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Prognostic Health Monitoring System

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Abstract*— Health monitoring systems consists of an array of sensors embedded into the waist belt or fabric for a soldier that allow continuous or intermittent monitoring of physiological signals is critical for the advancement of both the diagnosis as well as treatment of malfunction. The objective is in developing network architecture for a smart healthcare which will open numerous ways to monitor a health status of a soldier in a war field or elsewhere. C4I systems provide commanders a situational awareness--information about the location and status of enemy and friendly forces [1]. This work includes the various design aspects which is included as a part in C4I; this includes the various devices that are already available in the market, the biological aspects as well as significance of Heart Rate, Respiration Rate, Galvanic Skin Responses and also Body Skin Temperature. This work also includes the techniques to interface the signals onto a computer.

***Keywords*— Health Monitoring Systems, Biological Parameter, Wearable device, Skin Resistance, Body Temperature**

I. Introduction

An emphasis is given to multi parameter physiological sensing system designs, providing reliable vital signs measurements and incorporating real-time decision support for early detection of symptoms or context awareness. The use of wearable health monitoring devices that allow continuous or intermittent monitoring of physiological signals is critical for the advancement of both the diagnosis as well as treatment of malfunction for a soldier. The most significant advantage of this prototype is that it consists of miniature sensors that can be worn, such as a Waist Belt. This enhances its usability. This device in the future can be incorporated into common electronic communication devices that are already being widely used. Health Monitoring System (HMS) has drawn a lot of attention from the research community and the industry in last decade. There is a need to monitor a soldier's health status while they are in their battle field or in a personal environment. A variety of system prototypes and commercial products have been produced in the course of recent years and providing real-time feedback information about one's health's condition, either to the user himself or to a medical center or straight to a supervising professional physician, while being able to alert the individual in case of possible imminent health threatening conditions [2].

1.1. The C4I (Command, Control, Computing, Communications and Intelligence)

a. Command: It can be defined as the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of the mission. Command includes the authority and responsibility for effectively using available resources and for planning the employment of organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions.

b. Control: Authority which may be less than full command exercised by a commander over part of the activities of subordinate or other organizations. Physical psychological pressures exerted with the intent to assure that an agent or group will respond as directed.

Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission.

c. Computing and communications: Two pervasive enabling technologies that support C2 are intelligence, surveillance, and reconnaissance. (Computers and communications process and transfer information)

d. Intelligence (I): The product resulting from the collection, processing, integration, analysis, evaluation, and interpretation of available information concerning foreign countries or areas. One important capability that C4I systems provide commanders is situational awareness-information about the location and status of enemy and friendly forces, a necessary component for achieving superiority in decision-making; it does not alone guarantee superior decision-making. Commanders must take relevant knowledge and combine it with their judgment-including difficult-to-quantify aspects of human behavior (such as fatigue, experience level, and stress), the uncertainty of data, and the plausible future states resulting from actions by both their own force and the enemy--to make decisions about future actions and how to convey those decisions in ways to facilitate their proper execution. In doing so, commanders are supported by tools to enable and accelerate the planning and decision-making process. To be effective, command decisions must be implemented, a process to which C4I technologies are also relevant (e.g., in speeding up the link through which targeting information is passed to weapons, the so-called sensor-to-shooter link). The development and use of the right tools allow the commander to focus better on those issues associated with the essence of command--the art versus the science. As more and better-automated tools are developed and people are trained to use them, it will become even more important to recognize the art of command as distinguished from the mechanics of the tools used to provide information.

II. EXISTING WEARABLE DEVICES IN MEDICINE

A. *Wearable Physiological Monitoring [Smart Shirt]*

An emerging type of remote monitor is garments such as the Smart Shirt that incorporate strategically placed sensors and a wireless transmitter to send monitoring data to an external receiver. These garments automatically collect data on multiple vital signs and enable wearers to engage in normal activities. The Smart Shirt is made up of cotton fabric of the Sensatex containing Conductive fibre system that monitors heart rate, respiration, and body temperature. The system wirelessly sends data via Bluetooth to a base station to be collected and stored for later analysis. Potential applications for the shirt, which is intended for short-term diagnostic use and mostly restricted to research applications because of its high cost, include remote monitoring of postoperative and chronic disease patients, elderly persons at home, and soldiers in the field [3].

B. *Multiple Vital Signs Monitoring*

Many patients, particularly those who are elderly, have more than one health problem or chronic condition. Wireless systems under development can monitor multiple physiological functions, providing a broader spectrum of information that gives clinicians greater opportunities to manage the whole patient rather than individual health problems. Multifunction monitors like these may supplement or even replace some clinical services, and may help reduce costs as a result of more timely Treatments, earlier hospital discharges, or fewer emergency room visits. The device can record 7 vital signs like ECG, Heart rate, Bioconductance [fluid level], Temperature, Respiration, Oxygen, Posture or positional activity. These are very important vital signs that are required to be monitored in any patient who has had a heart failure.

