A Novel Assistive System using National Instruments LabVIEW Graphical Programming

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Abstract**—***Today health monitoring system related research has been the priority for all as pre diagnosis of any health related issue can help to save lives of many people. It involved multidisciplinary fields of research which included use of electronic sensors, biomedical diagnosis, embedded system, artificial intelligence etc. In today's busy world most people does not have time for proper medical checkup or does not have the economic support for the expenses related to it. In this paper we have proposed a novel assistive system called AHD (Automated health diagnosis) system which is cost effective, durable and easy to use. It will be very advantageous for elderly people in eliminating the excessive cost of diagnosis and unnecessary travelling to the hospital for whom regular health checkup is a priority aspect. This system will monitor patient health so that necessary medical support can be provided within appropriate time. AHD system involves uses of ECG (Electrocardiogram) signal, body vibration signal and the use of GSM technology. In case of abnormality this system will send text message to the doctor, hospital and the family members. We have used Ardunio Mega 2560 as a microcontroller, AD620 for ECG and LabVIEW as a visual programming language. This system will bridge the gap involved in the patient deteriorating health condition and health care entities.*

Keywords— Biomedical embedded system, ECG, AHD (Automated health diagnosis) system, Medical diagnosis, Signal Processing.

I. INTRODUCTION

Heart is the center of human anatomy which is the paramount of all organs. Based on the analysis it is estimated that in the year 2014 27.6 million adult with diagnosed heart diseases and every year almost 614,348 people die due to heart failure [Open data from Centre of Disease Control and Prevention]. Heart disease has ranked no 1 in causes of death. Hypertension or high blood pressure [1] has increased rapidly in few decades and resulted in 92% of all deaths due to heart failure. The advancement in Medical treatment has cure for almost all heart problems if taken care at early stage. Development of biocompatible prostheses, various diagnostic and therapeutic medical instruments ranging from clinical to micro-implants and also the common imaging equipment which involves MRI, EEG, and many other biomedical [2] operations. The AHD system proposed acquires the ECG signal [3] and the body vibration signal [4] and feed it to the microcontroller. The data is acquired and analyzed in real time. However it's not only the analyzing of a human health but also the necessary action should be taken. In the case of abnormality or if the data acquired during analysis outstrip the threshold provided then the GSM 300 module [5] used here is triggered and a text message is sent about the patient abnormality to the entities provided.

II. METHODOLOGY

The AHD system comprises of three essential parts. Firstly, ECG signal and acquisition and analysis, secondly body vibration signal and thirdly the text message handling process.

2.1 ECG (Electrocardiogram)

ECG is the transthoracic elucidation [6] of the electrical activity of heart in some interval of time. The electrodes are attached to the skin of the human body and the analysis is recorded externally. It's very useful in explaining the heart condition and the need of a pacemaker if required. There are four waves generated by ECG which includes a P wave, a QRS complex, a T wave and U wave where each of the waves is of different pattern in comparison to the other waves. These waves are the result of the Voltage vs. Time graph which is used to detect the functioning of the heart of the patient. Firstly, we have used three disposable Ag-AgCl button type surface electrodes connected to the AD 620-B instrumentation amplifier [7] with the circuit board through three individual ECG cables. The whole circuit parameters are calculated in accordance with the needed signal strength and the arduino Mega 2560 is also interfaced. Below in Fig 1 the normal healthy heart signal image has been shown and in Fig 2 the snapshot of the raw ECG signals acquisition process.

