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A REVIEW ON SMART WEARABLE SYSTEM FOR COVID-19 PATIENTS

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Abstract—*Corona virus disease 2019 (COVID-19) has emerged as a pandemic with serious clinical manifestations including death. A pandemic at the large-scale, places extraordinary demands on the world's health systems, dramatically devastates vulnerable populations, and critically threatens the global communities in an unprecedented way. While tremendous efforts at the frontline are placed on detecting the virus, providing treatments and developing vaccines, it is also critically important to examine the technologies and systems for tackling disease emergence, arresting its spread and especially the strategy for diseases prevention. The objective of this article is to review enabling technologies and systems with various application scenarios for handling the COVID-19 crisis. The article will focus specifically on 1) wearable devices suitable for monitoring the populations at risk and those in quarantine, both for evaluating the health status of caregivers and management personnel, and for facilitating triage processes for admission to hospitals; 2) unobtrusive sensing systems for detecting the disease and for monitoring patients with relatively mild symptoms whose clinical situation could suddenly worsen in improvised hospitals; and 3) telehealth technologies for the remote monitoring and diagnosis of COVID-19 and related diseases. Finally, further challenges and opportunities for future directions of development are highlighted.*

Keywords:Covid-19,Patients,Monitoring,Prevention,Wearable device, Telehealth,Remote

I. INTRODUCTION

Corona virus disease 2019 (COVID-19) has emerged as a pandemic with serious clinical manifestations including death. A pandemic at the large-scale like COVID-19 places extraordinary demands on the world's health systems, dramatically devastates vulnerable populations, and critically threatens the global communities in an unprecedented way. While tremendous efforts at the frontline are placed on detecting the virus, providing treatments and developing vaccines, it is also critically important to examine the technologies and systems for tackling disease emergence, arresting its spread and especially the strategy for diseases prevention. The objective of this article is to review enabling technologies and systems with various application scenarios for handling the COVID-19 crisis. The article will focus specifically on 1) wearable devices suitable for monitoring the populations at risk and those in quarantine, both for evaluating the health status of caregivers and management personnel, and for facilitating triage processes for admission to hospitals; 2) unobtrusive sensing systems for detecting the disease and for monitoring patients with relatively mild symptoms whose clinical situation could suddenly worsen in improvised hospitals; and 3) telehealth technologies for the remote monitoring and diagnosis of COVID-19 and related diseases. Finally, further challenges and opportunities for future directions of development are highlighted.

COVID-19 is a chronic condition or disease that causes inflammation and narrowing of the tubes, the passageways that allow air to enter and leave the lungs, making it harder to breathe [, If people with disease are exposed to a substance to which they are sensitive or a situation that changes their regular breathing patterns, the symptoms can become more severe. According to the latest World Health Organization (WHO) estimates, approximately 250 million people suffer from COVID-19 worldwide, and almost 250 million Americans are affected by this disease according to AAFA, This disease is a public health problem in both rich and poor countries. Although there is no cure for diesase, effective treatments are available. The best way to manage corona is to avoid triggers, take medications to prevent symptoms and prepare to treat it episodes if they occur. Currently, more than 300 million cases Corona of varying severity have been detected worldwide. In addition, there is a tendency to an increase in the number of patients with the virus, including young children. Therefore, the development of new methods and devices for the diagnosis of virus, including inexpensive portable devices, is a very urgent task. Modern technologies are able to provide important tools for diagnosing a wide range of various diseases, including Corona virus. At present, one can find a tendency to actively introduce modern technologies, in particular, in the development of modern low-cost portable devices for diagnosing or monitoring human condition.

COVID-19 is one of the most common chronic diseases and the third leading cause of hospitalization among adolescents. It is a medical condition that causes coughing, wheezing, and difficulty in breathing. During the period from 2008–2010, the prevalence of Corona virus was higher among children than adults. According to the Center for Disease Control, it affects 7.1 million (1:11) children and its rampancy has increased by 15% in the last decade. Records obtained from the Center for Disease Control and Prevention also indicate that in 2013, about 21% of high school students (grades 9-12) had COVID-19.It demands a great deal of health care utilization andentails a lot of missed days of school and work.

