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Study the Effects of Mobile Phone Radiations on ECG Signal using a Modified Elman-ANN

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Abstract: A number of studies have been conducted on the effect of radiations on ECG and EEG. In this work authors collect data interfered with the EMI effects in idle mode, 2G-Rx mode, 2G-TX mode, 3G-Rx mode, 3G-Tx mode. Authors use modified Elman-Artificial Neural Network approach for studying the radiation effects. 2G-Tx shows larger variations for Q, R & S in comparison with 2G-Rx.; for T variations are 15.38% in both cases whereas P amplitude shows larger variations in 2G-Rx.(Table 4-11) 3G-Tx shows larger amplitudes compared to 3G-Rx for S & T; variations are larger in P, Q, R amplitudes in 3G-Rx(Table 4-11). ECG is recorded while a student is receiving a call or transmitting a call in different modes. Data preparation for a single student takes about thirty five minutes in total collecting data for all of the five modes.

Keywords: Modified Elman, Electrocardiogram (ECG), Mobile phone radiations, 2G Modes, 3G-Modes, Delays, Activation functions.

I. INTRODUCTION

Heart is a muscular portion that acts like a pump and supplies blood throughout the body. The supply of blood to different parts of a body is necessary for a healthy life. The electrical activity is associated with heart and can be detected by means of electrodes. The activity is represented by the waveform as shown below Fig. 1[1] This figure denotes P,Q.R,S & T amplitudes for 101.ML11 file from MITBIH arrhythmia data base from physionet ATM. Heart beat is an outcome of blood circulation. Blood circulation provides a force to pump oxygenated blood to the peripheral tissues and deoxygenated blood away from the tissues. Cardiac excitation relates to the ionic contribution. [2] P, Q, R S and T are the amplitude values as shown in Fig.1. This electrical activity is interfered with the electromagnetic field of the mobile phone radiations and thus affected to more or lesser extent. There is increasing usage of electronic equipments and gazettes. Nowadays, almost everyone makes use of electronic equipments and is a basic necessity. Various studies have been conducted to study and investigate the effects of electromagnetic field on human ECG. Electromagnetic interference of a cell phone changes QTc interval in an ECG. The interval is prolonged. There is interference with voltage generated by heart in male patients who have myocardial ischemia. [3] The use of mobile phone during recording corrupts the data. Mobile phones are the source of interference particularly in the areas with poor coverage. [4] The authors in a study focus on the adverse effects of mobile phone radiations on pacemakers The authors suggests that patient using mobile phone and using pacemaker must be informed of the ill effects of Mobile phone radiations on pacemaker. [5] In a study the usage of Mobile phones, PCs, Electronic Appliances at home has been shown to have numerous benefits along with possible health hazards. The study also points that fields of low frequency 50 Hz, the electric and magnetic fields result in low values and the values are below occupational limits around electrical power stations.[6]

Electromagnetic fields are generated due to electrosmog emitted from home appliances in microwave range of frequencies. The study suggests that the exposure limits by the equipments like mobile telephony, microwave ovens should not exceed beyond non ionization radiation protection. [7]

