Vital Signs Measurement System with Energy Harvesting Module and Mobile application

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Abstract— There is increase in usage of wearable devices in different areas of daily life due to its ability to monitor real-time critical situations. In many cases, power is the limiting factor for such devices. A solution to overcome the limitations of power source is to harvest ambient energy to power the devices. As part of the paper, an energy harvesting module is designed, manufactured and tested along with a proposed wearable device for the measurement of vital signs. The energy-harvesting module is implemented to directly power the electronic circuit board by a flexible solar panel. This paper describes the proposed instrumented T-shirt powered by the solar panel applied directly on the T-shirt. The instrumented T-shirt is capable of measuring respiration rate, heart rate, and movement of the body. GSM technology provides mobility to doctors and medical in some extent. GSM is a good medium for the communication between doctor and patient and also for real time data transmission. In this project, using GSM technology, the ARM 9 microcontroller datas are sending to the mobile phone. Here datas are stored in ARM 9 in SD card.

Keywords— Wearable devices, GSM technology, ARM 9 microcontroller, SD card, respiration rate, heart rate, solar panel.

I. INTRODUCTION

A wearable system can be a viable solution for monitoring the principal vital signs of a person during daily activities for a variety of applications in the medical, sport, and wellness fields. In the medical field, one of the most compelling problems is the care to the elderly population that is expected to grow in the next years, since it raises questions about the cost of the structures and assistance activities. In particular, the availability of devices capable of autonomously monitoring elderly subjects during daily life measuring the body's primary functions guarantees the first assistance and provides a primary response to the emergencies.

Monitoring devices that are able to check the physiological status make it possible to assist the elderly person in his/her typical life place also outdoor, for example, street, supermarket, cafe, or church. The main advantages are decrease in the health costs both for the patient and for the medical corps, of the waiting time and of the overcrowding in the medical structures; on the other hand, the increasing of the people independence and their autonomy improve their quality of life.

Other interesting application fields are sports and wellness; in fact, wearable systems can constantly monitor the performance of the athlete and provide information in real time to improve constantly his/her physical activity. Therefore, it is expected that these devices can operate for an extended time where the activity is held, even outdoors.

Biomedical wearable systems enabled with electronics and sensors to store the very important signals are used for reporting in the literature survey. The system is interfacing with people who need to be monitored and in particular with elderly people, in the medical field, or with athletes, in the sports field, must have specific requirements to be accepted and used.

In many cases, power consumption is a limiting factor for such devices. For example, in assistive applications or outdoor applications, the use of batteries as a power source has several drawbacks such as the battery life, the need to replace periodically or to recharge with fixed energy sources, and their relatively large size and weight. Batteries unfortunately affect both for their weight and for their volume, and they constitute a problem to the environment, since they create problems of replacement and disposal. A viable solution to overcome the limitations of batteries as the power source is to harvest ambient energy to recharge, or better to directly power the devices.

II. LITERATURE SURVEY

A. A SMART ECG measurement system based on web-service-oriented architecture for telemedicine applications

A web-service-oriented ECG measurement system built to monitor the heart health of the cardiac patients has been presented by the Author as a part of the paper. The projected device is a smart patient-adaptive system able to provide personalized diagnoses by using personal data and clinical history of the monitored patient. In the presence of a pathology occurrence, the system is able to call the emergency service for assistance. An ECG sensor has the task to acquire, condition, and sample the heart electrical impulses, whereas a personal digital assistant (PDA) performs the diagnosis according to the measurement uncertainty and, in case of a critical situation, calls the medical staff.

B. Textile technology for the vital signs monitoring in telemedicine and extreme environments

The paper demonstrates two extensive applications of a smart garment equipped with monitoring of ECG, respiration, and movement. The platform includes MagIC for signals collections, a computer installed with software to handle the data and a universal mobile telecommunications system (UMTS) to send data to three cardiologists via emai used for the home monitoring of cardiac patients especially. Three patients daily-performed 3-min telemonitoring sessions for 30 days by using the platform. The whole system behaved correctly in 85 out of 90 sessions.

C. Sensing devices and sensor signal processing for remote monitoring of vital signs IN CHF patients

Chronic heart failure (CHF) is one of the major causes of hospitalization of elderly citizens and its affects major segment of the population. Outpatient model treatment with periodic visits does not have ability to detect the signs of destabilizations and which results in a high re- hospitalization rate. The paper focuses on building a complete integrated information and communication technology system that helps to collect important signs from CHF patients on a daily basis at home and sends the data automatically to the Hospital information system. This helps physicians to monitor their patients remotely and to take timely actions if necessary.

