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A Study on Health Monitoring System Using Smart Devices

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Abstract – This paper describes work in progress regarding health monitoring using smart phones. Our research combines ubiquitous computing with mobile health technology. We will use wireless sensors and smart phones to monitor the wellbeing of high risk cardiac patients. The smart phone analysis in real-time the ECG data and determines whether the person needs external help. Depending on the situation the smart phone can automatically alert reassigned caregivers or call the ambulance.

Index Terms—Smartphones, Healthcare, Applications of IT

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I. INTRODUCTION

The Smartphone is not only our best friend, it's also become our personal trainer, coach, medical lab and maybe even our doctor.

"Digital health" has become a key focus for the technology industry, from modest startups' focus on apps to the biggest companies in the sector seeking to find ways to address key issues of health and wellness. Apps that measure heart rate, blood pressure, glucose and other bodily functions are multiplying, while Google, Apple and Samsung have launched platforms that make it easier to integrate medical and health services.

"We've got to a point where with sensors either in the phone or wearable's gather information that we couldn't do in the past without going to a medical center".

"We can do the heart rate, mobile ECGs (electrocardiograms). Costs are coming down, and these sensors are becoming more socially acceptable.

Many health and fitness-related technologies have multiple applications and encourage wearers to be more engaged in their own fitness, help modify behavior by reminding wearers to exercise or take medication. Recent studies suggest that people who use connected devices to monitor health and fitness often do a better job of managing and preventing health problems.

A study led by the Center for Connected Health found that people who use mobile devices did a better job of lowering dangerous blood pressure and blood sugar levels.

A separate study published in the July 2014 issue of Health Affairs found that data collected by devices is not only useful for patients but can help doctors find better treatments.

The estimated direct and indirect cost of cardiovascular diseases in any country is huge, to reduce these costs and the anxiety of people with known cardiovascular problems we propose a portable monitoring system that monitors the heart and notifies the person or external party in case of abnormalities. Our monitoring system is meant for patients that have a known cardiovascular disease and need to be monitored around the clock. This project develops such a platform and focuses on heart patients. It aims at designing intelligent biomedical clothes for monitoring, diagnosing and treatment.

Our objective is to investigate and develop an application whereby a heart patient is monitored using various types of sensors (ECG, accelerometer, oximeter and GPS). The sensor information is collected and transferred wirelessly to a smart phone. Our solution analyses the ECG and other sensor data on the local device.

Our solution can monitor and we have mechanisms in place to locate the user in case of emergency

whether the patient is indoors or outdoors. We detect life threatening arrhythmias and give the patient general information about their health when they are not in a dangerous situation. We can also store extra information for further use by the health providers.

II. ARCHITECTURE

The heart patient has one or more sensors (e.g. ECG and accelerometer) attached to his/her body. External devices are used, such as a blood pressure monitor or weight scale, to collect periodically additional health data. We use off the shelf sensors enabling us to incorporate the best technology.

The sensors are Bluetooth enabled or integrated into the smart phone (e.g. GPS). The smart phone processes the sensor data and monitors the patient's wellbeing, and in case of an emergency, it automatically calls an ambulance to the location of the patient.

It can also warn caregivers or family members via SMS or phone when the patient is in difficulty. The data collected by the smart phone can be transmitted to the health care Data server via the internet. Avoid using bit-mapped fonts. True Type 1 or Open Type fonts are required. Please embed all fonts, in particular symbol fonts, as well, for math, etc.

Fig. 1: different smart devices

A. Sensors

Data from each sensor is collected and processed in the smart phone to establish a diagnosis. For high risk cardiac patients the ECG signal is the obvious data that needs to be collected continuously and should be given priority over all other sensor data. It is also important to store the ECG signal for further analysis by the cardiologist. Detecting falls using an accelerometer is another important indication that something is wrong with the patient. Using an accelerometer and other contextual information, we can also evaluate the level of activity of the heart patient. We assess this against the heart specialist's personalized guideline and either congratulate the patient for reaching his/her goal or encourage them to exercise a bit more. The level of physical activity recommended for a heart patient depends on his/her condition and health history. National Heart Foundation of Australia says that physical exercise improves the live expectancy of heart patients and they set guidelines to help heart specialists in setting a personalized level of activity for their patients. We use an integrated Bluetooth ECG/Accelerometer sensor from Alive Technologies.We selected this sensor since it has been demonstrated that it provides reasonably good signals for detecting normal or abnormal rhythms (arrhythmias).

