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ADJUSTABLE BED WITH REAL TIME DATA MONITORING AND ANALYZING FOR BED RIDDEN ELDERLY PEOPLE

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***Abstract*—The bedridden elderly (mostly under domestic care) need constant vigilance over them, specially their vital sign information. The market is filled with various single function monitoring devices which cost heavy and require trained operators. This project is addressing the timely need of automated real time biometric data capturing, analysis of bed ridden patients when the caretaker is not around. The developed bed is capable of adjusting itself to four preset levels being in line with the users' commands issued via a mobile application, easily. It also measure three bio metric parameters simultaneously and those real time measurements are displayed in screen by the bed. The caretaker or the medical professional in charge of the patient has the capability to view this data records through the database. Further the real time data are analyzed and at any detection of preset value change the caretaker is visually and aurally alerted.**

Keywords—**Adjustable bed, biometrics, monitoring and analyzing biometrics, bedridden elderly**

I. INTRODUCTION

Monitoring and keeping records of the patients' biometric data is one of the typical and basic tasks of hospitals. As the setting which almost each patient is require to be in, the timely evolvement of beds have led to touch free smart data monitoring systems that can work in any context. [1]
The caregivers are assisted with bed shape and function adjustments with the introduction of smarter beds. Yet most of them could only manipulate according to the user's preference of bed adjustments and track the data and give out alarms if any pre-set configurations altered.
They are not capable of tracking all the vital bio metric data simultaneously and analyzing each of them. So the caregivers obviously have to use several single function monitoring and detection systems. And all these machines and systems are to be directly connected to the patient via wires or tubes that compromise the patients' comfort.
Accurate biometric data calculation is a must for better health care delivery. Yet the use of single function systems for each calculation has made this more complex.
The conventional beds at the hospitals that are feasible of remote monitoring are complex, cumbersome and costs about $30,000, the same reason that put these smart beds beyond the reach of average senior living communities and residential settings. Patient monitoring devices connected to a patient with intrusive wires gives out loud alerts often leading to "alarm fatigue". [1]

A. Background and Motivation

Most of the chronically ill patients, and elderly bedridden need constant vigilance over them and biometric data be recorded continually using wired equipment and devices, which compromise their comfort. Most of them develop bedsores from lying stationary for an extended period too. Some of the patients are heart patients whose mental stress, tension too have to be treated. For patients needing continuous vital sign trend reporting, being hooked up to tubes, straps, and probes is very unpleasant and often impractical.
In order to minimize the difficulties of these traditional hospital procedures many smart beds have been introduced to the market lately. The problem with these smart beds is that they are expensive and have only one use, which is to prevent bedsores.

Most of the Smart beds available in the market focus primarily on luxury necessities than providing solutions for medical needs.

E.g.1:- The 360 Smart Bed a new smart bed has been designed which adjusts itself to fit different body positions, even raising the owner's head to clear the airwaves if it detects snoring. [2]

E.g.2:- Smart bed, a contraption that subtly adjusts to the patient's movements in the night.[3]

B. **Problem**

According to a study [4] conducted in 2007 an average of 16.7% patients develop pressure ulcers even under much skilled nursing facilities. There are several critical health monitoring issues related to the bedridden patients.

- Need to keep track of the vital health sign data like heart rate, temperature
- Need to adjust and change the position of the bed and patient to avoid the chance of pressure ulcers.
- Need to minimize the depressive mental states of patients that occur due to log term bed confinement.

Continuous tracking of vital signs is really important as health care professionals find great value in 24/7 vital sign trend monitoring – if the data is manageable. There is no shortage of devices and sensors collecting data, but they often generate reams of unfiltered data that may or may not be relevant to a physician or nurse. The challenge for technology providers is to offer a connected care solution that includes powerful data processing and a friendly user interface to present relevant data.

Pressure ulcers are devastating to patients and a costly issue in every healthcare setting. Effective and timely repositioning is required to prevent pressure ulcers and preclude unnecessary returns to acute care, or to a higher level of care within a post-acute setting. Pressure ulcers not only threaten the life of the patient, but also clog the health care system and drive up costs. Numerous studies have documented the cost and frequency of pressure ulcers and the corresponding impact on lost revenue.