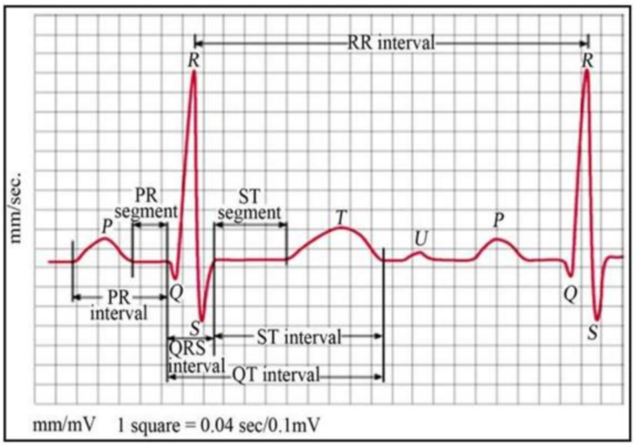

FIGURE 1: Normal healthy heart ECG signal

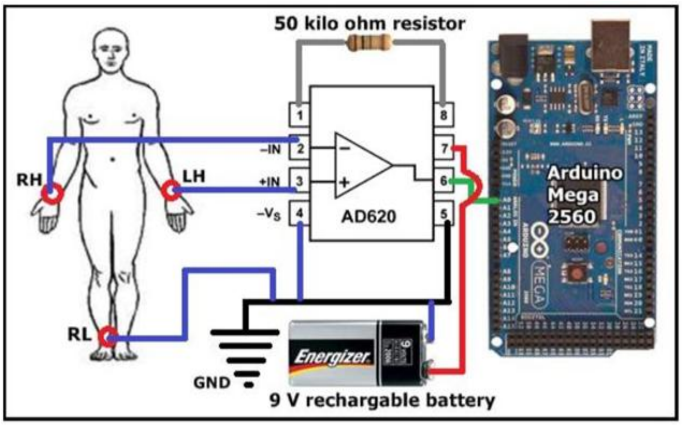

FIGURE 2: Raw ECG signal acquisition process

The ECG signal algorithm, the serial communication parameters are set via LVIFA toolkit settings. Then the real-time raw ECG signal is acquired and filtering, baseline wandering removal is done to get proper ECG signal. Now in an ECG signal, the peak amplitude value, depth voltage level and the RMS voltage are the three major factors with which we have to deal. Hence with proper analyser GUI blocks and with some logical techniques the feature extraction is done. Below in Fig3 the ECG signal collector is shown and in Fig4 the ECG signal analyser is shown.

