# Real Time Multi-Channel Wireless Health Monitoring System

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*Abstract*— In recent years the great innovations brings advanced technologies in Medicinal ground. Most of the Health Care – Hospitals are trying to make available and uphold the effective enduring treatment with more alert and preventions. Such an effective treatment requires a professional Patient Monitoring System. The Patient Monitoring System is a greatly developed technology for controlling and monitoring the situation of various Human-health parameters. Some of our human health parameters include temperature, heartbeat, blood pleasure, pulse, etc. needs a continuous monitoring. In rural area, many of the patients lost their life due to lack of medical facilities. Hospitals in metro cities are having lots of medical facilities and specialist doctors. But in rural area there is no facility available. In an emergency case, patient couldn't reach big hospitals in city from rural area. This is causing some time loss of their life. Hence to connect hospitals in rural area with hospital which are in metro cities is a major task to overcome such problem. To build such a system with low cost, fast and with great efficiency is necessary.

***Key words:*** Wireless Health Monitoring

## I. INTRODUCTION

The proposed system is used to remotely monitoring of patients using live streaming of health parameters as ECG, blood pressure, body temperature and blood pH. In these four parameters first three are the outputs of machines and last one is the analysis result of the chemical process. For getting ECG wave electrocardiogram is used. The output of electrocardiogram is given to proposed system as one of the input of system. While transferring the ECG wave maximum accuracy is required.

Sphygmomanometer is used to measure blood pressure. It measures systolic as well as diastolic blood pressure. When your heart beats, it contracts and pushes blood through the arteries to the rest of your body. This force creates pressure on the arteries. This is called systolic blood pressure. A normal systolic blood pressure is 120. The diastolic blood pressure number or the bottom number indicates the pressure in the arteries when the heart rests between beats. A normal diastolic blood pressure number is 80 or less. The output of Sphygmomanometer is used as second input for proposed system.

LM35 is used to measure body temperature. The output of LM35 is used as third input for proposed system. The normal human body temperature is *37°C.*The blood *pH* is measured by chemical process. A pH of 7 is neutral.

## II. HARDWARE IMPLEMENTATION

There are four health parameters are monitored in this system. Out of these four, three parameters are getting from their sensors and one i.e. blood pH is entered directly from keyboard. The output of all these sensors is given to ARM9 controller. The 16*2 LCD display is used to display temperature on board. GUI is designed using visual basic. The values of blood pressure and temperature are automatically updates in GUI. Continuous ECG waveform is displayed in GUI.

### *A. Input: ECG*

The ECG circuitry will consist of protection circuit, a instrumentation amplifier, isolation circuit, a high-pass filter, low pass filter, amplifier, notch filter, and adder. AgCl electrode, which convert ECG into electrical voltage is used. The voltage is in the range of 1 mV ~ 5 mV. Two electrode of chest connect to input of instrumentation amplifier through protection circuit of diodes. 10Kohm resister is used for current limiting purpose.

#### *1) Protection circuit*

Diode (D1, D2, D3, D4) are used to protect IC from over voltage when input voltage reaches to 0.7V then Diode get clamped and over voltage condition is avoided. Because of this input to instrumentation Amplifier will always be less than 0.7V.

#### *2) Instrumentation Amplifier*

The second stage is an instrumentation amplifier (Analog Device, AD620), which has a very high CMRR (90dB) and high gain (1000), with power supply +9V and -9V. A very high CMRR is very essential for Instrumentation Amplifier. The small ac signal voltage (less than 5 mV) detected by the sensor on the electrodes will be accompanied by a large ac common-mode component (up to 1.5 V) and a large variable dc component (300 mV). The common-mode rejection specified by the AAMI (Association for the Advancement of Medical Instrumentation) is 89 dB minimum for standard ECG and 60 dB minimum for ambulatory recorders. The CMRR of AD624 with gain of 1000 is shown on.

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$$\text{CMMR} = \frac{\text{Differential gain}}{\text{Common mode gain}} \quad (1)$$

The circuit is built around a single-chip instrumentation amplifier AD620, manufactured by Analog Device. The AD620 is a low cost, high accuracy amplifier which requires only one external resistor to set gain of the amplifier. The gain of the amplifier is determined by the following formula:

$$G = \frac{49.4K\Omega}{R_1} + 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

 

G = 1 + (49.4 k/RG) and R = 8K ohm. So, the gain of AD620 is, GAIN = 7.

*3) Isolation*

It is NPN silicon planar phototransistor optically coupled to a gallium arsenide infrared emitting diode. Isolation circuit is used to provide isolation between input and output. It protect patient from shock.

For checking the ECG signals on CRO we measure the ECG signals via CRO probes In most of the cases the Patient electrode ground and CRO ground is not the same, for such cases if the CRO ground is not properly earthed then the patient may get a Shock so for this reason we are interfacing a opto isolator which provides a optical insulation between the Electrode circuit and the output circuit.

