

A review on Diagnosis and Treatment methods for coronavirus disease with sensors

Ivan Miguel Pires
 Instituto de Telecomunicações
 Universidade da Beira Interior
 Covilhã, Portugal
 Computer Science Department
 Polytechnic Institute of Viseu
 Viseu, Portugal
 UICISA:E Research Centre
 School of Health
 Polytechnic Institute of Viseu
 Viseu, Portugal
 impires@it.ubi.pt

Abstract—Due to the dispersion of the pandemic situation related to coronavirus, different scientific studies were performed to stop the evolution of this virus over the world. It is a new virus, and no treatment was already developed for the procedure. It consists of a large family of viruses that cause illness ranging from the common cold to more severe diseases, such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). However, the most common problems are related to SARS-CoV. This paper intends to study the evolution of the research studies using different types of sensors for the treatment and diagnosis of this virus. It was verified that it is a subject widely researched, but only a small set of studies are using the sensors and technological equipments.

Keywords—*Coronavirus; sensors; illness; medicine; Internet-of-things.*

I. INTRODUCTION

In an year fustigated by coronavirus disease, a summer course was proposed, in the Polytechnic Institute of Viseu (Viseu, Portugal), the use of the different sensors available in the mobile devices, and sensors connected to a BITalino device [1] to detect different changes that are important for the diagnosis and treatment of coronavirus disease.

Coronavirus disease is a common virus that infects humans and it is mainly related to a upper respiratory infection, commonly named as Severe Acute Respiratory Syndrome (SARS-CoV) [2]. Still, the Middle East Respiratory Syndrome (MERS-CoV) is other type of coronavirus [2]. The symptoms are like a flu, but it may cause a major number of deaths than a common flu. The coronavirus disease is disseminated by the air by coughing and sneezing, close personal contact, touching an object or surface contaminated with the virus and rarely, by fecal contamination [3]. The most common detailed symptoms are runny nose, sore throat, feeling unwell, cough, and fever [4].

Based on the data published by the World Health Organization (WHO) [5], we passed from 1 confirmed case of coronavirus at 30th December 2019 to 19,187,943 confirmed cases at 8th August 2020, as presented in Figure 1. The same situation occurred with the number of deaths that shows an evolution of 1 death on 6th January 2020 to 716,075 deaths at 8th August 2020. It represents a small number of world population that, in 2020, is a total of 7.8 billion of persons around the world [6], but it is significative.

The purpose of this study consists on the research on the different studies available in IEEE Xplore related to the use of sensors and the presence of coronavirus. It was verified a small number of studies, but it may allow the creation of intelligent solutions related to Ambient Assisted living Systems [7]–[13].

The scope of this study consists in the research of solutions related to coronavirus disease that promoted the treatment and stops the dissemination of the virus. A smaller number of studies were found and the sensors that are mainly used are related to Electrocardiography and respiration sensors, location sensors, and inertial sensors.

The following sections of this paper are: Section II described the methodology of this review. Next, Section III describes the different sensors that can be used in the development of solutions related to coronavirus disease. The evolution of the dissemination of the disease is analyzed in Section IV. The different studies found were analyzed in Section V. Finalizing this study with the discussion and conclusions in Section VI.

II. METHODOLOGY

Based on the pandemic situation that the world is living, several studies and technological solutions have been developed for the reducing of the constraints promoted by this virus.

Thus, the IEEE Xplore database was used as basis for this study to perform a research on the recent developed solutions related to coronavirus. The keywords used for this research are “COVID-19” and “sensors”, or “COVID-19” and “mobile devices” to discover the current solutions that using sensors or mobile devices are related to coronavirus.

The inclusion criteria comprehend the studies published until 8th August 2020, which they have information related to the development of systems related to the treatment or diagnosis of coronavirus. The studies included must be published in English language, and they must include the use of sensors.

The studies that are related to other diseases combined with coronavirus were excluded. Also, the studies that did not presented the information clearly were excluded.

Next, the different sensors were analyzed to discover the best sensors for the diagnosis and treatment of coronavirus.

III. SENSORS

At complement to the different medical sensors and equipments available over the world, the use of biosensors may be powerful for a practical and preliminary commodity diagnosis of various diseases [14].

Mobile devices also gain the presence of different sensors and the capability of various sensors and equipments for the acquisition, processing and obtention of different results based on network connection [15]. These devices also allow the connection to other devices, such as a Bitalino device [1] that promoted the acquisition of medical data.

Thus, based on the different nature of the sensors available on the various devices. The following analysis may be presented:

- Accelerometer, magnetometer, and gyroscope: They may help in the tracking of the motion of the different users. They are available in the most common devices;
- Global Positioning System (GPS) receiver: It may help in the tracking of the location of the different users. However, it has several failures in indoor environments;
- Electrocardiography sensors: They may promote the tracking of the evolution of the heartbeat and other things related to coronavirus;
- Proximity sensors: They may allow the detection of the things that the user touched for further disinfection;
- Electroencephalography sensors: They may promote the detection of brain changes for the detection coronavirus;
- Respiration sensors: They may be used for the detection of the different changes in the respiration;
- Temperature sensors: It may be used for the control of the body temperature of the different persons;
- Electromyography sensors: They may be used for the detection of changes in the muscle activity;
- Blood Volume Pulse sensors: They may be used for calculation of the differences in blood volume pulse with coronavirus;
- Electrodermal Activity sensors: They may be in combination with other sensors to improve the different analysis.

