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Real time Health Monitoring using the Embedded Sensors of Mobile Phone

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Abstract - *Now-a-days, one of the most important device in our lives is a mobile phone. It is a robust computing platform with a variety of sensors. Embedded sensors have a variety of applications, including environmental monitoring, social media, safety, and healthcare. Mobile technologies, which have ingrained themselves into our lives, can better integrate health care into our daily lives. The goal of this project is to create a mobile health monitoring system that collects health data using the embedded sensors in mobile phones. Additionally, this device transmits data to a cloud server, where it is immediately accessible to medical professionals. Individuals will benefit from this system as they go about their daily lives and monitor their health*.

Key Words: **Global Positioning System , Fall detection , Step counting , Embedded Sensor.**

1. INTRODUCTION

Rapid improvements in healthcare services and low-cost wireless connectivity over the recent years have made it much easier to deal with the issue of fewer health providers. Nowadays, a person's mobile phone or smartphone is their primary means of communication. Mobile phones can currently communicate wirelessly via a variety of methods (GSM, Wi-Fi, Bluetooth and others). It enables both the development of new healthcare services and applications as well as the integration of mobile phones into already available healthcare services.

The fact that modern mobile phones come with strong embedded sensors, including a microphone, accelerometer, camera, and others, determines whether they are acceptable for use in healthcare. There have been studies of mobile phone sensing applications, for instance, in [1] a number of industries, including as healthcare, social networks, safety, environmental monitoring, and transportation. This study is concerned with the healthcare industry. Previously, occasional doctor visits have been the main source of information for personal healthcare. The ability to gather data from sensor-enabled phones has the potential to fundamentally alter how healthcare is assessed and provided. Recently, e-health has taken use of how pervasive mobile technology are to help people track their symptoms and receive treatment.

The system proposed is to develop a monitoring system using embedded sensors of Mobile devices. It assists in keeping track of crucial bodily indicators like temperature, SpO2, and NIBP. Additionally, users' step counts and falls are detected. Data collected by sensors is kept in a database, after which it is displayed in trend graphs. They provide you with a graph showing the trend of your health parameters over time. Additionally, this device transmits data to a cloud server, where it is immediately accessible to medical professionals.

2. MOBILE PHONE SENSORS IN HEALTHCARE APPLICATIONS

The mobile phones nowadays are equipped with a variety of sensors. These sensors enable the active and passive sensing of various health states and characteristics. The information gathered by the smartphone sensors can occasionally be combined with data on device usage, including call logs, app usage, and short messaging service (SMS) trends, to provide important details about a person's physical and mental health over time. This section examines various integrated phone sensors are utilized in health applications and how they are handled. The various sensors are :

1. Camera

Images and videos about a patient can be provided through the camera sensor on a mobile phone, which is valuable for applications like remote medical consultation. Teledermatology is a more significant instance of mobile device camera use in healthcare services, where the doctor uses photos of the patient's skin to make a diagnosis. A remote doctor's advice, which is utilized for teleconsultation is one example of a different sort of medical consultation employing a mobile phone camera [2]. Such applications reduce the overall frequency of patient visits to medical facilities, which ultimately improves healthcare.

2. Microphone

A microphone sensor is utilized in healthcare for communication. The microphone can also be used to gauge how a patient is feeling. For instance, it has been proven effective for individuals with myotonic syndrome, a disease

marked by sluggish muscular relaxation[3]. The voice recognition capabilities of smartphones are highly accurate. The microphone can be used by apps as a sensor to record audio and then analyze the signal.

3. Accelerometer

The primary use of accelerometers in the healthcare industry is to monitor a patient's level of physical activity. It is important since it helps lower the chance of developing a variety of chronic conditions. An accelerometer measures appropriate acceleration, which is the acceleration that people and objects experience relative to free fall.

4. Gyroscope

A gyroscope sensor is a device that can measure and keep track of an object's orientation and angular velocity. Compared to accelerometers, these are more modern. While accelerometers can only monitor linear motion, they can measure the tilt and lateral orientation of the item. The angle at which someone falls is measured using a gyroscope, which essentially aids in the fall detection of elderly people.

5. Magnetometer

Your phone's orientation in relation to the magnetic field of the earth is detected by a magnetometer. As it enables your phone to recognize directions and modify the map appropriately, this sensor is crucial to navigation and compass apps.

6. Global Positioning System

GPS is an antenna-equipped sensor that assists in navigation. It continuously receives satellite signals that are used to determine the location and distance travelled by your phone. GPS and magnetometer are both used by navigational apps to determine location and direction. The system will track, trace, monitor, and assist with patient care so that effective medical services may be provided given at the appropriate moment.

