Tele-HealthCare Tracking System Based on GPS for Diabetes Patient

Ghaida A. AL-Suhail, Shahad Atif, Rafaa Qasim and Hussein A. Hamza

Department of Computer Engineering, College of Engineering,
University of Basrah, Al-Basrah, Iraq
(Email: ghaida_alsuhhail@yahoo.com}

Abstract— This paper presents a design and implementation of Tele-healthcare tracking system based on GPS and Cellular network infrastructure to monitor patients; especially the children with Type 1 diabetes. The system depends on remote tracking of patient health data and position wherever they might be. The monitoring process can be done by the parents, caretaker, and doctor in the home/school/hospital. This system is simple and inexpensive to be implemented and can be used easily to detect an urgent or abnormal case, for instance, when there is a highly deterioration in the blood sugar. As a result, the system can find the location of the patient using GPS and then issue an alarm to the parents/caretaker by sending urgent SMS including the location, time and the patient condition in order to intervene and save the life of patient with less delay.

Index Terms— Tele-Health, Tracking System, GPS, Cellular Network, Healthcare, Diabetes, Google Map

1 Introduction

TODAY, Tele-health has the power to fit care around patients where it is needed. It can monitor conditions remotely and it can intervene when it spots something is wrong, way before it's too late. Predominantly the patient is in the home/school, elderly and children and who is suffering from a long term condition or has a chronic disease like diabetic Type 1 [1]. Indeed, Tele-health is the use of telecommunication technologies by health care providers and patients to exchange information and health services for patient care and monitoring. According to many emerge health programmes, it is found that when tele-health monitoring techniques and protocols for early intervention were implemented for patients with long term conditions, there was 15% reduction in in accident and emergency visits; 20% reduction emergency admissions to hospital; 14% reduction in elective admissions and bed days; 8% reduction in costs to the healthcare economy; and 45% reduction in mortality rates [1-2].

As a consequence, it is found that Tele-health system based on GPS, Cellular network and Internet of Things (IoT) network will provide active and real-time engagement of patient, hospitals, caretaker and doctors. Therefore, this paper is mainly concentrated to track the position of the patient with Type 1 diabetic using GPS; and send SMS to inform the parents or caretaker in the school/hospital about the location of the patient. In case of any abnormal or urgent conditions, the system sends automated messages (SMS) to the parent or caretaker once the blood sugar is rapidly deteriorated during the daily physical activities [3-4]. Diabetics are divided into Type 1 and Type 2. Patients with Type 2 diabetes are usually not treated with insulin and don't have to take measurements as frequently. They are instead recommended to have a healthier life-style. A Type 1 patient, mostly present in children (kids), has no insulin production and has to inject insulin during the day. If you thought that diabetes is only detected in elders, then think again. There are many kids all across the globe suffering from childhood diabetes, which can even cause death in extreme cases. A child needs to be pricked several times a day to monitor the blood sugar level. Therefore, the aim in this paper is to design and implement a simple Tele-health care tracking system just to monitor and help the life of kids with Type 1 diabetes.

The rest of this paper is organized as follows. Section 2 provides the proposed system model including th hardware system architecture and software design. As a result, some common advantages are presented in Section 3. Finally, Section 4 summarizes the conclusion and outlines of some future work to faithfully extend this work.

2 The System Model

In this Tele-healthcare tracking system, we design a simple system to send an urgent (Alarm) message to any number of mobiles belongs to the parents and/or to the caretaker. The Ambulance to save the people can also be informed by this device. The system at the patient uses a GPS receiver (Global Positioning System) to record the exact position of the patient with an accuracy of a few feet and then send the location, time and the data of bio-signals such as blood sugar level, heart beat rate condition via SMS over cellular network using GSM SIM card. At the parents/caretaker side, another GSM SIM card is then used to receive SMS from the patient; once the message is received it can be clicked on to connect the Google Map and specifying the location of the child patient. This process is periodically received to keep going on monitoring the child condition. On the other hand, this system can also be used for other monitoring purposes such as stolen vehicle tracking by police or owner, disable people tracking, field service management [5-8]. In [8], however FPGA is used to control and co-ordinate all the parts used in this system. When there is any accident, an accelerom-eter sensor is triggered and it sends signal to the FPGA.

