Electro Cardiogram (ECG) Monitoring using Internet of Things and predict future in advance using artificial intelligence

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Abstract
An IoT Based Electro cardiogram monitoring system will continue monitor the patient health condition related to heart and update immediately if any abnormality found in the patient health viz Wi-Fi to things peak application in mobile phone. The doctor located at remote location will monitor the situation accordingly and take appropriate decision, so that life time of the patient will be increased. In addition to it we may predict the health condition in advance using artificial intelligence. Based on patient health data we may produce trainee set and compare it with test set to estimate the variation in the health status and based on variation observed it may alert the doctor to indicate the early deterioration of patient health condition, so that we may arrest the growth of disease in advance. Here we are using ECG sensor to take the patient health data and it will be processed using Arduino board, Arduino microcontroller will compare the patient ECG with threshold limits, if it crosses lower or upper value it may alert the doctor. After processing it will transfer data to smart phone using Wi-Fi. Patient data will be continuously logged and it will be taken as trainee set and compared it with available test set to estimate the patient health condition in advance.

Keywords: 1.ECG Sensor, 2.ARDUINO UNO, 3.WI - FI

1. Introduction

Now a days the number of heart patients were increased due to various reasons viz change in food habits and timings, nature of food and lack of nutrition in food. Here we are acquiring patient health information using ECG sensor and processed using Arduino microcontroller board and transmit using internet of things. We can predict the future health condition of patient in advance using artificial intelligence. So that many of heart patience may continuously check their health status by their own

2. Literature Review

Health monitoring system using LPC2138 microcontroller was realized by srushti jagtap et al [1]. This paper collected using various sensors and processed using LPC2138 microcontroller and it will be displayed ON normal LCD screen
Development of an IoT based health monitoring system for e-health was realized by Md julhas Hossain et al [2]. This paper explained how to update the important health parameters and validate data.
Intelligent health monitoring system was realized by rishi kumar et al [3]. This paper explained how the sensor data will be read and processed by Arduino supported Wi-Fi enabled node MCU controller.
Analysis of IoT based health monitoring system using ARM7 was realized by Tejaswi et al [4]. This paper demonstrated that the patient parameters were transmitted over the IoT and finally it was displayed on UART and LCD.

Patient E-health monitoring system on ARM7 – LPC2148 microcontroller and GSM was realized by Priyanka A J et al [5]. This paper realized that the sensors were connected to LPC2148 and transmit information using GSM modem to doctor.
Smart and automatic health monitoring of patient using wireless sensor network was realized by Asha G Hagargund et al [6]. This paper demonstrated that the patient carries a batch of body sensors to collect their physiological parameters using Arduino and wireless sensor network.
Real time patient monitoring system based on internet of things was realized by mohammad salah Uddin et al [7]. This paper proposed an intelligent patient monitoring system to monitor the patient's health condition automatically through sensors based connected networks.
Intelligent patient monitoring system based on PLC with microcontroller was realized by umera banu et al [8]. This paper focuses on power line communication for transferring the patient parameters.
Zigbee based patient monitoring: Early detection of Alzheimer disease was realized by Shailesh V et al [9]. This paper proposes a ZigBee based home patient monitoring system which helps in early detection of Alzheimer disease. The location and movement patterns of a patient will be tracked and recorded with the help of short-range ZigBee communications.
Cloud based intelligent healthcare monitoring system was realized by Mr. Khyamling A. Parane et al [10]. This paper proposed a system consisting of a computing device and a number of sensors mounted on patient body.
Smart health care monitoring using wearable sensors was realized by Rishikesh D. borse et al [11]. This paper explores machine learning approach for continuously acquiring data using smart wearable sensors. The goal of this project was to provide early warnings of patient abnormally to doctor located in remote place.
Smart secure system for human health monitoring was realized by Nikhil Nair et al [12]. This paper demonstrated that the sensors were acquire the patient data and was processed using Raspberry pi and sent over the cloud to record keeping and transmitting patient information to doctor located faraway from patient.
Wearable sensors-based activity recognition for smart human health care using IoT was realized by Ning Hu et al [13]. This proposed an IoT and black chain-based health care monitoring system for human activity recognition via monitoring vital signals collected from wearable sensors remotely.
Enhanced IoT assisted wearable data analytics for patient monitoring and health care system was realized by Jaishankar et al [14]. The sensor data was collected here sent to cloud for storage and analysis for patient health, based on emergency the operator located at remote place generates emergency alerts to concerned doctor.
Adaptive vital signals monitoring system based on early warning score approach in smart hospital
context was realized by et al [15]. This paper proposed early score approach, based on patient data it generated score related to risk content of patient. Finally, we are generating this paper with 4 sections. Section [1] is giving introduction and clear idea about topic. Section [2] covers literature survey. Section [3] covers basic block diagram and tables related to software logic. Section [4] covers methodology followed here to generate messages to alert the doctor. Section [5] covers results and analysis. Section [6] references.