Most patients who are bedbound for a considerable amount of time inevitably develop mental depression. The inability to adapt to a life mar the effect of medication and treatments for the diseases too.

II. LITERATURE REVIEW

The normal functioning of a person's health is determined mainly from the quantification of the individual's body temperature and heart rate. In the past, only hospitals had health monitors, which was a huge and fixed monitoring device that was used to know the health status of bedridden patients and only the hospitals could afford such devices. And those had to be fixed to a place to know the health status of bed ridden patients.

These devices of monitoring at hospitals were not user-friendly and were not portable, making the patient be stationary all the time to measure the biometric parameters when required. And those machines needed manual command each time to measure the values as they were not programmed to measure data real time [4, 5].

Heart rate is the most important and mostly the obvious parameter of the cardiovascular system and it helps in assessing the patients' condition. It is the number of heartbeats per unit time and is expressed as beats per minute (bpm). The heart rate of a healthy adult at rest ranges from 70-75 bpm for both male and female adults. The heart rate rises steadily amid activities and returns gradually to a stable value after activity [6]. Temperature on the other hand is the ability of a body to generate and get rid of heat. The normal human body temperature is 37.0 °C [98.6 ° F]. Normal human body temperature depends on the time, place in the body, from which the measurement is made, and level of activity of the person [7]. The trend of cardiovascular disease has shown that heart beat rate is a determining factor for the possibility of a heart attack while an increase in the body temperature can induce fever on a patient [8]. The hospitals possess many single function monitoring devices for keeping track of the internal changes of the patients' body but they have limitations in regard to maintenance, cost, size of instruments, and mobility. The ways in which heart rate could be measured has been well established in cardiovascular studies, pulse rate measurement from fingertip and the neck has proven to be efficient [9].

The researches on efficient monitoring of human biometrics has been of great interest for a considerable time and the embedded systems too have been configured in several ways in the objective of getting accurate results. A system based on microcontrollers have been developed to measure both the heart rate and the body temperature and it sends the measured data to the phone as text messages [5]. The limitation of the work is that there are no preset thresholds as the system will continuously populate the mobile phone with instantaneous messages. Other embedded systems used for heart rate monitoring are PIC16FC44 and PIC16F877 [10, 11] among others. They measure the heart rate for a long time based on a real time monitoring algorithm.

With the arising trend in the development of systems for real time measurement of biometrics, the essential need of an efficient and effective scheme that reduce the mortality rates that occur due to ignorance is also taken care of.

It is a vital improvement in the health care sector that the monitoring systems with their advanced technology (embedded technology), accuracy and ability measure and give the health parameters out. The system monitors the heart beat and temperature of a patient simultaneously with the pulse sensor and the temperature sensor. The reports of the measured heart rate and body temperature are sent to central

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database at distinct intervals so that it helps keeping track of the patients' medical history.

If the read data are abnormal or rise or fall beyond the preset, defined threshold values, the device makes use of the sim808 GSM/GPRS/GPS shield to send a report of the patient's condition and possible location to a caretaker or doctor's mobile phone. This will help in fast tracking patient care response time for quick cross examination or further diagnosis. Important is that these parameters be measured and monitored frequently for the aged or the elderly in order to reduce the risk of falling critically ill and possibly sudden demise. The system is developed to constantly measure these bio metrics in the aim of reducing the mortality rate of the elderly.

III. METHODOLOGY

An adjustable bed was developed using screw jack and stepper motor and used commercial sensors supporting Arduino to simultaneously detect the heart rate, body temperature.
The bed was designed to be able to adjust to four preset levels upon user commands. The Figure 1 depicts the basic design of the bed with possible adjustments.

