Assistive Technology for Elders: Wireless Intelligent Healthcare Gadget

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Abstract: **Improving the quality of life for the elderly persons and giving them the proper care at the right time is the responsibility of the younger generation. But due to lack of awareness on proper elder care, unavoidable busy schedule etc. the elderly population is seem to be quite ignored. In such a scenario we are trying to find an amicable solution to this problem using a compact and user friendly system design. The proposed system is a compact device which has various wearable sensors all attached inside a glove. It has a process flow controller module and a communication control module. These modules perform together to excite an alert mechanism to the relatives or to the doctors via an SMS or a voice call to their mobile phones, whenever some critical situations arise. The system measures the heart rate, oxygen content in blood, body temperature and the pressure of the elderly person, which are the important parameters for a proper diagnosis.**

Keywords: ***Elder care, SMS alert, voice call, mobile health, Assistive technology.***

I. INTRODUCTION

The characteristic feature of human race to take care of their elders was carried over years till the beginning of the 21st century. But today, the fast moving world has almost forgotten this solemnity we have carried over so far. The increasing number of sandwich families has accelerated this deviation from our old day's custom of taking care of our elders. The shortage of caretakers for elderly people, lack of novel innovations in the field of elder care etc. has become a major problem nowadays.

Even though the younger generation wish to give full support their parents, they are not able to do so because of their wild rush for making their both ends meet, make them busy every time. So they find old age homes or private healthcare services as a solution for giving proper attention to their elders. This alone won't solve the problems we discussed just now.

So we propose a system which has the capability to solve many problems related to elder care. The system continuously monitors the vital parameters of the elderly person. Whenever there is a crucial variation in those parameters, the system gives a right time alert to the concerned medical expert and to the relatives by an SMS or by a voice call via its efficient alert and communication mechanism. The whole system is made wireless and all the parameter measurements is non-invasive for the convenient and free mobility of the elderly patient.

II. RELATED WORKS

In the field of assistive technologies for elders, many studies have been conducted. Many of those are dealing with monitoring of the daily routine of the elders, home arrangement for elder care etc. as in [1]. It also deals with the wireless communication, but the modern mobile technology is lacking in this system proposal. Since the elderly person needs a compact device for use so that he/she can avoid unwanted wire distraction, the design of the device should be precise enough to meet our specifications. [2] Deals only with the fall detection of the elderly person. The studies we see in paper [3] are all about developing a software model for mobile application for elder monitoring. We have to add the clear picture about the physical parameter variations of the elderly person. We also studied about the Holter mechanism that is available today. This device can store the physical parameters continuously. It doesn't have a proper alert mechanism in case of emergencies. Unlike all these, our system has a continuous monitoring exclusively for elders where a number of sensors are integrated together for a proper medical assistance.

III. MOTIVATION

The changing world always demands for the best from the technological world. Taking care of our elders and giving them right time health assistance has become an exigent subject recently. Research indicate that elderly people whose families put them in nursing homes or hospitals during their twilight years will observe their health worsen more quickly than those who stay in their home with some sort of assisted living. The main reason for this is lower quality of life. More specifically, many aging people feel lonely and occasionally totally deserted when placed in nursing homes or large hospitals. This lack of companionship and feeling of loneliness places

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excessive stress on our seniors and increases their health problems. This situation that we see in today's world made us to rethink deep about the possibilities that the technology can offer to the field of elder care and ambulatory services for elderly. From this, came out our idea of this system to provide a better assistive device for the elderly using Bluetooth technology.

IV. SYSTEM DESIGN AND WORKING

In our system, we have mainly three modules. They are,

A. The Sensor Module (SM)
B. Wireless Process Flow Controller (WPFC)
C. Receiver And Application Module (RAM)

These three modules are wisely interconnected in such a way that the user finds it comfortable to wear the module and continue with his/her daily activities. The sensor module is interfaced with the WPFC which makes use of PIC16F877A Microcontroller. The Controller continuously receives the physical parameter values that are coming from the SM. The necessary analog to digital conversion and reading data are carried out in the WPFC and it sends these processed values to the Central Monitoring System (CMS), via Bluetooth protocol. We assign some time constraints to each of the physical parameter values.