B. ECG

The ECG Device attached to a patient's skin, and collects the heart data, and sends to the Smartphone software that analyzes the information and if it finds abnormal diagnosis then sends message to family doctor and if found serious than immediately sends message to Ambulance and Family member. This is a cost efficient way to upload data which is not time critical. However, in case of an emergency, updates are immediately transferred to the Data server using the best available connection (e.g. GPRS). The specialist can access the Data server via a secure internet connection to remotely monitor the patient and if necessary update the threshold levels for the sensors. Relevant sensor data is stored in the patient's health record and can be used for further analysis.

C. Smart phone functionalitiess

The application in the smart phone receives the results from the sensors and determines whether an alarm should be raised. The results of the sensors can be inaccurate due to noise and inaccurate readings. The monitoring system is only useful if we know the quality of the data we receive from the various sensors and the quality of the diagnosis based on that data. Knowing the quality level we can put mechanisms in place to compensate for the lack of accuracy of certain sensors or get feedback from the patient to confirm a diagnosis. The application will therefore access the results of the sensors and if a threshold level has been reached the application needs to crosscheck whether the patient is in danger to avoid raising false alarms. In the current implementation we collect additional data from the sensor and if we still measure a life threatening situation the application will seek confirmation from blood pressure monitor and Alive ECG/Accelerometer monitor of the user. The user can disable the alarm in case of a false alarm. If the user does not react within a certain time (currently 30 seconds) an emergency call is automatically placed. This feature is included since many patients black out or experience speech and swallowing difficulties at the time of a heart attack. Since our target group will be mainly elderly people, the interaction with the

monitoring application needs to be simple, personalized and adapted to the user's health condition. For example we need voice interaction in case the patient has bad eyesight or vibration and flashing lights for hearing impaired patients. Furthermore, it is important to provide accurate but yet non-overwhelming information to the patient since we do not want to cause extra anxiety which would make the situation worse. For this reason we do not show an ECG diagram to a patient since we learned from discussions with cardiologists that this is a major source of anxiety for cardiac patients. The smart phone application stores configuration data and sensor readings in a local database. Depending on the patient, the specialist can configure one or more sensors to be used to monitor the patient. The configuration section is password protected and is only accessible by a medical specialist. The specialist determines which sensors should be used and configures the monitoring frequency and threshold levels for each sensor. For example some cardiac patients need to monitor their glucose level, whereas others need to monitor their weight and blood pressure. Also threshold levels for raising an alarm differ depending on the patient's age and condition.

D. Oximeter

Pulse oximeters for home use are small, lightweight monitors that painlessly attach to a fingertip to monitor the amount of oxygen carried in the body. An oxygen level of greater than 95% is generally considered to be a normal oxygen level. An oxygen level of 92% or less (at sea level) suggests a low blood oxygen. In addition to oxygen level, pulse rate is also displayed. Normal pulse rate values for adults 60-80 beats per minute2. Heart rate can be expected to increase some with exercise and oxygen saturation may slightly decrease (it should still remain at 90% or greater though).

1] Oximeter is used as a sensor to detect the heart rate of the User and send information to smart phone.

2] Smartphone Analysis the pulse and if any problem detected alert the user by beep sound. 3]Oximeter return value is greater than threshold value than immediately alert by beep and send message to family doctor and Ambulance.

III. PROTOTYPE

Heart monitoring

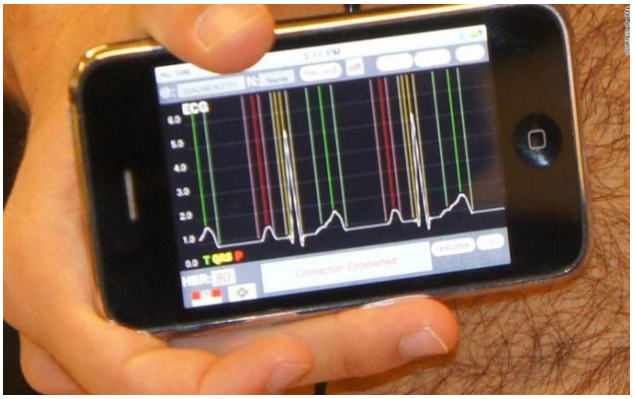

Fig. 2: Heart Monitoring System

The ECG sensor is the most crucial component of our architecture. ECG signals can be a source of errors which makes it hard to interpret arrhythmia correctly. In our prototype we work with a single channel, four electrodes ECG sensor. Noise, interference and non-rest conditions of the patient can contaminate the signal. This implies that we focus on extreme ECG signals.

