A SURVEY OF INTELLIGENT INFORMATION FORWARDER FOR PUBLIC HEALTHCARE MONITORING SYSTEM

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Abstract - The Health Monitoring System is a greatly developed technology for controlling and monitoring the situation of patients based on Human-health parameters. As healthcare costs are increasing and the world population is ageing, there has been a need to monitor a patient’s health status while patient is out of the hospital in his personal environment. To address this demand, a variety of system prototypes and commercial products have been produced, which aim at providing real-time feedback information about one’s health condition. The Health Monitoring system is based on modern wearable and mobile technology. Wearable Health Monitoring Systems are used to enable prevention and early intervention in case of health problems. The aim of this paper is to survey regarding public health monitoring using smart phones. The wearable sensors and smart phones are used to monitor the wellbeing of high risk patients, according to the situation the smart phone can automatically alert pre assigned caregivers or call the ambulance. The location of the patient can be tracked by using GPS to help the patient in emergency situation.

Keywords: Health Monitoring System, Wearable Sensor, Smart Phone, GPS

I. INTRODUCTION

“Prevention is better than cure”. The Health-Care Monitoring System aims to achieve this. A Growing health diseases is now the leading health-care concern of many countries in the world. Now Aged patients need more healthcare efforts as they present more cases of chronic illnesses involving higher healthcare costs. The risk will increase for patients if they are not being monitored or personally cared, many problems will cause or undetected. If no contact is made with them. Some of the Human health parameters include temperature, heartbeat, blood pressure, pulse are tracked by sensor that are used to determine the health status of the patients. Health-Care Monitoring Systems [1] can help people by providing healthcare services such as medical monitoring, medical data access, and communication with the healthcare provider in emergency situations through the SMS or GPRS. The patient and their family members will feel comfort by knowing that they are being monitored and will be supported if any problem occurs.

The figure 1 shows the overall process flow diagram for Health-Care Monitoring System. Each health monitoring system uses sensor for data collection that can be Wired or Wireless. The on-board body area sensors or wearable sensors is mainly used for collecting the physiological parameter [1] [2] [3] [4] [5] such as Blood Pressure (BP), Electrocardiogram (ECG), Blood oxygen saturation (SpO2), Heart Rate (HR), Temperature (T). Mobile phone is mainly used for gathering and processing data from sensors[4][5][11]. Health care centre periodically monitor the data for registered users and can analyse and process the data. The data analysed by the health care centre can stored the data in storage server. The history of patient record is maintained by the server. Initially the sensors collect the physiological data from patient. The data from sensors is further processed or analysed in any external processing unit. If the data analysed in processing unit is above than the threshold value then the emergency alert is immediately given to the health monitoring centre. The monitoring centre can take further action based on the result. If the data analysed in processing unit is in the normal range it can be analysed by Health-care monitoring centre and the data are stored in data storage server. The storage becomes cloud based so the Health Monitoring Systems can become low-cost, platform-independent, rapidly deployable and universally accessible. There are many key issues to be addressed while designing Health-Care Monitoring System, including:

- Designing a reliable sensor for monitoring the physiological parameter.
- Ensuring the reliable transmission of physiological sign data.
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- Providing privacy and security for patients.

Wearable sensors [1] [2] [7] which are used in this system provide mobility. It is a key benefit of the system and also the constrain for the design of sensor. In order to achieve this benefit, wearable physiological sensors must be small, low-weight, low-power and, wireless. In intensive care units, there is a need for continuously monitoring of patient health parameter such as their heart rates, temperatures, ECG etc. But in many cases, once the patients get well and they come back to home from hospital. But the disease may return, patients may get infected with a new Disease, there may be a sudden attack that may lead to his death. So in many cases, patients are released from hospital but still they are strongly advised to be under rest and observation for some period of time (from several days to several months). In these cases, Health-Care Monitoring Systems are used.

![Overall Process Flow diagram for Health-Care Monitoring System](image)

II. RELATED WORK

A. Classification

There are several wireless health-care researches and projects [1] [2] [3] [4] [5] that have been designed to provide continuous patient monitoring in hospital, real time collection of medical data in-house as well as hospital health-care monitoring. The different health monitoring systems developed are mainly based on three categories of ubiquity level that are shown in figure 2.
• **Controlled area** – This type of a system allow for patient monitoring only inside the boundaries of specific area usually inside the hospital. This system mainly requires BAN and PAN network in addition to the communication architecture.

• **Wide area** – In this system where patient can virtually have any arbitrary location (inside the coverage of WAN). Wide area system compulsory require WAN network.

