VITAL JACKET A WEARABLE MONITORING SYSTEM WITH SMS FACILITY

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ABSTRACT

Every function in the human body has been shown to exhibit circadian rhythmicity. Under controlled conditions in the laboratory, the endogenous nature of the rhythmicity can be demonstrated in ambulatory conditions, environmental factors and physical exertion can obscure or enhance the expressed rhythm. Biological processes that cycle in 24 hrs. Interval are called daily rhythm is endogenously generated but still susceptible to modulation by 24 hrs. Environmental cycle its called circadian rhythm. Many autonomic processes of individuals exhibit circadian rhythm including body temperature, cardiovascular etc. The four most commonly monitored vital signs are heart rate, blood oxygen saturation, and body temperature and respiration rate. The emergence of wireless technologies and advancement in on body sensor design can enable change in the conventional health care system, replacing it with wearable health care system, centered on the individual wearable monitoring system can provide continuous physiological data as well as better information regarding general health of individual. Thus such vital sign monitoring system will reduce health care cost by disease prevention and enhance the quality of life with vital parameter management. This paper proposed a wearable vital parameter monitoring jacket which measure all vital parameter like heart rate, blood oxygen saturation, respirations rate & body temperature of the person wearing the respective jacket, collect all the data and send to the respective physician on the assign telephone number using GSM modem, which in form of SMS so that preventive measure if required can be taken.

KEYWORD: vital parameter, circadian, rhythmicity, GSM modem, wireless
INTRODUCTION

The design of wearable monitoring vital jacket has been a growing topic of research interest in last decade, due to the potential application in medicine, sports & security. The vital jacket combines textile with innovative medical diagnostic technology. The benefits of bio-monitoring includes more freedom of movement, independence from stationary treatment for patient who need special care, and quality data collection in high performance sports as well as for fitness enthusiast [1]. With the increase in the size of elderly populations, as well as the emergence of chronic diseases because of change in lifestyle, there has been a need to monitor the health status of individual in their daily routine to prevent fatal disorder. The adoption of mobile healthcare technology is promising to enhance quality of life for chronic diseases patient and elderly as well as healthy individual. Further more it offers the potential to alter the current health care system by enabling out patient care and preventing unnecessary hospitalization. Designing a vital monitoring system for health monitoring is a very cumbersome task. There are many issue to be addressed including designing of reliable sensors, proper collection of data through use of reliable microcontroller, and sending the collected data in form of SMS on feed mobile number through GSM modem to the respective physician. Mobility is both a key benefit and constraint on the design to achieve this benefit wireless physiological sensors must be small, low weight & low power. The paper describe the design of simple low cost microcontroller based Heart rate through finger-tip sensor, body oxygen saturation, respiration rate and body temperature parameter measuring device in build in a jacket with LCD display and a wireless modem. Heart rate of subject is measured from finger-tip sensors similarly blood oxygen saturation based on photoplethysmography, body temperature using low cost lm35 and respiration rate using tmp100 (I2C interface) all these parameter are interface to Philips microcontroller p89v51rd2. This information is then transmitted wirelessly to doctor, which is not in the vicinity of the patient. SIMCOM300 GSM modem is interfaced serially to microcontroller through RS232.

BACKGROUND STUDY

There are number of health issue whose treatment benefits from continuous vital sign monitoring. Traditionally, when this approach is deemed necessary, it result in the hospitalization of the patient, with expensive equipment and medical personnel on hand; in some case patient may remain at home, but the use of bulky and expensive instrument remains. Must efforts has gone into the development of small, wearable device over recent years, with benefits including lower cost, greater mobility for patients and potentially improved physiological wireless enabling these device provide greater mobility and improve efficiency. A review of body sensors for health care applications, which help in monitoring all vital parameters of a patient or an athlete wearing a jacket, was given in [2] including design methods. There are no of demographic changes can be seen in Indian population, they are driving the move towards the use of wireless GSM modem and vital sign monitoring. The two most significant changes are ageing of population and rise in obesity problem. Both of these factors increase risk of developing various conditions that require medical intervention and the significant cost. Government have acknowledge this fact and are seeking ways of delivering healthcare, including use of personal health
system and telemedicine technique in developing countries most people due to lack of health awareness suffers from cardiovascular diseases, uneven respiration rate, falling oxygen percentage of human body and body temperature. When the heart beat, a pressure wave moves out along arteries at few meters per seconds. This pressure wave can be feel at wrist but it also cause an increase in blood volume in tissue which is detected by photoplethysmography. When the heart rate is below 60rpm may be refer as Bradycardia, while heart rate above 100 rpm is called Tachycardia, averaging heart rate related to age is shown in figure [a]. Respiration rate is the no of breaths taken within a set amount of time, typically 60 seconds. In case of respiration rate when the rate is less than the normal is called Bradypnoea, when it’s greater than the normal is called Tachypnea, averaging respiration rate related to age is shown in figure [b]. Body temperature depends upon the place in which body temperature measurement is measured, the time of day and the level of activity of person. The commonly occupied core body temperature is 37.0°Celsius.

