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Examining the Status of Big Healthcare Data in Mobile Environments: Framework Criteria and Selection

Erdal Erdal
Assistant Professor, Department of Computer Engineering,
Kırıkkale University, Kırıkkale, Turkey

ABSTRACT
Mobile devices are the center of our lives. The use of the devices exceeded their development objectives. They have become an inseparable part of ours with the application about photography, music, games, education and even health. Mobile applications have gained importance in areas that are not tolerated to delay or loss of data such as health field. There should be some sensitivity in the development of such applications. In this study, the criteria found in healthcare applications developed on mobile platforms have been examined. As a result of the study, suggestions are given to those who will develop health applications on mobile platforms.

Keywords: *Healthcare, Software Framework, Mobile Environment, Big Data*

I. INTRODUCTION:

Today, mobile or handheld devices are always on our side in our daily lives. The usage areas of these devices are increasing day by day. Today, however, resources such as computing power or data storage that these devices host sometimes cannot provide the required mobile computing power or analytics. Especially in mobile health (m-health) platforms which are used in health field which is one of the areas where data has reached large dimensions. These platforms require very different data types and big data storage requirements. The data to the platforms is usually taken from sensors placed on mobile devices. The development of services and health monitoring methods provided to patients in this area is a necessity. The aim of this study is to examine the criteria that are needed in mobile platforms, which their importance is increasing day by day, to examine the developed software frameworks and to present suggestions. The use of mobile devices in the field of health is difficult to collect and analyze the collected data. In addition, there are some situations that bring additional difficulties to these challenges. The limited storage capacity, limited screen size, limited processing power resulting from the nature of mobile devices also increases these challenges. The increasing size of the data and the data analysis, which is difficult due to this magnitude, formed the concept of "big data" and brought to the hot topic state which is frequently studied in the literature. In this context, first of all, the concept of big data analytics should be explained. This concept means that the operation of complicated algorithms before streams data flow and the meaning of this data. The concept of Mobile Big Data (MBD) means processing and understanding the raw data collected from the mobile device user from network level or application level that contains gigabytes to petabyte level. On mobile platforms, large data is sent to a remote server or cloud for analysis, which is among the solutions available in the literature. In order to analyze big data on mobile platforms, data mining approaches like clustering, classification and association should be done in these devices.

Electronic medical records (EMR) data that is produced by patients' produced from many sources, especially doctors, hospitals. Considering all data, enormous data is obtained. When the patient data is mentioned, laboratory tests, registration information, medical images, diagnostics, prescriptions, insurance, invoices are the first data that comes to mind. This data for a patient is composed of thousands like[1, 2].Considering the number of patients all over the world and the number of patients visiting hospitals, the big data problem in the field of health care can be understood more clearly. There are different points that produce data for patients. These data sources

include wearable sensors, smart phones and social media resources. These data are of great importance for doctors and hospitals, as they provide cross-sections of patients' daily lives. These devices regulate the patient's sleep, record heartbeat, ECG, body temperature, pulse, and location. Sharing the produced data with stakeholders is another challenge. However, such data may be regarded as raw data. There is an analysis requirement for data to be meaningful. Continuous follow-up of patients is constantly evolving with better sensors and better analysis techniques. The targeted method of 3M health strategy across the world is based on patient data Monitor, Measure, and Manage concepts[3].

The aim of this study is to examine the status of large health data in mobile environments and to present the criteria needed in this field. In addition, recommendations are made for software frameworks to be developed in this area.

II. LITERATURE REVIEW

This part of the study includes studies in the literature.

In 2013, Zaslavsky et al. make a study by mobile analytics categorized into categories[4]. In this study, cloud communication and communication areas of the systems in mobile devices are discussed. In this study, an architecture has been proposed to collect, manage and process the data flow on mobile devices. As a result of this study, bandwidth and energy savings were obtained in mobile devices.