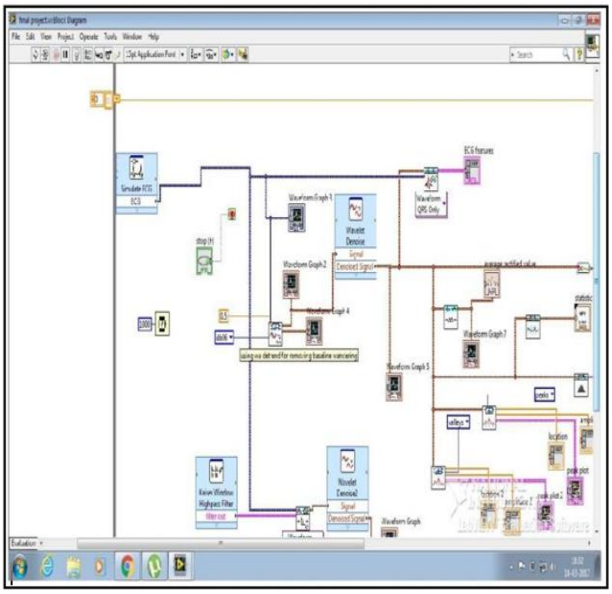

FIG 3: ECG signal collector

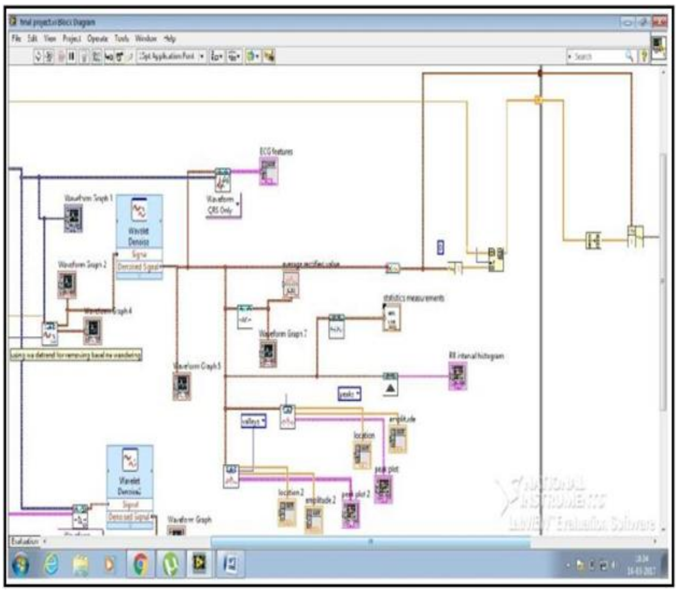

FIG 4: ECG signal analyser

In the signal analysis if the ECG parameters go beyond the threshold then the logic circuit displays abnormality and GSM module in triggered. Below in Fig5 the ECG signal output graph for normal heart condition is shown and in Fig6 the ECG signal output graph for abnormal heart condition is also shown.

