Experimental Research to investigate the effects of mobile phone radiations on ECG signal using Modified Elman and Narx Artificial Neural Network

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Abstract: Developing countries are focusing on mobile telecommunication infrastructure in place of fixed line systems technologies. The number of mobile phone consumers is increasing day by day. It is important and a subject of interest to know if there are radiation hazards and if they are what steps should be taken to improve or reduce the radiation effects. To establish a graphical representation of the amplitudes of different ECG components keeping mobile phone radiation or electromagnetic interference effects into consideration. The study includes use of 2G and 3G technologies. Thirty five ECG patterns are used for training and another thirty five patterns are used for testing. The testing patterns are those the network has not seen earlier. The Narx ANN shows a recognition rate of 100%.

Key words: ECG, Electromagnetic interference, ANN

Introduction

ECG is a record of the electrical representation of the working of the heart. The signal comprises of a series of beats in a regularly beating heart. The beat is an outcome of the circulation of blood. A force is experienced to that pumps blood to the tissues and forces deoxygenated blood away from the tissues. Disturbance taking place in orderly patterns gives rise to arrhythmias (Gary, 2016). Beat to beat variation occur in QRS axis in bidirectional ventricular tachycardia. The heart rate is typically between 140-180 (Mina et al., 2017). It is important to study diseases through reading of ECG. Studying the trends in ECG signal provides a look to understand life threatening heart condition (Mohamedet al., 2016). Electromagnetic interference due to mobile phone radiations is a major source of noise corrupting ECG. This source is likely to cause headache disturbance in sleep and variation in electroencephalographic activity(Venkappa et al., 2012). In a study mean heart rate has been found increasing in boys and girls participating in study duringtalking on mobile phone in comparison to when phone is ringing or is in resting state (Gholanreza, 2012).

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The author therefore undertook this study to investigate the radiation effects and derive some conclusion from this experimental research.

Materials and Methods

Data collection

As the study involves primary data, the consent of the students participating is very important. The ECG records are taken with consent of the participants. About fourteen records /beats are used in the study for analysis from each type of beats. The beats are considered from Idle mode, 2GRx mode, 2GTx mode, 3GRx mode, 3GTx mode. The experimental setup is required to collect data. This formulates controlled observation[6]. Data is collected using Biopac machine. Records obtained with the mentioned equipment are of a great help to the researchers to process signals and do experimentations. The interest in the students is aroused by the researchers who are into this work and conduct workshops and seminars. Study is useful for the information of patients who are using permanent pacemakers. The potential ill effects if collected or found may help in equipment installation in hospitals so that EMI effects may be avoided in machines gathering information about human biological processes.

Development of a model that works like an ANN

This model reads the amplitudes of P wave ,QRS complex amplitudes and T wave amplitude. The amplitudes are plotted in different modes to check the EMI Effects on ECG. Testing of the results is performed using Narx ANN using R2014aMatlab approach.

The authors in this study develop 5:4:2:1neural network as shown in Fig. 1 This is a five input that is based upon the five amplitudes of P,Q,R,S and T in ECG beat. There is a feed back from first hidden layer to context nodes and from context nodes to hidden nodes. Therefore the circuit is designed as per application. Inputs are presented to the input nodes.x1,x2,x3,x4andx5 are the inputs to the circuit, x6,x7,x8 are the hidden nodes,