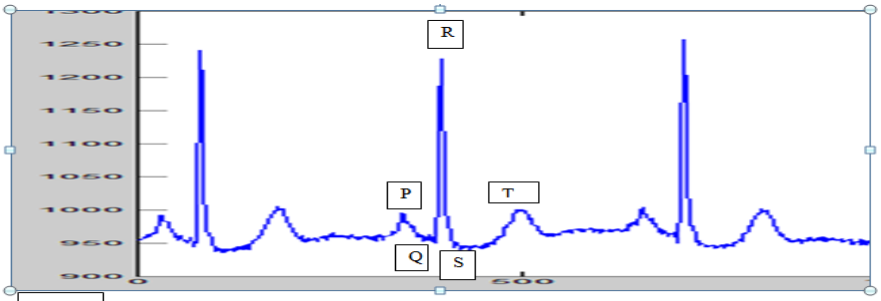


Fig. 1

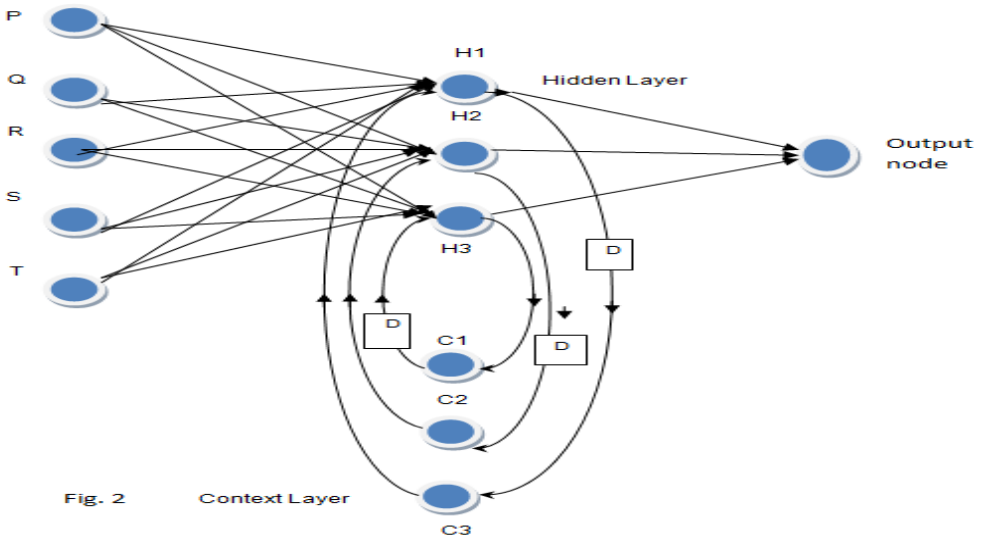
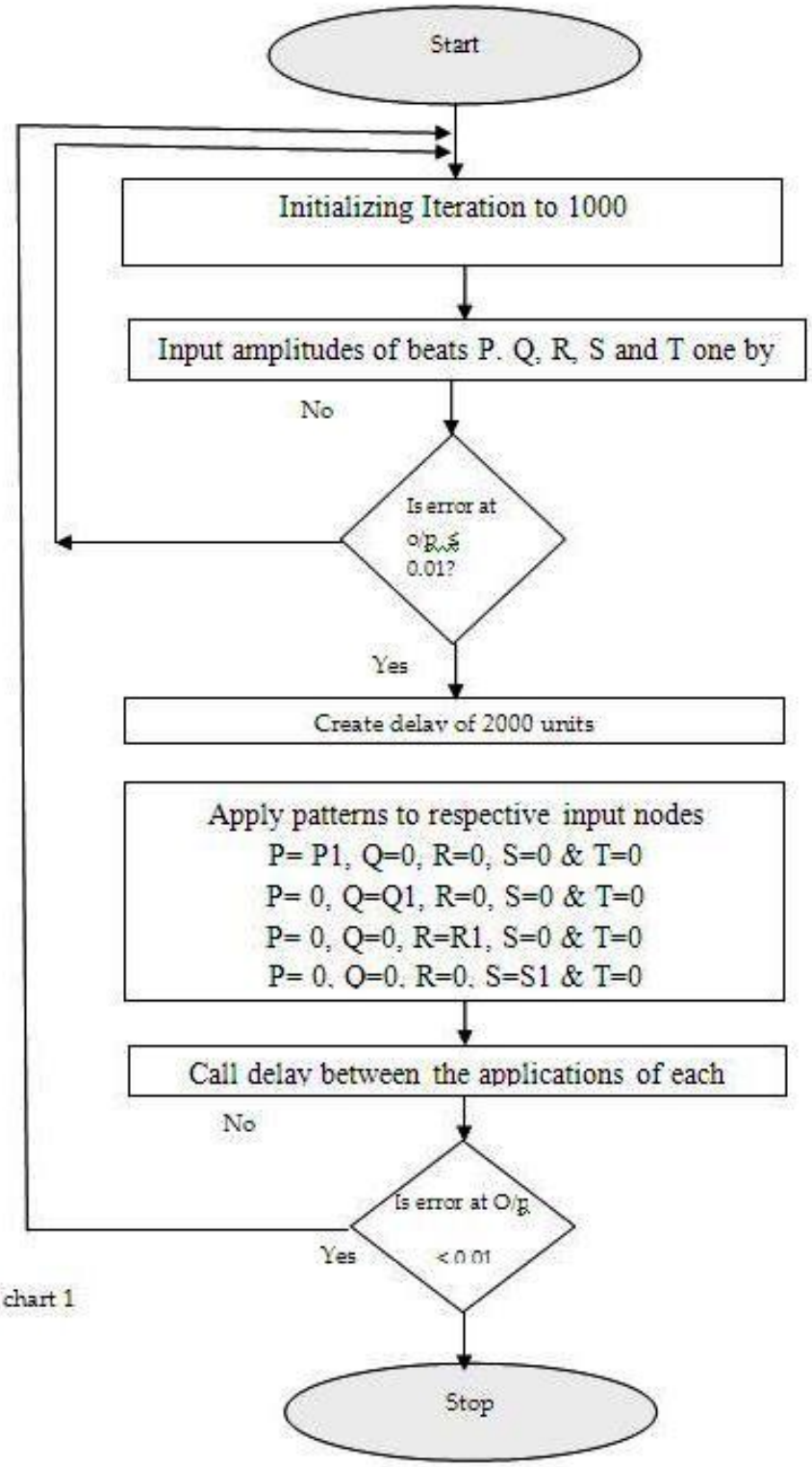