There are different tools for processing and analyzing data on mobile devices[5]. In the literature, a mobile phone toolkit called Incense collects behavioral data with the information it obtains from its users. In addition to such tools, there are studies aiming at optimizing resources such as decision making, battery, bandwidth, storage in literature. It supports the situation-aware and resource-aware approaches with its hybrid design which is equipped with a tool called Mobile miner suitable for mobile devices[6].A Spark-based software framework has also been proposed for managing and analyzing large data on mobile devices[7].However, some restrictions on mobile devices prevent their use for such purposes. These restrictions can be listed as storage, energy problems and memory. Due to these restrictions, heavy data mining operations cannot be performed on mobile devices. However, algorithms that operate on small data sets, which provide energy efficiency, work on mobile devices. In the literature, studies are also carried out in this field. For example, a distributed task management approach has been proposed in a study. In the study, an architecture was developed based on the data mining clustering that should be processed in the mobile nodes[8].Advanced machine learning and data analysis techniques have been proposed to improve energy efficiency in mobile and IoT devices[9].With these criteria, cellular networks-specific algorithms are needed to analyze large-scale mobile data on mobile devices. In this way, mobile service providers can provide customers with special services and opportunities[10].An architecture that regulates the use of resources in terms of energy consumption has been developed on cloud computing[11].

III. CRITERIA

The software framework for managing health data on mobile platforms should have some criteria. These criteria are as follows: Energy optimization, data offloading, sensor data management, mobile analytics, mobile app integration and data customization. What this criterion means is examined at this part of the study.

A. Energy optimization

The importance of energy in the world is increasing day by day. Therefore, energy optimization is one of the important issues discussed in the literature today. Therefore, it is one of the indispensable criteria for the processing of health services data on mobile platforms.

B. Data off loading

With data offloading, the amount of data carried on the cellular network is reduced and the bandwidth that can be used by other users is released. It is a term that can be used not only for wireless connections but also for wired connections if needed.

C. Sensor data management

With the developing technology, the concept of IoT has entered our lives. This concept is based on the flow of data from all objects. Another criterion for devices such as mobile devices that are always near us is that they support reading data from the sensors. In other words, the sensory data must be processed and can be collected.

D. Mobile analytics and customization

Mobile devices need to support mobile analytics in order to reduce the energy consumption and optimize the bandwidth. Otherwise, both the bandwidth and the energy consumption are

required to transfer all the collected data to the cloud or to another location.

In addition, the processing of the collected and processed data at the appropriate time is necessary in order not to affect the end user. Mobile analytics should not be performed in situations where the energy level or bandwidth of the mobile device is not appropriate. Considering this criterion of the system to be developed is very important for end users.

E. Mobile app integration

Today, mobile devices interact with devices used for different purposes. These devices include televisions, smart watches, smart glasses. For this reason, integration with other devices or applications is required in all studies.

Reference	Energy optimization	Data off loading	Sensor data management	Mobile analytics and customization	Mobile app integration
[4]	√	X	√	√	√
[5]	X	X	√	√	X
[7]	X	X	X	√	X
[8]	√	X	X	√	X
[11]	√	X	X	X	X
[12]	√	√	X	X	X
[13]	X	√	X	X	X
[14]	X	√	X	X	X

Table1. Current literature

Table 1 shows the details of the studies in the literature according to the criteria. As shown in the table, the studies in the literature focused on different criteria.

IV. SUGGESTIONS

In this study, the criteria for the systems developed for mobile platforms are listed. The criteria are explained in detail and the studies in this area are examined in the literature and the criteria which are found in Table 1.

In this respect, the following recommendations are presented.

- The energy optimization problem, which is important in all applications developed on mobile platforms, is also very important in the process of data processing.
- Bandwidth, which is one of the restrictions on mobile platforms, is a serious problem for devices using cellular networks. In addition, the importance of bandwidth increases with IoT. Therefore, data should be taken into consideration in all systems to be developed.
- With the developing technology, the concept of IoT stretched into our lives. Reading the data received from the sensors by the mobile devices that are always with us is hot topic in the literature. Therefore, the systems to be developed must be capable of reading data from the sensors.
- Sending all data to the cloud or another device on mobile devices has problems in terms of energy or mobile data used. Therefore, it is the most optimal way to process and analyze the data obtained in the device. However, this process should be done in the best time and the end user is least affected. For this reason, customization must be enabled in the systems to be developed.
- The importance of mobile applications in mobile applications has increased. Mobile application integration infrastructure must be prepared in the systems developed for sharing the obtained data with different applications.

V. CONCLUSION

The mobile devices that we use in every area of our lives are also frequently used in healthcare. In this study, new technology trends in health services systems and applications are examined and recommendations are presented. This list contains the criteria for health applications developed for mobile devices. The study is a guide for the applications for the health field.

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