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Advances in Computer Sciences

Open Access Journal | Volume: 4.1

ISSN 2517-5718

Review Article

DOI: 10 31021/ACS20224122

Smart Mobile Applications as a New Trend to Improve the Healthcare Sector

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Abstract

Recently, with the development of technologies, the healthcare sector has shown remarkable development in several areas. One of the most important of these technologies is smart mobile, devices, which have become widespread; they are increasingly owned around the world. Smart applications of mobile devices enable patients to contact medical care providers directly and help patients manage diseases by reading vital data such as blood glucose level, cholesterol in the blood, blood pressure rate, heart rate, and oxygen level. This type of technology helps monitor patients in their homes, especially for people who have chronic diseases and those recovering from surgeries. This research is intended to review smart applications in five broad fields of health care and cover their uses and implementation. These fields are diagnostics and treatment, electronic medical records for patients, education for medical students, patient monitoring, and assisting drug research.

Keywords: M-health; Mobile Applications; Health Care Applications

Smart mobile applications as a new trend to improve the healthcare sector.

Background

The current era of information and communication technology has fostered the tremendous growth of smart devices and applications. These devices and applications are used in human life daily. Smart mobile devices have become widespread and owned by more people around the world. These devices are considered computers-they contain features such as large screens, storage capacity, high-speed data flow, handling of multimedia, powerful processors, high-resolution cameras, NFC, Wi-Fi, Bluetooth, and portability. In addition, people use these devices more often than computers, and these features have become so ubiquitous that developers compete to provide various types of applications. Technology's presence has helped to improve the quality of the health care sector, as it contributes to managing crises and chronic diseases, raising the efficiency of prevention and protection from the spread of disease, and reducing costs and time involved in providing health care. In taking advantage of technologies such as sensors, Bluetooth, the wireless application protocol, 3G or 4G, Wi-Fi, or global positioning systems, the health care field has benefited greatly. Using mobile applications in health care fields is called mobile health (M-health). M-health involves providing health services through mobile platforms and applications connected to the internet using a cellular or wireless network. Its development has helped provide urgent solutions and great opportunities for the health sector. Mobile devices are characterized by their rapid and effective ability to collect and exchange health information between a patient and their health care provider and the ability to monitor the patient and communicate with doctors efficiently. Designing an application that serves the health care field requires assessing accessibility, high quality, and value. Access means that the user can access data at any time and place. High quality is represented in providing an integrated application with high-level medical services, and value means that the service provided is characterized by effectiveness. In this paper, we review smart applications in various areas of health care: diagnostics and treatment, electronic medical records for patients, education applications for medical students, patient monitoring, and assisting drug research.

Received Date: 25 October 2022, **Accepted Date:** 20 November 2022, Published Date: 26 November 2022

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Citation: Mafraq HI, Smart Mobile Applications as a New Trend to Improve the Healthcare Sector. Adv Comput Sci. 2022 Dec;4(1):122.

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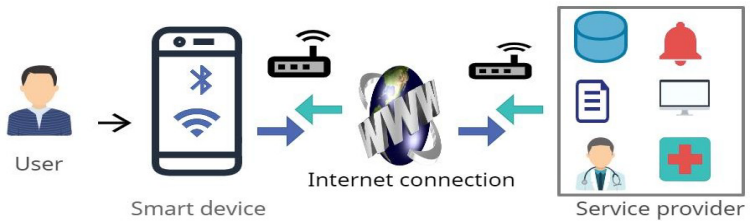

Figure 1: The Framework of Mobile Applications in Health Care

Technology Description

There are many technologies used in smart health care systems, such as IoT, big data, 5G, portable internet, artificial intelligence, cloud computing, sensors, smart mobile, and microelectronics. They can be used in treatment, decision-making, health management, disease monitoring and controlling, diagnosis, and research of medical and drugs. Patients, hospitals, doctors, and medical research can all benefit from technology use. Below, we review how each category can benefit.

- Patients can use wearable gadgets to keep track of their health at all times, request medical care through virtual assistants, and implement remote services from their homes'
- Doctors utilize a range of sophisticated clinical decision support technologies to aid and improve diagnosis. Doctors can address medical data using an integrated information system. Surgical robots and mixed-reality technology can help with precise surgery.
- In hospitals, radio-frequency identification technology can be used to manage people, materials, and supply chains, with integrated management platforms collecting data and assisting decision-making. Patients' experiences can be improved through the usage of mobile medical applications.
- From the standpoint of scientific research institutes, techniques such as machine learning can be used instead of manual drug screening, and big data can be used to discover suitable participants [1].