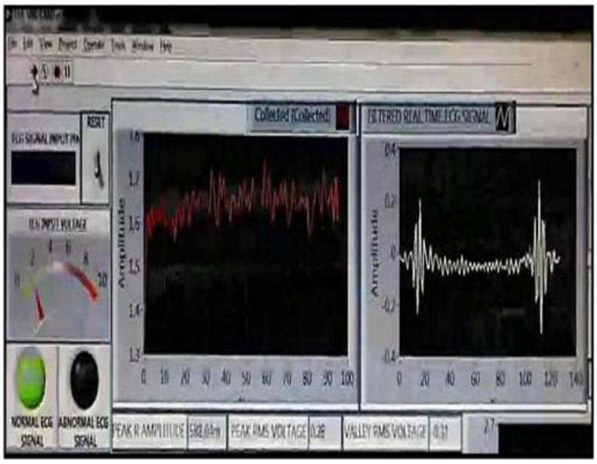

FIG 5: ECG signal output graph for normal heart condition

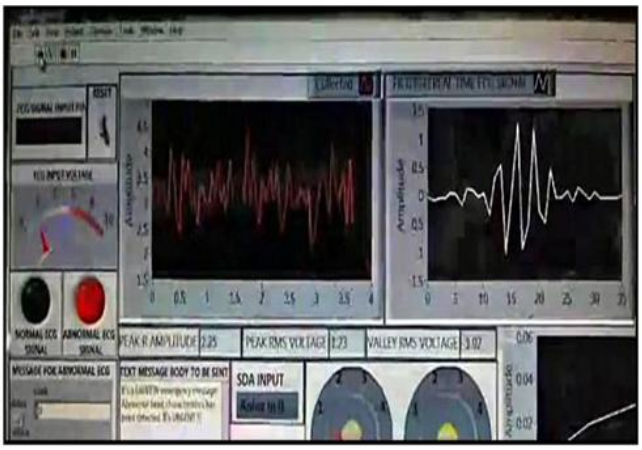

FIG 6: ECG signal output graph for abnormal heart condition

2.2 Body Vibration Signal

ADXL345 is a very tiny, lightweight and ultra-low-power, 3-axis MEMS accelerometer that measures [8] data in very high resolution (13bit) which ranges from +/-2g to +/-16g and its digital output data is acquired either by using a SPI or I^2C digital interface which ranges from 10Hz to 3200Hz. ADXL345 is very pertinent for mobile applications. It measures both the Dynamic acceleration and the static acceleration of gravity, where the dynamic acceleration is the result of the shock or mobility and the static acceleration is used in tilt sensing applications. Its other uses include activity or inactivity sensing which is detected by the presence or the absence of mobility by analyzing the acceleration detected on any axis with user-set threshold. Single and double taps are detected by Tap sensing and the descending of the device is detected by the Free-fall sensing. These functions are delineated to either of the two interrupt output pins. To lower the overall system power consumption and to minimize the host processor activity an integrated memory management system FIFO buffer is used to store data. The AI pin 1 and 2 of arduino Mega 2560 is [9] bridged with the ADXL345 supply pin, ground pin, SCL and SDA ports. The factual magnitude of the body vibration signal is retrieved from the AI pin 1 which is interfaced with SDA (Self Diagnosing Accelerometer). The analog signal retrieved is filtered and the threshold given is analogized. If the threshold exceeds the GSM module is triggered. Below in Fig7 the algorithm of body vibration signal is given and also in Fig 8 the real time body vibration signal monitoring system in labVIEW is given.

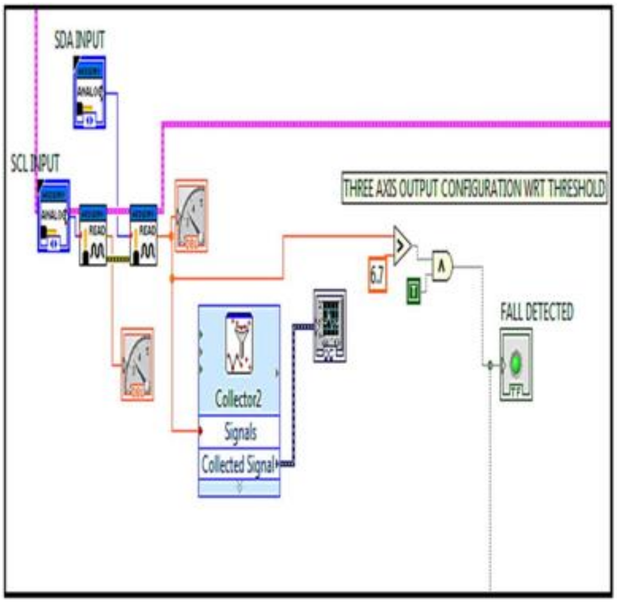

FIG 7: Algorithm of body vibration signaL

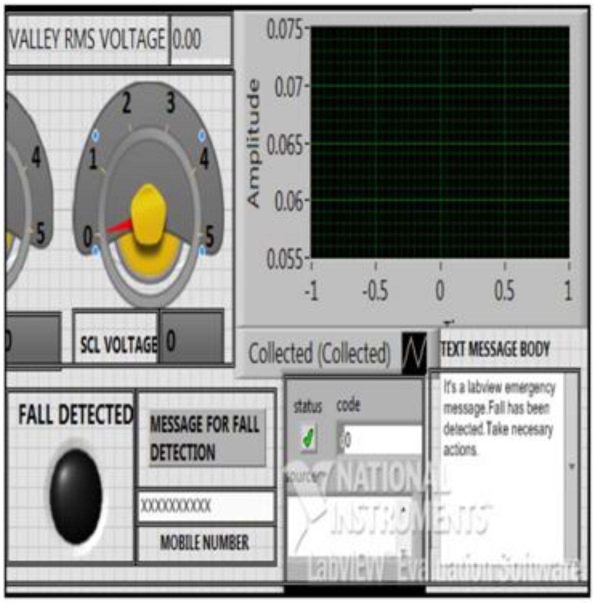

FIG 8: Real time body vibration signal monitoring system in labVIEW

2.3 Text Message Handling

The most important part of our proposed AHD (Automated heart diagnosis) system is sending the text message to the entities provided. The GSM uses AT commands in order to entrench communication between the microcontroller ATmega 2560 and the GSM 300 module. It works in the standard 1800 MHz frequency. We have used GSM 300 module [10-11] which has been interfaced with RS 232 cable with LabVIEW to get accurate output. The algorithm constructed using AT commands, and necessary baud rate for the particular text message to the entities phone number. Below in Fig 9 the text message algorithm snapshot is given.