The combination of the different systems allows the creation of a system that may promote the social distance, the diagnosis of coronavirus, and other things during this pandemic year.

IV. EVOLUTION

The dispersion of the coronavirus started by the end of the year 2019, fustigating the world with a high evolution of the contagious. According to the WHO [5], we passed from 1

confirmed case of coronavirus at 30th December 2019 to 19,187,943 confirmed cases at 8th August 2020, as presented in Figure 1. The same situation occurred with the number of deaths that shows an evolution of 1 death on 6th January 2020 to 716,075 deaths at 8th August 2020, as presented in Figure 2.

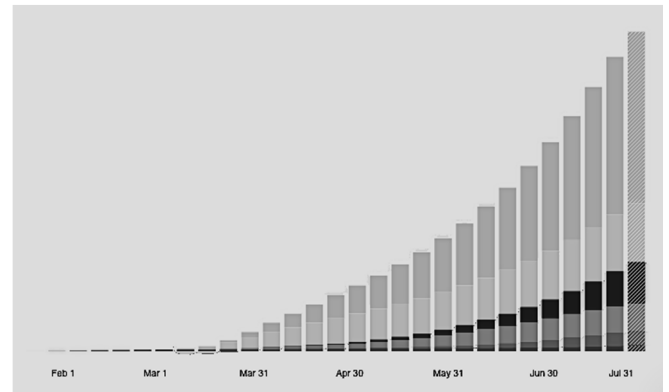


Fig. 1. Evolution of confirmed cases of coronavirus around the world.

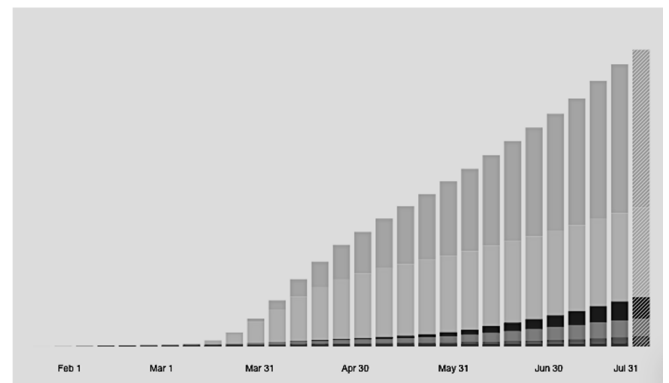


Fig. 2. Evolution of the number of deaths related to coronavirus around the world

Due to the evolution of the dispersion of the coronavirus, the number of studies related to the diagnosis and treatment is also increasing, as presented in Figure 3, where we have 234 studies published at IEEE Xplore at 8th August 2020. We also verified the use of the technology, namely mobile devices, to help in the diagnosis and treatment of coronavirus, and it is verified that only 22 studies are focused on the use of mobile technologies. Mobile devices and other types of equipment have different kinds of sensors. Still, it is verified that only 16 studies are related to the treatment and diagnosis of coronavirus with sensors.

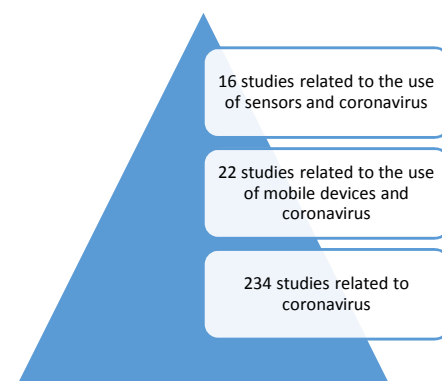


Fig. 3. Number of studies available at IEEE Xplore database

There are two types of coronavirus, such as Middle East Respiratory Syndrome (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS-CoV). Still, the different authors have only mentioned the SARS-CoV during the presentation of the number of cases around the world.

Mobile devices are used in the vast majority of people's daily activities, and they can improve health in monitoring and treatment of the coronavirus [16]. These devices are embedded with a large variety of sensors [15], such as inertial sensors, magnetic sensors, proximity sensor, light sensor, communication sensors, acoustic sensors, location sensors, digital camera and other over-the-air sensors. These sensors may promote different things. These are:

- Tracking of the users after diagnosis of coronavirus;
- Tracking of the user to obtain a well-known group of contacts for further diagnosis;
- Connection to different types of sensors that allows differential diagnosis related to coronavirus;
- Connection to the professional healthcare to monitor different situations and clarify various doubts;
- Inform the different occurrences of coronavirus and methods to combat.