• **Self-monitoring** – This type of a system allow patients can be located in any location but there is no involvement of medical centre. This system mainly require PAN network segment and BAN network.

### B. Communication technologies

Based on the ubiquity Level of health-care or remote monitoring system the three different communication technologies are used that are shown in figure 3.

1) **WAN** (Wide Area Network)
2) **BAN** (Body Area Network)
3) **PAN** (Personal Area Network)

### C. BAN

- It composed of tiny smart sensor deployed in, on, around a human body.
- The sensor deployed inside the human body is called In-Vivo or Implantable Body Area Network (IBAN).
- The Sensors are distributed on the human body for measuring the vital sign is called Wearable Body Area Network (WBAN).
- The sensors are, in-charge of measuring the physiological parameters and it communicate directly with the smart device and make the “BAN”

### D. WAN

- WANs are used to connect LANs and other types of networks together, so that users in one location can communicate with users and computers in other locations.
- Here the WAN can be used to connect different LAN. The user in one Local area network can communicate with medical center in another Local area network by using WAN.
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- The widely used WAN are Cellular network (GPRS, GSM, UMTS), Internet.
- A telemedicine application which aims to monitor patient health status requires continuous internet connection when patients are at home.

E. PAN

- A Personal Area Network (PAN) is used for data transmission among devices such as computers, Mobile phones and personal digital assistants.
- The widely used PAN is Bluetooth, ZigBee, IEEE 802.15.4, and Wi-Fi.
- The data from the Body area network are transferred to WAN by using the personal area network.

F. Health-Care System Developed for Controlled Area

There are several research project developed for controlled area health monitoring system. CodeBlue [2] is a prototype health care wireless sensor network that defines architecture for hardware and a framework for software. It is a combined hardware and software platform for medical sensor network. Harvard University have developed CodeBlue a medical sensor network platform for multi-patient monitoring environments. The hardware architecture design is an integration of sensors such as pulse oximetry, ECG, and motion analysis sensor that are equipped with commonly-used MicaZ and Telos mote designs. Each patient is equipped with sensor mote used to monitor the health status. The software framework provides protocol for device discovery and publishes and subscribe routing layer. By the use of device discovery protocol motes in the network can discover each other. Each node periodically publishes its node ID and the sensor type it help to identify the nodes in the network.

The queries and request for patient monitoring information is requested and issued by end user device and personal data assistant (PDA) devices operated by medical professionals. The CodeBlue system is also integrated with radio-frequency based localization system that is called as mote track. It is mainly used to track the location of patient and caregivers. It is valuable for large hospital settings. CodeBlue is based on publish/subscribe routing layer in which the sensor publish the data about the relevant channel and the end user subscribe the data about particular channel. CodeBlue is implemented in TinyOS and provides protocols for integrating wireless medical sensors and end-user devices. The routing layer of CodeBlue is based on the Adaptive Demand-Driven Multicast Routing (ADMR) protocol. The main purpose of TinyADMR is to deliver queries and responses under the effect of node mobility, multiple simultaneous paths, and an error-prone communication channel.

The LOBIN system [3] is a healthcare IT platform to monitor several physiological parameters. The main purpose of the LOBIN system is to store and show the data associated with the patients in real time. The location algorithm is mainly used to track the location of patients; it can accurately determine the room where the given patient is located. The LOBIN architecture composed of four subsystems. The healthcare monitoring subsystem consists of smart shirt to be worn by the patient. Every smart shirt is equipped with a device. The device can collect the data from the patient and process the physiological parameter and transmit the data wirelessly. The location subsystem consists of set of beacon points which are deployed in well-known position and set of end device which are carried by the user. The wireless communication infrastructure subsystem is responsible for carrying data, which forward the data to the management subsystem. The management subsystem represents the information technology infrastructure that maintains the information associated with every single patient. The device used to measure the physiological parameter is wearable, non-invasive, portable and washable. The routing algorithm is used in wireless communication infrastructure subsystem. Dynamic source routing algorithm is used for forwarding data.

