International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 16 (2018) pp. 12843-12845


# Detecting the patterns of Coronary Artery Disease and Hypertension using Artificial Neural Network

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**Abstract**

Throughout the course of life, people tend to develop a lot of problems with their minds and bodies which may lead to severe external as well as internal discomfort. This internal discomfort is nothing but change in the heart-rate, blood flow variation, change in respiration rate etc. These variations create certain patterns, which are different from the normal subjects. Artificial Neural Network is one of the information processing and classifying method. In this paper we have used a neural network model to automatically analyze the blood flow variation datasets and classify the patterns into two classes to detect Coronary Artery Disease (CAD) pattern and Hypertension pattern. The proposed method is tested and we have obtained satisfactory results.

*Keywords*: Artificial neural Network (ANN), Blood Flow Variation (BFV), Fast Fourier Transform (FFT), Disease Characterization.

## INTRODUCTION

Artificial Neural Networks and Machine Learning are the emerging data analysis paradigms, which learn from experiences or illustrations. The curiosity to understand the internal mechanism of the human body (i.e. from head to toe) has led to various techniques and evolution of instruments. These methods can be used to acquire physiological as well as biological signals. These signals consist of relevant information about various illnesses, diseases, abnormalities etc. One such instrument called Peripheral Pulse Analyzer designed at Electronics Division (B.A.R.C) Bhabha Atomic Research Centre records the blood flow to generate its variability by acquiring the signals at fixed interval of time. The main objective of this study, is to process these signals & associate it with respective patterns of diseases mentioned above with the help of ANN [1, 2].

## PROPOSED METHODOLOGY

The proposed methodology consists of following approaches: - First approach is to provide raw signal (time domain signal) to the network model. Second approach is to provide FFT of the raw signal (frequency domain signal) to the network model

### Data Selection

Data was collected using PPA, the signal generated is nothing but the changes of the electrical conductivity of the human body caused by the flow of blood. Signals consist of ascent which occurs at the arrival of the pulse wave, & elastic after-waves are present [14]. There are eight morphological patterns found by Dr. Jindal et al as follows: -

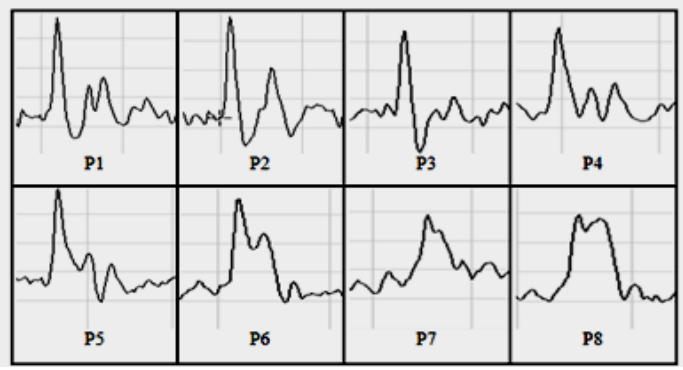


**Figure 1.** Eight Morphological Patterns

It is observed that P1 is found in normal subjects and P8 is found in severely diseased subjects. Out of these eight patterns we have selected sufficient number of samples of pattern-1, pattern-6 and pattern-8 for analysis purpose, data selection consists of two approaches defined earlier.

### Network & Training Function

Model used in this study is depicted in Figure 2

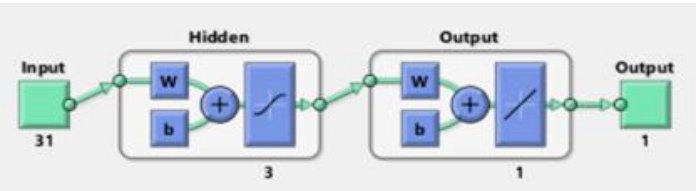


**Figure 2:** Block Diagram of ANN Model

A Feed Forward Model of 3 layers, input layer, hidden layer & output layer is used. The training procedure used is supervised learning. In supervised learning network model is provided with the inputs as well as the desired outputs. Training Function 'trainlm' Levenberg-Marquardt back propagation is used. Weight is assigned to each connection between the layers. This back-propagation algorithm compares the desired and acquired

results and adjusts the weights iteratively until minimum error is reached. The performance function used is 'MSE' i.e. mean square error = 0.001.

### Testing and Simulation

When the network is successfully trained, the network is tested and simulated to examine whether it can discriminate the data into classes or not. Testing with the known data is called memorization and testing with the unknown data is called generalization. Accuracy of the network depends on various factors such as input, training algorithm, training function etc.

## RESULTS

**Table 1:** Comparison Table.

| Network Model 1st Approach | Memorisation% | Generalization% |
|---|---|---|
| Training 1 | 97 | 92 |
| Training 2 | 95 | 81 |
| Training 3 | 93 | 85 |
| Network Model 2nd Approach | Memorisation% | Generalization% |
| Training 1 | 90 | 77 |
| Training 2 | 92 | 81 |
| Training 3 | 94 | 91 |

Three network models were trained and tested 161 known samples and 26 untrained similar samples. These three models provide accuracy above 90% for the trained data i.e. memorization as mentioned above. But the generalization accuracy varies as follows: - Network model with raw data (time domain) samples provide 76%, 89% respectively. Network with the frequency domain data provides 88%, 92%. Network model with peak difference and location differences provide 77%, 92% respectively.

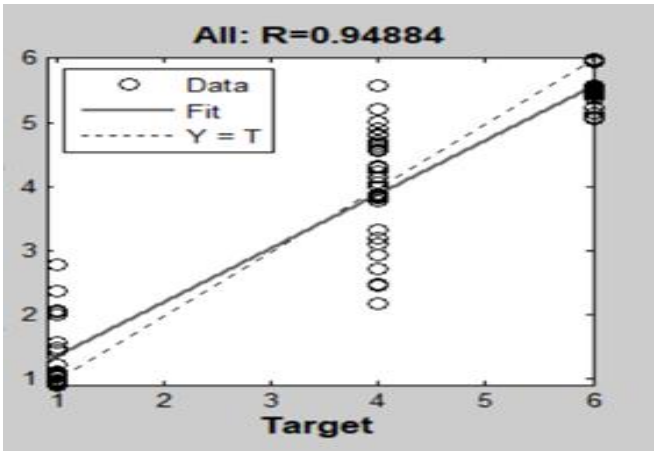


**Figure 3:** Training, Testing, Validation graph.

Figure 3 represents training, testing and validation graph of the trained samples. After each training process the results vary, so most suitable and accurate network model which is able to generalize can be selected.

## CONCLUSION

We have collected waveform patterns of subjects having Coronary artery disease (66 in number), Hypertension (55 in number), and controls (40 in number). Artificial Neural Network designed by us can differentiate waveform patterns of P1, P6 & P8 with accuracy 85%. Hence it can be used to detect abnormalities like coronary artery disease and hypertension. Incidences of diseases are on a rise nowadays, & early detection can make a big difference for people suffering from these diseases.

## FUTURE SCOPE

For more accurate results future work focuses on using another approach called statistical analysis for detecting and calculating the number of patterns repeated and compare the results with ANN output.

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