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Safety Watch: Providing Human Security through Smartphone's

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Abstract-- SafetyWatch is a computerized wristwatch with functionality to provide safety and security to the users. This watch contains intelligent wearable sensor organised in a Bluetooth piconet controlled by a central application implemented on a mobile phone. The piconet is organised automatically, without any user's intervention. Observed data is stored locally at the control node and safety measures are triggered automatically in case of any emergency or extremity. Cloud Computing is a backbone for deploying intelligent security actions to provide real time safety to the user's. In this paper we have also discuss some possible extensions that can enhance SafetyWatch functionalities.

Keywords-- Cloud Computing, HRV, Mobile Application development, GPS, Embedded System, Mobile Computing, Mobile healthcare monitoring, Smartphone.

I. INTRODUCTION

SafetyWatch is a wrist watch that can do far more than just to tell time. With specially designed application in mobile device, SafetyWatch provides security to the users.

As Mobile technology is rapidly changing the face of communication in the whole world. Mobile Phones have emerged as the most essential and favoured tools for communication by humans all over the world. Today out of seven billion peoples in the world, approximately six billion are Mobile Phone subscribers. Though they were produced primarily to assist in communication between individuals who are geographically apart and on the move, in the recent times they have become multifunctional devices. The perception about mobile phones is changed. Now mobile phones become Smart phones as they have fast CPUs and newer operating systems and also contains features as multiple sensors (e.g., microphones, cameras, accelerometer, gyroscopes), multiple wireless technology (e.g., Wi-Fi, 3G and Bluetooth), and positioning systems (e.g., GPS, Wi-Fi triangulation), as well as advanced storage capabilities.

With such powerful computational power, smart phones are ready to take on applications that were never before thought of in challenging areas like human safety and security, healthcare, agriculture and education. Particularly in human safety and security, timely communication and instant help is a critical and lack of it means pain and suffering or even life and death.

We therefore propose the SafetyWatch device and an innovative application, which aims to provide safety and security to the users at real time location. There have been efforts in the past in concerning the safety of users [2][9][10][11], but to the best of our knowledge, this is a first time a system has been developed to provide security to the user automatically in case of any emergency or extremity without user's intervention.

Our contribution can be summarized as follows:

1. We present a SafetyWatch device that capture the user's HRV.
2. We evaluate the application triggering equation by means of participants data.
3. We propose a security architecture using Cloud Computing to provide real time security.

The remainder of this paper is structured as follows. In Section II, we present the brief description of human HRV (Heart Rate Variability). In Section III, we have discussed Cloud Computing and its benefits in mobile computing. In Section IV, we discuss architecture while Section V presents details on implementation. Conclusion& future work is given in Section VI.

II. HRV

Heart rate variability (HRV) refers to the beat-to-beat alteration in heart rate. The clinical relevance of HRV was first appreciated in 1965 when Hon and Lee noted that fetal distress was preceded by alterations in interbeat intervals before any appreciable change occurred in the heart rate itself[8]. On standard electrocardiogram (ECG), the maximum upward deflection of a normal QRS complex is at the peak of the R-wave (Figure 1), and the duration between the two adjacent R-wave peaks in termed as the R-R interval. Heart rate variability, that is, the amount of heart rate fluctuations around the mean heart rate is produced because of the continuous change in the sympathetic parasympathetic balance that in turns causes the sinus rhythm to exhibit fluctuations around the mean heart rate[5].During resting conditions, the electrocardiogram (ECG) in normal individual demonstrate periodic variation in R-R interval. Such HRV measurements provide reliable, non-invasive information on the autonomic nervous system, including its vagal and sympathetic components [6]. The most widely used methods for the measurement of HRV can be grouped under the time-domain and

frequency-domain categories. Time-domain methods are based on the beat-to-beat or NN intervals (NN is used in place of RR to emphasize the fact that the processed beats are "Normal" beats)[12], which are analysed to give variable such as SDNN (Standard deviation of NN interval), RMSSD (Root Mean square of successive difference), NN50, the number of pairs of successive NNs that is differs by more than 50ms, pNN50 and NN20 etc[1][8]. On the other hand frequency domain methods assign bands of frequency and then count the number of NN intervals that matches each band. In SafetyWatch, we have used a combination of both time-domain and a frequency domain method to filter the HRV.