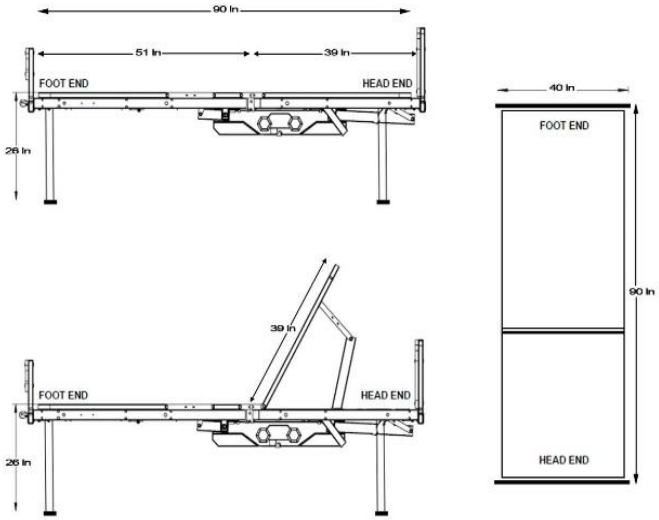

Figure 1- Bed adjustment design and arrangement of devices

A status meter was designed and implemented to detect patient's mental stress via the skin conductivity (GSR), based on the principle that the resistance of the skin varies in accordance with the emotional states. If the stress level is high the skin offers less resistance, and if the body is relaxed the skin resistance is high. The low resistance of the skin during high stress is due to an increase in the blood supply to the skin. This increases the permeability of the skin and hence the conductivity for electric current. The sensor module was designed in a way to initiate playing stress releasing beats at any detection of high stress.

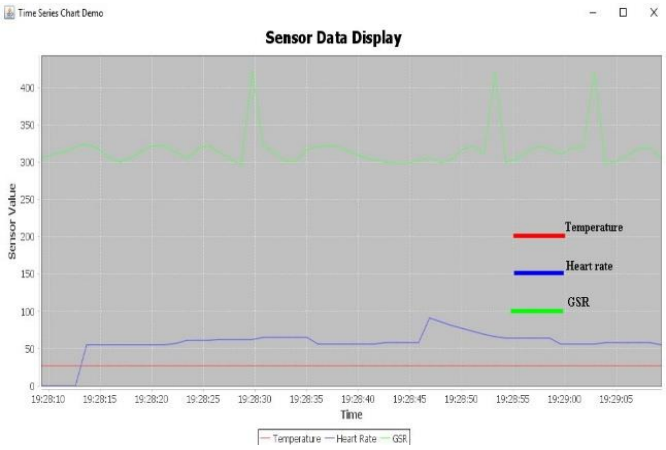

Figure 2- Real time biometrics display by the bed

Further a mobile application was developed to control the bed adjustments via Bluetooth and to access patient records. The arrangements were made to display the measured real time biometric data in a screen by the bed, alert the care taker at any detection of abnormal sign data.
Figure 3 below shows the interaction between the system components.

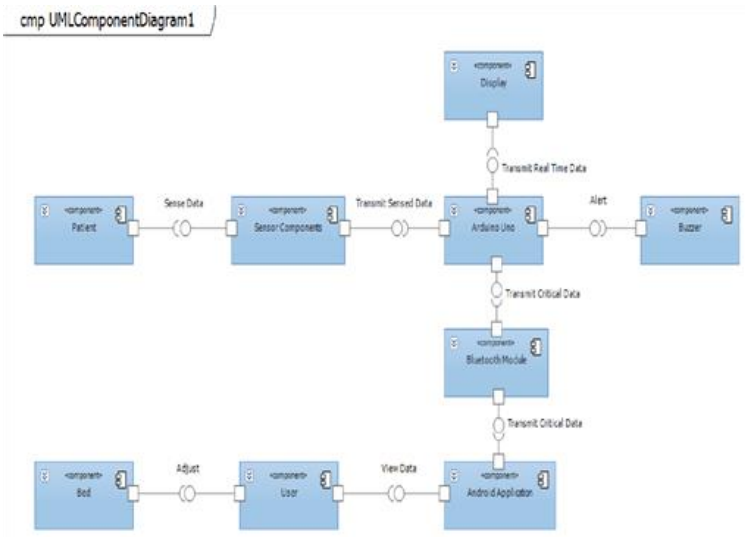

Figure 3 - Component diagram

A. **Technologies explored / adapted**

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Arduino mega 2560

The Arduino Mega is a microcontroller board based on the ATmega1280 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

MIT App Inventor

App Inventor for Android is an open-source web application originally provided by Google, and now maintained by the Massachusetts Institute of Technology. It lets the computer programmers to create software applications easily for the Android Operating System. It contains a graphical interface which is very user-friendly very similar to Scratch and the StarLogo TNG user interface, which allows users to drag-and-drop visual objects to create an application that can run on Android devices. The developed prototype bed, and the sensor component, with the android application was tested with preset test cases giving the expected functionality.