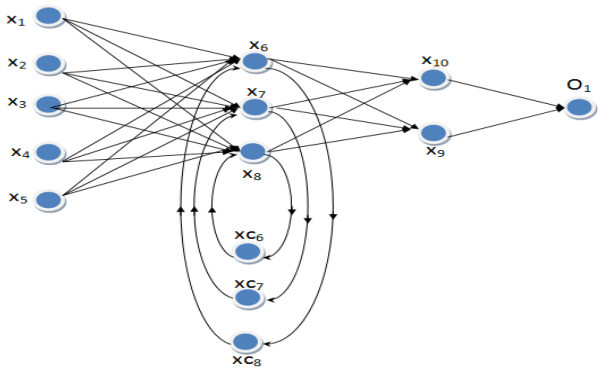


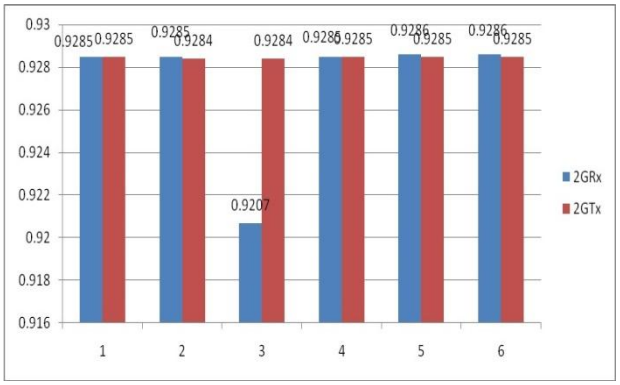
Figure 1: 5:4:2:1neural network

xc,6xc7,xc8 are the context processing nodes. Arrows indicate paths of feed back from hidden to context and from context to hidden nodes. X9 and x10 are the second hidden layer nodes. O1 forms the output node.The information is processed by various layers. Initially the interconnections among different layers are provided by random weights. The weights update with each presentation of input at the input. A feedback from hidden to context and context to hidden neurons has the capacity to learn the patterns. The patterns are read from the network one by one. Presenting actual input from the machine like P,Q,R,S and T one by one to the input of the developed network yields output at the output node. The results are tabulated. First hidden node and output node use tansig as the activation function. Second hidden node and context neurons use logsig as the activation function.S.S.E=[1-Oo]^2

There is a feedback from hidden nodes to context nodes. Delay is used onlythat is required for moving data from hidden to context nodes.

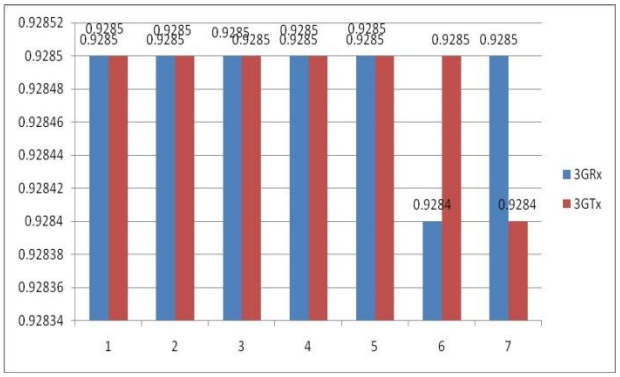
Plot of the data helps to compare radiation effects in 2GRx, 2GTx and 3GRx and 3GTx Modes.

P wave Amplitudes in 2G Modes



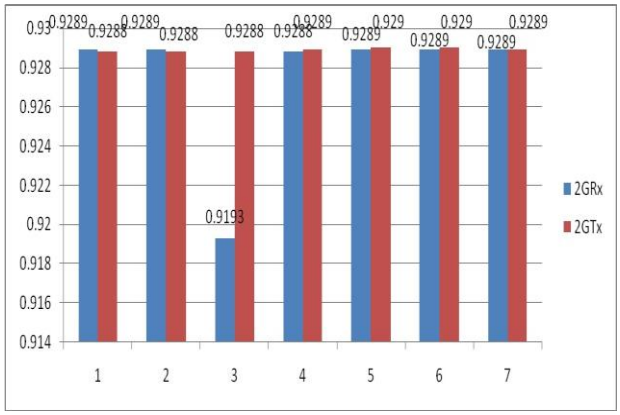
P-Amplitudes show higher values in three instants 2GRx. One value is higher for 2GTx and in three instants no change is experienced.

P- Amplitude in3G Modes



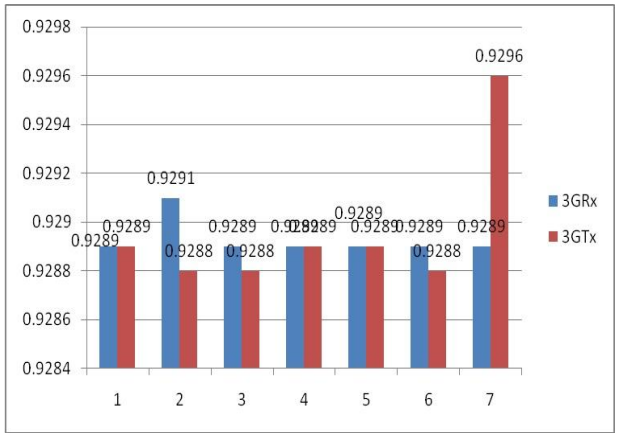
In one instant 3GRx shows higher value, in one more instant 3GTx shows higher value. In all other readings values show similar readings.