*4) High Pass and Low Pass Filter*

We take the band pass filter the frequency range of 0.04 Hz ~ 35 Hz. The filter is implemented by cascading a low-pass filter and a high-pass filter. The data of low-pass and high-pass filter are implemented by simple RC components; ECG signal is in frequency range of 0.5Hz to 35Hz. Hence we have used high pass filter and low pass filter. Therefore lower cut-off frequency for HPF is 0.5 Hz.

Fc = 1/2*pi*RC
C = 1uF
R = 330 kΩ
Fcutoff = 1/ 2 * 3.14 * 1µf * 330KΩ
Fcutoff = 0.489 Hz

Low pass filter allow signal below 35Hz only.

Fc = 1/2*pi*RC
C = 0.1uf
R = 47 kΩ
Fcutoff = 1/ 2 * 3.14 * 0.1µf * 47KΩ
Fcutoff = 35 Hz

*5) Amplifier (OP07)*

8 pin DIP package, low input offset voltage and high open loop gain. This non- inverting amplifier is used for signal conditioning purpose, gain provided by amplifier is 143. Total gain required for ECG circuit is 1000. Using variable resister gain adjusted to 143.

*6) Notch Filter*

A Notch filter is a filter that passes all frequencies except those in a stop band cantered on a centre frequency. A closely related Knowledgebase item discusses the concept of the Q of a filter. This Knowledgebase item focuses on high Q notch filters - the type that eliminates a single frequency or narrow band of frequencies. A closely related type of filter - a band reject filter, is discussed in a separate knowledgebase item. The amplitude response of a notch filter is flat at all frequencies except for the stop band on either side of the centre frequency. The standard reference points for the roll-offs on each side of the stop band are the points where the amplitude has decreased by 3 dB, to 70.7% of its original amplitude.

Notch filter is used to provide zero output at particular freq. It eliminates power line noise at 50Hz. It contains H.P.F and L.P.F called twin-T network. It is having signal of frequency between 47Hz to 53Hz. The output of notch filter is +2.5V. It connects to input of adder circuit. Adder circuit shifts the signal from ±2.5V to 0-5V. And this output gives to ADC.

### *B. Input: Blood Pressure*

Sunrom blood pressure measurement unit is used in this system to measure blood pressure. This device gives data serially with 9600 baud rate. The output of this device is in ASCII code. This is a fully automatic and having great clinical accuracy device.

### *C. Input: Body Temperature*

Temperature sensor are basically classified into two types-

1) Non-Contact Temperature Sensors: These temperature sensors use convection & radiation to monitor temperature.
2) Contact Temperature Sensors: Contact temperature sensors are then further sub divided into three type.
   a) Electro-Mechanical (Thermocouples).
   b) Resistive Resistance Temperature Detectors (RTD).
   c) Semiconductor based. (LM35, DS1820 etc).

LM35 is used as temperature sensor. The output of this sensor is given as one of the input for ADC. LM35 is an integrated analog temperature sensor whose electrical output is proportional to Degree Centigrade. LM35 Sensor does not require any external calibration or trimming to provide typical accuracies. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

## III. GLOBALLY INTERFACING

Right now I am using Team Viewer to connect other system present in any place in the world. In future we can develop own system to stream data continuously. TeamViewer is a proprietary computer software package for remote control, desktop sharing, online meetings, web conferencing and file transfer between computers.

## IV. CALIBRATION OF SYSTEM

The desired system is calibrated for temperature and blood pressure sensor in Noble Hospital, Pune. In table no .1, difference of room temperature is estimated. In table no. 2, difference of blood pressure of one person at different time is estimated. In table no. 3, difference of blood pressure of five different persons for two times estimated.

| Sr No | Date | Time | Temperature | | Difference |
|---|---|---|---|---|---|
| | | | System | Thermometer | |
| 1 | 23/11/2017 | 10:00:00 AM | 25.1 | 25.3 | -0.2 |
| 2 | 23/11/2017 | 10:15:00 AM | 25.3 | 25.3 | 0 |
| 3 | 23/11/2017 | 10:30:00 AM | 25.4 | 25.5 | -0.1 |
| 4 | 23/11/2017 | 10:45:00 AM | 25.3 | 25.3 | 0 |
| 5 | 23/11/2017 | 11:00:00 AM | 25.6 | 25.2 | 0.4 |

| | | | | | |
|---|---|---|---|---|---|
| 6 | 23/11/2017 | 11:15:00 AM | 25.4 | 25.6 | -0.2 |
| 7 | 23/11/2017 | 11:30:00 AM | 25.5 | 25.5 | 0 |
| 8 | 23/11/2017 | 11:45:00 AM | 25.6 | 25.7 | -0.1 |
| 9 | 23/11/2017 | 12:00:00 PM | 25.5 | 25.6 | -0.1 |
| 10 | 23/11/2017 | 12:15:00 PM | 25.5 | 25.7 | -0.2 |