C. *Critical Care Device:*

Critical Care delivers ventilator flow tracings, patient vital signs data and rhythm strips. Practitioners can access virtual real-time and historical data. Critical Care is now in the advanced testing stages. Critical Care can greatly reduce and even eliminate time delay in the clinical assessment and treatment of patients. Clinical features include:

a. Virtual Views – Remote, virtual real-time monitoring of live cardiac rhythm strips and other waveform data such as pulse oximetry, end tidal CO_2 and peak ventilator pressures. Strip Zooming – The zoom feature maintains relative size of waveforms and the background grid allows for easy assessment and measurements.
b. Automated Caliper – The automated caliper measures designated intervals, both automatically and manually.
c. Strip Scrolling – The scroll function allows users to quickly scroll through stored waveform data, such as telemetry strips.
d. Patient Data Display – Tidal volume, airway pressure, flow and volume readings are also available in virtual real-time, directly from patient monitors.

Access to typical bedside patient monitoring data is also available including heart rate, respiratory rate, temperature, blood pressure and additional numeric and waveform data captured by the patient monitor. An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

III. METHODOLOGY

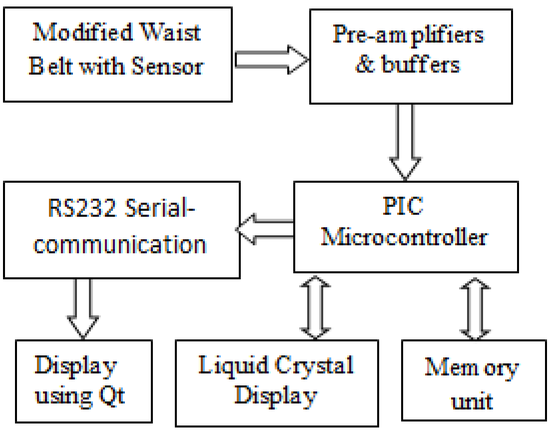

Fig 1. Block Diagram

A view of the system is shown below with the help of a block diagram (Fig. 1). A sensor is a device which receives and responds to a signal or a stimulus. The biological signals originating from the body signals needs to be converted into electrical signals. Hence, sensor can be defined as a device which receives a signal and converts it into electrical form which can be further amplified and used for several applications in electronics devices. In this work, four sensors are used to measure different body parameters. They are heart rate sensor, respiration rate sensor, temperature sensor and galvanic skin responses (skin conductance) sensor. In the following section the detailed description is given.

a. Heart Rate Sensor: Here the device uses Infrared sensor which can easily be clipped to finger ends to detect the heartbeat by finger plethysmography technology. The unit is lightweight, easy to handle, extremely durable. The Infrared probe is designed to get the best result in all type of pulse rate measurement applications. The pulse can also be shown by LED indication, which glows as per the incoming pulse at fingertip.

b. Respiration Rate Sensor: The human respiration rate is usually measured when a person is at rest and simply involves counting the number of breaths for one minute by counting how many times the chest rises. Respiration rates may increase with fever, illness, or other medical conditions. When checking respiration, it is important to also note whether a person has any difficulty breathing. This device alsouses Infrared sensor, a belt is wrapped around the chest for measurement of respiration rate. IR LED and an IR Sensor is mounted ina closed box, where anobstacle is placed between them. The ends of the obstacle are tied to the belt using the spring. Whenever there is a displacement of the belt, due to breathing the IR sensor detects the change and there is a corresponding change in the voltage. This output is fed into the micro-controller for processing and displaying [4].

c. Temperature Sensor: The LM35 series temperature sensor is precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full -55 to +150°C temperature range.

Fig 2. LM35

LM35 has an output voltage that is proportional to the Celsius temperature and the scale factor is .01V/°C. The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 V°C at room temperature and +/- 0.8 °C over a range of 0 °C to +100 °C [5].

d. *Galvanic Skin Response (Skin Conductance):* The device measures the electrical conductance (which is the inverse of the electrical resistance) between 2 points, and is essentially a type of ohmmeter.

The two paths for current are along the surface of the skin and through the body. Active measuring involves sending a small amount of current through the body. Here a voltage divider circuit and an Op-amp LM358 are used to obtain the measurement from the skin. This circuit is a Unity-Gain amplifier and the output is taken through a 10K ohm resistor. Thus, the value is fed to the microcontroller for displaying purposes [6]. Due to the response of the skin and muscle tissue to external and internal stimuli, the conductance can vary by several microsiemens. When correctly calibrated, the skin conductance can measure these subtle differences. There is a relationship between sympathetic activity and emotional arousal, although one cannot identify which specific emotion is being elicited [7].