3.BLOCK DIAGRAM

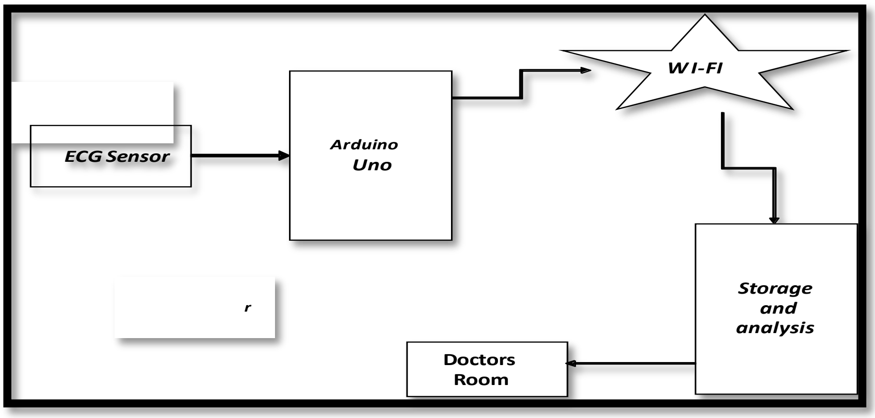

FIG-1: Block Diagram

4. Methodology

This paper proposed a method for measuring patient health condition by taking electro cardiogram (ECG) and it can compare the data with threshold lower and upper limits, if any abnormality is there it will identify and give the alert to the doctor. This processing will be done by Arduino microcontroller board using embedded c language. The data will be sent to smart phone mobile application thing speak viz Wi-Fi.

ECGsensor (AD8232)

ECG Sensor is used to measure heart functioning of the patient using 3 leads.

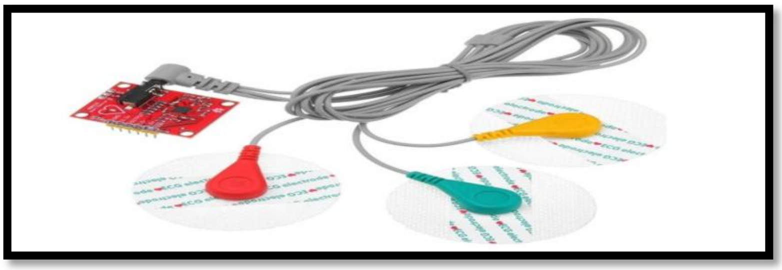

Fig2: ECG Sensor

Fig3: ECG Sensor with terminals

Table 1: Lead Position during measurement

Electrode name	Electrode colour	Location
RA	Red	Right Arm
LA	Yellow	Left Arm
RL	Green	Right Leg

Threshold:

Table 2: Threshold Values

Heart rate	49 to 100bpm for men&55 to 108bpm for women
P Wave duration	81 to 130ms for men& 84 to 130ms for women
PR Interval	119 to 210ms for men&120 to 202ms for women
QRS duration	74 to 110ms for men&78 to 114ms for women