Table 1: Calibration Reports for Temperature Sensor for room Temp

| Sr No | Date | Time | Blood Pressure (Diastolic) | | Difference | Blood Pressure (Systolic) | | Difference |
|---|---|---|---|---|---|---|---|---|
| | | | System | Device | | System | Device | |
| 1 | 23/11/2017 | 10:00:00 AM | 85 | 87 | -2 | 125 | 126 | -1 |
| 2 | 23/11/2017 | 10:05:00 AM | 86 | 86 | 0 | 120 | 122 | -2 |
| 3 | 23/11/2017 | 10:10:00 AM | 85 | 88 | -3 | 127 | 123 | 4 |
| 4 | 23/11/2017 | 10:15:00 AM | 87 | 87 | 0 | 130 | 125 | 5 |
| 5 | 23/11/2017 | 10:20:00 AM | 84 | 85 | -1 | 127 | 127 | 0 |
| 6 | 23/11/2017 | 10:25:00 AM | 85 | 86 | -1 | 128 | 127 | 1 |
| 7 | 23/11/2017 | 10:30:00 AM | 86 | 85 | 1 | 128 | 129 | -1 |
| 8 | 23/11/2017 | 10:35:00 AM | 85 | 86 | -1 | 125 | 128 | -3 |
| 9 | 23/11/2017 | 10:40:00 AM | 85 | 84 | 1 | 124 | 121 | 3 |
| 10 | 23/11/2017 | 10:45:00 AM | 84 | 85 | -1 | 125 | 123 | 2 |

Table 2: Calibration of Blood pressure sensor for same person

| Person | Date | Time | Blood Pressure (Diastolic) | | Difference | Blood Pressure (Systolic) | | Difference |
|---|---|---|---|---|---|---|---|---|
| | | | System | Device | | System | Device | |
| 1 | 23/11/2017 | 11:00:00 AM | 86 | 87 | -1 | 123 | 126 | -3 |
| | 23/11/2017 | 11:05:00 AM | 87 | 85 | 2 | 123 | 122 | 1 |
| 2 | 23/11/2017 | 11:10:00 AM | 91 | 88 | 3 | 125 | 123 | 2 |
| | 23/11/2017 | 11:15:00 AM | 93 | 94 | -1 | 127 | 125 | 2 |
| 3 | 23/11/2017 | 11:20:00 AM | 79 | 81 | -2 | 129 | 127 | 2 |
| | 23/11/2017 | 11:25:00 AM | 81 | 80 | 1 | 128 | 127 | 1 |
| 4 | 23/11/2017 | 11:30:00 AM | 91 | 85 | 6 | 130 | 129 | 1 |
| | 23/11/2017 | 11:35:00 AM | 95 | 91 | 4 | 133 | 128 | 5 |
| 5 | 23/11/2017 | 11:40:00 AM | 93 | 88 | 5 | 123 | 121 | 2 |
| | 23/11/2017 | 11:45:00 AM | 91 | 89 | 2 | 124 | 123 | 1 |

Table 3: Calibration of Blood pressure sensor for five persons with two readings each

## V. RESULT

Temperature sensor calibrated with room temperature for 10 readings. Blood pressure sensor is calibrated for same person with taking 10 readings. The difference between results obtained in desired system and existing system in one of the hospital in Pune, found to be somewhat equal.

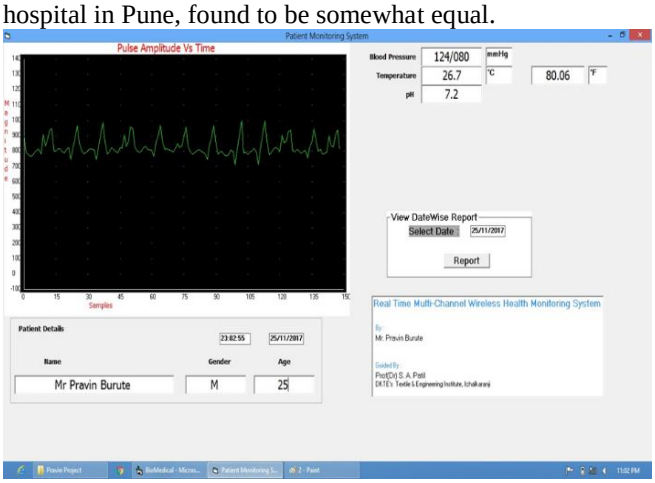


Fig. 1

The above Fig shows the desired GUI for results. In this we found that accuracy of ECG waveform found to be very good.

## VI. CONCLUSION

In real time multi-channel wireless health monitoring system, only four parameters where monitoring. It is continuously monitoring all parameters with best accuracy in real time changes. The data storing function of this project works well. Online streaming achieved by TeamViewer is with good.

## VII. FUTURE IMPLEMENTATION

There are only four parameters are included in this system. In future by our requirements we can add another parameters and it can be developed for unlimited number of patients. By using this type of developed system, health monitoring system will become stronger and efficient.

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