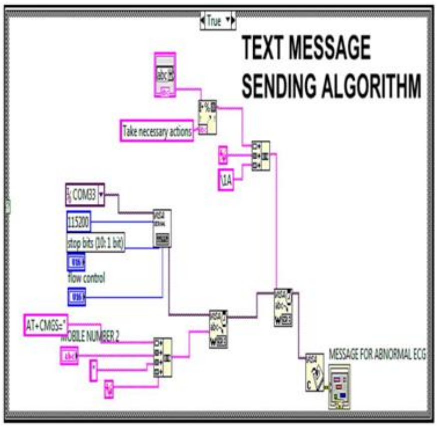

FIG 9: Snapshot of the text message algorithm

III. WORKFLOW CONTROL LOGIC

The wireless transmitter part is a small box attached to the waist of the human body which has two distinguishable signal acquisition sections one is the signal modification and the second is the transmission section. The first section consists of three electrodes which are met at a preamplifier's input junction. These electrodes acquires human heart's ECG signal and sends to the preamplifier circuit for necessary amplification. The second section consists of an accelerometer module as well as a gyroscope module to so that body vibration signals and tilting angles can also be measured along with X,Y and Z all of these three axes. Now these three signals ECG signals, vibration signal and tilt angles are sent to a microcontroller based ADC module and its digitized output signal is connected to wireless Zigbee [12] transmitter module. These are the part of the signal modification and transmission section. The wireless Trans receiver part is basically a single board RIO or SBRIO a specially designed board by National Instruments [13] for biomedical signal analysis and signal & data transfer and reception purposes. An algorithm is at first built in a VI of NI-LABVIEW and then it is dumped to SBRIO so that it can work on its own loops continuously with respect to its data acquisition via a wireless Zigbee module. This part also has a transmission section to mobile phones as an auto-forward-conditional text message. Lastly basically a mobile phone which receives an auto-forward-conditional text message from the **SBRIO** part. We would like to implement modern GSM (Global System for Mobile communication) technology for text message service. Below in Fig 10 the work flow diagram is given and also in Fig 11 the block diagram of the control logic and signal flow is given.

