Journal of Discrete Mathematical Sciences & Cryptography
ISSN 0972-0529 (Print), ISSN 2169-0065 (Online)
Vol. 26 (2023), No. 4, pp. 1189–1196
DOI : 10.47974/JDMSC-1566

Healthcare surveillance based on cloud computing utilizing mobile devices

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Abstract

Cardiologists utilized electrocardiograms (ECGs) to observe cardiac disease in everyday life. A system for reading ECGs outside the hospital based on a Mobile Instrument (MobileInst) was developed to make it easier for specialists to observe their patients' ECGs. A MobileInst receives an ECG signal and sends the signals to an ECG instrument based on the proposed system. By using MobileInst, ECG equipment alarms can be detected. A Cloud Alarm Service (SCA), which records ECG signaling and alert information, receives alarm information when MobileInst receives alarm signals. MobileInst displays the ECG signaling and alarm data when the messages are received by Alert Server. Using the suggested scheme, specialists can keep track of their patients' ailments through ECG signaling sent to their MobileInst devices. Signals for this study were collected from the MIT-BIH PhysioBank database. In observing patients, the technique was found to be accurate in providing accurate results.

Subject Classification: *Primary 93A30, Secondary 49K15.*

Keywords: *ECG signal, Healthcare observation, Service for cloud alarm (SCA), Mobile instruments (MobileInst).*

1. Introduction

Over the last decade, heart disease has been the leading cause of death worldwide. Heart seizures, strokes, and further circulatory disorders account for *45%* of all deaths according to data of Euro Population Health Association (EPHA) [1]. Heart disease treatment and prevention are essential subjects in modern therapy. ECG observation in everyday life is a vital step in the treatment of cardiac disease, and it is likewise an essential subject in the medical and engineering disciplines. With widely and their mobility of smartphones, smartphones are now utilized for heart observation. Many authors have conducted analyses on the utilize of smartphones in ECG observation, for example, [2,3]. The authors demonstrate an ECG observation system based on a MobileInst in [2]. ECG signaling is sent to a MobileInst, which then sends it to a remote server. Specialists can analyze the ECG on a PC after logging onto the server. In this scheme, MobileInst constantly sends ECG signaling while the scheme is working, which can consume a great deal of power and network bandwidth. Furthermore, the authors do not provide alarm software. Some authors provided alarming methods, the majority of which utilized SMS or mobile calls for example [3-6]. Details about pulses alarms are detailed in an SMS in [7]. However, it is difficult to describe an ECG signaling in an SMS.

2. Related Works

Death may occur suddenly due to acute health problems. There are many people around the world who die unexpectedly after discovering that one or more of their organs is malfunctioning. Abnormal symptoms are exhibited by these organs before they occur. They are known as bio-signals, and sensors can detect and collect them. As per the search scope, gateways and microcontrollers are used to upload data in IoT-based remote healthcare systems. Among the most widely used microcontrollers in this field is Arduino. Multiple projects utilize the NodeMCU, which is based on the ESP8266. ESP8266 and Arduino are also used by others [12]. It is sometimes possible to use an Arduino board in conjunction with a Raspberry Pi board. An Arduino board can be linked to a Raspberry Pi utilizing the gateway of Raspberry Pi. A Raspberry Pi can also be used in projects to process data and upload it to the IoT server. There are some projects that use cell phones as gateways, while others use Arduino as a processing platform [16, 18].

In many projects [10-15], sensors are wired to the microcontroller or wirelessly (the HC-06 Bluetooth module is an example). There are many different sizes and configurations of IoT solutions. It was built on the web using tools such as Node.js, WebSocket, a GUI interface, and HTTP server [8,9,14].

Several mobile healthcare apps have been developed using Android Studio, which is another fantastic tool for app developers [10, 11, 13].

3. System Methodology

An ECG is sent to a remote server for processing using this technique. Medical data is sent from the patient to the specialist via the transmitter (specialist/patient) through this device. The window sampling method (1000 samples, and sampling rate: 200 Hz) takes 5-Secs, while filtering takes 9K bytes. For the proposed scheme, ECG signal noise and patient artifacts are compensated for continuously reading these sample windows throughout the day. Following is a module for measuring and analyzing the complex QRS, QT wave, , and PQ wave patterns in cardiac electrical activity to detect damage or illness.

3.1 *Filtering and Extracting Features from ECG Signals*

In an ECG, environmental and biological noise is reduced. Physios are high-frequency noise (baseline drifts greater than 0.03Hz). The electrodes of an ECG can shift. Radiofrequency noise, electrode contact noise, and electrosurgical noise all constitute ambient noise. A low, high, and notch filter is available for ECG waveforms between 0.1 and 250Hz. There is no P- or T-wave.

In order to maximize the number of beats in the ECG segment, the window size is chosen at 200 Hz (at least 5-beats). Q-R intervals and S-P-T peaks are used for measuring the QRS complex and breadth. An approach for low-cost peak detection based on feature extraction is presented in this paper. Other reasons exist for detecting R-peaks.