Fig. 2

In the current research work authors discuss the radiation effects on recorded ECG. The students are convinced about the study and are willing to participate in the work. The source of data for the study is data in ideal mode and from 2GRx, 2GTx, 3GRx, 3GTx mobile phones. The investigation is carried out with the use of a Elman artificial neural network. The Elman ANN is a modified form of the network used in this work. In an artificial neural network each neuron in a layer has specific connection with units from previews layers. Set of weights in the interconnecting neurons encodes a model as per learning. [8] ANNs are trained to map the desired data by updating the random weights among the links. The weights and bias links to the nodes learn the behavioural patterns of the network. Elman networks comprise of input nodes, hidden layer, an output layer and a feedback connection from the output of hidden layer to the context nodes and from context nodes to hidden nodes. Elman has backward connection from hidden to context neurons. The values from previous steps are stored due to delay in connections. [9] Network is capable of recognizing the patterns and generates the outputs in response to the sensed input. The non linear patterns are spatial and temporal patterns both. A Modified Elman ANN is shown in Fig. 2 Activation functions are applied at the hidden layer and output layer nodes. The activation functions are log sigmoid. In Elman all nodes in the hidden layer are connected to all nodes in the context layer and all nodes in the context layer are connected to the hidden layer nodes. Modification in the working of the Elman is introduced by using only feed forward network training approach without the target. Target is

supplied only for computation purpose. D is the software based time delay. Sum square error is calculated between the output of the network and target output as shown in equation 1

S,S.E=(1-Actual output)^2 (i)



Flow chart 1

Secondly the feedback from context neurons to hidden neurons is only partial. Out of nine values matrix only three values are used for the processing. Software delays are used for the working of the network as shown in Fig .2. The network trains the patterns taking into consideration all of the P, Q, R, S and T amplitudes from different beats comprising different patterns. Also in the procedure P; Q; R; S and T are trained individually. Once the network stabilizes it is checked for the training data on which the network has been trained and results are normalized and recorded Also the network is tested with the patterns that the network has not seen earlier. An error of the order of 0.01 is achieved in both of the cases.

2. Methodology:

The steps involved in the process are explained with the help of Flow chart 1.

3. Experimental setup

Biopac 150[10] is the ECG machine used in this work for data collection. Source of data are the students of post graduation department at NITTTR institute research laboratory at Chandigarh, India. The students participating in the study are healthy in almost same age group. People from other age groups also need to be involved with different genders and pertaining to different regions. This can be an extension of this work. History of the candidate participating in the study can be recorded and incorporated as certain parameters. Analysis of data is performed with the help of MatLab2014a. The experimentation is performed first for data collection by machine. Secondly the patterns are recognized by the modified Elman shown in Fig. 2. Concept of working of Elman artificial neural network is studied with Mat Lab 7. The signal appears at a node. It is passed through different delay units. After every delay the signal is picked and connected to the output node. Computed output is compared to the original signal. An error computation is performed .The circuit functions like an adaptive filter. Modified Elman in the study is made to perform. Network used has five inputs, three hidden, three context neurons and one output node. Network processes the amplitude information. Inputs are presented at the input nodes. Each of the input is connected to each of the nodes in the hidden layer. The outputs of the hidden layer are connected to the context nodes with delay. Delay is system delay in processing data. The outputs from the context neurons are connected to hidden neurons. The feedback with delay forms the memory of the network that generates capability to learn the patterns. All the hidden neurons are linked with output node. Log sigmoid is the activation function at various nodes. The random weights connect the links between different nodes. As a pattern is presented to the input nodes, the links are updated and an output is generated. Patterns are presented one by one and the network is made to respond. The learning takes several epochs. The network is trained to learn all the patterns. The weights are stabilized. Training patterns are tested in the first instance. Testing patterns are then passed through the network. Network processes the patterns and show correct classification for 100% patterns. Modification of Elman is performed in following steps:

1. The network does not use back propagation. Only feed forward network is used to carry out the work. There is a virtual target of 1.Sum square error is calculated as:

S.S.E = (1-Actual output) ^{2} .Feedback from hidden neurons to context neurons is partial. Partial feedback forms a memory of the network. There are software delays.Training and testing is carried out in two stages: P, Q, R, S & T amplitudes from a single beat forming a pattern is applied at the input nodes. Network processes the data and generates an output. Other beats are trained in a similar way. P, Q, R, S & T amplitudes are then applied individually. Training and Testing of the network is performed in the second stage for data P=P, Q=0, R=0, S=0, T=0 forming a pattern. Similarly P=0, Q=Q, R=0, S=0, T=0 forms patterns for Training and Testing. The procedure follows

as per flow chart 1 with every pattern presented. Weights are updated and network shows learning. Repeated training of the collectively applied patterns and individually applied patterns is performed a number of times when iterations are set to 1000. After that network is ready for testing.

4. Results and discussion

Amplitudes of P, Q, R, S and T shown in Fig. 1 are the key points in an ECG signal. Variations in different amplitudes have relationship with the working of different chambers in the heart. As the variations are caused by the effect of mobile phone radiations. These need to be studied. Signal processing with the Mat lab 2014a is used in this work for the study of radiation effects on ECG signal when it is recorded.

4.1 Features.

Network is trained with patterns formed with the amplitudes of P, Q, R, S and T in an ECG beat and read using signal processing approach. The patterns are formed in 3G, 2G and idle mode. Similarly P, Q, R, S, T amplitudes considered individually and in respective manner forms patterns that are utilized to train the network. The network once trained learns the variations. The variations in the beats are sensed at the input nodes and presented at the output. The classification of testing results for collective inputs is presented in Table 1

Table 1 Amplitudes effects when P, Q, R, S & T collectively applied to the network.

S.No	Idle	2GRx	2GTx	3GRx	3GTx
1	0.43038	0	0	0.313446	0.087814
2	0.062447	1	0.772059	0.716418	1
3	1	0.37931	0.772059	0.880597	0.08871
4	0.414346	0.913793	0.705883	0.38806	0.083333
5	0.255274	0.138012	0.44853	0.313433	0.117383
6	0.226582	0.827587	0.301471	0.119404	0.078853
7	0.565401	0.551725	0.661765	0.597014	0.076165
8	0.518987	0.431035	0.970588	0.283583	0.080645
9	0.56962	0.568964	1	0.089552	0.949982
10	0	0.639521	0.610294	1	0.106631
11	0.337131	0.344828	0.625	0	0.080645
12	0.168776	0.499999	0.551839	0.537314	0.103943
13	0.077215	0.741379	0.639705	0.22388	0.104839
14	0.168776	0.37931	0.654411	0.074627	0
Target ≥ 50%	4 (28.57%)	7 (50%)	11 (78.57%)	5 (35.71%)	2 (14.28%)

