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Portable Device to Monitor Vital Health Parameters

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Abstract - *In this survey paper, we will develop a portable device to monitor the vital health parameters of a patient. The system can be used to monitor vital parameters such as blood pressure, pulse rate, body temperature and pulse oximetry. Most of the time patients are unaware of their actual conditions. It is not necessary that doctors are available by their side every time. Now-a-days most of the disease are curable if detected in time. So we have tried to design a system that gives information about his/her physical condition. The device gives information of the vital parameters. This device provides a low-cost, easily accessible human health monitor solution bridging the gaps between the patients and the doctors. The solution is based on the Raspberry Pi and integrated sensor ICs. It also comprises of blue-tooth module to share data. Home care technologies play important role in the home-based health care approach. The main goal is to develop a cost-effective user-friendly health system to serve the elderly people in the community.*

Key Words: **Vital parameters, pulse oximetry, Raspberry Pi**

1. INTRODUCTION

Due to rapid medical development in the modern societies, the health care systems has become much more mature and efficient. Now-a-days the prevalence of chronic disease is common concern. The regular in-clinic/in-hospital health system are being replaced by the portable devices and individual wearable monitoring systems. In order to reduce the current burden of public health system and promote the popularity of routine health self-check, many techniques have been developed for making faster and accurate pre-diagnoses with ease-of-use for laymen. Around the world, there are variety of health care systems each having different characteristics and structure according to the available resources requirements and needs. Health care system can be defined as a system that helps society in protecting and improving health of population.

Monitoring systems like the one measures pulse rate, respiration rate, glucose level, oxygen saturation of blood etc., are of very important in medical practice. These devices are very commonly available in hospitals and health care center which are displayed in the interface of the device. When the patient monitoring is required to get the information of the vital parameters all monitoring devices are under the same roof. This helps a lot in monitoring the current state and the progress of the patient. The traditional devices used in clinics/hospitals are quite bulky, so the patients usually need to visit these places every time for routine check-up. Regularly visiting doctors after medical treatment or for routine check-up is very time consuming, monotonous and costly too. The routine check-up comprises of measuring vital parameters like body temperature, heart rate and blood pressure. Depending on this data, physician can observe the patient's recovery or have idea upon the health condition of the patient. After the patient has recovered i.e. the condition of the patient is not critical this can be measured at the patient's home. Regular visit for recovered patients are usually inconvenient especially for elderly people.

Chronic diseases are at the edge to be the world's leading causes of death and disability, and will account for almost 3/4th of all deaths by 2020[1]. To address the health problems related to general public, small portable devices are available for the cardiovascular diseases (CVDs) that can provide immediate support for most of the patients at home. In according to the World Health Organization, CVDs are the first cause of death, equivalently 30% of global death in 2008. This figure is estimated to rise up to about 25 million of deaths by 2030[2]. Despite of the efforts in preventing of CVDs, we should prepare for reducing the increasing pressure on the public health-system.

2. PROBLEM STATEMENT

With the increasing population, home-health care industry is growing significantly. Through past years, huge improvements were noticed in the world of technology and computerized systems. The medical industry had remarked advances at the level of smaller packaging, multi-functionality and lower cost. In biomedical embedded world, the most significant specifications include ease of operation, portability, safety and lower audible noise level at an inexpensive cost. One of the increasing popular public concerns is human health. Anything else becomes meaningless if one gets sick or dead. For this reason, people spend a lot of money to keep sound health. Unfortunately, people always find that it is too late to receive serious medical care when things are non-invertible. If early actions can be taken in time then lots of patients can be cured.

However, access to too many medical equipment is inconvenient and expensive. Heart rate and body temperature are the most vital ones among the most notable indexes of the human health, and they have the advantage of easy access. Moreover, unlike the X-ray, the measurement of heart rate and body temperature has no effect on human health itself. There are some devices in the current market which can provide raw medical measurement data patients and doctors, but the patients may not interpret the medical the measurements into meaningful diagnosis since they have very little medical background. On the other hand, if raw medical data is delivered to the doctor, it kills much time and might cause medical health issue, but in case of emergencies time can never be wasted. Most of the products available in the current market have these major drawbacks with limitation in flexibility and portability.

3. LITERATURE REVIEW

As in [3], the author serves the basic need of healthcare device's portability approach. Even though the only thing author has proposed is temperature measurement for which the whole setup would lose the cost versus functionality trade off debate, the portability and data transfer are well managed.

As in [4], beating the basic PQRS method and bringing the LEDs in the sensing service makes this paper one of the most eccentric and innovative approach for blood pressure, heart rate and temperature measurement. Yet it shows an epic failure in the department of displaying the results.