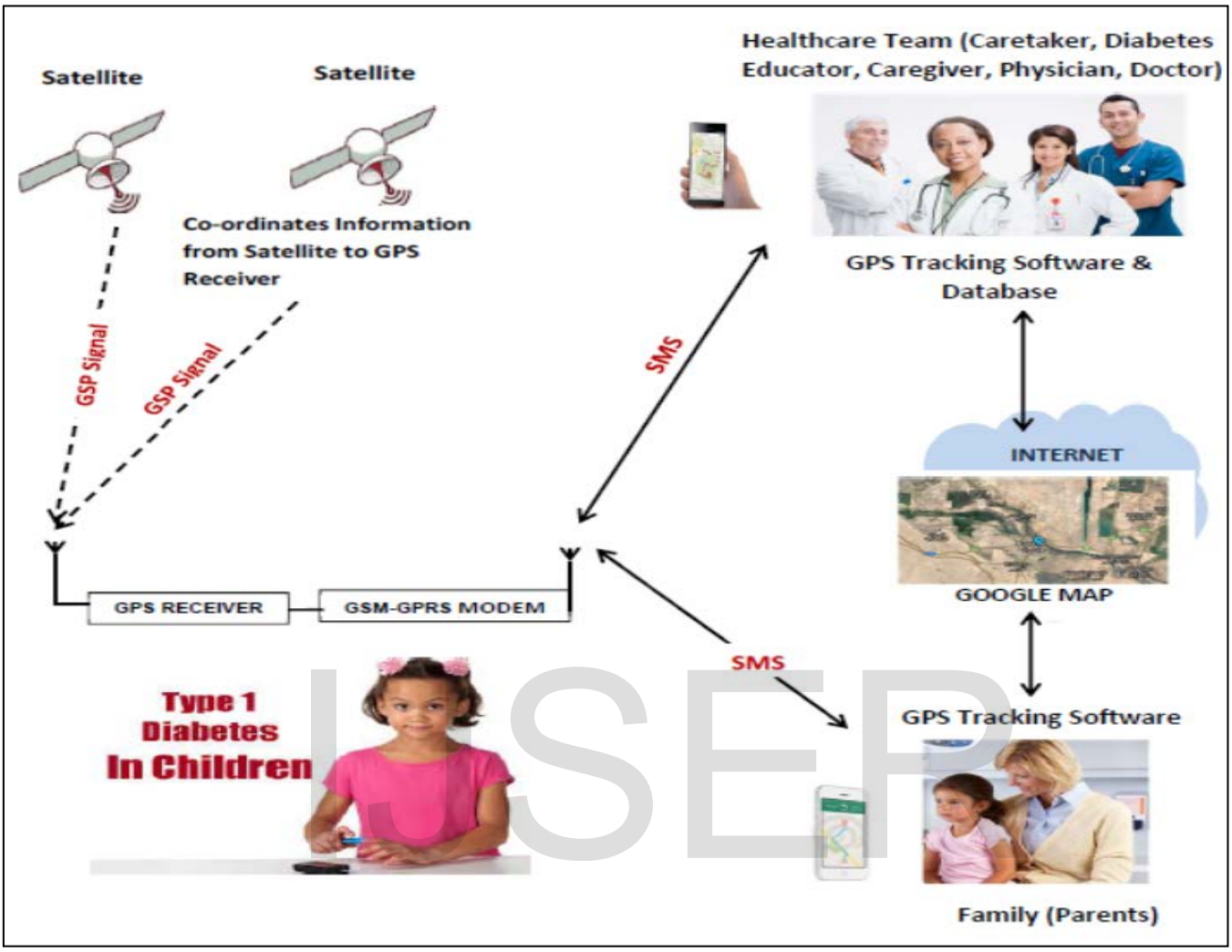

Fig. 1 Architecture of Tele-Health Care System Based on GPS for Diabetes Patient

2.1 System Architecture

Figure 1 shows a general architecture of Tele-healthcare tracking system based on GPS and smart mobile phones. The healthcare team should include patient, family members, a physician, a diabetes educator, and a lifestyle coach (trainer/nutritionist). Within this system, there are two main units: (i) The diabetes patient health monitoring unit and (ii) Control unit. The first unit consists of biomedical sensors such as blood sugar sensor, GPS receiver and GSM SIM card. The main part of system is microcontroller (Arduino) which is used to access the data. To measure the instantaneous blood sugar level of patient there will be a blood sugar sensor. To convert the output of sensor into electrical signal to the microcontroller, the signal conditioning (transducer) should be used. As controller operates only on digital data, so this analog data is to be converted into digital form by using ADC. But ADC is inbuilt in controller (processor). So the output of the signal conditioner circuit is directly connected to Arduino.

