raises the issue of their relevance as these are based on the patients’ voluntary participation and their knowledge on how to use the application. There are applications that allow for the option of delivering data and locations about potentially infected patients by members of the community but such applications are not widely used. Corontine [8] is one example of an application that allows for a geographical tracking of the patients informing the authorities if the home-quarantined person leaves his or her location. The users of the application have the possibility to activate or deactivate location as they prefer.

In some countries, there are ideas for developing applications that would make it possible to issue an international and country E-pass for the movement of vehicles during the lockdown period in order to allow people to reach their homes and reunite with their families. These applications would to a great degree make it easier for people to travel in case of emergency situations, such as a necessity for a medical treatment or in case of a death of a family member. In this way, it can be ensured that the necessary supplies are transported also in cases when some persons are in isolation or when a whole area is in lockdown. In the previous period, for some locations there were purpose-oriented applications developed for sending requests asking for food supplies and medication to be delivered. These applications often allow volunteers to join and participate in the delivery of meals and medication to persons in isolation.

There is a growing number of existing applications that provide a platform for obtaining necessary information about medical treatment from patients who have already been medically treated. Such applications allow patients to give their contributions to the fight against the COVID-19 pandemic. An example for this type of application is COVID-19 Tracker HealthLynked Corp and Outbreaks Near Me which allow for the monitoring of symptoms in the way that the users can provide information about their health condition if they have been tested positive and inform medical personnel about it. These applications ensure a secure and anonymous self-report of the symptoms. Also, some applications allow users to deliver information regarding people in their vicinity who are suspected to be affected by COVID-19.

Some applications allow people to exchange their COVID-19 infection personal experiences. These applications allow users to browse stories of others and thus gain helpful information on medical treatments of consequences caused by COVID-19. Very useful option is to allow filtering information per country and different categories in order to obtain certain data more easily. Especially beneficial are the tips on how to more easily overcome the quarantine period and lockdown, both of which affect mental health to a great extent. The goal is to help people reduce stress levels by means of trackers to check mood and emotional well-being.

One interesting option that certain applications have integrated is the self-evaluation test for COVID-19. For this purpose, some applications use simple surveys based on an assessment of symptoms and in accordance with guidelines by the WHO. With regard to the previously mentioned, some applications use advance artificial intelligence algorithms for the assessment on potentially infected persons. In addition to the assistance provided to general population, certain applications assist medical personnel as well. For example, Chikitsa Setu App assists medical staff by providing video tutorials and answering to their questions relating to COVID-19. What is important in terms of features is the possibility to establish a communication channel between patients and doctors, as well as other stakeholders. Considering the fact that it is necessary to collect and analyse a great amount of data, numerous applications have the purpose of efficient monitoring and predicting the potential spreading of the virus.
3. Mobile Applications: Objectives and Features

COVID-19 monitoring applications have been contributing to the fight against the pandemic to a great extent. For instance, certain mobile applications for monitoring and warning about COVID-10 may assist in controlling the chain of infection at the national and international level.

Table 1. Objectives and features of mobile applications

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<th>Objective</th>
<th>Features</th>
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| Monitoring of patients and remote assistance | - Useful information about patients  
                                - Smart-tracking of patients  
                                - Communication services  
                                - Information and treatment tips  
                                - Enhanced diagnosis and efficient treatment  
                                - Early detection and diagnosis of infection  
                                - Important contact information |
| Monitoring and forecasting of pandemic spreading | - Useful statistics about number of patients and death cases  
                                - Geographic map of currently active positive cases by municipalities  
                                - Data exchange between authorities and other stakeholders |
| Control and prevent pandemic spreading | - Updated news and information related to fight against COVID-19  
                                - Data on the proximity (mutual distance) of COVID-19 positive users  
                                - The preventive guidelines suggested by WHO and other authorities  
                                - Instructions for self-protection and isolation  
                                - Automate the reporting process to help prevent potential COVID-19 exposures  
                                - Support decision making process |
| Vaccine and medicine development and supply chain | - Development of vaccines for immunisation  
                                - Development of medicine to recover from infection  
                                - Development of medicine to improve immunity |