Specially developed software written in Java takes the action for the alert mechanism by controlling the GSM Modem. The software can be customized for giving different emergency numbers, changing the service providers' number, fixing a range of physical parameter values etc. The Software was developed using Eclipse. The Java environment provides a fast and effective response to the data processing step and to the alert mechanism. The parameter values that reaches the PC is constantly monitored by this software and if some critical situations arise the software will control the GSM modem attached to the PC to send an SMS or a voice call to the concerned medical expert or to the relatives. The critical situation can be pr-defined by the user. The different parameter variations can be set in the application by the advice of medical experts. Throughout this document the medical expert and the relatives are referred to as destination. The GSM modem can function as a mobile phone having basic operations like sending an SMS or placing a voice call to the concerned medical expert or relatives. The developed application is customizable with the GSM Modem configurations. The system architecture is given in Figure.1.

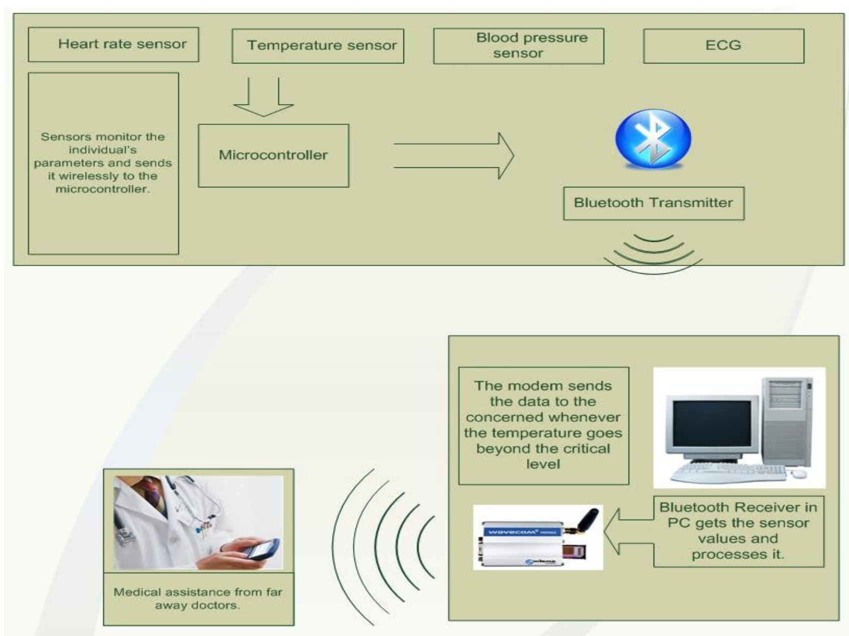

Figure.1 System Architecture

A. The Sensor Module (SM)

The sensor module has four sensors integrated to it. We are mainly focusing on heart rate, blood pressure, oxygen content and the body temperature. The details of these are as follows.

1. Heart Rate Sensor

The detection of heart rate by checking the pulse on the hands is the conventional method. Here we use a photo transistor IR LED arrangement which the user can easily fix the clip like set-up, in the finger tip without any inconvenience. The volume changes of blood at the tip of the finger can be detected as voltage output from the photo transistor. This analog voltage output is fed to the WPFC for processing.

2. Temperature Sensor

For sensing the temperature, we use DS1620 which is an 8 pin IC with three wire communication. The DS1620 Digital Thermometer and Thermostat provides 9-bit temperature readings which indicate the temperature of the device. With three thermal alarm outputs, the DS1620 can also act as a thermostat. Temperature settings and temperature readings are all communicated to/from the DS1620 over a simple 3-wire interface. This data also is read by the WPFC.

3. Blood Pressure Sensor

High blood pressure is a common risk factor for heart attacks, strokes and aneurysms, so diagnosing and monitoring it are critically important. However, getting reliable blood pressure readings is not always easy. Traditional blood pressure monitoring requires a cuff, wrapped around the upper arm and inflated until blood flow is completely cut off. The examiner then gradually releases the pressure, listening to the flow until the pulse can be detected.

With the new monitor as in [9], no cuff is required. Instead, the device takes advantage of a method called pulse wave velocity, which allows blood pressure to be calculated by measuring the pulse at two points along an artery. The two points decided are two points of index figure. That posed a challenge because blood pressure in the hand varies depending on its position: If the arm is raised above the heart, the pressure will be higher than if it is below the heart. The researchers solved that dilemma by incorporating a sensor that measures acceleration in three dimensions, allowing the hand position to be calculated at any time. This not only compensates for the error due to height changes, but also allows them to calibrate the sensor for more accurate calculation of blood pressure. As the wearer raise the hands up and down, the hydrostatic pressure changes at the sensor. Correlating the change of pulse wave velocity to the hydrostatic pressure change, the system can automatically calibrate its measurement. The equivalent analog output signal will be fed to WPFC.