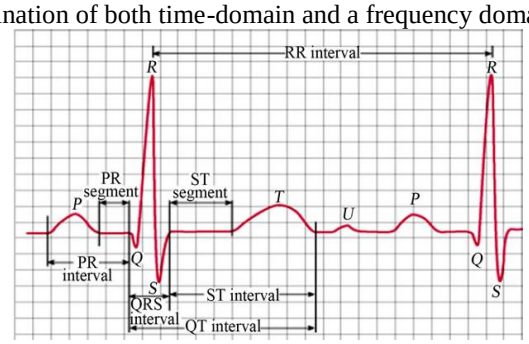

Figure 1: The normal electrocardiogram with component wave labeled

III. MOBILE CLOUD COMPUTING

Mobile Cloud Computing (MCC) is the combination of cloud computing, mobile computing, and wireless networks to bring rich computational resources to mobile users, network operators, as well as cloud computing providers. "Mobile Cloud Computing at its simplest refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and mobile computing to not just smartphone users but a much broader range of mobile subscribers"[4][7]. Cloud Computing is a completely new IT technology and it is known as the third revolution after PC and Internet in IT[3]. The cloud services are generally classified as IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and SaaS (Software as a Service). IaaS enables the provision of storage, hardware, servers and networking components. The client typically pays on a pay-as-you-go basis. Thus, clients can save cost as the payment is only based on how much resources they really use. On the other hand, PaaS offers an advanced integrated environment for building, testing and deploying custom applications. And in SaaS, it supports a software distribution with specific requirements. In this service, the users can access an application and information remotely via the internet and pay only for that they use.

The limitation of mobile computing can be overcome by using cloud computing in mobile computing. The advantage of mobile cloud computing (MCC) are :

1. *Extend battery lifetime*: Limited battery is one of the main concerns for mobile devices. Several solutions have been proposed to enhance the CPU performance and to manage the disk and screen in an intelligent manner to reduce power consumption [4]. However, these solutions require changes in the structure of mobile devices, or they require additional hardware which increases costs. Cloud computing on the other hand provides a large computational power over the cloud that means large and complex work can be done on cloud that helps in large amount of power consumption.
2. *Improving data storage capacity and processing power*: Storage Capacity is also a constraint for mobile devices. MCC is developed to enable mobile users to store/access the large data on the cloud through wireless network.
3. *Improving reliability*: Storing data or running application on clouds is an effective way to improve the reliability since the data and application are stored and backed up on a number of computers.
4. *Scalability*: The deployment of mobile applications can be performed and scaled to meet the unpredictable user demands due to flexible resource provisioning.

IV. ARCHITECTURE

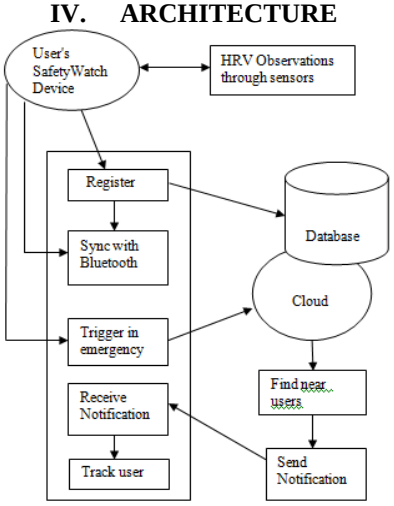

Figure 2 Architecture of the proposed work

The Figure 2 shows the overall architecture of the proposed system. It consists of User, SafetyWatch, Cloud Database. Window Azure database is used in SafetyWatch application to store registered users data and to track on their current location and to find out the users currently present nearer to the victim. Notification Hub is used to send notifications.

V. IMPLEMENTATION

The proposed system consists of two components namely SafetyWatch Device and SafetyWatch Application.

1. *SafetyWatch Device*: SafetyWatch is a wrist watch that contains an intelligent wearable sensor to calculate HRV of the user. The hardware design includes Arduino Pro Mini with Atmel 328P microcontroller whose sketch is developed in C programming language. The design also incorporate specially designed IR sensors to oversees the users heart rate variability. It also contains a Bluetooth module, it is a master slave module that is responsible to drawing a connection in between SafetyWatch and its mobile application in mobile device.

2. *SafetyWatch Application*: SafetyWatch Application is implemented using VS Express for Windows Phones. This application includes Registration module, GPS module, Bluetooth module, MCC module, Notification module.

i) *Registration module*: The function of this module is to register the user with its name, phone number, and GPS location to the cloud database. User fill the form to register yourself to SafetyWatch Database. User also provide five number which can be contacted during any emergency. The Figure 3 shows the registration form design.