Q-Amplitudes in 2G Modes



Q Amplitude has higher values in four instants in 2GTx. In rest readings in2GRx

Q-Amplitudes in 3G Modes

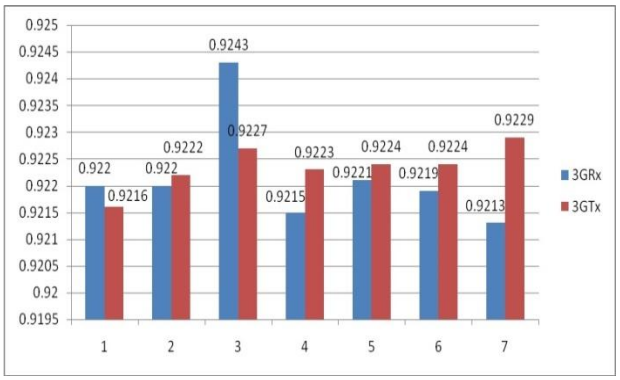


In 3G mode 3GRx shows greater value in three beats. In one beat 3GTx value is higher. In rest of the cases values are comparable.

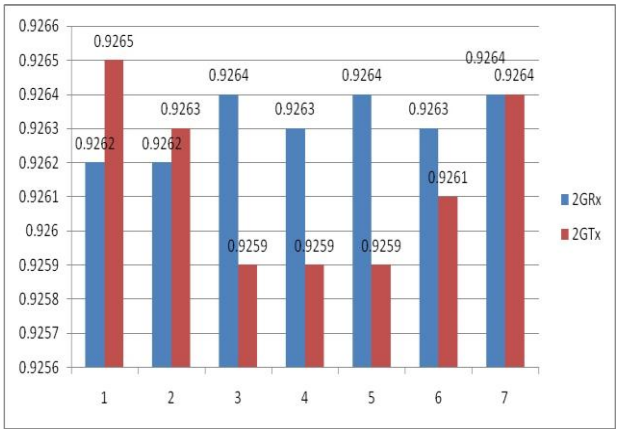
R-Amplitude in 2G Modes

R-Amplitudes show increasing values in 2GTx in six instants out of a total of seven instants.

R-Amplitude in 3G modes

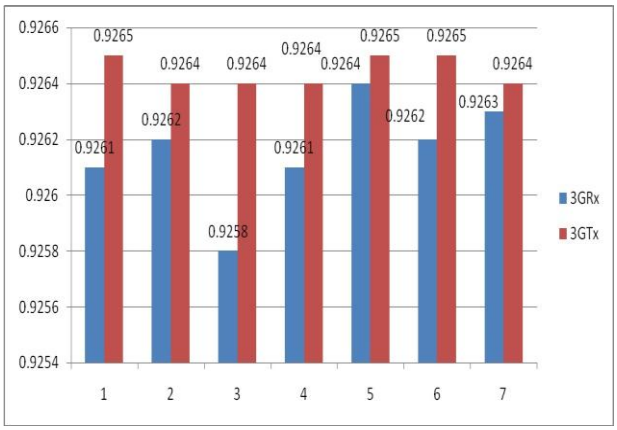


S-Amplitude in 2G Modes



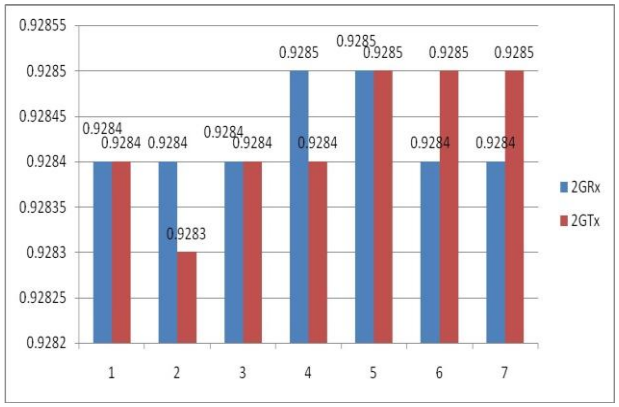
S-Amplitudes show higher values in four instants. In two instants 2GTx shows higher values. In one instant values are comparable

