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Data Forwarding and Vital Sign Monitoring for Heart Failure Prediction Using Raspberry Pi.

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ABSTRACT

Heart failure (HF) could be the leading cause of death in the many individuals. Due to the prevalence of HF connected problems, it is necessary to find out methodologies that would facilitate the monitoring, and treatment of heart disease on daily basis. In this project, important vital signs like heart rate, blood pressure, breath movements and temperature of the patient are monitored and are connected to raspberry pi. The health related data of patient is updated continuously to the doctor using HTML page with the help of Wi-Fi. In the case of warning, an alert is given with the help of buzzer. During emergency period, SMS is sent to doctor concerning the patient's health condition. Doctor can take care of patient remotely by Turning ON/OFF in HTML page in order that the corresponding led will be ON/OFF near the patient which indicates the necessary medication to be taken.

Keywords: Heart failure, vital sign, Raspberry Pi, SMS, HTML.

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INTRODUCTION

Heart failure, sometimes known as congestive heart failure, happens when the heart muscle doesn't pump blood well. There are many factors that result in heart disease like coronary artery disease, high blood pressure and faulty heart values. For the purpose of predicting the heart failure it's necessary to monitor some vital signs. There are some vital signs that indicate whether or not the person is normal or abnormal such as pulse rate, respiratory rate, temperature, blood pressure.

A single risk issue could also be enough to cause heart failure, however a combination of these factors additionally will increase risk. These factors can be monitored continuously with the assistance of WBAN consisting of sensor nodes for identification. Recent technological developments in low-power integrated circuits, wireless communications and physiological sensors promote the development of little, light-weight, ultra-low-power monitoring devices. A body integrable network, therefore known as WBAN, can be formed by integrating these devices. WBAN with sensors consuming extremely low power is employed to monitor patients in critical conditions. It helps to handle numerous drawbacks related to wired sensors that are normally employed in hospitals and emergency rooms to monitor patients. It makes use of wireless communication technologies to forward the data. WBAN consists of a number of tiny sensor nodes and gateway node used to connect with the external database server. The gateway node could connect the sensor node to wide spread telecommunication networks. These communication networks might be a standard telephone network, mobile phone network, hospital network or WLAN hotspot known as Wi-Fi. There is no special standard for WBAN targeting health care applications. The popular wireless technologies used for medical monitoring are Bluetooth, Zigbee and Wi-Fi. The data obtained is forwarded to the webpage which helps the doctor to monitor the patient condition remotely.

EXISTING SYSTEM

Telemonitoring involves the transfer of physiological information like blood pressure, weight, electrocardiographic signals or oxygen saturation through technology such as telephone lines, broadband, satellite, or wireless networks. By incorporating lot of data telemonitoring additionally guarantees to detect HF deterioration earlier, providing a lot of prompt and effective intervention. Two recent meta-analyses have suggested that telemonitoring in ambulant HF patients will improve mortality by 17 to 47% throughout the six to twelve months of follow-up and reduce hospitalizations by 7 to 48%. However, two massive subsequent randomized controlled trials recommend caution before wide use of telemonitoring. In Telemonitoring to boost Heart Failure Outcomes (TELE-HF), a telephone-based interactive voice-response system that obtained symptom and weight information provided no significant benefit over usual care in terms of all-cause rehospitalization rates or death.

Similarly, Telemedical Interventional Monitoring in Heart Failure Study (TIM-HF) wasn't able to demonstrate a major impact of telemonitoring on HF-related rehospitalization rates or mortality. In distinction to a lot of productive implementations of telemonitoring, TELE-HF relied on patient-initiated communication: patients had to use a toll-free telephone system in which an automated voice asked a series of inquires to which that they had to retort by keypad. Also, nurses in TELE-HF weren't authorized to vary the medication plan without physician consultation, adding a layer of communication and delay. There also needs to be timely transmission of data, receipt of the data by the appropriate staff that can analyze and act upon it. Feedback loop to the patient is given with directions, sufficient patient empowerment to understand and implement the instructions. Also, though telemonitoring guarantees to reduce the requirement for in-person follow-up, it may actually increase the workload involved. In the TELE-HF study, while there were only 25 patients per website on the average, there have been 884 incidents per website requiring responses.