7. Proximity Sensor

Without making physical contact, a proximity sensor can detect the presence of items close by. Nearly all smartphones have them at the top of the screen. The light passing through this sensor is infrared. It recognizes and responds to each physical thing that comes into contact with this light.

8. Biometric Sensor

They are frequently employed for security purposes, identify people using bodily characteristics. Using physical characteristics for identity authentication offers improved protection because they are specific to an individual. Some of the biometric sensors in your smartphone includes Fingerprint Scanner which when you place your finger on the scanner, a capacitive surface in the device generates electrical impulses depending on the ridges of your finger and second is Iris Sensor this records and recognizes your iris's pattern using infrared light that is undetectable to the human eye.

9. Atmospheric Sensor

Several environmental characteristics of your device, such as atmospheric pressure, ambient temperature, air humidity, etc., are detected by atmospheric sensors. The atmospheric sensors are the thermometer which monitors both the internal and external temperatures of the object. A barometer measures the atmospheric pressure in the immediate area. Sensors that detect air humidity these sensors gauge the humidity of the air around you.

3. PROPOSED WORK

The proposed monitoring system with embedded sensors is presented in this section. Figure 1 displays the system architecture. The three main parts of the proposed system are data collecting from sensors, data storage and display through trend graphs, and real-time data transmission to a cloud server and then developing a mobile application.

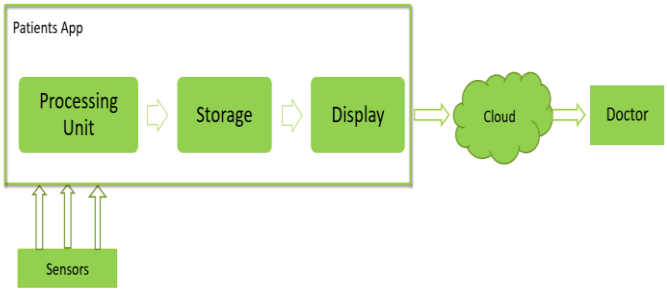

Figure -1: System Architecture

Sensors such as accelerometer, gyroscope, gps, and magnetometer are used to collect the data. The information acquired from the sensor is then applied to user fall detection and step counting. We will also track vital signs like temperature, SpO2, and NIBP using this system. Data collected by sensors is entered into a database and displayed using trend graphs. furthermore, we'll see how sensor data is gathered and utilized for step counting and fall detection.

3.1 Step Counting Algorithm

- In this firstly we obtain accelerometer data, including acceleration along the X, Y, and Z axis. Accelerometer sensor measures acceleration also monitors the acceleration caused by gravity. The sensor framework expresses data values using a conventional 3-axis coordinate system.

- Then obtain the 3-D acceleration data's magnitude and get the difference in magnitude from previous value [4].

- If value of difference is greater than particular threshold value then can say there is some sudden change and step is detected.

This is how we measure steps, and a graph that shows the user's daily, weekly, and monthly step counts may subsequently be created using this data in developed mobile application.

3.2 Fall Detection Algorithm

- Initially we gather data from sensors such as accelerometers, gyroscopes, and magnetometers. The force of gravity is measured by the device's acceleration sensor together with any other applied acceleration. The gyroscope calculates a device's x, y, and z axis's rate of rotation in rad/s.

- Calculate the orientation of the device. You can keep track of a device's position in relation to the frame of reference for the earth by determining the orientation of the device (specifically, the magnetic north pole). The technology uses the accelerometer and geomagnetic field sensor of a device to calculate the orientation angles. The system offers information for three orientation angles using these two hardware sensors: azimuth (degrees of rotation about the -z axis), pitch (degrees of rotation about the x axis), and roll (degrees of rotation about the y axis).

- Use the gyroscope to obtain the rotation vector. A rotation that describes the change in angles across the timestamp is calculated by integrating the gyroscope's output over time.

- The single magnitude vector will be created from the three-axis acceleration measured by the accelerometer. A method known as Signal Magnitude Vector (SMV) is used to calculate the values of the three axes (X, Y, and Z) in order to determine an accelerometer's threshold value.

- When a user falls, the SMV will cross a fixed-value threshold vector, allowing us to detect the fall[6].

- Additionally, we calculate the phone's degree at that moment; if it is greater than certain degrees, the user is regarded to be in danger.

Additionally, the system sends SMS to mobile numbers that are stored in the SQLite database. When tracking is initiated, a service runs in the background and continuously monitors the user. Using a GPS sensor, the SMS provides the user's current location.

4. RESULTS

Results from the step counting algorithm proposed can be seen in Table 1 . The results are encouraging, although only two to three steps worth of error are seen. Trend graphs are then used to illustrate the steps count collected from the suggested algorithm, as shown in Chart 1.