It is characterized by episodic respiratory symptoms and intermittent exacerbations. The symptoms, airflow obstruction, and exacerbations in Virus vary greatly in both frequency of occurrence and severity. Monitoring these events is crucial to the care of patients with the disease and is directed at the early detection of exacerbations and monitoring of the day-to-day control of COVID-19. Monitoring can also be extended to investigate reasons for poor control and reasons for exacerbations, such as noncompliance and exposure to triggers.It is important to identify who will perform the monitoring because this has implications for the type of data that are collected, their validity, and their accuracy. It can be monitored by the following people:

The patient with Corona Virus because self-monitoring allows the early detection of exacerbations; The treating physician to assess control of disease and investigate reasons for poor control; and Health care managers to assess the quality and cost of care for patients with COVID-19.

This article reviews COVID-19 monitoring from each of these perspectives.

COVID-19 is a chronic disease affecting one in nine Australians. As of 2014, 1.5 out of every 100, 000 deaths in Australia were due to COVID-19. People with the Virus have sensitive airways which react to environmental triggers, causing ‘flare ups’. This is when muscles in the wall of airways tighten and swell, narrowing the airway itself. This, in combination with the production of mucus can block the airway to varying degrees. Resulting in symptoms such as coughing, wheezing, tightness in the chest and shortness of breath, making it extremely difficult to breathe.

I. LITERATURE REVIEW

Estimating instant case fatality rate of COVID-19 in China
Authors: Yan-niMi, Ting-ting Huang
Published in: International Journal of Infectious Diseases, 2020.

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is of great concern. As of April 19, 2020, the number of confirmed COVID-19 cases had passed 2 160 000 worldwide (World Health Organization, 2020a). More than 82 000 cases had been confirmed and more than 4600 patients had died in China. At present, the outbreak in China has been essentially controlled. More than 100 countries worldwide are now facing and dealing with the COVID-19 epidemic, including the United States, Spain, Italy, Germany, Iran, France, the United Kingdom, and South Korea.

For an unprecedented epidemic such as COVID-19, it is important to assess its hazards. The case fatality rate (CFR) is the ratio of the number of deaths divided by the number of confirmed cases over a certain period of time. This is the most direct index to reflect the lethality of the disease. Since the occurrence of the epidemic in China, the CFRs of COVID-19 have been examined in many studies published in the literature. However, the literature on CFRs of COVID-19 is subject to several limitations. When a pandemic is still ongoing, the resulting CFR (the number of deaths divided by the number of confirmed cases), called the naive CFR, does not represent the true CFR (Kucharski and Edmunds, 2014).

Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy
Authors: GrazianoOnder 1, Giovanni Rezza 2, Silvio Brusaferro 3
Published in: JAMA, 2020.

Only 3 cases of coronavirus disease 2019 (COVID-19) were identified in Italy in the first half of February 2020 and all involved people who had recently traveled to China. On February 20, 2020, a severe case of pneumonia due to SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) was diagnosed in northern Italy's Lombardy region in a man in his 30s who had no history of possible exposure abroad. Within 14 days, many other cases of COVID-19 in the surrounding area were diagnosed, including a substantial number of critically ill patients. On the basis of the number of cases and of the advanced stage of the disease it was hypothesized that the virus had been circulating within the population since January.

A second possible explanation for the high Italian case-fatality rate may be how COVID-19–related deaths are identified in Italy. Case-fatality statistics in Italy are based on defining COVID-19–related deaths as those occurring in patients who test positive for SARS-CoV-2 via RT-PCR, independently from preexisting diseases that may have caused death. This method was selected because clear criteria for the definition of COVID-19–related deaths is not available.Electing to define death from COVID-19 in this way may have resulted in an overestimation of the case-fatality rate. A subsample of 355 patients with COVID-19 who died in Italy underwent detailed chart review. Among these patients, the mean age was 79.5 years (SD, 8.1) and 106 (30.0%) were women. In this sample, 117 patients (30%) had ischemic heart disease, 126 (35.5%) had diabetes, 72 (20.3%) had active cancer, 87 (24.5%) had atrial fibrillation, 24 (6.8%) had dementia, and 34 (9.6%) had a history of stroke. The mean number of preexisting diseases was 2.7 (SD, 1.6). Overall, only 3 patients (0.8%) had no diseases, 89 (25.1%) had a single disease, 91 (25.6%) had 2 diseases, and 172 (48.5%) had 3 or more underlying diseases. The presence of these comorbidities might have increased the risk of mortality independent of COVID-19 infection.