D. A novel energy management approach for smart homes using Bluetooth low energy.

The system introduced in this paper involves communications among smart appliances, a central EMU and a WN. As it is possible to see, the decision- making centre is represented by the EMU, where a fuzzy-based algorithm deals with the HEM. The consumer may turn on any appliance at any moment of the day without taking into account that, at that moment, it can be also in peak hours. The proposed fuzzy-based algorithm allows the switching ON of the appliance or suggests to the consumer which is the more appropriate start time. In fact, when an appliance is turned on, it sends a request to the EMU that checks the available stored energy in the storage system. Moreover, the EMU communicates also with the smart meter in order to know about the updated prices in that time slot. When the EMU receives the information about the amount of stored energy, it schedules a convenient start time for the appliance according to the proposed fuzzy-based algorithm and notifies the consumer. At this stage, the consumer can decide whether to accept the schedule proposed by the EMU, for instance the time period falls during peak hours or the level of stored energy is not enough, or to ignore it, switching on the appliance.

E. Miniature wearable wireless real-time health and activity monitoring system with optimized power consumption

Wearable health and activity monitoring devices are used to enable prevention and early intervention in case of health problems. In order to be widely adopted, these devices must be comfortable, easy to use and provide meaningful, error-free data. A prototype of a real-time wireless monitoring system equipped with triaxis acceleration is presented in the paper. And Tri-axis uses an integrated accelerometer, one-lead electrocardiogram (ECG) and temperature. Embedded data processing allows for on-device detection of heart rate and body position with a possibility of generating alarms and warnings based on thresholds. It is a wearable device, intended to be attached on a patient's chest and to communicate acquired and processed data to a mobile phone used for visualization, control and further communication.

F. Wireless sensor network based wearable smart shirt for ubiquitous health and activity monitoring

The smart shirt measures electrocardiogram (ECG) and acceleration signals continuously. The continuously monitoring of the health data is done by the sensors of the smart shirt and conductive fabric to get the body signal as electrodes. The ECG data been measured and the physical activity data are transmitted in an ad-hoc network in IEEE 802.15.4 communication standard to a base-station and server PC for remote monitoring. The shirt is fitted with small size and low power consumption (which reduce the battery size) wearable sensor devices. The device includes an adaptive filtering method to cancel artefact noise from conductive fabric electrodes. The device is also tested to get the clear ECG signal during running or physical exercise of a person.

G. Energy-harvesting wearables for activity-aware services

The proposed energy-harvesting wearable sensor architecture is called Human Activity Recognition from Kinetic Energy, or HARKE. Using off the-shelf products, here design a kinetic-energy harvesting data logger, which shows that the energy-harvesting voltage switches to clearly distinguishable patterns as the user changes her activities. On the basis of test environment, result provided by HARKE was similar to the results of an accelerometer-based HAR system and it consumed only small fraction of the limited harvested energy. Energy harvesting or scavenging is a process of converting various forms of ambient energy sources, such as kinetic, thermal, radio frequency, and solar or light, into electrical energy, which we can use to power a small electronic device. In recent years, significant advancements in energy-harvesting hardware technology, leading to many off-the-shelf products available at low cost. This proves that replacing the battery of a wearable sensor with an energy-harvesting is conceptually possible.

III. PROPOSED SYSTEM

The model describes a self-sustained wearable system for heart rate, respiration rate, and movement measurement. An energy-harvesting module, which implements a solar panel, is used to supply the electronic circuit board of the wearable system obtaining a novel autonomous system. Consequently, the wearable system is designed keeping attention to low-power characteristics. The supplying power is decreased by using low-power circuits for heart rate and respiratory rate measurements, and the data transfer is obtained by GSM.

The key objective of the proposed model is to design a low power wearable device with an energy harvesting module has to be designed and implemented for the measurement of vital signs. The electronics device helps to continuously monitor heart functionality of the Cardiac patients and it updated the medical log history. In case of any alarming situations notifications in the form of messages will be generated and sent to relative to take care of the patient. The people who notified the patient's condition include relatives and concerned doctors for instant help.

The block diagram for the proposed system is shown in fig 1. The electronic circuit board includes conditioning sensor circuits. The textile conductive sensors are used for measuring cardiac activities. The flexible solar panel used as energy harvesting system to supply the circuit board. Flexible solar panels of the Power Film Solar were investigated to the small dimensions and the flexibility that permits the wearability of the T-shirt. GSM technology provides mobility to doctors and medical in some extent. Transmission of health care parameters in an accurate manner and also provides the alert system in case of emergency. Thus, GSM is a good medium for the communication between doctor and patient and also for real time data transmission. Due to real time monitoring and feedback facility, it becomes easy for doctor to take preliminary action.