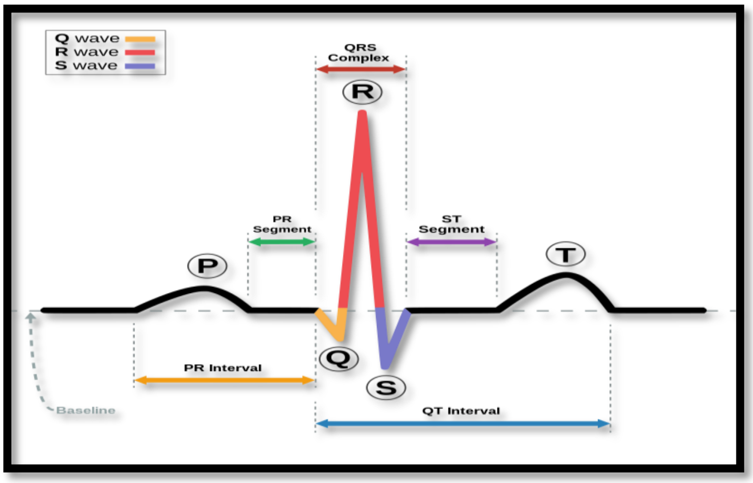

Fig4: Single ECG wave

Arduino Uno

Arduino Uno board is a microcontroller device based on ATmega328P. It contains 14 digital I/O Pins in which six can be used as PWM O/Ps and other six can be used as analog/Ps.

Thing Speak:

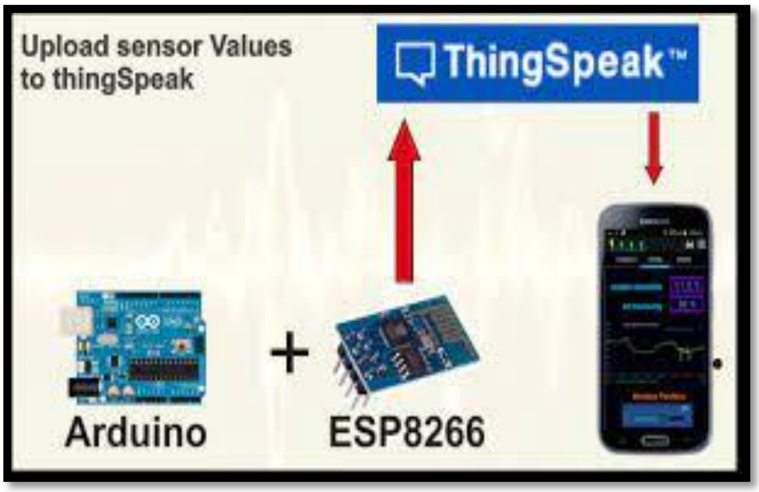

Fig5: Data Transfer using ESP8266 to Things peak application

Flow Chart:

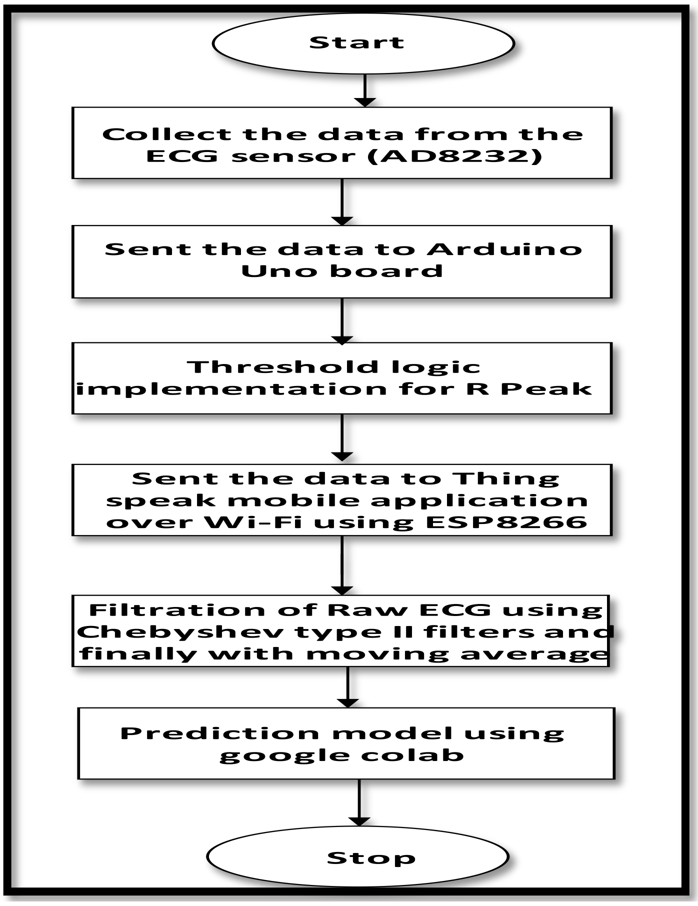

Fig6: Flow Chart for ECG Monitoring and prediction

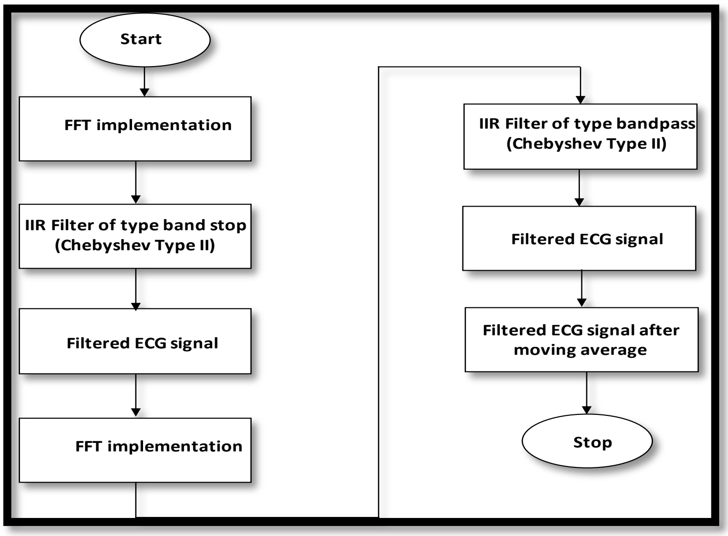

Fig7: Flow Chart for ECG Filtering Process

Raw ECG Signal was converted to frequency domain using FFT (Fast Fourier Transform). Then it was filtered using Chebyshev filter type II of type band stop in order to eliminated the electrical noise at 50 Hz. Then again, the output of filtered ECG signal will be converted to frequency domain using FFT. Then again passed the output of FFT to IIR filter of Chebyshev type II band pass. Then the output of Chebyshev Type II bandpass will be under moving average of 100 samples.

We can able to Detecting abnormal heartbeats and heart diseases from ECGs. An ECG is a 1D signal that is the result of recording the electrical activity of the heart using an electrode. It is one of the tools that cardiologists use to diagnose heart anomalies and diseases.
The original datasets used are [the MIT-BIH Arrhythmia Dataset]
MIT-BIH Arrhythmia dataset:
* Number of Categories: 5
* Number of Samples: 109446
* Sampling Frequency: 125Hz
* Data Source: Physio net's MIT-BIH Arrhythmia Dataset
* Classes: ['N': 0, 'S': 1, 'V': 2, 'F': 3, 'Q': 4]
The PTB Diagnostic ECG Database
* Number of Samples: 14552
* Number of Categories: 2 (Normal vs Abnormal)
* Sampling Frequency: 125Hz
* Data Source: Physio net's PTB Diagnostic Database