A great number of the applications described above is intended to provide digital assistance to the medical systems by means of monitoring the spread of the virus and patients’ health condition. In addition to statistical data about how the pandemic spreads at the local, state and global level, a great number of applications have been developed to assist patients in self-monitoring their health or a potential development of symptoms. Furthermore, numerous applications are equipped with features that allow for different systems to function, such as transport, logistics, education, etc. Therefore, key features of mobile applications include various materials about prevention of virus spreading, monitoring and remote assistance, etc. We summarize the objectives of mobile applications as shown in Table 1.

3.1. Monitoring Patients and Remote Assistance

Many applications are intended to provide useful information about patients such as their symptoms, location and contact information. Some applications enable users to provide information about their health condition or to notify the medical personnel about it, while others are based on data entry by medical personnel. These features enable to observe users’ health parameters such as temperature, heart rate, oxygen saturation, blood pressure, etc. Also, most mobile applications provide useful information about nearby hospitals and test centres, emergency phone numbers, travelling information, vaccines and common frequently asked questions. Therefore, some applications provide digitised support to the medical system to monitor patients. Patients can self-monitor their health, in order to track and observe the evolution of COVID-19 symptoms. Also, a very useful feature is remote consultation through video communication, audio call support system, instant messaging, etc. Advanced features enable virtual assistance through interacting with users in natural language and by using voice communication.

Most mobile applications include guidelines, educational materials and infection prevention advice and guidelines. For example, mental health is a very important aspect during isolation and lockdown period, which emphasises the importance of providing advice on how to work on one’s mental health. Self-assessment is a feature that allows users to monitor some parameters which help detect potential symptoms of infection or mental health issues. This is important for early detection and diagnosis which is required for an efficient treatment. For instance, machine learning methods can be used to extract complex features from X-ray scans to correctly diagnose and distinguish cases of COVID-19 from pneumonia and normal cases.
3.2. Monitoring and Forecasting of the Pandemic Spreading

Many mobile applications have the tracker feature to enable virus surveillance features and provide statistics periodically, some even in real time. This feature provides useful information to monitor the spreading of the pandemic as well as to provide the current status and statistics from a global or local perspective. These data are necessary to take appropriate measures to fight against the pandemic. Information about the number of confirmed infected patients, recovered people, death cases, and others can be used to monitor and forecast pandemic spread. The detection of COVID-19 transmission chains helps limit the spread of the pandemic.

3.3. Control and Prevention of the Pandemic Spread

The main purposes of the mobile applications are to provide information about COVID-19 statistics, useful guidelines and important contact addresses to combat the spread of the pandemic. Collecting and processing of data such as the number of infected people in a certain area, trends in infection and recovery, a list of individuals who do not follow the rules of isolation, monitoring contacts, etc., enables appropriate decision-making in the fight against the pandemic. Also, there are other ways to control and reduce the pandemic spread. For example, some applications allow users to detect other devices that have the same application installed. If one of the users is found positive and the application has registered a closeness to others, they will be notified by the application about it. Therefore, mobile applications assist medical specialists to lead more effective and efficient contact tracing with people infected with COVID-19. Besides, a very useful feature is self-reporting which automates the reporting process and helps prevent potential COVID-19 exposures.

3.4. Vaccine, Medicine Development and Supply Chains

Data science and artificial intelligence help augment scientific understanding of a disease caused by the COVID-19 virus. Sophisticated AI/ML algorithms enable scientists to use real-world data required for understanding the virus, as well as to develop vaccine and other medicine for immunisation. Different information and communication technologies have an important role in improving diagnostics and prognostics, transport and logistics performance, operations cost optimisation, etc. Also, with limited supplies of vaccines and a complex array of factors that influence health risks, authorities are scrambling to decide about priorities in line to receive the vaccines. Machine learning has a very important role in solving this issue. Machine learning can help leverage all the available data to detect important patterns for decision-making.