Comparative replication and immune activation profiles of SARS-CoV-2 and SARS-CoV in human lungs: an ex vivo study with implications for the pathogenesis of COVID-19
Authors: HinChu,JasperFuk-Woo Chan
Published in: IEEE 2020

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is an emerging coronavirus that has resulted in nearly 1,000,000 laboratory-confirmed cases including over 50,000 deaths. Although SARS-CoV-2 and SARS-CoV share a number of common clinical manifestations, SARS-CoV-2 appears to be highly efficient in person-to-person transmission and frequently cause asymptomatic infections. However, the underlying mechanism that confers these viral characteristics on high transmissibility and asymptomatic infection remain incompletely understood. Methods: We comprehensively investigated the replication, cell tropism, and immune activation profile of SARS-CoV-2 infection in human lung tissues with SARS-CoV included as a comparison. Results: SARS-CoV-2 infected and replicated in human lung tissues more efficiently than that of SARS-CoV. Within the 48-hour interval, SARS-CoV-2 generated 3.20 folds more infectious virus particles than that of SARS-CoV from the infected lung tissues ($P<0.024$). SARS-CoV-2 and SARS-CoV were similar in cell tropism, with both targeting types I and II pneumocytes, and alveolar macrophages. Importantly, despite the more efficient virus replication, SARS-CoV-2 did not significantly induce types I, II, or III interferons in the infected human lung tissues. In addition, while SARS-CoV infection upregulated the expression of 11 out of 13 (84.62%) representative pro-inflammatory cytokines/chemokines, SARS-CoV-2 infection only upregulated 5 of these 13 (38.46%) key inflammatory mediators despite replicating more efficiently. Conclusions: Our study provided the first quantitative data on the comparative replication capacity and immune activation profile of SARS-CoV-2 and SARS-CoV infection in human lung tissues. Our results provided important insights on the pathogenesis, high transmissibility, and asymptomatic infection of SARS-CoV-2.

Potential applications of wearable sensors in closed-loop management of STEMI patients during pandemics
Authors: Xiaorong Ding
Published in: 2020May 2020IEEE Reviews in Biomedical Engineering
Coronavirus disease 2019 (COVID-19) has emerged as a pandemic with serious clinical manifestations including death. A pandemic at the large-scale like COVID-19 places extraordinary demands on the world's health systems, dramatically devastates vulnerable populations, and critically threatens the global communities in an unprecedented way. While tremendous efforts at the frontline are placed on detecting the virus, providing treatments and developing vaccines, it is also critically important to examine the technologies and systems for tackling disease emergence, arresting its spread and especially the strategy for diseases prevention. The objective of this article is to review enabling technologies and systems with various application scenarios for handling the COVID-19 crisis. The article will focus specifically on 1) wearable devices suitable for monitoring the populations at risk and those in quarantine, both for evaluating the health status of caregivers and management personnel, and for facilitating triage processes for admission to hospitals 2) unobtrusive sensing systems for detecting the disease and for monitoring patients with relatively mild symptoms who's clinical situation could suddenly worsen in improvised hospitals and 3) telehealth technologies for the remote monitoring and diagnosis of COVID-19 and related diseases. Finally, further challenges and opportunities for future directions of development are highlighted.

Prospects for Designing a Portable System for Monitoring of the Patient's Condition with COVID-19
Authors: Ivan V. Semernik, Alexander V. Dem'yanenko
Published in: 2019 IEEE
In this article the prospects and possibilities for creating an individual wearable system for monitoring the condition of a patient suffering from COVID-19 and preventing attacks of the disease are discussed. As the basic method of determining the condition of the patient is considered the technique for determining the transmission coefficient of a certain frequency microwave signal through the chest. The proposed method is non-invasive and harmless and can be used for patients of all age groups.

