Telemedicine with Automated ECG Analysis

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Abstract

The trend of mobile communication has been growing up from past several years. It can be used as integral part in Health Care Technology. Due to modernization, heart-problems are gradually increasing. The difficulties of transportation and limitation of cardiologist's availability at many places are raising the need of telemedicine and automated analysis of ECG. This paper describes implementation of telemedicine for heart patients with the help of automated ECG analysis. ECG analysis can be done with the help of C6713 DSK and code composer studio. Telemedicine is implemented using GSM modem. The system proved to be quick and reliable.

1. Introduction

Today, heart patients and senior citizen population who have more heart problem is increasing, so the number of people who need constant attention for their heart problem is increasing. Though the hospital can accommodate many patients but the number of doctors is limited. Thus, they may not able to reach all patient simultaneously. Thus, it requires to find system that can analyse ECG automatic using digital signal processing.

ECG stands for Electrocardiogram. This is used to detect arrhythmia of heart.The word Telemedicine can be described as medicine with telephone technology. This can be supported with an automated ECG analysis. After analysing ECG, on the basis of certain condition controller will trigger GSM modem to send a short message to doctor's mobile if ECG of a heart patient is abnormal.

2. Block Diagram of System

The figure 1 shows main blocks used for this system.

ECG machine: This is used to take ECG of the patient. It contains noise removal filters as ECG taken from electrode has many noise.

C6713 DSK: This Digital Signal Processor developed by Texas instruments. This can be used to run MATLAB code for analysing ECG.

Microcontroller: This will be triggered by C6713DSK if there is any abnormality. After it, this will trigger GSM Modem. AT Commands of the GSM modem will be executed by microcontroller.

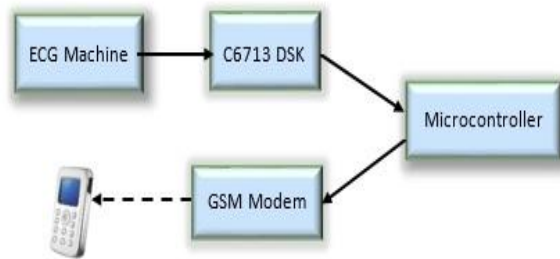**GSM Modem:** This is used to send message to a particular number which is specified by Microcontroller.

will be done automatically using Digital Signal Processing and MATLAB. If the abnormality found then doctor will be informed by SMS using GSM.

This process will be done in certain steps which are mentioned in below flowchart (figure 3)

Figure 1. Block Diagram

3. ECG Outline:

ECG is measured by placing electrode on patient's body at certain places. ECG is basically a voltage that is generated by contraction and expansion of heart. As shown in figure 1 This ECG is taken by machine in which there are certain filter to filter out noise. ECG with lower noise has defined peak values those are P, R, T, U and certain valley those are Q and S. These Peaks and Certain segments and interval like P-R segment, S-T segment, QRS interval is used to detect abnormality and types of problemof heart.
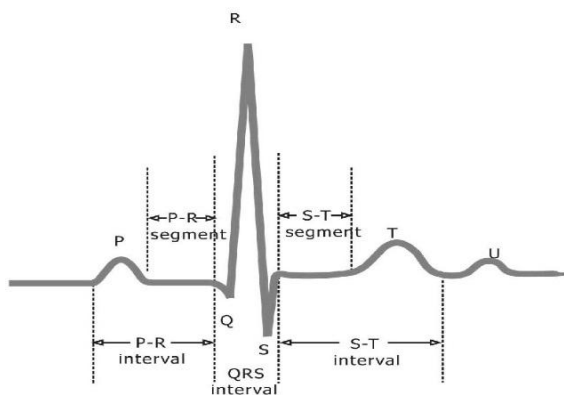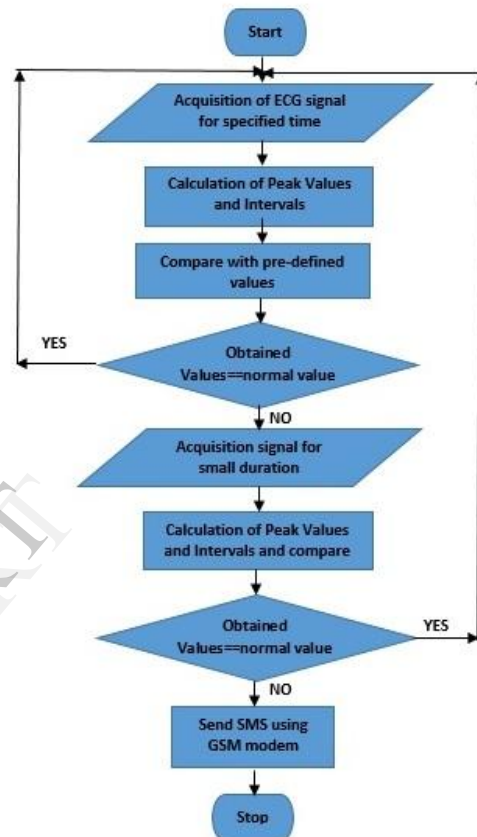