In this work, we will focus on smart mobile applications in health care. The framework for mobile applications in health care is shown in Figure 1. Individuals use mobile devices or tablets that support internet connection and Bluetooth to connect to the internet and get services from providers.

Importance and Applications

Smartphones have become indispensable. They are used in accomplishing all daily activities, such as studying, following up on work, social communication, and managing health. Smartphone applications have improved health care services, making them more effective, as well as providing rapid communication with doctors and health care providers. They also help increase the efficiency of health services and improve productivity. Their benefits are evident in countries with large populations that are socially and economically diverse. These applications also help those of low socioeconomic status who cannot afford medical insurance or treatment by making it easy to communicate and consult with doctors. In addition, they help relieve congestion and overcrowding in clinics [2].

Smart applications for mobile phones are used in several health care areas, the most common of which are presented below [2-5].

- Monitor patients-Smart applications help monitor patients, especially the elderly, patients with chronic diseases, and children.
- Manage medical records-Medical staff can review and understand patients' conditions in or outside the hospital.
- Diagnoses of diseases-Applications help diagnose diseases accurately by evaluating patients health conditions and symptoms.
- Monitoring chronic infectious diseases-The most popular application in this field is HESN. The Ministry of Health in Saudi Arabia launched it on Oct 1, 2012, and it is considered a version of the Public Health Solutions for Diseases Surveillances and Management that was launched in Canada to monitor the SARS virus. HESN is an electronic system intended to monitor infectious diseases, help reduce outbreaks of epidemic diseases, determine the percentage of vaccinated population, evaluate the level of vaccine stock, help organize and manage work, and create reports. After COVID-19, it was developed by adding records for all COVID-19 patients [6].
- Personal health monitoring-Applications can help individuals to monitor their weight, activity, and vital signs.
- Help in the medicine field-Some applications are designed to help patients remember to take medicine, record the correct doses, and help them to adhere to the dose at the specified time. An example of this is the MOH Formulary application, which provides information on pharmaceuticals. Users can learn about approved medications and their features, side effects, and regulations.
- Telemedicine and telephone consultations for patients-Patient can contact and consult doctors and via audio, video, or text chat. The SEHA application is an example. The Ministry of Health in Saudi Arabia launched it on March 12, 2017 to provide online medical consultations. It was later developed to include information about COVID-19 to raise awareness [6].
- Reserving appointments in health facilities or obtaining health services-The Mawid application is an example. The Ministry of Health in Saudi Arabia launched it on Dec 29, 2017. It allows users to make, cancel, or reschedule medical appointments, as well as handle referrals [6].

Motivation

The use of smartphones and the internet in Saudi Arabia is close to 100% [7]. One of the most important motivators for this research is to activate technology and utilize its features to increase our health quality. In particular, smart applications on smart devices can help manage human health and provide a greater quality of life through disease management. In Saudi Arabia, many populations suffer from chronic diseases, according to Members (n.d.); 18.3% of adults suffer from diabetes, 15.2% have high blood pressure, 28.7% are obese, and 18.5% have high cholesterol. Due to these widespread chronic diseases among the Saudi people, smart applications should be used to help patients' self-management of diseases and provide effective health care. This work is intended to raise awareness of this technology and highlight some applications that assist patients in self-managing their health.

Research Method

We searched Google Scholar and some digital databases in the Saudi Digital Library, such as IEEE, EBSCO, Science Direct, Springer Journals, and medical journals for smart applications in the field of health care using keywords such as mobile applications, health care applications, and fields of mobile applications. We read the relevant

studies and categorized them based on popular fields of mobile applications' use in health care, as shown in the next section.

Review of Work

M-Health

The World Health Organization defines M-health as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (date, p. #). In addition, it is considered one of the components of e-health.

Advantages of M-health include the following:

- It helps health care staff enter patients' information, treatment plan, and medical history periodically, thus helping to reduce medical errors [8].
- Staff can access patient data anytime and anywhere [8,9].
- It helps staff monitor chronic diseases outside the hospital and makes telemedicine available) [9].
- It improves patients' health care and reduces the length of hospital stays [9].
- It raises the efficiency of health services and increases productivity [8,9].
- It facilitates communication between patients and health care providers [9].
- It limits the spread of infectious diseases [8,9].
- The most important challenges related to M-health are the following:
- In some cases, the level of security and confidentiality of patient information is insufficient, and patients' information can be obtained and used without their knowledge [10].
- Diagnosis reliability is not always high; misinformation between a patient and doctor can lead to misdiagnosis [10].
- Some doctors may not be satisfied with the way payments are processed [10].
- In some countries, there are no clear policies or laws regarding the adoption of smart applications [11].
- All parties might lack experience using mobile devices and services, including medical care employees, doctors, and patients [11].