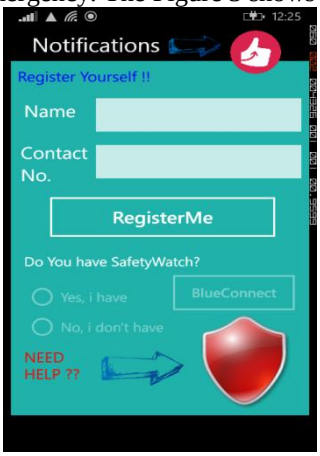

Figure 3 SafetyWatch Registration form

ii) *GPS module*: The task of this module is to locate the user's current geographical coordinates value (Longitude and Latitude) when the user click on RegisterMe button on Registration form as well as the another important functionality of GPS module is to find out the coordinate values whenever the user changes its location to some value (in meters) of distance automatically. This module also perform the reverse geo-coordination as user cannot interpret the location by reading longitude and latitude values.

Another important task of it is to find out the track between the two geo-coordinate sets, one is of the victim and another is of the helper.

iii) *Bluetooth Module*: The job of this module is to perform communication between SafetyWatch device and the application on mobile phone. This module receives the data from the device and analyse it and perform task as designated automatically for example if the data received is "TR" then this will start communicating with cloud database, etc.

iv) *MCC module*: This module has four task to perform. First is to insert the entries of the user data in the Cloud Database as shown in Table 1. Second is to update the entries of the user especially the geographical coordinates in the Cloud Database. Third is to find the nearest user to the victim by calculating their geographical data. And last responsibility of mobile cloud computing is to send the signals for notification when the respective signal is received from Bluetooth module

v) *Notification Module*: This module has a very specific task as to send notification to all the relatives specified in registration process and also to those users that are nearer to the victim identified by the cloud at real time. All notifications should be triggered automatically without user intervention and all notification should be triggered instantly is also carried out by this module. The Figure 4, Figure 5, shows the notification receive by the users and Figure 6 shows the tracking of the victim.

Figure 5 Notification Received by the relatives and near users.

Table 1 Microsoft Azure Cloud Table Data

ID	NAME	CONTACT	DEVICE	LOCATION	COMPLETE
2278WE4C-2345-65M7-234RNO8D9900	PARIKSHIT VERMA	+919650386386	CaCk1PE7ZnEcuVaCKPx...	POINT(77.70674,28.9951)	False
2EP3M034-3452-5490-WP2385KLEQ20	JSS NOIDA	+919023453189	CaCk1PsTevVxxQ23fvF...	POINT(77.48598,28.67265)	False

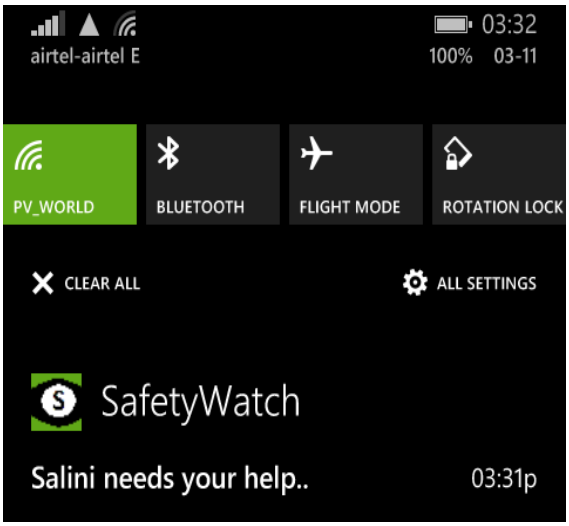

Figure 6 Notification arrived at Action Center

Figure 7 Tracking of victim

VI. CONCLUSION & FUTURE WORK

We have proposed a human life security system called SafetyWatch. Appealing to the requirement of human security, many approaches of providing security to user through mobile phones have been explored but the main drawback on them are they are not automatic means those application requires human intervention and are not intelligent enough. Therefore, we have presented a system that contains a device and an innovative application that highlights the Smartphone's ability to dispense the security of human users automatically and in a intelligent manner so that the user can be saved from any crisis at real time. The Figure's presented in this paper clearly shows the achievability of the task to provide safety to the users.

Future plans are to conduct studies in a variable environment with large number of users and to evaluate the application's role in transforming security delivery and improving outcome in a more accurate manner.

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