IV. CONCLUSION

The project Nanny Bed is an automatic adjustable bed that measures the bio metric data of a bedridden patient real-time. This project is carried out to fulfill the requirements of a convertible smart bed with the ability of streaming real-time biometrics of patients, who need constant vigilance on their health condition. The developed bed and monitoring system can be incorporated with Medical Centers, Medical Consultants and caretakers to enable better and smarter care patient status tracking.

RECOMMENDATIONS

Nanny Bed is a novel system in Sri Lanka that helps medical professionals and caretakers to monitor the bed ridden patients 24x7.

The patients, their caretakers and the supervising medical staff should be made aware of the system developed and the problems addressed by the system.
The users should interact more with the system and provide their feedback and ideas to improve and adopt the system to far more tightly.

The medical professionals should be encouraged to use the system for diagnosis and the evaluation on bed ridden elderly. The patients and the caretakers should be made aware of the efficiency of such an integrated system.

FUTURE WORK

The Nanny Bed is currently implemented with the essential feature set, but to make it a more complete solution for an integrated biometric data monitoring unit the following improvements have to be added.

- Improve the Nanny bed to detect the patients' physiological behavior and adjust the bed automatically to keep patient at comfort instead of the caretaker adjusting the bed through the app at patient's verbal request.
- Let the caretaker/doctor configure the critical biometric data levels for each bedridden patient separately instead of using a preset configuration, for more accurate diagnosis.
- Improve the system to give commands via an updated technology like a GSM module to enable adjusting the bed, and viewing critical data reports even when the app user is out of the general Bluetooth range.
- Do a sub dermal implant of conductive metal clips to detect more accurate skin conductivity values.
- Develop the bed to measure more bio metric data types like blood glucose level, blood pressure.

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V. REFERENCES

[1] D. Waltisberg, B. Arnrich and G. Tröster, "Sleep Quality Monitoring with the Smart Bed", *Pervasive Health*, pp. 211-227, 2014. Available: 10.1007/978-1-4471-6413-5_9.

[2] B. S. B. F. Mailonline, "Smart mattress adjusts to sleepers' bodies to prevent SNORING," Mail Online, 04-Jan-2017. [Online]. Available: http://www.dailymail.co.uk/~/article-4086768/index.html.

[3] "Sleep Number's smart bed adjusts to your nighttime fidgeting," Engadget. [Online]. Available: https://www.engadget.com/2017/01/03/sleep-number-360-smart-bed-auto-adjustments/.

[4] S. Hengstermann, A. Fischer, E. Steinhagen-Thiessen, and R.-J. Schulz, "Nutrition Status and Pressure Ulcer: What We Need for Nutrition Screening," J. Parenter. Enter. Nutr., vol. 31, no. 4, pp. 288–294, Jul. 2007.

[5] A. E. Ibhaze, E. C. Eleanor and F. E. Idachaba, "E-health monitoring system for the aged," 2016 IEEE International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech), Balaclava, 2016, pp. 298-299, doi: 10.1109/EmergiTech.2016.7737355.

[6] Souvik Das "The Development of a Microcontroller Based Low Cost Heart Rate Counter for Health Care Systems" International Journal of Engineering Trends and Technology, Volume 4, Issue2, 2013.

[7] Body Temperature, Bets Davis, http:// health.yahoo.com/infectiousdiseasesymptoms/bodytemperature/healthwise

[8] Burke E, "Precision Heart Rate Training, A self Guide". International Conference, University of Toronto Canada. Prentice Hall, 2010.

[9] Galen P, et al., "Systems And Methods For Detecting And Monitoring Arrhythmias Using the PPG," ed: US Patent 20,120,310,100, 2012

[10] Ufoaroh S.U, Oranugo C.O, Uchechukwu M. E, "Heartbeat Monitoring and Alert System using GSM," International Journal of engineering Research and General Science, Volume 3, Issue 4, 2015

[11] Ahmed F, "A portable recorder for long term fetal heart rate monitoring," Microprocessors and Microsystems, vol. 26, pp. 325-330, 2002.