4. Oxygen Content Detector Sensor

Determining a patient's need for oxygen is the most essential element to life; no human life thrives in the absence of oxygen. So the measurements of this parameter became vital in diagnosing both respiratory and cardiac problems. The basic setup of this system consists of two LEDs and a single detector - one red LED and one infrared LED. These two diodes correspond to the wavelengths of oxyhemoglobin and deoxyhemoglobin. Here the setup uses the amount of light reflected, while traditional finger pulse oximetry often uses the transmission of light. The LEDs are pulsed alternately, allowing individual measurements of the intensity of reflected light using the single sensor. The ratio of the intensities is taken to quantify amount of oxyhemoglobin vs. deoxyhemoglobin, giving the blood oxygen level. The parameter value, thus reaches WPFC.

B. Wireless Process Flow Controller (WPFC)

WPFC mainly consists of a microcontroller with a Bluetooth transmitter module. Here, in our system we use PIC16F877A microcontroller. The different sensor outputs that are fed to the WPFC on a time basis is properly analyzed and sent to the application module (CMS) in a convenient bit format. For the transmission, we make use of the Bluetooth IC microIceBlue™. The microIceBlue™ implements a Serial Port Profile and allows simple point to point wireless communication of devices that incorporate this profile over Bluetooth. Bluetooth wireless protocol enables high-speed data transfer with portable devices such as handheld computers, phones, data-collection devices, etc. at low cost for up to 100 meters at 200kbaud or more. Radio power is 14dBm at a carrier frequency of 2.4GHz. Power supply is 5V at 150mA maximum.

C. Receiver and Application Module (RAM)

The data coming from the WPFC is received by the Blue tooth receiver module which is connected to CMS. This PC will act as the CMS. The application software developed using Java, constantly monitors the vital parameter values and checks for critical variations in their values. In case of an emergency situation, the software controls the GSM Modem attached to the PC to send an SMS to the destination. After a specified time if the doctor is not responding to the message by any reply, then the software will direct the Modem to place a pre recorded voice call to the doctor's mobile, making sure that the critical situation is properly informed to the concerned.

V. THE APPLICATION MODULE

The customizable software for continuous monitoring of the elderly person is developed by Eclipse in java environment. Eclipse is an integrated development environment (IDE) for Java. Eclipse is created by an open source community and is used in several different areas, e.g. as IDE for Java or for Android or as a platform to develop

Eclipse RCP applications, etc. The developed application is flexible in data processing and in hardware control.