4. Mobile Applications for COVID-19 and Emerging Technologies

Applications for tracking COVID-19 positive cases use a wide range of technologies. In addition to standard technologies for developing web and mobile applications, certain applications use other possibilities of other technologies that improve their features such as IoT, 5G, blockchain, QR, etc. [9].

Figure 2. shows the most frequently used technologies for mitigating the impact of the COVID-19. These digital technologies play an important role in an efficient response to the COVID-19 pandemic.

GIS technologies provide spatial information support for decision-making in order to improve effectivity of prevention and control of the COVID-19 spread. The review [1] summarizes research in the context of geography and group studies by the geospatial theme. The GIS has a key role to aggregate big data from multiple sources, to visualize information, to track confirmed cases, predict transmission, etc. [10]. Therefore, the GIS enables features for disease control, including the ability to store demographic information and a variety of spatial analysis functions. The GIS systems use spatial analytics to map the occurrence of the virus. In many cases, the GIS uses location-based services.

![Figure 2. The most frequently used emerging technologies for mitigating the impact of the COVID-19 pandemic](image-url)
and GPS to help epidemiologists and authorities identify high-risk areas. The GPS is widely used to monitor real-time and location of people infected with the virus. This technology enables tracing other potential patients. Some advanced applications use GPS technology in order to detect whether a user of the application has been close to users positive to COVID-19. These applications enable cross-checks of the GPS history on the mobile phone with historical geographic data of patients. The application functions in such a way that it to a great extent relies on the user’s data on self-reports with regard to their exposure to COVID-19. In addition, some applications allow users to detect other devices that have the same application installed. If it has been detected that one of the users of the application is positive and if the application detected proximity of persons infected, it will notify the users about it by means of Bluetooth technology.

Bluetooth technology is most frequently used for checking if the user is in the proximity of a person diagnosed with COVID-19 (proximity calculation). Examples of applications using this technology for sending updates about a potential contact with a person infected with COVID-19 are TraceCovid and TraceTogether. These applications notify users if they have been exposed to COVID-19 through close contact with other users of the applications. In the case when two users using this mobile application come to a close contact, the code is transmitted between their devices and is stored into their applications provided that Bluetooth is enabled on both devices. If one of the users using this application is later diagnosed with COVID-19, the authorities can check data recorded in the application of the user in order to track all persons who have come to a close contact with the person diagnosed with COVID-19.

Google and Apple jointly created the Exposure Notifications System out of a shared sense of responsibility to help governments and the global community fight the pandemic through contact tracing. These two companies developed API and technology based on the operative system in order to assist public applications in contact tracing. This framework allows contact tracing applications to use Bluetooth Low Energy (BLE) for documenting interactions of people and tracking whether the owner of the mobile phone came into close contact with someone who was later diagnosed with COVID-19. If this scenario happens, the user is sent a warning stating that he or she came into close contact with a person who has now been diagnosed with COVID-19. Once they have been warned, the users can self-isolate or decide to take the test.

IoT technologies enable the collection, analysis, and transmission of data efficiently, which is the key factor for decision-making. Therefore, the IoT is helpful for a patient infected with COVID-19 to identify the symptoms and provides a better treatment rapidly. It enables to digitally capture the data from the patient without any human interaction which improves the safety of the patient and data gathering efficiency. The IoT enables remote diagnosis, as well as treatment of patients. For example, the IoT enables monitoring patients’ chronic diseases that increase the risk of death caused by the COVID-19 virus. Therefore, there are many possibilities of using IoT technologies such as those that enable one to avoiding touching various objects and surfaces in offices [11]. R.P. Sigh et al. [12] identify significant IoT based applications to tackle the COVID-19 pandemic. Some applications use QR to enable an easier, faster and safer monitoring of the symptoms. This platform is intended to assist medical networks that monitor the pandemic as well as patients who have been examined or are in home quarantine.

Mobile applications could be a simple tool to assist in diagnosing the virus, based on the sensitivity and specificity of the disease and to notify users. To this purpose, machine learning algorithms and other advanced artificial intelligence tools can be used. The potentials of machine learning for contactless COVID-19 screenings are enormous [13]. These technologies assist in an efficient detection of patterns and trends for a great amount of data. For example, these technologies enable active surveillance for COVID-19 based on speech recognition techniques through a mobile application [14], [15], [8].