Another parameter blood oxygen saturation is the relative measure of the amount of oxygen that is dissolved or carried in a given medium. it can be measured with an oxygen probe. Arterial oxygenation is measure using pulse oximetry. Pulse oximetry is a simple low cost optical technique that can be used to detect blood volume change micro-vascular bed of tissue. Photoplethysmograph is often obtained by using a pulse oximeter, which illuminates skin measure change in light absorption. Photoplethysmograph tool uses an emitter-receiver pair to determine blood flow. It consists of matched infrared emitter and photodiode, which transmit change in infrared reflectance resulting from varying blood flow. a led, is used to transmit light through skin. Detector, which is positioned on surface of skin, can detect reflection or transmission of waves from various depths and from highly absorbing or weakly absorbing tissue.

<table>
<thead>
<tr>
<th>WOMEN</th>
<th>AGE</th>
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<td>18-25</td>
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**Table [a]** averaging heart rate is related to age

<table>
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<tr>
<th>BIRTH TO 6 WEEKS</th>
<th>30-60 BREATHS PER MINUTE</th>
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<tbody>
<tr>
<td>6 MONTHS</td>
<td>25-40 BREATHS PER MINUTE</td>
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<td>3 YEARS</td>
<td>20-30 BREATHS PER MINUTE</td>
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<td>18-25 BREATHS PER MINUTE</td>
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<td>10 YEARS</td>
<td>15-20 BREATHS PER MINUTE</td>
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<td>ADULTS</td>
<td>12-18 BREATHS PER MINUTE</td>
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**Table [b]** averaging respiration rate is related to age
PREVIOUS WORK

Patient monitoring facilitates the extension of healthcare services to remote and sparsely populated areas by avoiding the need of expensive medical premises. With mobile technologies, physicians can access patient information in a quick, efficient and secure way from any location. A number of larger and smaller projects have been developed, some of them financed by the EU and NSF (such as Wise bed [4] and WASP [5], others by individual universities or hospitals. In the early years, due to lack of standardization and suitable platforms such wireless patient monitoring systems were only developed as part of huge, internationally funded projects. (Ubiquitous Monitoring Environment for Wearable and Implantable Sensors) [6] Project addressed general issues related to using wearable and implantable sensors for distributed mobile monitoring, such as measuring arrhythmic heart disease. The system consists of five major components, namely the Body Sensor Network (BSN) nodes, the local processing unit, the central server, the patient database and the workstation (WS). A number of wireless biosensors including 3-leads ECG, 2-leads ECG strip, and SpO2 sensors have been developed. To facilitate the incorporation of context information, context sensors including accelerometers, temperature and skin conductance sensors are also integrated to the BSN node. A compact flash BSN card is developed for PDAs, where sensor signals can be gathered, displayed and analyzed. Apart from acting as the local processor, the PDA can also serve, as the router between the BSN node and the central server, where all sensor data collected will be transmitted through a Wi- Fi/GPRS network for long-term storage and trend analysis. A graphical user interface is developed at the workstation for retrieving the sensor data from the database. Another comprehensive project, the Code Blue Project [7] is intended to design an information plane tying together a wide range of wireless devices used in medical settings, especially addressing large scale disaster situations and develops a range of medical sensors integrated with Mica2, Mica Z and Telos motes running on Code Blue software stack. Code Blue software framework provides protocols for device discovery, publish/subscribe multi hop routing, and a query interface allowing caregivers to request data from groups of patients. Code Blue also integrates an RF-based localization system to track the location of patients and caregivers. Pietro Valdastri et al. [8] used a ZigBee-ready stack in a point-to-point wireless model to measure aortic and ventricular pressure and temperature through a sensor implanted in farm pigs. The firmware dealing with the communication protocol was developed to validate the low level features of the IEEE 802.15.4 standard in an implanted in vivo monitoring task. This resulted in a lighter version of the ZigBee stack. In particular, the complete firmware of the implantable unit required 12.5 KB, whereas 32 KB would be necessary for the whole ZigBee stacks. Dagtas et al. [9] proposed a system that measures ECG data and sends it to a local server for further processing. Digitized ECG data is continuously transmitted to the Home- Server via the ZigBee network. Results of the analyses at the mobile device are sent to the server and stored there for future reference. The goal is to provide a repository for more detailed analysis of the data by medical professionals or detection algorithms. Hung-Chieh Yu and Shu-Ming Tseng [10] proposed an IEEE 802.11 based wireless patient monitoring system. This system
has much higher power requirements than ZigBee based systems. H. Hong et al. [11] proposed a point-to-point ZigBee based system that measures, stores and displays ECG data and step count of a patient. The transmitter is located on a necklace carried by the patient and the receiver is located onto a PDA carried by a doctor or a nurse. Junho Park et al. [12] used a contact-type microphone and Maxstream’s Xbee Pro wireless module to get heart sound signal and send it via a ZigBee based network to a monitoring database. In this system, the central monitoring system polls the patient side modules to get data with a best error rate of 2.5 % and an average error rate. The system, called (Maglietta Interattiva Computerizzata), [13] is composed of a vest, including textile sensors for detecting ECG and respiratory activity, and a portable electronic board for motion detection, signal preprocessing and wireless data transmission to a remote monitoring station. A new concept in healthcare, aimed to providing continuous remote monitoring of user vital signs, is emerging. An innovative system named WEALTHY [14] is presented, were smart material in fiber and yarn form endowed with a wide range of electro physical properties (conducting, piezoresistive, etc.) are integrated and used as basic elements to be woven or knitted in fabric form. The simultaneous recording of vital signs allows parameters’ extrapolation and intersignal elaboration that contribute to make alert messages and synoptic patient table. Most of the studies mentioned above imply limited flexibility and configurability. They are expensive to develop since they do not use off-the-shelf solutions to implement networking in a power-efficient and user-friendly way. With the proliferation and standardization of wireless sensor devices the trend is towards simpler and much cheaper solutions based on standardized nodes and networks. In this study, pulse oximeter sensors and IEEE 802.15.4 compliant wireless modules are used to implement a mesh network where patients’ oxygen saturation, heart beat rate and plethysmogram data are stored and displayed on a PC that is connected to local gateway or base station. The proposed system has the advantage of scalability and mobility over other alternatives. It is fully based on e-textile and freely available hardware and allows easy and reasonably priced setup and tailoring [9, 10,11,12]. Even though very similar in principle to the one described in [14] our system is more robust, more cost effective and the provided user interface is more elaborate and flexible.