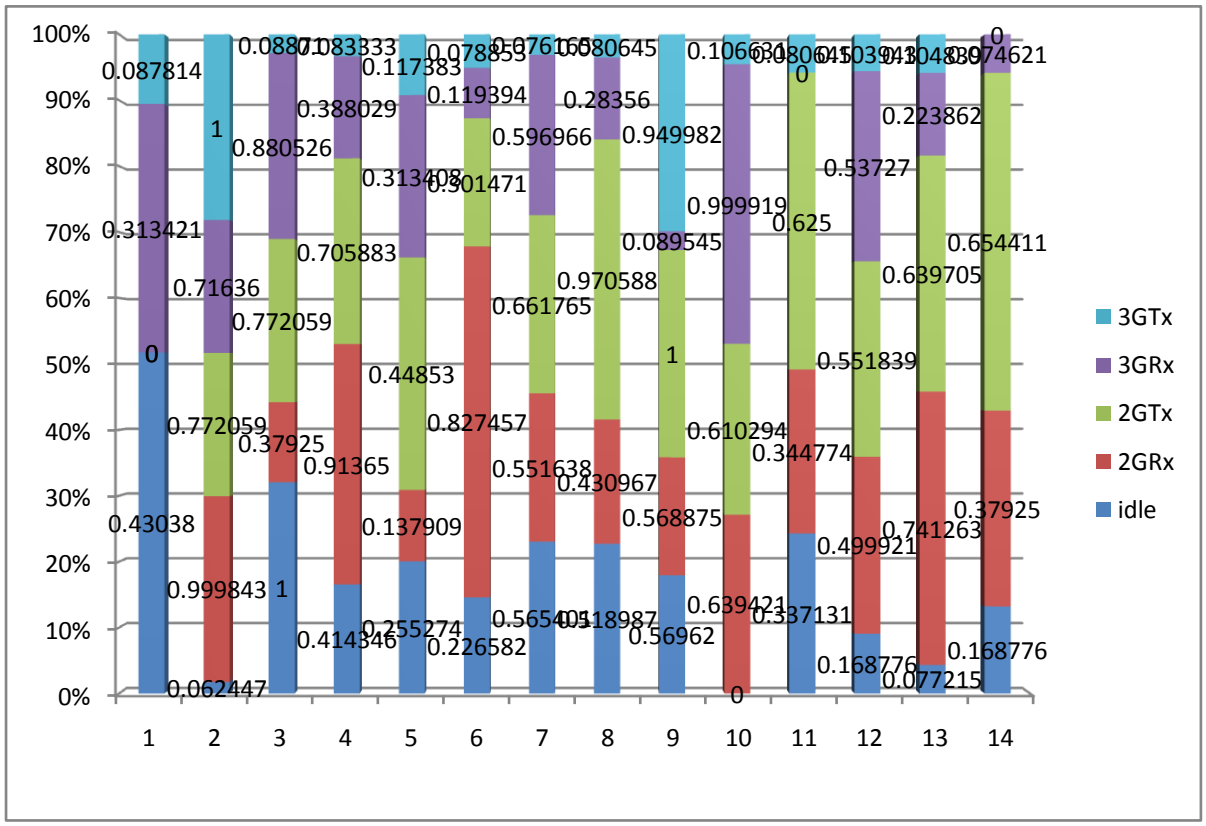


Fig. 3 Amplitudes effects when P, Q, R, S & T collectively applied to the network.(shown graphically)

P, Q, R, S and T amplitudes collectively applied to check for the radiation effects. There are seven beats in 2G-Rx that are greater than 0.5(50%) for the normalized outputs. 2G-Tx has eleven, 3G-Rx has five and 3G-Tx has two beats. 2G-Tx is showing larger variations compared with all other modes. 2G- Tx shows variations greater than 2G-Rx where as 3G -Rx shows larger variations compared to 3G- Tx. The results are presented in graphical form in Fig. 4. Table 2-11 show target values in % with ≥ 0.5(50%) in last row of each table.

Table 2 Amplitudes P, Q, R, S & T collectively applied as a beat representation in (3G Modes)

S.No	3GRx Training (Amplitude variations)	3GRx Testing(Amplitude variations)	3GTx Training(Amplitude variations)	3GTx Testing(Amplitude variations)
1	0.313421	0.0	0.087814	0.0
2	0.71636	0.179191	1	0.75
3	0.880526	0..225434	0.08871	0.125
4	0.388029	0..248555	0.083333	0.0
5	0.313408	0.046243	0.117383	0.25
6	0.119394	0.346821	0.078853	1
7	0.596966	0.317919	0.076165	0.875
8	0.28356	0.358382	0.080645	0.5
9	0.089545	0.346821	0.094982	1
10	0.999919	0.369942	0.106631	0.875

11	0.0	0.439306	0.080645	-
12	0.55727	1	0.103943	-
13	0.223862	0.369942	0.104839	-
14	0.074621	-	-	-
Patterns with target≥ 50%	5 (35.71%)	1 (0.071%)	1 (0.071%)	6 (60%)

Training and Testing variations in 3GRx respectively are 35.71% and 0.071%. The variations are 0.071% and 60% in 3G-Tx.