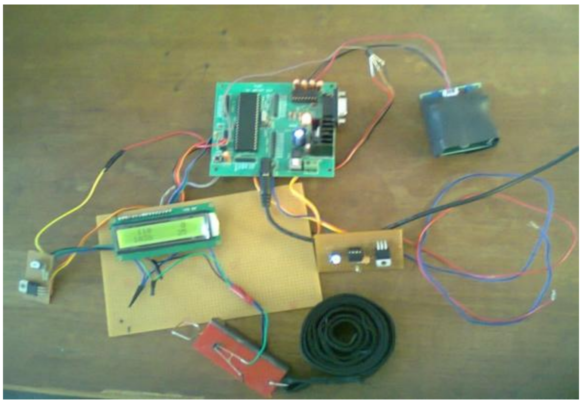

Fig 3. Snapshot fo the modul0065

The device developed successfully gives the human body heart rate in the range 70-110 beats per minute.The device can give the human body respiration rate in the range 9-24 breaths per minute.This device also gives the galvanic skin response (skin conductance) of the human body in the range 1100-650mV.The device measures the human body and a skin temperature which varies in around 36 degree Celsius and also the room temperatures will be displayed [8].

A medic view of a Health monitoring system (Fig 4) used in C4I project has been displayed. All the measured parameters have been displayed using serial port communication in Qt. This form gives details about all the values of measured parameters, date and time, current readiness, alert situation and remedies that have to be followed at certain conditions [9].

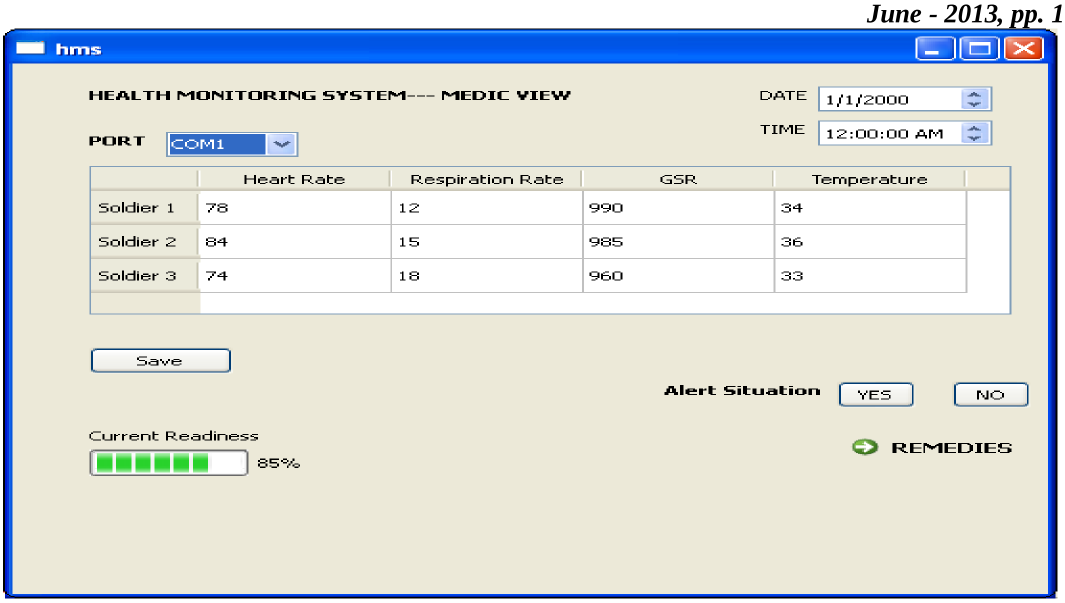

Fig 4. Front End of Qt for HMS

Health monitoring systems are intelligent physiological monitoring devices used in C4I, which provide real-time feedback to the soldier or to a remote monitoring station. This device monitors the body parameters by means of integrating sensors and wires integrated into a wearable device. Here the sensors acquires the signal from the sensors, and then are electronically processed so that the results are calculated and displayed on the LCD [10].

IV. Conclusions

This system is capable of monitoring the health status(of the soldiers in a battle field, fire fighters, mine workers etc. Also these systems will be useful for monitoring the health status in remote places. The data collected from the device of the soldier using the wearable health monitoring systems should be kept private. The transmission of the data should be encrypted and be secured. Continuous monitoring with early detection has likely potential to provide individuals with an increased level of security of acquired data [11]. There are many improvements which can be brought about from this device designing. A RF module can be included for the communication purpose i.e. R.F transmitter and receiver can be used to get the system working in the absence of any other network systems [12]. The GSM communications can be implemented for mobile telephony systems, these modules require a particular GSM networks and can be monitored from distance places. Another alternative and the best among all will be the use of GPS enabled system. The memory unit is embedded in the device, so that a required remedy for particular alert situation can be managed.

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