Table -1: Results from Step counting algorithm

Steps taken	Steps counted by algorithm
50	48
125	124
100	97
80	79
140	138

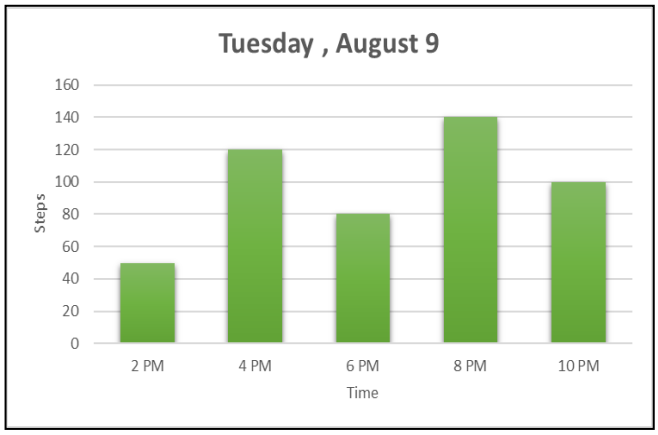

Chart -1: Steps Counter graph

The mobile application used the fall detection data that were derived from based algorithm obtained threshold values. Figure 2 depicts the main screen. In order to display the users' current location as shown in Figure 3, the mobile application sends SMS detailing the users' location from Global Positioning System sensors on the smartphone. Additionally, we gathered the vital parameters for this application and graphed them as shown in Figure 4.

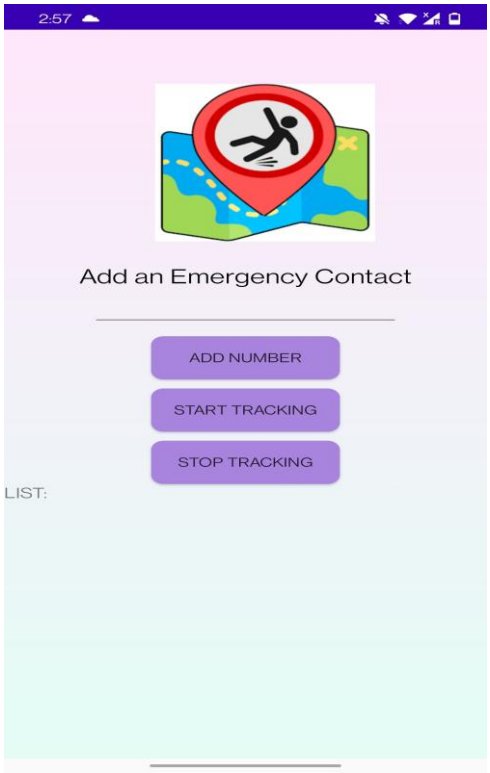

Figure -2: The main screen of mobile application

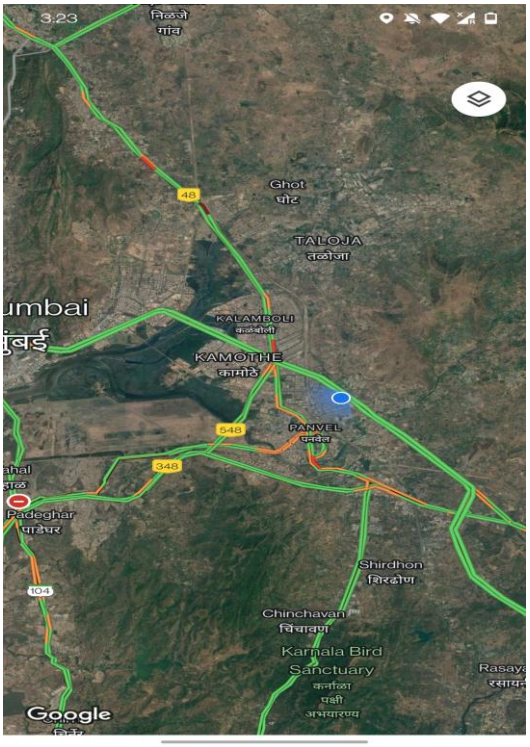

Figure-3: A map showing users' locations

Figure-4: Vital Parameters trend graph

5. CONCLUSIONS

In this paper, we present a prototype for a health monitoring system for mobile phones that uses embedded sensors with step counting and fall detection capabilities. Because so many people across the world currently own a mobile phone, the major purpose for using them in the healthcare industry is to increase the quality and accessibility of healthcare services. Another benefit of using mobile phone-based healthcare solutions is that they can lower the cost of those services.

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