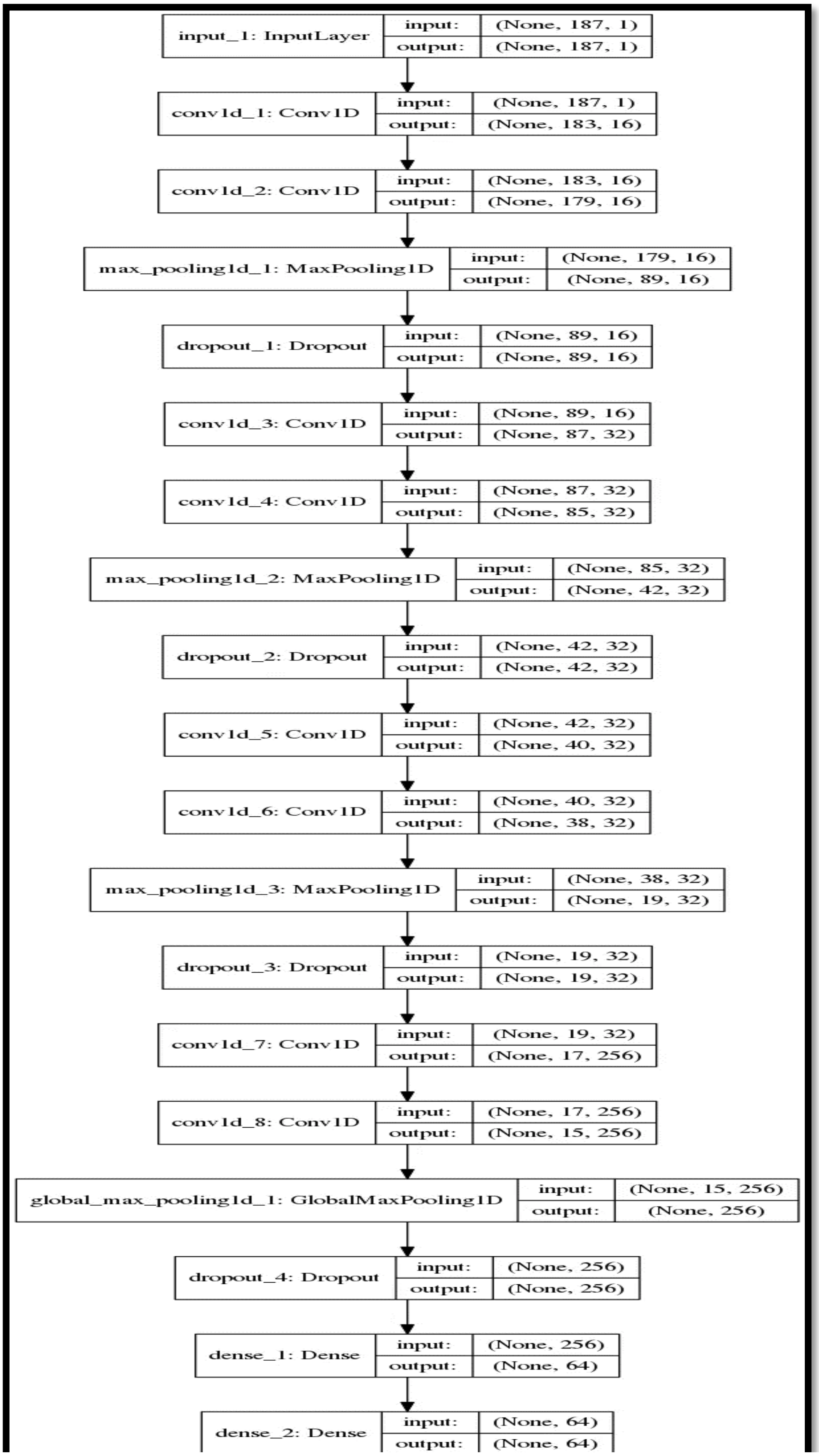

Fig8: Keras model

5. Result and Analysis

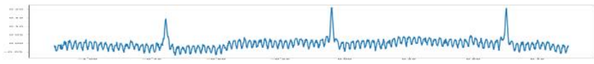
Fig9: Raw ECG Signal

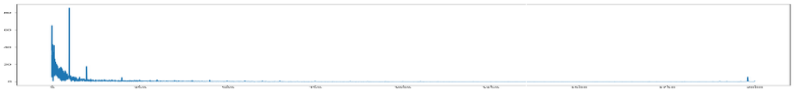
Fig10: Raw ECG after FFT implementation

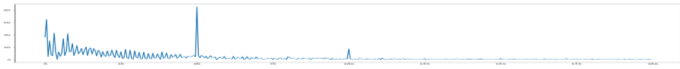
Fig11: IIR Filter response

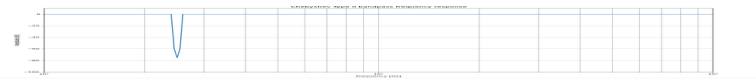
Fig12: Chebyshev Type II Bandpass Frequency Response


Fig13: Filtered signal

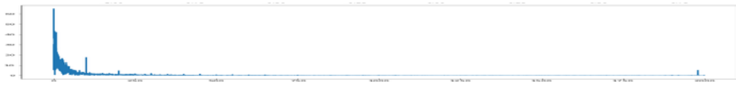
Fig14: FFT of Filtered Signal

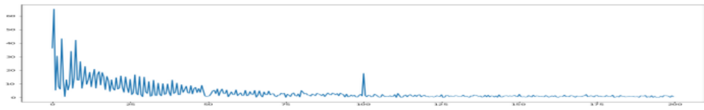
Fig15: IIR Filter response after FFT of filtered signal

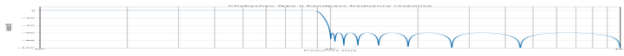
Fig16: Chebyshev Type II bandpass frequency response

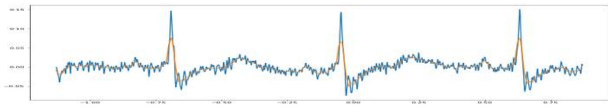

Fig17: Filtered Signal

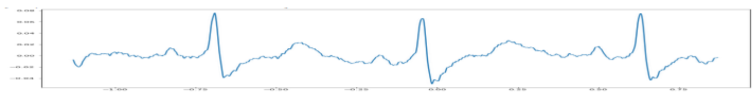
Fig18: Moving Average filter output (up to 100 samples)

Similar to first we can use a neural network based on 1D convolutions but without theresidual blocks:
Results
MIT-BIH Arrhythmia dataset:
* Accuracy: **98.5**
* F1 score: **91.5**
The PTB Diagnostic ECG Database
* Accuracy: **98.3**
* F1 score: **98.8**
Transferring representations
Since the PTB dataset is much smaller than the MIT-BIH dataset we can try and see if the representations learned from MIT-BIH dataset can generalize and be useful to the PTB dataset and improve the performance.
This can be done by loading the weights learned in MIT-BIH as initial point of training the PTB model.
From Scratch:

* Accuracy: **98.3**
* F1 score: ** 98.8**
Freezing the Convolution Layer and Training the Fully connected ones:
* Accuracy: **95.6**
* F1 score: **96.9**
Training all layers:
* Accuracy: **99.2**
* F1 score: **99.4**
We can see the freezing the first layers does not work very well. But if we initialize the weights with those learned on MIT-BIH and train all layers we are able to improve the performance compared to training from scratch.

6. Conclusion

The Electro cardiogram (ECG) monitoring system was realized using various smart wearable ECG sensor with Arduino board. The Arduino board was processing data using software written in embedded C language. The processed data sent Over Wi-Fi network for storage and analysis of patient data monitored and analyzed by remote doctor located faraway from patient. Patient health also predicted using machine learning algorithms in python. This type of health care facilities requires in now a day due to increase number of patients and due to lack of health care facilities at rural areas.

7. References

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