In case of emergency the doctors might not be available all the time therefore there will be a delay in taking remedy actions immediately. Here the home gateway could be PC or laptop normally connected to the power line, however the internal battery ensures about 5h of autonomy in case of power failure. As an existing prototype is using Bluetooth power consumption will be more. The system faces the difficulty of using the instrumentation designed in controlled environment of a clinical situation.

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PROPOSED SYSTEM

In the proposed system, Heart Failure is predicted accurately with the assistance of WBAN sensor nodes connected on body. These sensors can provide the information of vital signs that leads to heart failure. The data obtained with the assistance of WBAN sensor nodes is given to Raspberry Pi. Then the collected data is forwarded to the HTML page continuously, so that the doctor can monitor the patient condition remotely at anytime from anywhere. Additionally, the data is also displayed near the patient section. In case of emergency, buzzer is used to alarm sound near patient section and also an emergency message regarding that particular risk factor is sent to the doctor's mobile. Doctor opens HTML page in his mobile to respond to the patient's scenario. Doctor prescribes the required medication to the patient remotely by turning ON the particular switch in HTML page. The corresponding LED will glow near the patient section, so that the treatment can be done to the patient remotely.

BLOCK DIAGRAM

In Figure 1, Block Diagram of proposed system for prediction and diagnosing heart failure is shown. Data of vital signs associated with the prediction of heart failure is obtained with the help of sensors. Data obtained is converted into Digital with the assistance of ADC. Then it's forwarded to raspberry pi for processing the information. Data is displayed near patient section and updated in the html page continuously for every 10 seconds. In case of emergency, an alert is given near patient section with buzzer sound and SMS is sent to the doctor. Doctor can take care of patient remotely by opening the html page in his mobile. Then the required medicine is indicated through the webpage relating to the particular vital sign that is critical. So the corresponding LED glows near the patient section related to vital sign that is critical indicating the medicine to be taken.