A new medical invention which harnesses the power of Smartphone technology could revolutionize the treatment of heart patients. It not only automatically identifies anomalies in heart-rate, but also alerts doctors in seconds helping them treat patients more quickly. Many of the problems with the heart are not very well understood. It's very difficult for doctors to anticipate what is going to happen. This device will provide a better understanding of what is going on.

The small, lightweight monitor consists of four non-invasive electrode sensors attached to the skin which are linked to a radio module and computer chip which clips onto a patient's belt. Data is fed to the user's Smartphone where it can be viewed in real time for anything up to 150 hours on a single charge. Complex algorithms flag up any abnormalities with data sent to a doctor for examination via a picture attachment on text or email. The system collects very reliable and precise data, "but above all it provides an automatic analysis and immediate transmission of data to the doctor, preventing him or her from having to work through hours of recorded data.

Its size, its lightness, its ease of use, the fact that it measures continuously and remotely, which allows analysis to take place anywhere, makes this device very attractive to doctors.

Many doctors are already using Smartphone apps, It allows them to monitor different aspects of a patient's health and get data to specialists wherever they are.

In some respects this is a good thing because it's going to ensure portable medical devices will be effective. These devices can be effectively merged with our application to detect abnormal conditions of the heart patient and send an alarm signal to the hospital or caretakers so that the patient is hospitalized immediately.

Fall Detection

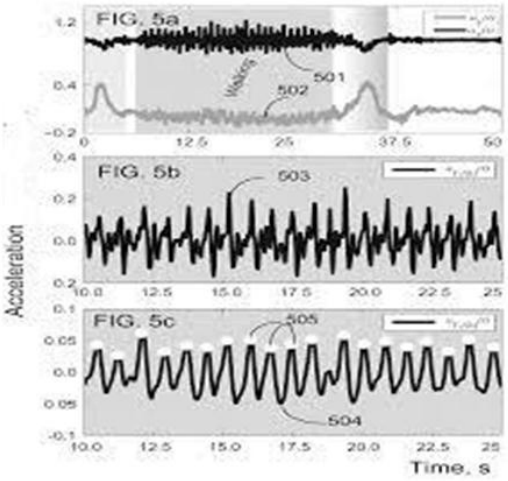

Fig. 3: Fall Detection Method

The algorithm focuses on large accelerations and the user s upper body position. After a large acceleration the users position is analyzed if a fall is detected. An acceleration is not classified as a fall when the position is upright or the accelerometer detects activity.

Based on testing, the algorithm is able to detect around 90% of all the falls along with 5% of false positives. The accelerometer sensitivity can be adjusted to the person s movement characteristics . High fall sensitivity implies that the algorithm classifies an acceleration faster as a fall compared to a low sensitivity level.

In order to accurately detect a fall we need to calibrate the accelerometer. When a patient has attached the monitor to the body, will be asked to stand upright. This will set the accelerometer to the upright position and after an acceleration the algorithm can determine whether a fall has occurred based on the current position of the patient.

Local Identification

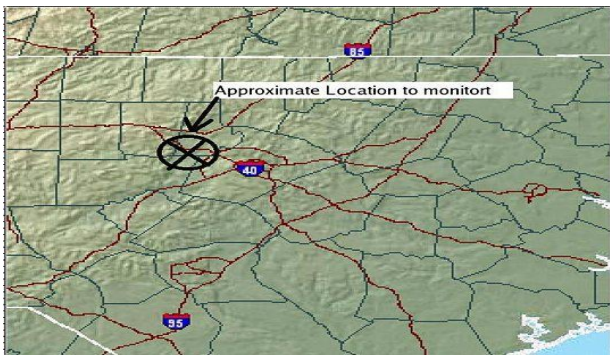

Fig. 4: Local Detection Method

We can use GPS to determine the location of a patient in case of an emergency. However GPS is only useful outdoors and in clear sight of GPS satellites.