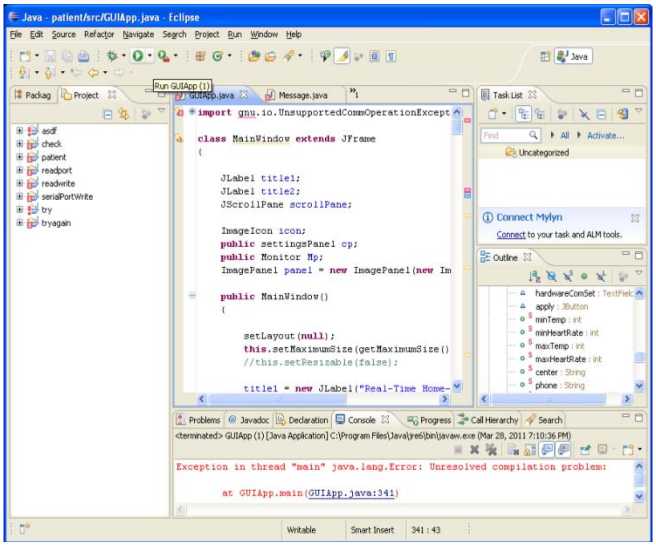

Figure. 2 Application code window in Eclipse

VI. FLOW CHART

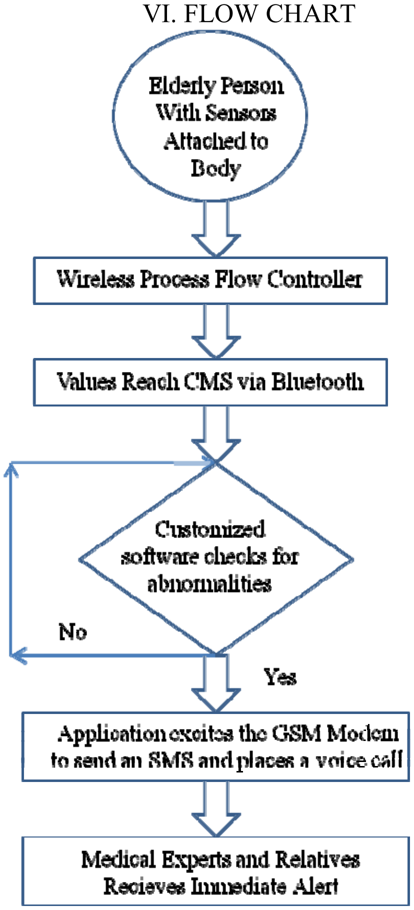

Figure 3. Elder Monitoring Algorithm

The flow chart in figure shows the basic functionality of the system. The data flow path and alert mechanism algorithm is clearly shown in the figure. The continuous checking of parameter variations by the application software will be uninterrupted even after one or more alert action. The alert mechanism never affects the continuous working of the software.

VI. ERROR ANALYSIS

Many test experiments have conducted in about 10-15 elderly persons to check the accuracy of the designed system. It is clear from the results that the system outputs are having only very small difference with the manual output. As of now we have tested only the heart rate and body temperature reading of the elderly. Our future work will mainly concentrate upon setting up the hardware for blood pressure and oxygen content in blood and to test it. The results are as follows.

Experiment	System Output(Beats/Minute)	Output Measured Manually(Beats /Minute)
Test1	71	71
Test2	70	71
Test3	70	70
Test4	69	68
Test5	69	69

Table 1. System output vs. Manual output (Heart Rate)

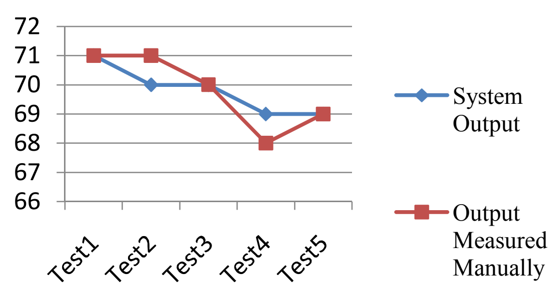

Figure 4. Error Analysis of Heart Rate

Experiment	THERMOMETER VALUE (IN °F)	MONITORED TEMPERATURE (IN °F)
TEST 1	95.3	97
TEST 2	95.3	96
TEST 3	96.3	96.5
TEST 4	98.2	97.5
TEST 5	98	98

Table 2. System output vs. Manual output (Temperature)

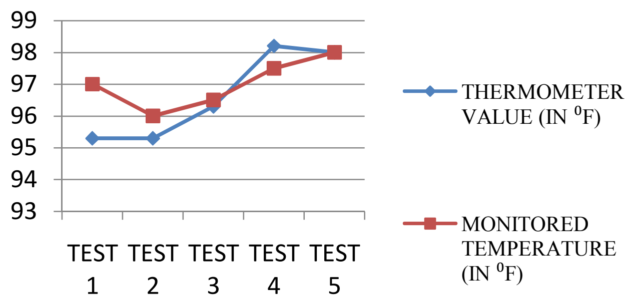

Figure 5 Error Analysis of Body Temperature

VII. FUTURE WORK

Future work includes, adding more sensors to the sensor module, making the system even more compact etc. The gloves, especially the design and the materials used to make the gloves are yet to be identified and tested. The scope of the designed system can be expanded to remote villages and country sides, where the availability of medical experts is comparatively less than as in cities. We also aim to set up a central monitoring station in our nearby locality so that the villagers can also be benefited by the system.

One of the significant problems we met with was the connectivity. The remote areas in developing countries face many connectivity problems. Even though they have a number of private service providers, their expansion of their service domain is not reached our villages yet. But we hope, this problem can easily be solved, because recently, many of the private service providers have started thinking of expanding their services to rural areas also. So this gives us a ray of hope. A few more modification is also to be accomplished on the software customization and data storage. We have tested and verified the reliability of the system for the temperature and heart rate as of now. We are trying to integrate some other important parameters also along with this current set up.

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