G. Health-Care System Developed for Self-Monitoring

HealthGear [4] is a wearable real time health monitoring system. It can monitor, visualize and analyse the physiological data. HealthGear consist of set of physiological sensor, wirelessly connected via Bluetooth to a mobile phone. The mobile phone store, transmit and analyse the data. The sensor is non-invasive and wearable. The blood oxygen level and pulse can be monitored by the blood oximeter while sleeping. HealthGear system is mainly intended to monitor the user in their sleep in order to detect sleep apnea event. The three different parts used in HealthGear system is oximetry sensor, wireless data transmission, and mobile phone. The HealthGear system uses Nonin oximeter. It is off-the-shelf constant monitor sensor which is small, light-weight and flexible. The serial data stream produced by sensor is send to the mobile phone by using a wireless transmitter. The central processing unit of HealthGear is Mobile phone. HealthGear use audiovox SMT5600 GSM mobile phone, which can run in Microsoft windows mobile 2003 operating system. HealthGear service is registered in the service discovery protocol.
The HealthGear system uses two methods for automatic detection of sleep apnea event. Multithreshold time analysis method operates in time domain and spectral analysis method operates in frequency domain.

**H. Health-Care System Developed for Wide Area Monitoring**

KNOWME [5] is an end to end body area sensor system that can use the Nokia N95 mobile phone for continuous monitoring and analysing of bio-metric sensor. The off-the-shelf sensor can integrated with mobile phone for collecting and analysing biometric signal. Paediatric obesity is targeted application in KNOWME system. It helps to understand, treat and prevent the childhood obesity it is necessary to develop a multimodal system to track individual stress and physical activity. Obesity is a high risk growing healthcare concern for youth and adults. KNOWME network composed of three tier architecture. First tier is called as WBAN layer or sensor layer, which wirelessly provide physiological signal. WBAN comprised of on-board sensor. Second tier is mobile phone which acts as a data collection hub for external sensor. It also processes the data locally and provides instant feedback to the user. The back-end server act as a third tier, which provide additional processing and data storage. KNOWME’s execution priority is lower than other higher-priority tasks, such as incoming and outgoing calls. Whenever there is resource contention with higher-priority tasks, the mobile phone will simply terminate the KNOWME application. The mobile application is divided into two components KMcore and KMclient. KMcore comprised of seven components in four layers. KMcore is mainly used to collect and process the physiological data and provide storage for data KMcore service manager.

**III. SYSTEM ARCHITECTURE**

**A. Overview of Health-Care Monitoring System**

The proposed system for Health-Care Monitoring System is based Wearable Wrist Sensor and Smart phone for monitoring and diagnosis, which is specially designed to efficiently increase the public health care system for people in more economical and friendly manner. The wearable Sensor Provide more comfort for patients, with the absence of wires reducing costs and providing more flexibility. Furthermore, it offers the potential to alter the current health-care system by enabling out-patient care and preventing unnecessary hospitalisation. Most mobile devices now include an integrated GPS tracking system can provide the position information of the monitored person so that the medical personnel can be dispatched to the right location more promptly in an emergency situation. The health-care monitoring system mainly composed of three parts that are shown in figure-4.

- Wrist Device
- Mobile Application
- Cloud Storage Server.

**B. Wrist Device**

The wrist device is a wearable device that can wear on body. The wrist device is an integration of multiple medical sensors. The new wrist device is redesigned to include the more sensors. Bluetooth low energy (BLE) technology is used for connecting with an Android phone to form a personal area network. It was developed by using TI CC2540 which is a system-on-a-chip with BLE support.

**C. Mobile Application**

The physiological data are measured by wrist device that can be sends to the mobile phone through Bluetooth Low energy technology. The mobile application is developed for analysing and processing data and makes a subsequent decision. The application will therefore access the results of the sensors and check if a threshold level has been reached. Based on the results from the application can determine whether the emergency alert should be raised. The mobile application can receive the data from sensor at different times. E.g. The skin temperature every 2 second, heartbeat and SPO2 every 3 second, and ambient temperature every 10 second. The data can be sent to health care monitoring centre for further analysis.
D. Cloud Storage

The health-care monitoring system maintains the cloud server for data storage. The health record for each user is stored in the cloud server. The cloud server is mainly useful for maintaining historical patient record. The data from the cloud server can accessed by anyone, anywhere at any time, cloud can contain large amount of storage which can be scaled according to application needs. Modern technology is being shifted to Cloud based platform as it is suited for long-term data storage.