4. System Design and Implementation

4.1 *A SCA's Designing and Implementating*

A high level of reliability is provided by SCA in its cloud services. Provides MobileInst with the capability to deliver its AlarmMsgs to specialists' phones. As illustrated by Figure 1, our SCA is comprised of four components: the The Server that Receives Messages (SRM), Monitoring of Alarms and Information (MAI), Server for Message Pushes (SMP), and Server of Web (SoW). In addition to receiving alarm messages, SRM also transmits them. MAI stores a copy of received alarms. With the help of the ECG signal, a message will be sent from SoW to the specialists' phones through SMP. ECG signaling may be reviewed by the specialist after receiving the message from SoW.

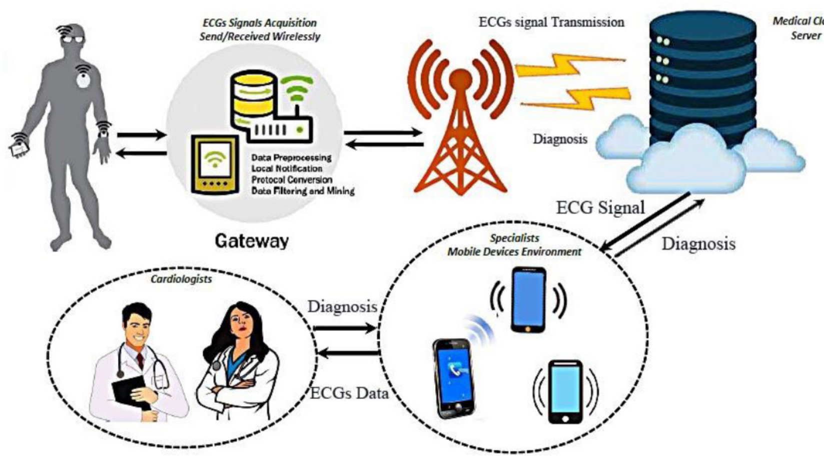

Figure 1

The Infrastructue of Overall System

5. Experimentation Based on Findings

The situation is illustrated in Figure 2. A test setup as well as a scenario of anomalous alerts are included in the ST section. SCA receives and records alarms. Samsung Galaxy mobiles are used to receive customer alert messages. A ringing and vibrating notification are sent to the recipient. An overview of the alert and ECG signs is displayed when the notice is presented. Time consuming that required for processing the EEG data along with each call by using 5G Mobile network listed in Table 1.

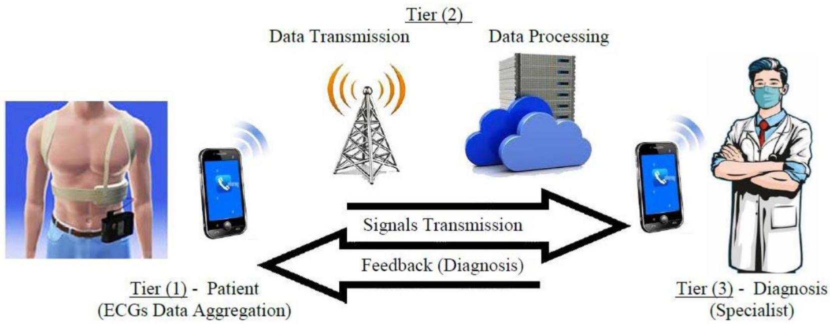

Figure 2
Mobile Instrument for Processing ECG Data

Table 1
The time consuming of ECG data processing with mobile Instruments

No.	**Mobile Service by Zain Network /5G**	**No.**	**Mobile Service by Zain Network /5G**
	Time Consuming (ms)		Time Consuming (ms)
Call-1	1892	Call-1	429
Call-2	1696	Call-2	2663
Call-3	1625	Call-3	3215
Call-4	1624	Call-4	2428
Call-5	1609	Call-5	2833
Call-6	7368	Call-6	377
Call-7	2349	Call-7	461
Call-8	1970	Call-8	5895
Call-9	1932	Call-9	751
Call-10	1602	Call-10	3154

Conclusion

MIT-BIH arrhythmia database is used to determine the severity of arrhythmias, and the real measurement signal is used to determine the autonomic nervous system's state to avoid chronic diseases sooner. A real-time ECG observation and warning system utilizing Android was planned, built, and tested in this project, considering the alarm processing and architecture of the system. It was concluded from these findings that the system was user-friendly and reliable. Mobile networks are supported by a powerful network environment. It is also possible to optimize MobileInst's energy consumption when delivering messages. The information would be useful to healthcare professionals who specialize in cardiology and heart disease. Arrhythmia characteristics will be studied further, and algorithms will be developed to improve judgment accuracy, so a single judge's error will be reduced in future.

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Received March, 2022
Revised May, 2022