Machine learning assists in detecting persons with the greatest risk from COVID-19 [16] infection in the way that different trends and patterns in clusters of data about infected persons can be identified such as age, sex, history of the disease, place of residence, etc. At the same time, machine learning can assist in assessing the potential way of the pandemic spreading, i.e., where and when the virus could start spreading [17]. For instance, travel history of the infected patient can be automatically tracked, which may allow for monitoring the spread of the virus [18]. Another example is the application of machine learning in the analysis of recorded voices with the aim of detecting whether the user of the application has some of the symptoms. These voice recognition applications work in the way that the user records his or her voice voluntarily after which, by means of applying certain machine learning algorithms, it is assessed whether the user has some symptoms or not. There is a great number of applications based on these technologies and features. The aim of these applications is to use machine learning algorithms to automatically detect if a person is suffering from.
COVID-19, based primarily on sounds of their voice, their breathing, coughing and crowdsourced data collection. This also helps applications in measuring lung capacity, comparing information on lung capacity to thousands of data by other users, including those who are infected. In this way, the values of these parameters are compared to the parameters of an “average user” to assess whether the individual is potentially infected with the virus. Besides, machine learning had an important role in the development of medication and the vaccine, detection of infected patients, observing efficiency of the existing medications for similar diseases, mapping where the virus comes from and forecasting the next pandemic. The genome sequence and molecular docking, which include different machine learning techniques, can be used for the development of the vaccine [19]. Recently, the first steps were made towards developing a revolutionary system based on the neural network called COVID-Net the aim of which is to enable differentiating the cases of COVID-19 from other diseases by means of analysing lung scans [20], [21], [22]. Therefore, an application of neural networks can, to a great degree, assist in fighting against the pandemic caused by the COVID-19 virus.

In addition to the already mentioned technologies, other advanced technologies are also being considered. For instance, we can use the blockchain technology for fighting the COVID-19 pandemic in different cases such as to collect data efficiently and facilitate data sharing, protect user identity and limit sharing of personal information, trace medical equipment, etc. For example, blockchain technology enables tracking of reported data related to the number of new cases, deaths, and recovered cases obtained from trusted sources [23], [24], [25]. Therefore, there are many opportunities of using blockchain technology. For example, MiPasa is a multi-party, multi-source verifiable data-sharing platform that uses Blockchain technology to enable open data platform to support COVID-19 response. Furthermore, there are other applications that use the blockchain technology to address various COVID-19-related issues. These applications are used for different purposes such as: public safety, logistics tracking, food supply chain, fake news debunking, etc. Therefore, Blockchain proved itself to be a helpful resource in fighting against COVID-19.

5. Conclusions and Future Research

The pandemic caused by the COVID-19 virus requires co-operation at the global level and a multidisciplinary approach. Great opportunities and potentials of implementing various technologies have become especially important for monitoring of patients and remote assistance, monitoring and forecasting of the pandemic spreading, control and prevention of the pandemic spreading, vaccine and medicine development, supply chains, etc. This paper has presented the possibilities of implementing certain technologies for the development of advanced mobile applications used in fighting the pandemic. Many of the already developed mobile applications are the backbone for introducing quality and efficient measures in the fight against the virus spreading and the development of medication. By means of implementing adequate solutions, chains of infection can be tracked, the spread of the various suppressed and warnings on potential infections issued. This is why in many countries of the world there have been different mobile applications developed that provide support to patients, healthcare workers, the authorities and other stakeholders.