Detection and Monitoring of COVID-19 Trigger Factor using Zigbee
Authors: Miss. AnumehaLal , Mr. Girish A. Kulkarni
Published in: International Advanced Research Journal in Science, Engineering and Technology,Vol. 3, Issue 7, July 2016
COVID-19 is one of the widespread chronic diseases. Firstly, the medical background of COVID-19 is given. Pathology and symptoms are presented. COVID-19 is a chronic condition that mostly affects adolescents. It is a condition that requires continuous monitoring of the symptoms in order to provide an effective course of treatment. It also requires a strict adherence to medication prescribed by the physician. However, the aim of this study is to develop a system, which is based on a periodical data collected by the different sensors. There is no cure for COVID-19. Symptoms can be prevented by monitoring factors which can trigger COVID-19 attack. So it is very much needed that there should be a system which can monitor air parameter on regular basis and warn the patient when these factor can trigger their COVID-19 attack.

Wireless sensor networks in monitoring of COVID-19
Authors: DinkoOletic
Published in: IJRSE 2013
COVID-19 is one of the widespread chronic diseases. Rising prevalence increases the burden of personal disease management, financial expenditures and workload, both on sides of patients and healthcare systems. Firstly, the medical background of COVID-19 is given. Pathology and symptoms are presented. Afterwards, the problem of persistent COVID-19 management is introduced with a short overview of traditional disease management techniques. A review on approaches to COVID-19 telemonitoring is made. Effectiveness of home peakflowmetry is analysed. Employment of low power wireless sensor networks (WSN) paired with smartphone technologies is reviewed as a novel COVID-19 management tool. Using the technology, the aim is to retain the disease in a controlled state with minimal effort, invasiveness and cost, and assess patient's condition objectively. WSN-s for sensing of both COVID-19 triggers in the environment, and continuous monitoring of physiological functions, in particular respiratory function are reviewed. Sensing modalities for acquiring respiratory function are presented. Signal acquisition prerequisites and signal processing of respiratory sounds are reviewed. Focus is put on low-power continuous wheeze detectiontechniques. At the end, research challenges for further studiesare identified.

Monitoring the patient with COVID-19: An evidence-based approach
Authors: Harold S. Nelson, MD
Published in: Apr 17, 2000

The monitoring of symptoms, airflow obstruction, and exacerbations is essential to COVID-19 management. Patients who practice self-monitoring in conjunction with use of a written action plan and regular medical review have significantly fewer hospitalizations, emergency department visits, and lost time from work. Either symptom monitoring or peak expiratory flow monitoring is satisfactory, provided the results are interpreted with reference to the patient's own baseline COVID-19 status. Regular monitoring by physicians also improves health outcomes for patients, provided the physician is systematic and monitors control, medications, and skills at regular intervals. Additional monitoring tools are under evaluation, and these include measures of airway responsiveness, airway inflammation, and Internet- based monitoring systems. Administrators need to monitor the quality and cost of care, as well as compliance with national management guidelines. Assessment of the hospitalization rate and regular audit may achieve these aims in the hospital setting. The best way to assess and monitor COVID-19 in primary care remains an unresolved yet crucial issue because primary care physicians manage the vast burden of illness caused by COVID-19. Monitoring COVID-19 outcomes is an essential step toward the successful implementation of national guidelines for the management of COVID-19.