Mobile devices contain many types of technology, such as networks, mobile middleware, mobile commerce stations, location services and content creation. Other examples include short message service, the wireless application protocol, global systems for mobile communication, universal mobile telecommunications systems, Bluetooth, 3G or 4G, Wi-Fi, and global positioning systems.

In this work, we focus on smart applications on mobile devices, especially in the field of health care.

Smart Mobile Applications in Health Care

The spread of the internet of things (IoT), sensors, cameras, Bluetooth, cloud computing, big data, facial and fingerprint recognition ,light detection will contribute to the development of health services, diagnosis, communication with doctors, and health tracking, especially in remote areas [12]. Smart applications using these technologies will give telemedicine a promising future and provide an effective means of using. In addition, the presence of these technologies and the emergence of new technologies, such as sensors in smartphones, will helpdevelop the health sector. It has become possible for patients contact medical care providers directly, and these technologies help patients managing diseases through applications' ability to read vital data such as blood sugar level, cholesterol, rate of blood pressure, heart rate, and oxygen level. These technologies can also help monitor patients in their homes, especially for people who have chronic diseases or those recovering from surgeries [13]. Smart applications are used to understand the context of a patient's environment, vital functions, and other data through sensors. The information is saved and processed or sent to a larger control unit. These applications can also be used for diagnosing or for displaying or controlling data [14]. The two most popular smartphone operating systems are Android and iOS, which have more than 165,000 applications used in health care, patient monitoring, diagnosis, and detection of many diseases [15].

Smart Mobile Applications in Areas of Health Care

According to health care needs, mobile applications are divided into many areas. We discuss the most common areas [16,1] or fields below

Diagnostics and Therapy for Diseases

With the spread of modern technologies such as machine learning, artificial intelligence, sensors, robots, and expert systems, diagnosis by machine has become more accurate than human diagnosis. It has become used in diagnosing difficult-to-treat diseases such as types of cancers, tumors, infections such as hepatitis, and diabetes. Modern technology helped reduce misdiagnosis and enabled the management of diseases and the provision of appropriate treatment in a timely manner [17]. In addition, these technologies are used in clinical decision-making. The emergence of robots and virtual reality systems has helped provide treatment to patients and perform surgical operations effectively. Smart applications on smart devices have provided easy, convenient ways to diagnose disease, provide consultations, give patients direct contact with doctors, and monitor patients' vital signs. Thus, smart mobile applications have helped in the development of health care services [18], including Seha, Blood Donation Smart, Test Your Vision, Test Vision, Audiogram, re: Mind, and Pregnant + app Festersen & Corradini, 2014; [19-23]. Smart applications are also used to limit the spread of diseases. For example, the Saudi Ministry of Health launched five applications to reduce COVID-19 effects and prevent its spread: Tabaud, Tawakalna, Tetamman, Seha, and Mawid [24].

Electronic Medical Records for Patients

Medical records have gone through many stages; they started with paper and leather manuscripts in which doctors recorded notes and medical prescriptions. Arab scholars wrote medical references and notes about patients and the medicines used in their treatment. By the mid-nineteenth century, most physicians were writing down their patients' data and notes in the form of annual volumes containing patients' files arranged alphabetically. At the beginning of the twentieth century, the idea of establishing a special section for medical files appeared in hospitals, in which employees would arrange and preserve files and provide doctors what they needed during their work. Medical records have been handwritten on paper for a long time, in files containing major medical data, tests, diagnoses, treatment, follow-up reports, and important medical decisions. Subsequently, with the development of technology, these records were automated. Electronic health records preserve all patient information electronically and allow files to be exchanged between medical institutions [25]. Many mobile applications are used to manage electronic medical records, making interaction between health care providers and patients easier and helping patients monitor their health continuously. Examples of these applications are AidIT [26] and mPHR [27].