Many heart patients will spend most of their time indoors and in order to automatically determine the location we use WiFi and GSM as a means to determine the location. Since GSM Cell id and WiFi access points are not automatically related to a location, the user has to relate a particular location with the Wi-Fi/GSM Cell data.

The user can be automatically spotted by Wi-Fi access points and GSM Cells and assign these to a particular address. If GPS is available the longitude/ latitude coordinates are also assigned to the address. When an alarm is raised the application will automatically start sensing the environment for Wi-Fi access points and GSM Cells. If a match is found, the related address will be used as the current location of a patient. For this scenario to work, the user needs to sense and input the addresses where he/she is normally staying.

IV. CONCLUSION

This paper described a personalized health monitoring application using a smart phone and wireless sensors. We are able to detect life threatening arrhythmias locally on the smart phone and, if the patient is in danger, we can contact an ambulance automatically. In normal situations, our system monitors and records the sensor data for inclusion in the patient health record which is used for further analysis by a specialist. Our system is designed with personalization in mind. The heart specialist can select one or more sensors to be used for a particular patient and configure the corresponding threshold levels for that patient. Our application will generate alarms or warnings when thresholds have been reached. We will process ECG and other sensor data locally on the smart phone, therefore we will be able to supervise a patient without being continuously connected to a health-centre. This reduces the workload of medical staff, communication costs and motivates the patient's self-care. Our solution is meant to monitor the patient

continuously and an issue is the battery life of the used devices. However studies show that a lot of heart patients are sedentary and can therefore charge the smart phone while being monitored. Our target audience is patients that have had a heart attack, or are at high risk. We learned from discussions with cardiologists that these patients are worried that a heart attack will occur again. They are very motivated to wear a device that can monitor and reassure them and intrusiveness seems not to be an issue for these patients. We believe that our system is a step towards promoting patient's autonomy and by providing personalized monitoring and advice we hope that it will give the patients more confidence and improve their quality of life.

This is a cost efficient way to upload data which is not time critical. However, in case of an emergency, updates are immediately transferred to the Data server using the best available connection (e.g. GPRS).

The specialist can access the Data server via a secure internet connection to remotely monitor the patient and if necessary update the threshold levels for the sensors. Relevant sensor data is stored in the patient's health record and can be used for further analysis.

REFERENCES

[1] Guide to Health Informatics, Third Edition, Enrico Coiera

[2] Ya-Li Zheng et.al., "Unobtrusive Sensing and Wearable Devicesfor Health Informatics", IEEE Transactions on Biomedical Engineering, Vol. 61, No. 5, May 2014

[3] Lesar TS, Lomaestro BM, Pohl H. , "Medication prescribing errors in a teaching hospital: a 9-year experience", Arch Intern Med. 1997;157:1569-1576

[4] Bates, David W., "Using information technology to reduce rates of medication errors in hospitals", British Medical Journal, International edition 320.7237 (Mar 18, 2000): 788-91

[5] Organizational Aspects of Health Informatics: Managing Technological Change, Nancy M. Lorenzi, Robert T. Riley

[6] Herasevich, Vitaly; Litell, John; Pickering, Brian, "Electronic Medical Records and mHealth Anytime, Anywhere", Biomedical Instrumentation and Technology, suppl. Horizons 46.2 (Fall 2012): 45-8.

[7] RossKoppel, Joshua P. Metlay, et. al. "Role of Computerized Physician Order Entry Systems in Facilitating Medication Errors ", The Journal of the American Medical Association, March 9, 2005, Vol 293, No. 10

[8] AmitGarg et al. "Effects of Computerized Clinical Decision Support Systems on Practitioner Performance and Patient Outcomes: A Systematic Review", The Journal of the American Medical Association, March 9, 2005, Vol 293, No. 10

[9] Osheroff JA, Teich JM, Middleton BF, et al. "A roadmap for national action on clinical decision support". American Medical Informatics.

[10] Henning Müller, Nicolas Michoux, David Bandon, Antoine Geissbuhler, "A review of content-based image retrieval systems in medical applications—clinical benefits and future directions", International Journal of Medical Informatics, Volume 73, Issue 1, February 2004, Pages 1–23