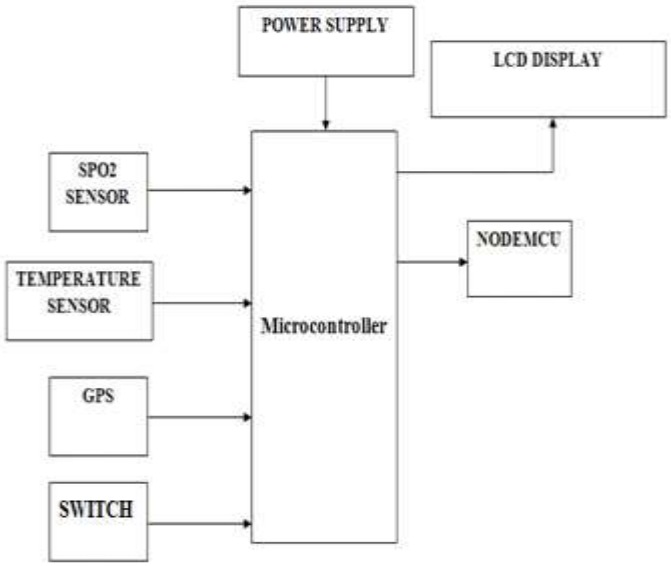
I. PROBLEM STATEMENT

COVID-19, a chronic health condition prevalent in children can be characterized by breathlessness, chest tightness and coughing. A COVID-19 attack can be triggered by a variety of factors including environmental conditions, intense physical activity, humidity and dust. In the United States, as of February 2020, 17 million children (10%) were reported to be suffering from COVID-19. This condition is generally more prevalent among adolescents in the age group of 41-67. Due to the high prevalence of it in children and the difficulty involved in diagnosing the condition it becomes imperative to come up with technological solutions for continuous care and management of patients with this chronic disease.

I. PROPOSED SYSTEM

The COVID-19 Monitoring System is designed around a microcontroller for gathering, sending and receiving information from different sensors and external servers. The aim of the architecture design is to provide an easier access to information and services, better patient healthcare services, transparent and efficient use of healthcare resources, and a fast response by the hospital side in case of COVID-19 attack. Symptoms can be prevented by monitoring factors which can trigger COVID-19 attack. So it is very much needed that there should be a system which can monitor air parameter on regular basis and warn the patient when these factor can trigger their COVID-19 attack.A portable system for non-invasive diagnosis of Broncho pulmonary diseases and continuous monitoring of the patient's condition is a combination of two compact modules radiating and receiving, located on the side of the chest and back, respectively. The position of each module is fixed and does not change over time. The fixation point of the modules is determined based on the individual characteristics of the patient's body.

I. ARCHITECTURE DESIGN



Currently, there are a large number of developments of portable systems that are capable of diagnosing or monitoring the condition of a patient suffering from COVID-19. However, the vast majority of such developments do not find widespread introduction into clinical practice, either due to the presence of deficiencies inherent in the methods used, or due to the complexity of the procedure for licensing medical equipment. Diseases was carried out. The analysis of the results presented in the article allows us to conclude that people around the world are very interested in the implementation of integrated monitoring, information. There is the possibility of the patient's treatment by telephone or other means of communication in a specialized Call Center for advice on symptoms and necessary actions. The most complex systems involve the use of home systems, including portable systems, telemonitoring, and telemedicine. Analysis of the effects obtained after the introduction of such programs of care about the health of the population, leads to the conclusion about their effectiveness.ittriggers are usually and distinctively categorized with allergens such as pollen, dust, cockroaches, and mound, food and food additives, exercise, irritants in the air such as smoke, air pollution, chemical fumes and strong odors, infections, medications, and many other factors, One trigger for it is the allergies and it is a common problem. Approximately 80% of people with it have allergies to airborne substances such as tree, grass, and weed pollens, mold, animal dander, dust mites, and cockroach particles.COVID-19 can be managed by taking an active role in its management via ongoing treatment and building a strong partnership with doctors and other health care providers. COVID-19 action plans are said to be one of the most effective interventions available. A Written action plan is key to effective management, because it is written by the patient, in conjunction with their doctor. Such that they can both easily recognize changes in the patient’s severity and provide clear instructions on how to respond.

CONCLUSION

When the engineer will design a new product he must study everything related to his idea to avoid its errors and he must interest to introduce high quality, low cost, high accuracy, small size and easy to use product, then he should take customers opinions and suggestions to improve his skills in the next design.Thus, this paper discusses the prospects for introducing a portable system for diagnosing it. A block diagram of the system is presented on the basis of a cheap patient status sensor in combination with a portable computing device - a smartphone, tablet, etc. Such a structure will significantly reduce the cost of the device, which will contribute to its wider distribution. As the main method of state control, it is proposed to use the method of measuring the transmission coefficient of the microwave signal through the patient's chest. In this case, measurements are carried out at a single point, but for a long time, for example, when the device is continuously worn during the day. The advantages of using microwave technologies allow us to apply the proposed structure to monitor the condition of patients of all age groups, including young children. The integration of additional sensors for the patient’s vital activity and the state of the environment, together with

the use of modern IT technologies, will enable the creation of a comprehensive system for monitoring the patient's condition and informing him of the necessary actions in a timely manner.

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