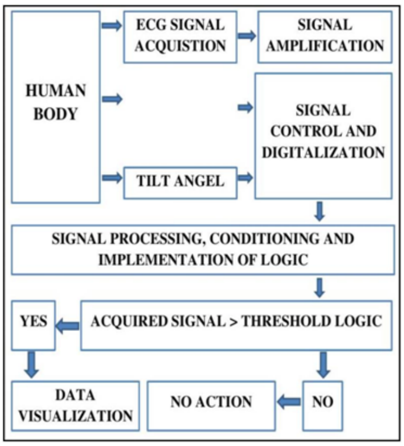

FIG 11: The block diagram of the control logic and signal flow

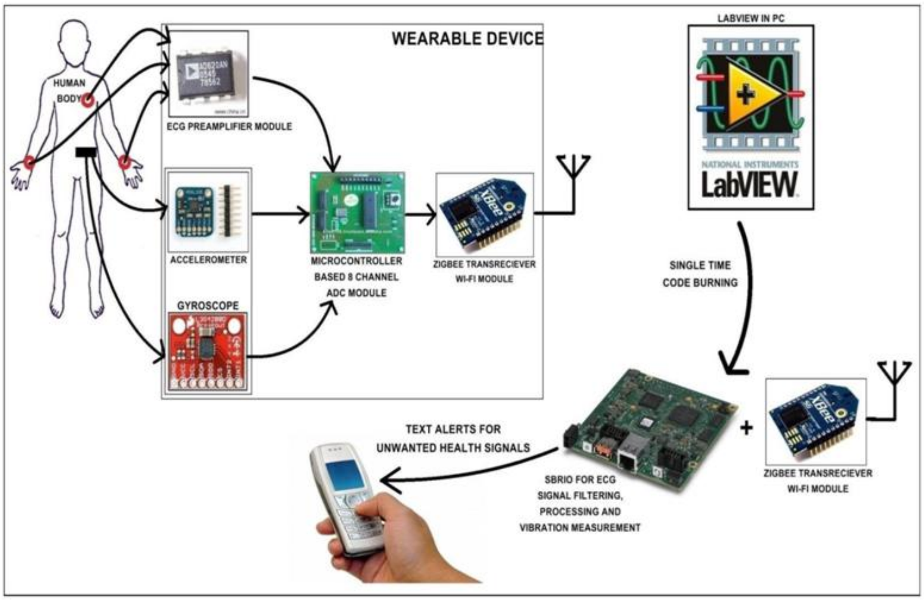

FIG 10: Workflow diagram

IV. RESULTS

The GSM algorithm of two different types for the ECG and body vibration signal has been implemented successfully in TRUE-FALSE case structure. The accumulated vales are compared continuously which consists of three different types of parameters which consists of Peak amplitude value, depth voltage and the RMS voltage with their own threshold value. If theses threshold values get exceeded then the GSM module gets triggered and text message gets initiated. We have done several tests successfully. Below in the table 1 and 2 we have shown the test results of two specific tests which we have successfully done and in Fig 11 the front view of the panel is shown.

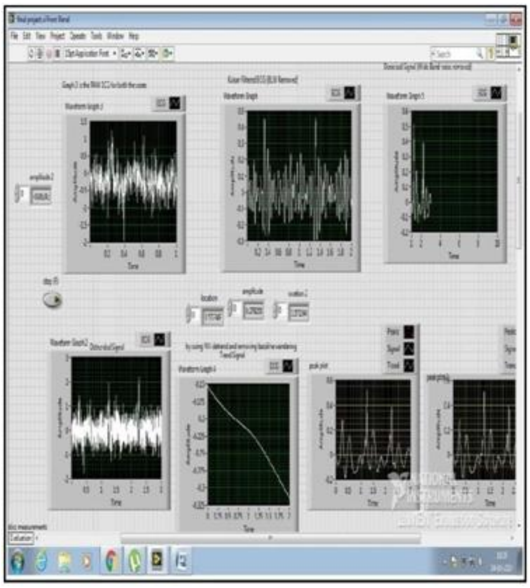

FIG 11: Front view of the panel

TABLE 1
CASE STUDY 1

Name of Parameters	Natural Voltage	Threshold Voltage	Results
Peak Voltage	+2.1 mV	+2.15 mV	+2.12 mV
Depth Voltage	-1.76 mV	-2.0 mV	-1.69 mV
RMS Peak Voltage	+1.82 mV	+2.10 mV	+1.76 mV
Body Vibration Voltage Rating	+5.80 mV	+6.7 mV	+5.93 mV

TABLE 2
CASE STUDY 2

Name of Parameters	Natural Voltage	Threshold Voltage	Results
Peak Voltage	+2.10 mV	+2.15 mV	+2.19 mV
Depth Voltage	-1.76 mV	-2.0 mV	-2.17 mV
RMS Peak Voltage	+1.82 mV	+2.10 mV	+1.96 mV
Body Vibration Voltage Rating	+5.80 mV	+6.7 mV	+6.63 mV

V. CONCLUSION

There are considerable differences in the profile of heart signals or ECG signals from one person to another so the result will also vary with differences in the ECG signal. The Most important thing that needs to be kept in mind is to fit the accelerometer perpendicular to our body to ensure to get the actual normal or abnormal tilt angle or vibration of our body.

The goal of this paper is to implement the proposed theory and making a prototype AHD (Automated health diagnosis) which will be very cost effective system, easy to use, durable with no side effects and prevent human from death and dangerous emergences which has been done successfully.

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