Figure 4: Architecture for Health-Care Monitoring System

E. Application of Health Monitoring System

- The hospital bills can be reduced, since the patients are hospitalized from their homes.
- Ease in sharing data when the patient can move from one hospital to another hospital.
- The communication between the patients and care giver is easy.
- Can be combined with other system to create a new medical application.
- Non-invasive Monitoring.
- The data can be accessed by anyone, anywhere at any time.
- The system provides better health care in economical and friendly manner.
- Increases mobility and out of hospital care and monitoring.
<table>
<thead>
<tr>
<th>PLATFORM NAME</th>
<th>APPLICATION</th>
<th>TRACKED PARAMETER</th>
<th>COMPONENT USED</th>
<th>COMMUNICATION TECHNOLOGIES</th>
<th>SYSTEM HIGHLIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Guard [6]</td>
<td>Monitoring in extreme situation</td>
<td>ECG, HR, BP, SpO2</td>
<td>Sensors, Cables and User device.</td>
<td>BAN - Serial Cable WAN - Bluetooth</td>
<td>Monitoring data can be digitally stored during 9 hours on the device or streamed to base station</td>
</tr>
<tr>
<td>CodeBlue [2]</td>
<td>Real time monitoring of multiple patients in hospital</td>
<td>ECG, HR, SpO2, EMG</td>
<td>Wrist strap, finger sensors and EMG sensor</td>
<td>BAN - IEEE 802.15.4 PAN - IEEE 802.15.4</td>
<td>Mote track is used to track the location of patients and caregivers.</td>
</tr>
<tr>
<td>HealthGear [4]</td>
<td>Real time monitoring to monitor the oxygen level and pulse while sleeping</td>
<td>HR, SpO2</td>
<td>Sensor, mobile phone</td>
<td>BAN – Bluetooth</td>
<td>HealthGear monitor the user in their sleep in order to detect Sleep apnea event.</td>
</tr>
<tr>
<td>SmartVest [7]</td>
<td>Monitoring of the health status and geo-location of uses to ensure the safety and effective completion assigned task</td>
<td>ECG, HR, T</td>
<td>Vest with e-textile sensor integrated, Wearable data acquisition and processing hardware and remote monitoring station</td>
<td>BAN – Proprietary from extreme in the ISM band (2.4 GHZ) PAN - USB</td>
<td>Continuous transmission of data to remote monitoring station</td>
</tr>
<tr>
<td>MASN [8]</td>
<td>Real time collection of ECG data</td>
<td>ECG</td>
<td>ECG micro-sensor with RF motes and ECG server.</td>
<td>BAN – Wired PAN – IEEE 802.15.4</td>
<td>Energy-aware cluster formation using energy level determination of sensor nodes</td>
</tr>
<tr>
<td>LOBIN [3]</td>
<td>Real time data collection of patients using non-invasive wearable device</td>
<td>ECG, HR, T</td>
<td>E-textile t-shirts, location devices, WSN, storage server.</td>
<td>BAN - e-textile PAN - IEEE 802.15.4 WAN - Internet</td>
<td>The Location algorithm is used to determine the hospital room of patients.</td>
</tr>
<tr>
<td>MEDISN [9]</td>
<td>Medical emergency detection in hospital environments or disaster events</td>
<td>ECG, HR, SpO2</td>
<td>Physiological monitor, Network gateway, Relay points, back end server.</td>
<td>BAN – IEEE 802.15.4 PAN – IEEE 802.15.4 WAN- INTERNET</td>
<td>The network can be able to span wide geographical areas.</td>
</tr>
<tr>
<td>KNOWME [5]</td>
<td>KNOWME is an end-to-end body area sensing system employing for pedestrian obesity</td>
<td>ECG, SpO2</td>
<td>WBAN of sensors, mobile phone, Back end server.</td>
<td>BAN - Bluetooth WAN-Cellular network</td>
<td>Wearing KNOWME was like “having a doctor in your pocket.”</td>
</tr>
<tr>
<td>LiveNet [10]</td>
<td>Long term health monitoring applications with real-time data processing and streaming and context classification</td>
<td>ECG, EMG, T</td>
<td>PDA, sensor hub, 3-D accelerometer</td>
<td>BAN – Wired PAN – Wi-Fi (IEEE 802.11b)</td>
<td>Parkinson symptom detection system, Epilepsy seizure detection and long-term behavioural modelling</td>
</tr>
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</table>
IV. CONCLUSION

The intelligent information forwarder is a health monitoring system to improve the patient safety using the smartphone and wearable wrist sensor. Wearable wrist sensors enable the patient to move from one place to another easily and used for monitoring physiological signals of multiple patients when the patient was in their homes. The wearable health monitoring systems have potential to provide low-cost, ubiquitous, unobtrusive health monitoring that enables early detection and better treatment for patients. Future enhancement of the paper is based on improving the security for data in cloud using authentication, authorization and user access control incorporated in the system and improve the life time of sensor.

V. REFERENCES