**PROPOSED SYSTEM**

The proposed system has been divided into measurement of four important vital parameter, which is described, with the help of a block diagram [c]. Hardware development involves design and development of sensor circuit, Philips microcontroller circuit and MAX232 circuit. PROTEL DXP is used for simulation, schematic capture, and printed circuit board (PCB) design. The whole program is written and assembled using EMBEDDED C language. The program is written based on the P89v51rd2 specific instruction. When finger is placed between photo diode and Super-Bright LED at the sensor circuit, the output is detected at pin 7 of Op Amp. Microcontroller is used to perform the signal processing from the sensor circuit. MAX232 connects the microcontroller circuit to GSM modem via RS232 cable. An alert message will be sent to mobile phone by modem.
1. HEART RATE MEASUREMENT

Using a high intensity type LED and PHOTODIODE sense heartbeat. The change in volume caused by the pressure pulse is detected by illuminating the fingertip’s skin with the light from an LED using a photodiode sensor. With each heartbeat, a surge of blood is forced through the vascular system, expanding the capillaries in the finger, and changing the amount of light returning to the photodiode. Very small changes in reflectivity or in transmittance caused by the varying blood content of human tissue are almost invisible. Valid pulse measurement therefore requires extensive preprocessing of the raw signal. A suitable operational amplifier is needed to amplify the heartbeat signal, due to its very low amplitude compared to the surrounding noise. For this project, TLO84 is chosen. A super bright LED is suggested in the circuit as it can also perform well as light sensor.
Flowchart [a] working of heart rate measurement

1. Start
2. Start timer for 10 seconds
3. During 10 seconds timer
4. If Hardware interrupt generate
   - Increment heart rate counter
5. If Timer interrupts generated
   - Heart rate = 6 * heart rate count
6. Display heart rate
7. Stop
2. BODY OXYGEN & TEMPERATURE MEASUREMENT

Sensor head of pulse dosimeter contain two led and photo detector. One led emits in visible range and other in the infrared. Each led is illuminated in turns. The detector may be placed to detect light transmission or light reflection from skin. The ratio of detected light signal is directly proportional to blood oxygen level. Amplification and filtering can improve signal strength and SNR ratio it’s working is shown through flow chart [b] The LM35 series are precision integrated circuit temperature sensors, whose output voltage is linearly proportional to the Celsius temperature. The lm35 thus has a linear advantage over linear temperature sensor calibrated in Kevin, as user is not required to subtract a large constant voltage from its output to obtain centigrade reading. Therefore its used to measure body temperature is given in [a].