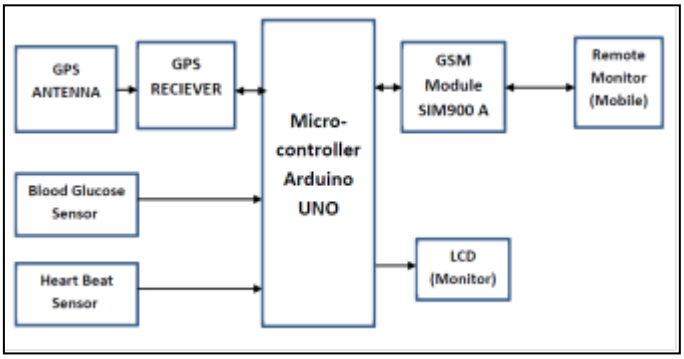

Fig. 2 Block diagram of hardware system description.

Figure 2 illustrates the hardware system description including GSM module GY-NE06MV2, GSM SIM900A Module, Arduino Microcontroller, biomedical sensors, LCD and remote monitor using mobile phone connected to Google Map over Internet.

2.2 GPS Receiver

The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites [8]. In this paper, GPS receiver can log to Latitude and Longitude of the patient at all time and anywhere. By using the location sent by the GPS periodically, the remote mobile station can receive SMS and understand the position of patient (Latitude and Longitude) and the blood sugar level and hence take an immediate action to intervene and help the patient. We used GY-NE06MV6 GPS Module as shown in Fig. 3 [5].

Generally message received by GPS is called NMEA [National Marine Electronics Association] message format and the mostly used NMEA protocol is NMEA0183 Protocol. GPS sentences beginning with the following specifications: $GPGGA, $GPGSA, $GPGSV, $GPRMC, and $GPVTG. And sentences also begins with $GPMSS [7].

Fig. 3 The GY-NE06MV6 GPS Module .

2.3 GSM Modem

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. A GSM modem is wireless modem sends and receives data through radio waves. A Dual-Band 900/1800MHZ-GPRS multi-slot class 10/8 GPRS mobile station class B is used. Once the GPS GY-N06MV6 Module in Fig. 3 is used to log the longitude and the latitude of patient which is stored in the µc memory; then the GSM module sends an SMS to the family member (parents) or to the healthcare team (caretaker, doctor, etc.) containing the location of patient.

2.4 Micro Controller

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. Fig. 5 illustrates the hardware description of Arduino UNO. Fig. 6 shows the blood sugar and heart beat sensors.

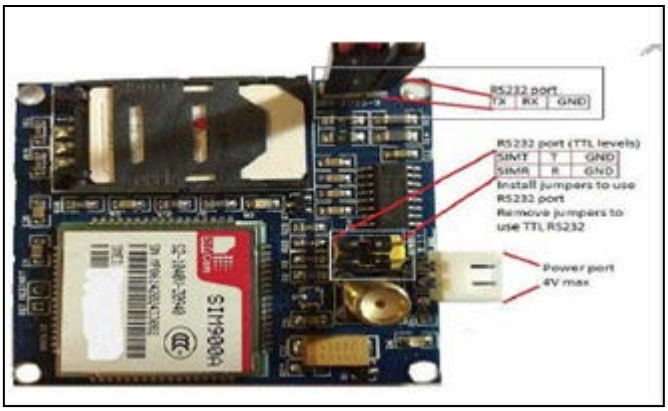

Fig. 4 The GSM SIM900A Mini

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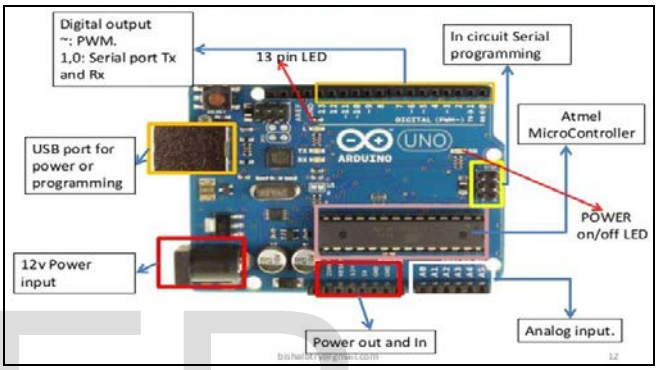

Fig. 5 The hardware description of Arduino UNO

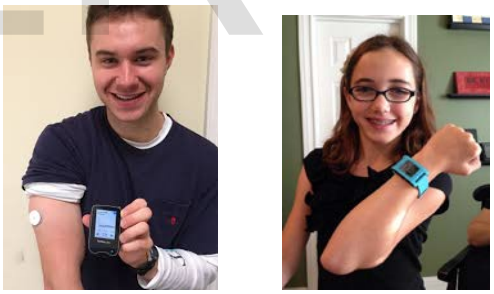

Fig. 6 The wearable blood Sugar and heart beat sensors at the patients

The complete system implementation can be shown as in Fig. 7. Each module is defined according to its library software and interfaced with Arduino UNO via PC.