V. RESULTS

There are only 16 studies available in the IEEE Xplore database that related the COVID-19 and the use of sensors, on 8th August 2020. The authors of [17] presented a low-cost system to track the symptoms of coronavirus diseases with the use of different sensors, such as body temperature sensor, heart rate sensor, respiration rate sensor, and other sensors to collect different vital signs. All sensors have a pattern defined for the normal healthy state of each individual, where the coronavirus disease may be detected with the correlation of the different symptoms and the values obtained with the various sensors. The authors also proposed the signal processing of the different sensors and networking with the healthcare professionals to remotely inform the symptoms. The patients are also notified to talk with their professional healthcare. It may be used for the detection of preliminary situations.

In [18], it is presented the coronavirus as a disease related to the abnormal respiratory status, and an early detection and isolation is vital to stop the contagious. The authors proposed the implementation of a neural network for the analysis of the respiratory characteristics from RGB-infrared sensors. They obtained results with 83.69% accuracy, 90.23% sensitivity and 76.31% specificity on the identification of health status of respiratory.

Based on the data acquired from different people and shared collectively with smartphones, the authors of [19] proposed a social sensing system to share the information related to coronavirus by people in online sensing networks in Spain. It may be used to provide social quarantine strategies to decrease the contagious of the virus.

One of the main goals for the treatment of the coronavirus is related to prevention. Thus, the authors of [20] proposed the use of IEEE 802.11ah technology for the monitoring of

patients with coronavirus anywhere at any time, sending the data related to different sensors over the network.

As well known the mobile devices include different sensors in their hardware, including location, inertial, and proximity sensors, and it allows the communication and access to social networks for the recognition of the persons that have contact with an infected person [21]. However, this system should have privacy constraints, and the user may accept it. The coronavirus affected different sector of the economy, including academic, governmental and industrial sectors. However, the massive sharing of different types of data allows to control the dissemination of this disease, and it can be considered as a digital vaccine.

Mobile devices have several sensors embedded, including network sensors, inertial sensors, acoustic sensors, and location sensors. A small set of devices also include temperature sensors, ambient light sensors and other sensors related to the environment. The sensors available in the mobile devices may be used as an early detection of the virus, predicting symptoms, and monitoring the known infected persons, because the location of the infected persons may help in the prevention of the contact with other non-infected persons [22]. It may reduce the evolution of the propagation of the virus or prioritize the diagnosis in some persons.

The authors of [23] presented a literature review of the technologies present in wearable devices and telemedicine for the monitoring of the different health states related to the coronavirus disease. The authors verified that the wearable devices may be suitable for the persons in risk or that there are in quarantine, evaluating the health state of healthcare and management professionals and hospitals and improving the triage. It was also verified that the mobile devices have several sensors embedded that can be used for the detection of the disease for the recommendation of further examination at the hospital. Finally, it is always related to the telemedicine, and the different cases can be accompanied by healthcare professionals.

In [24], it is presented a system to promote the social rules. Thus, the authors detect the proximity to the face and notify the user if a very proximity is detected. For this purpose, the authors developed a two-gesture detection approach with the sensors embedded on a smartwatch, including inertial and magnetic sensors. The proposed method was tested, and it helped in the reduction of the number of face touches and their duration.

The authors of [25] presented a prototype of a monitoring device to assist the users and reduce the diffusion of the coronavirus with different sensors for several purposes, such as face touching, and sound, considering the use of inertial sensors, location and acoustic sensors available in the conventional used mobile devices. The proposed system also adds the functionality of vibrating and sound awareness to notify the user that touched the face with social and artificial intelligence methods.

A modified standard joint unscented Kalman filter (JUKF) method was used to create a non-contact based respiration rate monitoring that is important for the detection of different parameter associated to the coronavirus, presenting reliable results [26].

The authors of [27] presented different methodologies that allow the underwater detection of coronavirus with the use of

various sensors available in the different types of devices. However, they reported reliable results with the proposed system.

In [28], a wearable called EasyBand was proposed for the monitoring of the trace of positive cases of coronavirus, and the encouragement of the social distance. It presents different electronics solutions that allow the tracking of the distance, and other parameters related to the prevention of the coronavirus, attempting to reduce the contagious.

VI. DISCUSSION AND CONCLUSIONS

Coronavirus is widely expanding over the world, presenting different problems. However, the most dangerous and expanded is the SARS-CoV that affects the respiration track and cause a significant number of deaths.

The technology may promote the creation of different solutions to stop the dissemination of coronavirus, and various studies related to SARS-CoV with the use of mobile devices and sensors have been done.

There are only a low number of studies, representing around 7% of studies, that uses the well-known sensors for the monitoring of the health status related to coronavirus, and 9% of the studies, that are using mobile technologies for the same purpose. However, this research is increasing, and several research programs are available over the world for the creation of the best solution.

This study presented the aggregation some examples of systems related to the treatment of diagnosis of the coronavirus. It is possible to verify that the combination of the different functionalities available in the various studies promotes the creation of a useful system for a large number of people.

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