Figure 2. ECG Signal

4. Methodology:

In conventional method, ECG is analysed by cardiologists by examining its interval and peak value. In automated ECG analysis, this procedure

Figure 3. Flowchart

1. ECG Acquisition

ECG of patient is acquired using ECG machine. This machine is connected with the C6713 DSK Development board. Sampling frequency for the acquisition is varies according ECG machine but it should be higher than 500 Hz. ECG machine is connected to Line in input pin. This acquisition continuous for particular time interval. This signal value stored in memory of the DSK board.

2. ECG Analysis

Peak and Segment Calculation: To analyse ECG, calculation of peak and various segment is required. For this purpose MATLAB is very useful tool. Peak value of stored ECG that is stored as array can be calculated using 'findpeaks'. This function has two return value those are value of peaks and its indices in array. It will find local maxima of the given array of ECG.This is used to find peaks P, R, T, and U.

```
[pks,locs] = findpeaks(ecg,'sortstr','descend');
pks = pks(1:4);
locs = locs(1:4);
```

To find valleys Q and S, the whole array of ECG is made negative and then peak values of that negative array is found out. That values are made negative again to get original values. Location of these values are also deduced from that array.

```
neg_ecg= (-ecg);

[valley,locs2]=
findpeaks(neg_ecg,'sortstr','descend');
valley = (-valley(1:2));
locs2 = locs2(1:2);
```

Location array of both peaks and valleys are concatenated together and is sorted in ascending order. This sorted array is used to calculate segment values. To calculate segment, location of former peak is subtracted from later peak and then multiply with sampling period. 'locs' is an array of peak location. 'locs2' is an array of valleys location.

```
all_locs=[locs locs2];
all_locs= sort(all_locs);
```

For calculation of QRS interval location of Q peak is subtracted from location of S peak and after it will multiply with sampling period. This will give value of segment or interval QRS.

```
QRS_complex= 0.001.*(all_locs(4)-all_locs(2))
```

Comparison with Normal value: After measurements of peak value and segment these value will be compared with the stored normal value.

These normal values are stored in memory of C6713 DSK board. Peak value of measured ECG will be compared to Peak values of stored database. Segment value will be checked with their normal specified range. On the basis of this comparison condition of heart patient will be decided.

If values will be found abnormal then this time above mentioned process will occur for short duration of acquisition. After this once again comparison will occur and on the basis of last comparison trigger signal will be generated if the condition is abnormal.

3. Microcontroller And GSM Modem

In continuous two comparison, if condition is not normal then microcontroller will receive a trigger pulse. This microcontroller have AT Command stored on its memory. This will be used to send message to a particular saved number using GSM modem. This will directly send a message as it is triggered by microcontroller.

5. Conclusion

This system has mainly benefited because of its automated ECG analysis. Due to this feature it is useful for rural area where doctor is not going to visit that rural area hospital every day. During this time if any kind of abnormality will be found in patient's heart then doctor will receive a message. It is also useful in big hospital where number of doctors are limited.

6. Reference:

[1]   http://www.mathworks.in/
[2]   http://www.ecglibrary.com/ecghome.html
[3]   http://www.mathworks.in/products/connections/product_detail/product_35602.html
[4]   http://ecg.utah.edu/lesson/3
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