In the proposed framework sensors are worn on the body and non- intrusively monitor a person's physiological state. The body vital signs (e.g.: heart rate, respiratory rate etc.) are recorded through the sensor nodes and transmit to the smart phone, where the data of vital signs is stored in SD card in ARM 9 and will further transmitted to remote locations if needed. This paper is targeted to achieve a practical and affordable health care by allowing an individual (cardiac patients, athletes, sportsmen) to keep a regular check on his cardiac functioning and in any uncertain conditions ; the persons (caretakers, doctors , sports instructors) can provide instant help or advice to be safe from any major health issues.

The techniq ue of Photoplethysmography uses LEDs (light emitting diodes) and photo detector to measure the blood volume. The sensor should be placed in those areas of body where the blood is having a higher concentration (e.g. finger tips, ear lobes etc.). Measurement of respiratory rate of a person uses the technique of Photoplethysmography. Photoplethysmography is a technique used nowadays for monitoring patient's pulse rate. The sensor used for this task is pulse sensor which is very small in size and can be worn or wrapped around the index finger or on ear lobe. Sensor module includes light source photo detector and LEDs. The idea behind the concept is the optical detection of changes in the blood volume. Changes in light intensity are used to check the changes in volume level of blood which is very helpful in cardio vascular systems. During the cardiac cycles output voltages from the sensor module will be converted into beats per minute through microcontroller board.

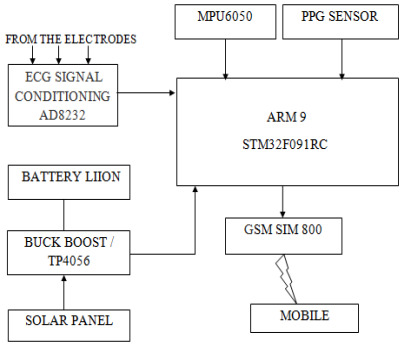

Fig. 1 Block Diagram

The accelerometer can be used to measure instantaneous acceleration due to forces acting on the sensor. Analysis of accelerometer data requires extraction of features such as mean, standard deviation, and energy for each axis, and correlations between axes. Students can be provided with an insight on how physiological responses tend to be affected by physical activity. Examples include, displaying readings and waveforms of sensor measurements obtained while a person is at rest, in comparison to while a person is walking. Therefore, a need to incorporate accelerometer measurements in context-aware applications such as stress detection can be demonstrated. Furthermore, the appropriate placement and positioning of sensors for different applications can be presented. For example, it can be shown that placing the accelerometer on the hip helps in classifying physical activity.

The ECG sensor detects small changes in electrical activity of the skin at every heartbeat. The measurement is used to analyze the functionality of the heart based on the regularity of the heartbeats. An important processing step in ECG signal analysis is the extraction of the QRS-complex and detection of the R-wave peaks. Using these functions, demonstrations on the different configurations of electrode placement used to acquire the ECG measurements can be provided. Typical characteristics of ECG waveforms like the QRS-complex, P-wave and T- wave segments and their corresponding range of time intervals for normal and abnormal recordings can be understood. ECG signal artefacts such as low frequency baseline wandering and high frequency power line interferences that occur during signal acquisition can be observed.

IV. RESULT

The proposed model is implemented and the results from the circuit are obtained as sms in mobile phone .There is also provision to view the waveforms of ECG. In this model the energy management section includes solar panel, buck-boost section, balanced charging section and LiIon battery.the obtained result is shown in fig 2.

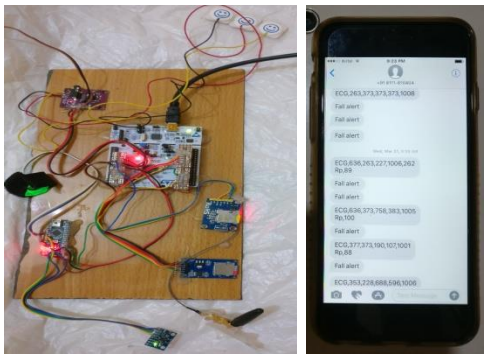

Fig. 2 Obtained Result

V. CONCLUSIONS

The need for the physiological patient monitoring system is very crucial. Especially the technologies which can be widely acceptable and cost effective have to be implemented. So the study in the growth of e-Health and telemedicine and with the development in the era of smart phones technology, it will be a good and efficient way to implement the wireless based patient monitoring system using android technology. This way of implementation is suitable not only in the remote areas, but it also finds its applications in the ambulance, hospitals and old care centers etc. Therefore improvisation health care using the technology is in demand. In this project electronic circuit board powered by an energy-harvesting module is presented. For this project the relevant datas are collected from the literature review. Low-power circuits have been implemented in the circuit board measuring heart rate, respiratory rate and movement of the body. Solar panel is used to generate the requested power. The power management could be adapted so as to accumulate a large amount of energy when possible, for example, outside in the sun, in order to use this energy in environments where radiation levels are not sufficient to directly switch ON the system.

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