The pandemic has shown that it is necessary to cooperate globally. For this reason, it is necessary to improve co-operation of different institutions at the local and international level. For the realisation of such a co-operation, it is necessary to establish adequate mechanisms for communication and co-ordination of different activities. For instance, efforts are being made for the development of an electronic system for issuing international E-passes for the movement of vehicles during lockdown. In this way, it can be ensured that people can travel in cases of emergency, such as a medical treatment, death of a family member, etc. Furthermore, such an application would allow for a smooth transport of essential goods, which is a pre-requirement for grocery stores, bakeries, pharmacies, etc. This can be achieved by means of exchanging data among institutions, which can be mitigated by means of connecting different applications. However, this represents a significant challenge as it is necessary to develop compatible applications. The challenge is even greater due to the diversity of applied technologies and different features of mobile applications. One solution for this issue can be in the adoption of the standard framework and guidelines for the development of applications which would allow their compatibility. For instance, the standard framework for the development of mobile applications needs to address the issue of personal information and privacy protection, security, the methods of collecting data about the location and movement of people, the way information is being exchanged between applications, etc.

Experience has shown that many people do not adhere to isolation measures if they have been tested positive for COVID-19 or if they have developed symptoms. In order to solve this issue, certain applications for tracking locations and people have been developed. Besides tracking, different reports
may be generated as well as a more direct interaction with doctors ensured. Several solutions for this purpose have been developed but they raise privacy concerns. This is the reason why the greatest number of applications already developed for this purpose relies on a voluntary registration of the patients and the option of the GPS on mobile devices to be enabled. In other words, the key questions that remain to be answered in terms of the implementation and further development of these solutions are related to privacy issues and the legislative framework of collecting and using data.

At the same time, the problem of using some technologies such as Bluetooth is related to the network bandwidth. For instance, the bandwidth of this technology is much greater than the recommended distance and the signal can pass through the walls, which may cause wrong flagged contacts. This is an open question that requires a more active role of researchers and the ICT industry.

What has been of great importance is the possibility to apply AI for a fast analysis of data which results in analyses of certain patterns, i.e., cause and effect relationships between individual events. In this way, new systems of forecasting the spread of the pandemic may be developed, as well as for diagnosing the symptoms. The application of VI/ML has greatly contributed to a more efficient management of the pandemic and making timely and appropriate decisions. The application of VI/ML can assist in building an intelligent platform that collects data from various sources and with the aim of enabling automatized tracking and predicting the spread of the pandemic in the future. At the same time, a dynamic neural network can be developed for extracting visual characteristics of the disease, as well as for an identification of how the pandemic is spreading geographically. This would, to a great extent, assist in adequate tracking of and medical assistance to infected persons. In this way, endangered regions, as well as individuals, may be identified and, accordingly, adequate measures applied. Furthermore, VI/ML are used for speeding up the process of testing medications in real time, as standard testing consumes too much time, allowing the whole process to require significantly less time, which the human factor perhaps never could. Still, there are some challenges related to the application of an adequate algorithm as well as collecting great amounts of data that can be used. For example, there is a challenge of collecting a potential dataset of cough sounds, required for self-diagnosis, because of the diversity of languages.

In addition to the above-mentioned technologies and possibilities, there are numerous potentials for the application of other advanced technological solutions. For instance, UAVs (Unmanned Aerial Vehicles), i.e., drones, can provide many benefits during the COVID-19 pandemic. They can be used to reach inaccessible areas to provide crowd surveillance, public announcement, screening masses, spraying disinfectants and delivery of medical and other supplies. However, there are some vulnerabilities of this technology such as security issues, safety of drone operations, regulatory policies, as well as technology issues such as battery life capacity. Therefore, this is a very interesting research area due to a huge potential of using this technology in conditions such as a pandemic.

The mobile applications have been developed to provide different possibilities based on a great number of technologies. While some are intended for a simple display of information and guidelines, others have advanced possibilities of detection whether in the vicinity of the user there is an individual who has been infected as well as assessment of the potential infection based on the users’ voice analysis. Regardless of the purpose and the possibilities of mobile applications developed so far, they have proven to be an important tool in fighting the COVID-19 pandemic. Also, there are numerous unused potentials and possibilities for further development and wider applications of information and communication technologies. This requires additional efforts of the research community, the industry, the authorities and medical workers in finding new ways of using modern technologies for developing advanced features of mobile applications.

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