2.5 Software Design

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides standard form functions of the micro-controller into a more accessible package [5-6].

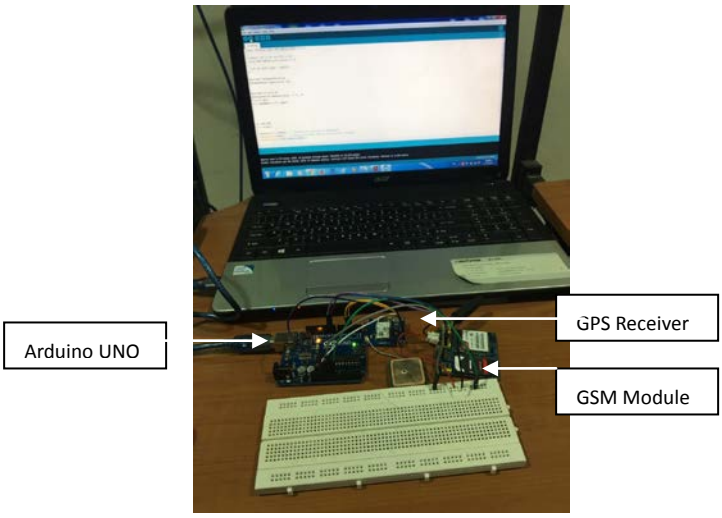

Fig. 7 The implementation of Tele-health Tracking system via PC

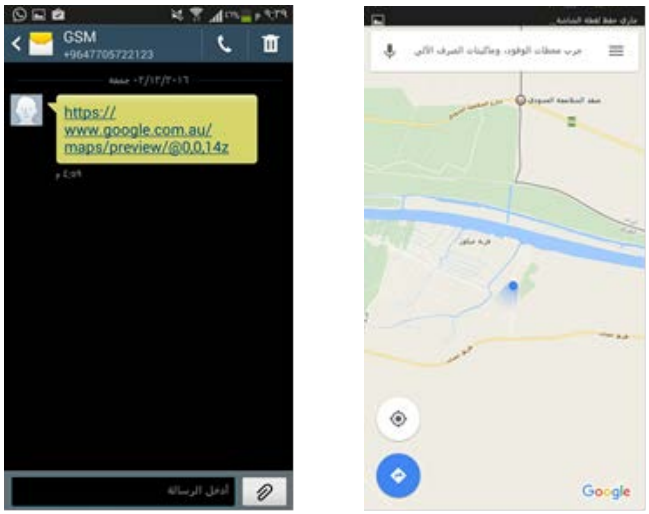

Fig. 8 The SMS message received periodically at the mobile phones of healthcare team and after click on the hyper link the location of the diabetes patient appears on Google Map

At the remote monitor (family or healthcare team), SMS is programmed to be received periodically each 30 minutes, for example. Consequently, Fig. 8 depicts an example of SMS issued by Tele-healthcare system at the patient and sent to the healthcare team. The SMS contains hyper link which can be clicked on to connect the website of Google map and then find the location of patient.

3 Some Common System Advantages

In this section, we summarize the main advantages of the designed healthcare system in Section II as follows:

• The system is integrated with Google Map to ease healthcare team in viewing and locating the diabetes children patients who cannot serve and help themselves when there is a highly glucose (sugar) level decrease in their blood whenever and wherever as long as there is an Internet connection (remotely accessible).

• The system will use the inexpensive Short Message Service (SMS) to transmit the location information using GSM-GPRS mobile network.

• The system is simple and can be easily implemented for a variety of monitoring applications to help such as elderly people, disables since it uses the popular Google Map website to track their location easily when they are in urgent health conditions.

4 Conclusions

In this paper, we introduced a simple and inexpensive telehealth care tracking system based on a variety of recent wireless technologies such as GPS, GSM-GPRS, and Google Map website application. The system can effectively help and monitor the children with Type 1 diabetes and intervene to save their lives before the time becomes too late; especially when they are away from the healthcare team (family, parents, doctors, etc.).

It is completely integrated so that it is possible to track anytime from anywhere. It has real-time capability, emerges in order to strengthen the relations among people. However, the accuracy of system is affected by some factors such as weather, environment around the patient and healthcare team, type of GPS receiver. For future work, the system can be developed to transmit the data sensed from remote patient such as blood sugar level, temperature, heart beat rate, etc. to the database system of the hospital PC server in order to keep tracking on the patient with chronic diseases for long term conditions. However, the system can be easily extended using wifi IoT to avoid the SMS charges via mobile cellular networks.

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