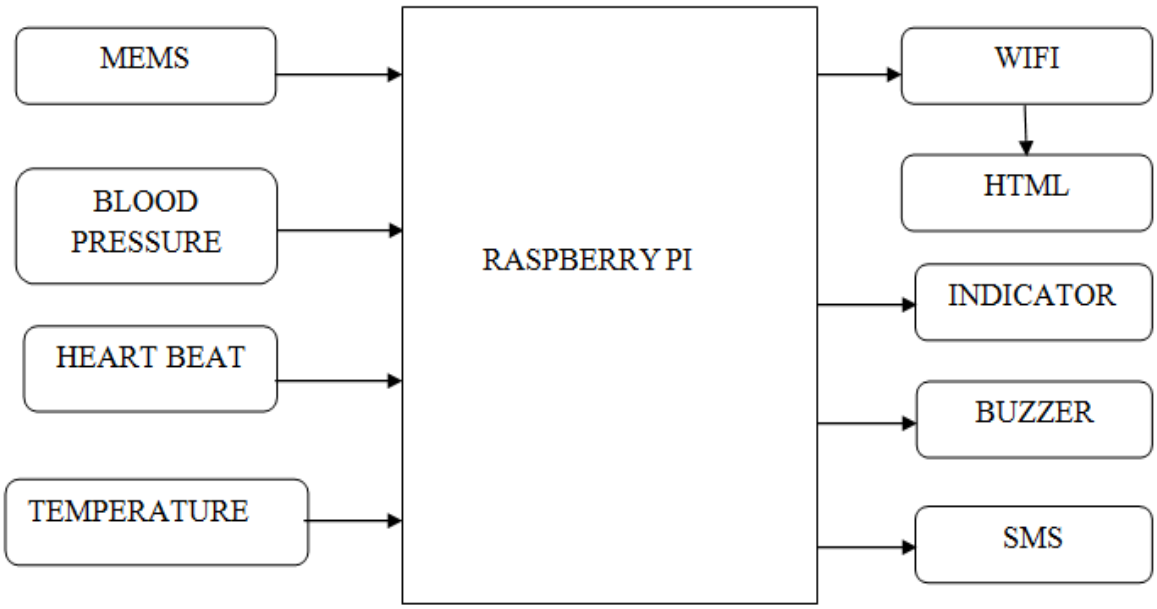

Figure 1: Block Diagram representation of Heart Failure Monitoring System

Fuzzy Rule Base

The fuzzy rule base is characterized by a group of "If-then" rules, in which the antecedents ('If' part of the rule) and consequents ('then' part of the rule) involve linguistic variables. The collection of these rules forms the rule base for the fuzzy logic sub-system. The rules are developed based on the view of medical experts on diagnosis of heart failure.

A structure of rules within the rule base is: if (x = A) and (y = B) and (z = C) then (S = O), where x, y, z are inputs variables, A,B,C are fuzzy sets of the input variables, S is the output and O is fuzzy set of the output variable within the fuzzy region specified by the rule.

MEMS

MEMS sensor is attached on the body of patient for monitoring chest movements continuously. An accelerometer is an electromechanical device that measures acceleration forces. It contains a poly silicon surface-micro machined sensor and signal conditioning circuitry to implement open-loop acceleration measurement architecture. The output signals are analog voltages that are proportional to acceleration. The ADXL335 uses single structure for sensing the X, Y, and Z axes. As a result, the three axes sense directions are extremely orthogonal and have little cross-axis sensitivity.

Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. Temperature with LM35 is often measured more accurately than using a thermistor. The LM35 generates a higher output voltage than thermocouples and will not need that the output voltage be amplified.

Blood Pressure Sensor

To measure the patient's blood pressure, air will be pumped into the cuff to be around 20 mmHg higher than average systolic pressure. Then the air will be slowly released from the cuff causing the pressure within the cuff to decrease. As the cuff is slowly deflated, it is possible to measure the tiny oscillation in the air pressure of the arm cuff. The systolic pressure will be the pressure at which the pulsation starts to occur. Controller is employed to detect the point at which this oscillation happens and then record the pressure in the cuff. Then the pressure within the cuff will decrease further. The diastolic pressure is going to be taken at the point in which the oscillation starts to disappear.

Heart Beat Sensor

When the heart beats, a pressure wave moves out on the arteries at a few meters per second. This pressure wave can be felt at the wrist, but it also causes a rise in the blood volume within the tissues, which can be detected by a plethysmograph.

Raspberry Pi

The Raspberry Pi is a credit card sized single-board computer with an open-source platform. Higher-spec variant increases the Raspberry pi GPIO pin count from 26 to 40 pins. The SD card slot has been replaced with a modern push-push type micro SD slot. It have several models, All models feature a Broadcom system on a chip (SoC), which has an ARM compatible central processing unit (CPU) and an on chip graphics processing unit. Secure Digital (SD) cards are used to store the operating system and program memory in either the SDHC or Micro SDHC sizes.

Python

Python allows programmers to use fewer lines of code than would be possible in languages such as assembly, C, or Java. Python programs don't need to be compiled before running them, like C programs. However, need to install the Python interpreter on computer to run them. The interpreter is the program that reads the Python file and executes the code. Many of the things that are possible in C can be done in Python. Computations are slower in Python than in C, but its ease of use makes Python an ideal language for applications that aren't computationally intensive.

HTML

HTML is a simple, universal mark-up language that permits the web publishers to create complex pages of text and pictures that can be viewed by anyone else on the web, regardless of what kind of computer or browser is being used. There is no need of any special software to create an HTML page but it's necessary to have a basic text editors like notepad. HTML is simply a series of tags that are integrated into a text document. HTML tags are typically English words or abbreviations however they are distinguished from the regular text as

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a result they are placed in small angle brackets.