As in [5], while most of the papers concerning the biomedical healthcare assistant focus on making or using smaller and easier sensing methods this paper brings the computation of the acquired data almost near to real time and also shows promising communication protocol implementation.

As in [6] the author designed an open, flexible wireless and portable system for monitoring vital signs in healthcare scenario. Here the author used NFC technology to reduce the power consumption and obtain user friendly system. This paper has two main advantages: 1. Cost effectiveness achieved by using Arduino 2. An innovative approach to use NFC as syncing medium. But the results are questionable when it comes to analog sensors whose real time data may also need to be shown through display.

As in [7], ignoring the I2C implementation since it is not covered in the proposed scheme the paper gives a good brief idea of how the algorithm of logic implementation will work. Also the approach of using thermal sensors for respiratory rate measurement is itself quite an innovative idea.
As in [8], the author used digital pre-processing, so that the results could be compared with similar state-of-the-art methods. Ultralow power analog notch and median filters have been used so that would be used for the removal of power line noise and baseline wander. The author has proposed a new way of processing the pulse train generated by the IF sampler.

As in [9], author uses GSM/GPRS module for transmitting the ECG parameters to increase the device mobility. The algorithm here takes into account the properties of wireless technologies of transmission. The analog signal is converted into digital and processed by the controller. SD card availability is there for storing the results. And transmission through GSM. Because of the use of GSM, there is lots of interference that distorts the ECG signal. As the ECG is of low amplitude. So doing both the task i.e., recording and sending cannot be done at the same time.

Table -1: Summarized review

Sr. No.	Title	Year	Key points	Remarks
1.	Accurate temperature measurements for medical research using BSN[3]	2011	Portability and temperature sensor	Limited and poor performance
2.	Design of a low cost BP and body temperature interface[4]	2013	New ways of sensing	Poor data exchange interface
3.	Remote monitoring of ECG and body temperature[5]	2014	Multiple sensors, good data exchange, efficiency	Very useful for implementation
4.	An open NFC based platform for vital signs monitoring[6]	2015	Use of NFC	Too many dependencies
5.	Human body respiration measurement using digital temperature sensor with I2C interface[7]	2013	Coding algorithm	Old interface

Table 1 gives brief review of the papers.

4. MATERIALS AND METHODS

The proposed solution is a portable device whose main characteristics are low cost, small form factor and low consumption. The proposed system is based on Raspberry pi. Maintaining the Integrity of the Specifications.

1. Respiration rate:

As in [10] the respiratory rate are traditionally measured by counting the respiration rate for at least 30 seconds and then multiplying by 2. Counting for 15 seconds is not a good option as small and any miscounting can result in increase in errors when multiplied by 4. Disease can be detected from the respiration rate values. It can be tachypnea, bradypnea, hyperventilation, hypoventilation, Cheynes-Stokes, Biot's respirations, Sighing, Obstructive breathing [11].

2. Heart rate

As in [12], normal heart rate for adult ranges from 60 to 100 beats a minute. A lower heart rate at rest implies that heart function is more efficient and cardiovascular fitness is also better. There are many ways in which the Heart Rate speeds up or slows down. Normal heart rates range from 60-100 beats per minute (bpm). Bradycardia is defined as a resting heart rate below 60 bpm. Heart rate from 50 to 60 bpm are common among healthy people and does not require special attention. Tachycardia is defined as a resting heart rate above 100 bpm, though persistent rest rates between 80-100 bpm, mainly if they are present during sleep, may be signs of hyperthyroidism or anemia. It also shows the traditional way to monitor the heart beats i.e., by placing fingers on the wrist, counting for 30 seconds and then multiplying it by 2. But use of this method has error prone.

3. Temperature

Body temperature is a measurement of the body's heat. As in [13], Normal human body temperature, also known as normothermia or euthermia, depends upon the measurement place. Different parts of the body have different temperatures. Rectal and vaginal measurements, or measurements taken directly inside the body cavity, are typically slightly higher than oral measurements, and oral measurements are somewhat higher than skin temperature. The commonly accepted average core body temperature is 37.0 °C (98.6 °F).

4. Pulse oximetry

As in [14], the normal levels of oxygen in blood ranges from 96 to 99% in healthy individuals. SpO2 lower than 90% is defined as acute respiratory failure. When SpO2 drops by 3 to 4% from its usual level, even if it is not less than 90%, an acute disease may be suspected. With "normal" body temperature, the level of oxygen saturation also varies from person to person.