Flowchart[c], [b] working of temperature and calculation of oxygen % of body
START

MAKE WRITE PIN L-H TO START CONVERSION

IF INTERRUPT GENERATED

YES

MAKE READ LINE LOW

READ ADC DATA LINES

MAKE READ PIN HIGH

READ DATA PIN

STOP
3. RESPIRATION RATE MEASUREMENT

Respiration rate is measured using TMP100 temperature sensor. TMP100 are two wires, serial output temperature sensor available in SOT23-6 packages. Requiring no external components, the TMP100 are capable of reading temperature with a resolution of 0.0626 °C. The tmp100 features SMBUS and I2C allowing unto eight devices on one bus. The TMP100 are specified for operation over a temperature range of -55°C to +125°C.
4. PHILIPS MICROCONTROLLER:

When the heart beat signals, blood oxygen %, body temperature, and the rate at which temperature during inhale and exhale exhibiting the respiration rate is detected all the input is processed & analyze d. the input value is collected and displayed on LCD. MAX232 will interface microcontroller with RS232 interfacing between Philips microcontroller and GSM modem is established. All the collected data is send to feed mobile number of respective physician so that it can take the preventive measures if necessary.
5. GSM MODEM

In this project SIMCOM300 GSM modem is used. GSM modem can be external devices. An external GSM modem is connected to device through serial cable like GSM mobile phones, a GSM modem requires SIM CARD from wireless carrier. In order to operate GSM modem which support a common set of standard AT commands. With AT commands reading & sending message can be sending without any doubt. The number of message can be processed by GSM modem per minute is very low which only 6 to 10 SMS per minute.

![Figure 1. GSM modem](image1.png)

![Figure 2. sms of vital parameters](image2.png)

RESULTS

![Figure 3. Proposed system](image3.png)
CONCLUSION

In this paper, the evolution of wearable systems for chronic disease management has been discussed, with examples drawn from the literature. An evaluation of current sensing technologies has been provided for the major physiological parameters (the vital signs), as well as a review of on-body communication from an electromagnetic perspective. Current sensors technology for vital-sign monitoring is promising to alter the traditional chronic monitoring routine. However, designing non-invasive body-worn sensors is very challenging, often requiring a broad understanding of the nature of the disease and its effect on physiological parameters. Although there are sensors available off-the-shelf for cardiac and respiration rate monitoring, there is still a need for improvement to achieve continuous and truly non-invasive monitoring of these parameters. The main constraints for sensor design are:

• Low power requirements;
• Reliability;
• Security; and
• Conformal design.

In order to achieve unobtrusive monitoring, implementation of wireless modules is vital. Integration of wireless modules to on-body sensors not only provides mobility for the patient, but also has the potential to change the conventional healthcare system with real-time feedback support. The limitations for wireless modules are low power requirements, reliable data transmission, compatibility with the sensor and conformal antenna design. Although wireless protocols are available for on-body communication, there is still a need for development, in order to ease the existing constraints. Although the design and implementation of on-body monitoring systems presents a challenging task with several constraints, the benefits of employing multi-parameter monitoring systems for the prevention, prediction and management of diseases are myriad. On-body monitoring systems with multiple sensors are not only capable of providing an extensive database of the patient’s medical history: the simultaneous usage of multi-parameter monitoring sensors can also verify or correct the collected data, adding redundancy into a potentially safety-critical system; or the additional information can place a particular event detected into context. For example, the previously mentioned blood oxygen saturation monitoring system can be used in combination with heart rate monitoring device for acquired data verification purposes: if there is a failure in the electronic circuitry or software of the cardiac-activity monitoring system, a critical situation can be triggered by the blood oxygen saturation monitoring device. On the other hand, there may be alternative in-
interpretations of certain symptoms (that is, there may be more than one cause) that could be more easily resolved given more information; for instance, a (sudden) drop in blood oxygen level levels would be of more concern if the patient had been relatively inactive, compared to if the system had detected an increase in physical activity. Thus, multi-parameter monitoring systems will be more reliable and useful, compared to single-parameter monitoring devices. Finally, over recent years our group has contributed to the literature on this topic, with numerous publications on the characterization of on-body channels, the investigation of the effect of the human body on antenna performance, as well as the establishment of a communication link between sensors and body-worn units. Our goal is to utilize the accumulated knowledge within the group on on-body propagation to design multi-parameter body-worn units. To this end, some of the current research activities focus on reliable transmission of vital signals.

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**BIOGRAPHY**

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