S-Amplitudes in 3G modes



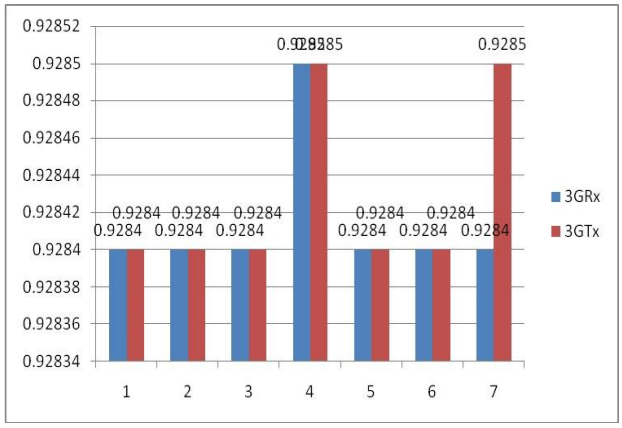
In 3GTxall the amplitudes are showing higher values compared to 3GRx

T-Amplitudes in 2G Modes



In 2G –Mode in two instants two values are having greater values in 2GRx. Two values are higher in 2GTx. Rest of the values are haing same magnitude.

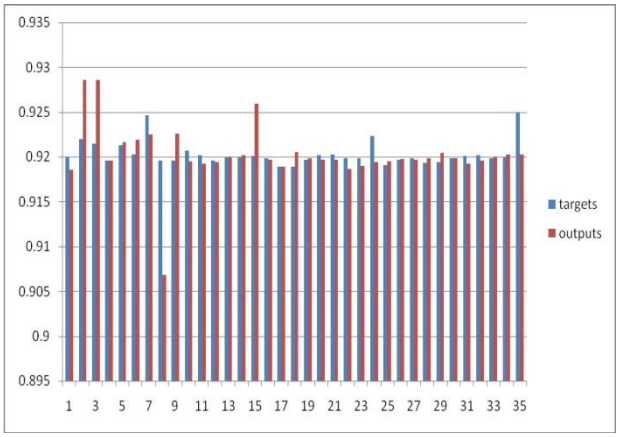
T-Amplitude in3G Modes

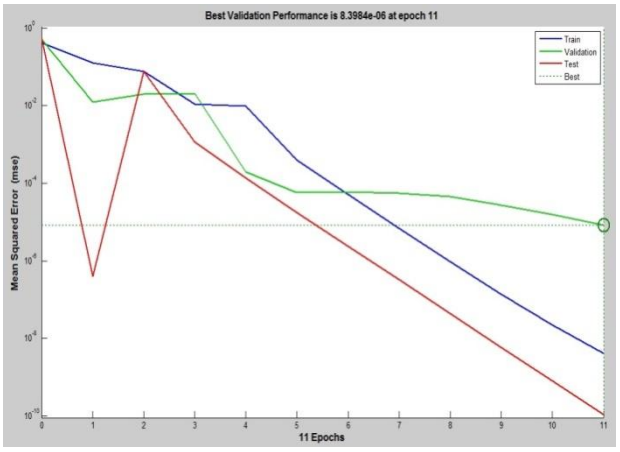


In 3G mode all the values are comparable except in one mode where the value of 3GTx is higher.

Further the results are simulated with the help of Narx circuit. The results obtained by the model show 100% classification. The results using Narx ANN are presented inthe plot.

The results obtained with NARX ANN takes eleven iterations, 0:00:02 seconds to complete the simulation. Validation check shows a reading of zero.





Conclusion

The variations experienced are plotted in the bar graphs shown in Figures above.The last plot shows the testing results of the Narx ANN.The data or the number of beats required in the study should me more to arrive at a close solution/conclusion. Variations in the beats are taking place. There is a need to keep the variations to a low level. This requires modifying the antenna designs installed in the mobile phones. Design of new antenna is the future scope of this study.

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