RESULTS AND DISCUSSION

The vital Signs necessary to predict the Heart Failure are Blood Pressure, Respiratory rate, Temperature, Heart Beat. These parameters are monitored continuously with sensors and the obtained values are assigned to Raspberry Pi. The sensor values are displayed near the patient section for every 10 seconds as shown in figure 2.

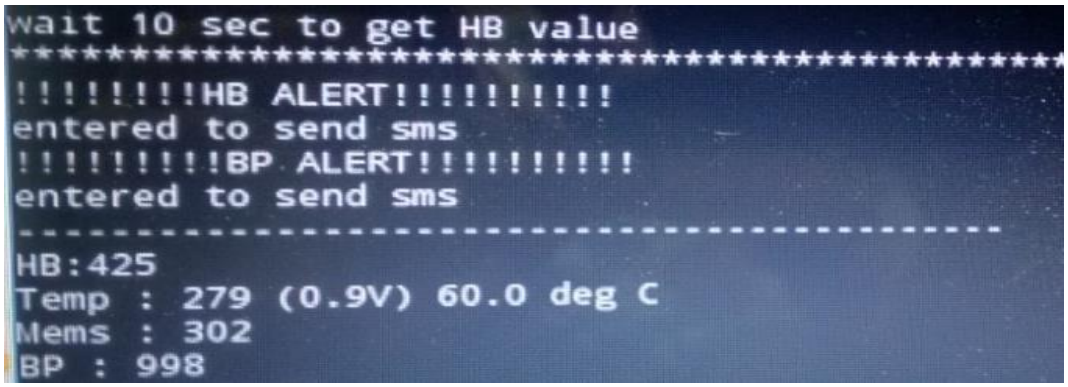

Figure 2: Calibrated values of Sensors for Vital Sign Monitoring

Data collected with the help of sensors is forwarded to the webpage with the help of Wi-Fi as shown in figure 3 and is updated continuously so that it is possible to monitor the patient condition and indicate the medication at anytime from anywhere as shown in figure 4.

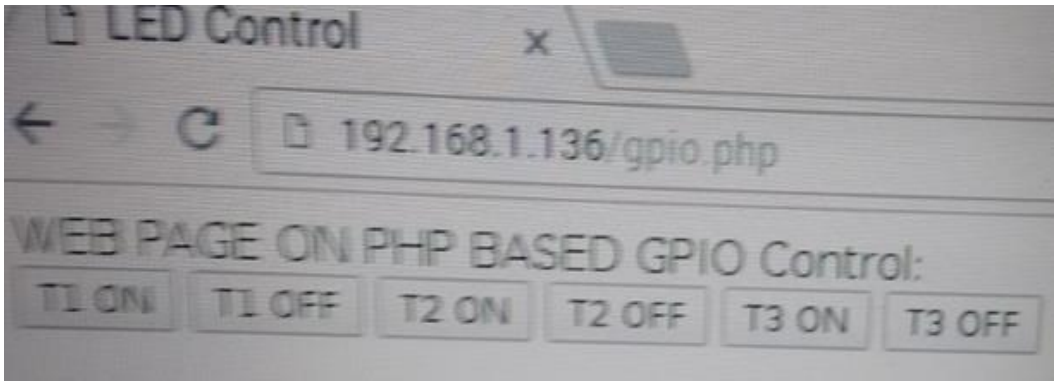

Figure 3: webpage to monitor and control the vital signs of patient

Figure 4: Turning ON the LED of corresponding Emergency vital sign using webpage

In figure 5 as shown below, Doctor monitors these parameters continuously with the help of webpage through his mobile. In case of emergency regarding any particular vital sign buzzer sound will occur near patient and an emergency SMS regarding that particular parameter will be sent to the doctor mobile as in figure 6.