5. Blood Pressure

Blood pressure is the pressure rate at which blood flows in the human circulatory system. It is related to the rate of heart beats, and the force with which heart beats. Mainly blood pressure is recorded as two numbers. One of them is systolic and the other is diastolic. Systolic the pressure is blood flow when heart contracts and is normally should be less than 120 mm Hg. For diastolic, it is the pressure of flow of blood in arteries during the heart in rest and its value should be less than 80 mm Hg. From [15], the different cases of hypertension can be known. It shows three different hypertension. Those are pre-hypertension, high blood pressure having two stages. One in the range of 140-159 systolic and 90-99 diastolic and the other stage having systolic range 160 mm Hg and above and diastolic 100 mm Hg and above.

Table -2: Various Vital parameters measuring method

Sr. No.	Sensor	Functionality	Traditional method	Emerging Technologies
1.	ECG	Electrical activity of heart	12-leads and ECG machine	1-lead, 3-lead, And 5-lead,
2.	Blood Pressure	Arterial pressure measurement	Sphygmomanmeter	Determination using red and infrared light passing through pulsating blood in vascular tissue
3.	Oxygen saturation	Indicates the amount of oxygen in patient's blood	Lancets, Test strips and Oximeter	The red LED Measures Deoxygenated haemoglobin and the infrared LED Measures Oxygenated haemoglobin
4.	Heart rate	Frequency of cardiac cycle	Stethoscope	Acoustic sensors
5.	Body Temperature	Measure of body's ability to generate and get rid of body heat	Thermometer – typically mercury or alcohol based	Non-touch infrared based Digital Thermometer

The table 2 shows various health parameters, what the related sensors measures i.e., their functionality, the traditional method used for measuring the values by the doctors and the now the technologies which are emerging for their measurement.

Table 3 shows a small comparison with the availability of sensors in the summarized papers. From this table we come to know that not all comprises of all the sensors. The tick mark shows that the sensor is present. S1 is for the temperature sensor, S2 is for the blood pressure sensor, S3 for the heart rate sensor, S4 is the ECG electrodes sensor and S5 is for the Oximetry sensor. Another thing is the portability and performance comparison of summarized paper.

Table -3: Sensor availability in the summarized papers

Sr. No.	Title	S1	S2	S3	S4	S5	Performance	Portability
1.	Accurate temperature measurements for medical research using BSN[3]	✓						✓
2.	Design of a low cost BP and body temperature interface[4]	✓	✓				✓	✓
3.	Remote monitoring of ECG and body temperature[5]	✓		✓			✓	
4.	An open NFC based platform for vital signs monitoring[6]	✓						✓
5.	Human body respiration measurement using digital temperature sensor with I2C interface[7]	✓						✓

4. PROPOSED SYSTEM

This system acquires body temperature, heart rate, pulse rate, oxygen level and blood pressure of an individual and transfers data using Zigbee module. The device displays the information on the display and stores it. The main microcontroller of the device is Raspberry pi. The figure 1 shows the proposed block diagram of the system.

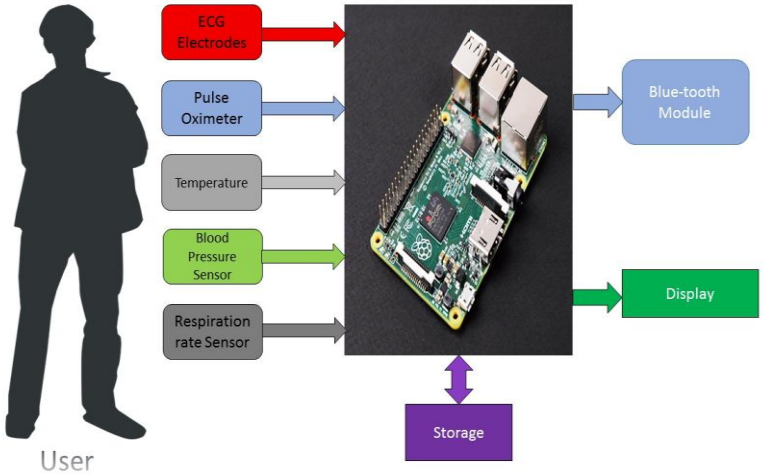

Fig -1: Proposed System

5. CONCLUSIONS

From the review we concluded that portable health monitoring system is user friendly as can be used easily, cost effective moreover it is providing accurate result too. As this project is based on micro-controller and ZigBee technology is used to transmit data. This can be of great use in the field of medicine and helps the Doctor to keep a keen eye on the patient's health.

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