Authors	Country	App name	Purpose	OS	Tested	Users
Mobile applications of diagnostics and treatment						
Festersen & Corradini, 2014	Denmark and Copenhagen	Mind.	Helps patients with bipolar disorder communicate with doctors, enter and display their health data, and organize medications and prescriptions.	Android, iOS, and Windows.	Y	Patients with bipolar disorder
Garnweidner-Holme et al., 2015	Norway	Pregnant + app	Measures gestational glucose for pregnant women. The application records blood-sugar levels and provides valuable information for patients to maintain a healthy levels. It also provides information on gymnastics and healthy eating.	Android and iOS	Y	Pregnant women
Elasayed et al., 2018	Sudan	Test Your Vision, Test Vision, Audiogram	Used to test hearing and vision. Applications were tested on 30 university students and 30 primary students in Sudan. The aim of the study was to verify the validity and accuracy of the results of testing these applications. The study found that these applications' accuracy is high.	Android	Y	Any user
Alharbi et al., 2021	Jazan City, Saudi Arabia	Seha	Used for medical consultations. Doctors approved by the Ministry of Health respond to patients' queries via voice, video, and chat at any time. Through the information provided by the patient, the doctor makes a diagnosis and guides the patient to the necessary treatment.	Android and iOS	Y	Doctors and patients
Batis & Albarrak, 2021	Riyadh City, Saudi Arabia	Blood Donation Smart App	Studies the advantages and preferences of applying blood donation in Riyadh City. It helps identify donors as well as centers in need of donors.	Android and iOS	Y	Donors or blood donation centers
Mamoun et al., 2021	Ajman City, UAE	SHIFAA	Telemedicine that provides the following services: diagnosing diseases and monitoring patients remotely; consulting doctors via video and photos; ordering, purchasing, and delivering medicines; calling an ambulance; and booking appointments with doctors remotely. It also involves a pharmacy system in which suppliers and doctors can check whether a drug is available, and it stores the information for education and training purposes.	Android	N	Any user
Mobile applications of electronic medical records						
Lamprinakos et al., 2014	Athens, Greece	AidIT	Used to manage patients' medical records. This application allows patients to keep their medical records, health history, and personal data, including medical tests and their results. It contains a schedule of medications, their times,and their dose. Also contains the patient's treatment plan.	Android	Y	Patients and health organizations registered with the National Health Organization
Choi et al., 2020	Seoul and Busan, Korea	mPHR	Developed to be used in emergencies. Data was collected from three large hospitals in Seoul and Busan. A server and cloud service were developed for this application. Information from medical records among three hospitals is shared and exchanged.	Not mentioned	Y	The emergency departments in three hospitals in Seoul and Busan
Mobile applications of medical education						
Choi et al., 2018	Seoul, Korea	AEMR	Used to train nursing students to make clinical decisions and think critically.	Not mentioned	Y	Nursing students
Li et al., 2019	Taiwan	EZ-HCM	Used in education for medical students. Researchers studied their acceptance of the application and the extent to which they benefited in learning medicine.	iOS and Android	Y	Students in the health care management department at National Taipei University in Taiwan
Mobile applications of patients monitoring						
H.-H. Li et al., 2015	Taiwan	-	The authors suggested an application to provide long-term health care for the elderly, giving their familizes information on rehabilitation appointments and allowing them to communicate with their doctors.	iOS and Android	N	Patients, their families, and medical staff
Semple & Armstrong, 2017	Toronto	Launched by QoC Health	Used in Women's College Hospital, which performs outpatient surgeries . It was designed to monitor patients, photograph their wounds every day, and communicate with surgeons daily.	iOS and Android	Y	Women who received surgeries at Women's College Hospital
Cedeno-Moreno & Vargas-Lombardo, 2020	Panama	DiabApp	Proposed to help diabetic patients self-manage their disease by giving them correct and accurate measurements. It allows them to track their physical activity, communicate with other patients, and read articles. It provides them a list of foods suitable for them and shows graphs of their general condition.	Android	Y	Any patient suffering from diabetes
Mobile applications of assisting drug research						
Osahon et al., 2020	Benin City, Nigeria	medPlan®	Used to ensure glaucoma patients' adherence to medication.	Android, iOS, and Windows	Y	200 patients suffering from glaucoma
Aldughayfiq & Sampalli, 2021	Canada	NFC	Proposed to reduce errors in dispensing medication and determining. In addition, it works to verify patient identity before dispensing drugs.	Android, iOS, and Windows	Y	Tested on 21 participants
Mirpuri et al., 2021	India	App	Two researchers and three epilepsy specialists designed this application. The application consists of several services, such as medication appointment reminders, recording the number of daily seizures, recording the patient's daily habits (such as sleep) to improve the treatment plan, educating the patient about health, and communicating with doctors.	Android, iOS, and Windows	Y	96 epilepsy patients from North India

Examples of Applications in the Five Fields

Table 1: Shows details about the applications mentioned in the five fields discussed in this section.