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Figure 5: monitor and control the vital signs of patient remotely using mobile

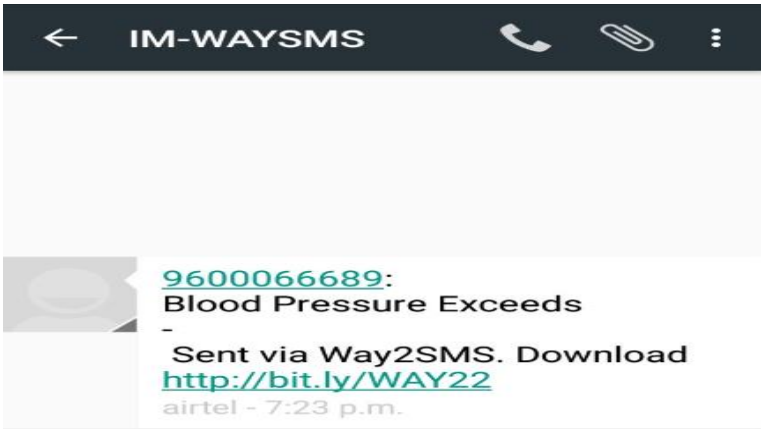

Figure 6: Emergency SMS to Doctor mobile

It is possible for the doctor to take care of patient in such kind of situation at anytime from anywhere using webpage in his mobile. So the doctor takes care by turning ON the corresponding LED near patient section remotely using webpage in his mobile as in figure 7. It indicates the necessary medicine to be taken by the patient for reducing the risk factor due to that parameter.

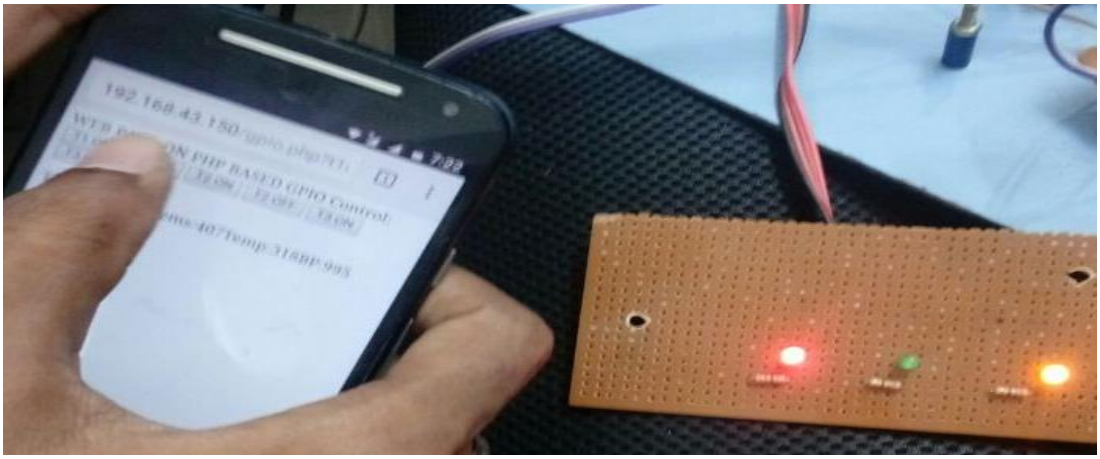

Figure 7: Monitoring and control of vital signs remotely through mobile

CONCLUSIONS

As there is an increasing burden of Heart Failure, it is necessary to create an innovative care system for heart failure patients. A number of heart disease prediction techniques have been developed so far but they are very expensive and time consuming. Using this proposed technique, a way for heart disease prediction can be found. This proposed method provides healthcare to CHF patients by continuously detecting

changes in vital parameters. During emergency case, message of specific emergency condition is sent to the doctor. It alerts the physician during emergency in order to give immediate care. Since modern age is the era of smart phone, proposed technique can reach to the people of every level in the society. At any level of our society who have smart phone can easily take precaution for heart failure. This monitoring provides more effective and efficient collection of data and reliable transmission. Cost effective analysis and less computational time are the advantages of remote monitoring. In future, it is necessary to develop the sensors that monitor the vital signs with low power consumption at desired level of accuracy and also to identify the vital signs to be monitored for a patient according to the symptoms of that particular patient.

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