Education Applications for Medical Students

Education through mobile devices and their applications is known as mobile learning. This form of education is different from distance education, in which educational content is accessed through mobile devices only. One of its advantages is that it is collaborative and interactive, and it enables students to learn anytime and anywhere. Its use in the medical field is a new trend. Studies have proven the efficiency and effectiveness of this type of education in the medical field, as students benefit from virtual reality and augmented reality techniques, multimedia programs, and the use of images and video to increase understanding. Additionally, students can join educational lessons from anywhere in the world [28]. Examples of these applications are AEMR [29] and EZ-HCM [30].

Patient Monitoring

Some patients require long-term care that includes monitoring their health conditions, raising their spirits, and educating them about their health. These patients include people with chronic diseases, the elderly, or people with high-risk pregnancies. This long-term care costs health facilities a lot of resources and effort, and it reduces the number of beds available in hospitals. It may also cause some problems for patients, such as acquiring infections [31]. With the development of technologies such as mobile devices, Bluetooth, sensors, and IoT, health care providers can provide medical services such as remote monitoring of patients' vital signs and treatment plans. This will help reduce costs and provide the best, most efficient health services [32].

Mobile application use supports long-term health care for patients with chronic diseases, especially the elderly, and helps them understand their health status [33].

Mobile applications are used to monitor patients after surgical operations [34]. There are also many applications for monitoring blood glucose, such as Dieta Para, Diabéticos, SocialDiabetes, RT Diabetes, Diario de la Diabetes, Glucosio, Mi Glycemia, gluQUO, Fundación para la Diabetes, Con la Diabetes, and Conoce tu Diabetes [35].

Assisting Drug Research

As mobile technology has been used increasingly in the medical field, scientists have realized its importance. Its use in the field of medicine has become an urgent matter as scientists have come to understand its ability to administer medications to patients. A machine can program, but a human needs to organize time, create a plan, and remember the correct time to give medication. More than 14,893 applications are used in medicine management [36] for patients with chronic diseases such as asthma [37]. Mobile applications have also been used to reduce errors in dispensing medication and determining doses. In addition, they can verify patients' identity before dispensing drugs [38]. Mobile applications have also been used to confirm epilepsy patients'adherence to treatment among those with a low level of education about medication. As they suffered from many seizures and loss of consciousness, it was difficult for doctors to ensure that patients adhered to their medication schedule [39].

Table 1 shows details about the applications mentioned in the five fields discussed in this section.

Comparative Analysis

As mentioned previously, smart mobile applications help doctors and patients monitor diseases and limit their spread. In this section, we compare the most important applications of telephone counseling in some of the Gulf States. These applications are considered the most prominent smart solutions to combat COVID-19, which appeared in December 2019 in Wuhan, China, and created significant hurdles for global governments, research, and communities of medical and global health. It is an extension of the SARS virus [40], which has spread and mutated continuously. Therefore, applications to help prevent this disease, which represents a recent threat to human health, have been more significant.

More than 476 smart applications have been created around the world to mitigate this pandemic. These applications have been launched for various purposes related to this disease, such as remote medical consultations, monitoring infected patients, monitoring the current state of the disease, controlling it, booking vaccinations, and examination appointments [41]. In this section, we focus on the most prominent applications in remote medical consultations in four of the Gulf States: Saudi Arabia, the Emirates, Kuwait, and Bahrain (Table 2). In these areas, social distancing and reduced hospital visits are important to reduce transmission [42].

Research Challenges

The significant challenge considered the main limitation of this work is time. In this paper, we discuss only popular fields of mobile applications of health care. In addition, we do not cover all applications of these fields, only provide examples. We do not cover areas such as personal health management, monitoring chronic infectious diseases, telemedicine and telephone consultations, and other miscellaneous aspects.

Conclusion and Future Work

Smartphones have become indispensable. They are used in accomplishing all daily activities, such as studying, following up on work, social communication, and managing health. We reviewed smart applications in the field of health care, considering only smart applications in the most common fields. We focused on diagnostics and treatment, electronic medical records for patients, education applications for medical students, patient monitoring, and assisting drug research.

In future work, we intend to cover more fields of health care, mention the largest possible number of applications, and present their advantages and disadvantages.

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