Table 3 Amplitude P, Q, R, S & T collectively applied as a beat representation in (2G Modes)

S.No	2GRx Training (Amplitude variations)	2GRx Testing(Amplitude variations)	2GTx Training(Amplitude variations)	2GTx Testing(Amplitude variations)
1	0	0.535714	0	0.2
2	0.999843	0.714286	0.772059	0.025
3	0.37925	0.321429	0.772059	0.1
4	0.91365	0.214286	0.705883	0.05
5	0.137909	0.321429	0.44853	0.125
6	0.827457	0.285714	0.301471	0.025
7	0.551638	0.714286	0.661765	0.025
8	0.430967	0.25	0.970588	0
9	0.568875	1	1	0.025
10	0.639421	0	0.610294	0
11	0.344774	0.392857	0.625	1
12	0.499921	0.75	0.551839	0.65
13	0.741263	-	0.639705	0.425
14	0.37925	-	0.639705	-
15	-	-	0.654411	-
Patterns with target ≥ 50%	7/14(50%)	5/12(41.66%)	12/15(80%)	2/13(15.38%)

Training and Testing variations in 2G-Rx respectively are 50% and 41.66%. The variations are 80% and 15.38% in 2G-Tx Training and Testing.

Table 4 Amplitudes P, Q, R, S & T individually applied as a beat representation in (2G Modes),2G Rx Training

S.No	P	Q	R	S	T
1	0	0.431034	0.782609	0.859649	0.454545
2	1	1	0	0	0.727273
3	0.37931	0	0.304348	0.877193	0.181818
4	0.913793	0.431034	0.717391	1	1
5	0.137931	0.086207	0.5	0.947368	0.636364
6	0.827586	0.517241	0.826087	0.912281	0.545455
7	0.586207	0.258621	0.608696	0.877193	0.363636
8	0.431034	0.241379	0.586957	0.912281	0.454545
9	0.568966	0.189655	0.543478	0.929825	0.727273
10	0.706897	0.482759	1	0.929825	0

11	0.344828	0.275862	0.565217	0.807018	0
12	0.5	0.206897	0.369565	0.824561	0.363636
13	0.741379	0.465517	0.73913	0.894737	0.727273
14	0.37931	0.310345	0.73913	0.947568	
Patterns with target ≥ 50%	8(57.14%)	2(14.28%)	11(78.57%)	13(92.85%)	6(46.15%)

2G-Rx Training show variations 57.14%, 14.28%, 78.57%, 92.85%and 46.15%% respectively in P, Q, R, S & T

Table 5 Results with P, Q, R, S & T (% variations) individually applied as a beat representation(2G Modes),2G Rx Testing

S.No	P	Q	R	S	T
1	0.107142	0.851852	1	0.052634	0.09756
2	0.428571	0.851852	0.877193	0.105263	0.073172
3	0.25	0.925926	0.877193	0.157901	0
4	0.25	0.925926	0.77193	0.105263	0.048781
5	0.214287	0.88889	0.894737	1	0
6	0.178571	0.925926	0.91228	0.21053	0
7	0.285713	0.925926	0.964912	0.078193	0.09756
8	0	1	0.77193	0.105263	0.121951
9	0.607142	1	0.894737	0	0.121951
10	0.892858	0	0	0.578948	1
11	0.642858	0.666668	0.105263	0.368422	1
12	0.892858	0.333332	0.14035	0.315818	0.1
13	0.464284	0.481481	0.157875	0.473685	0.1
14	1	0.629629	0.350877	0.421052	-
target ≥ 50%	5 (35.71%)	11 (78.57%)	9 (64.28%)	2 (14.28%)	2 (15.38%)

2G-Rx Testing show variations 35.71%, 78.57%, 64.28%, 14.28% and 15.38% respectively in P, Q, R, S and T amplitudes when tested individually.

2G-Tx Training show variations 78.57%, 85.71%, 21.42%, 92.85% and 21.42% respectively in P, Q, R, S & T Amplitudes when tested individually.

Table 6 Results with P, Q, R, S & T (% variations) individually applied as a beat (2G – Modes),2G-Tx Training

1	0	0	0	0	0.388889
2	0.772059	0.68	0.206897	0.707317	0.333333
3	0.772059	0.72	0.258621	0.780488	0.333333
4	0.647059	0.686666	0.344828	0.609756	0.277778
5	0.448529	0.586667	0.241379	0.707317	0.111111
6	0.301471	0.46	0.017241	0.682927	0.111111
7	0.661765	0.586667	0.103448	0.707317	0.277778
8	0.970588	0.933333	0.827586	0.878049	0.833333
9	1	1	1	1	1
10	0.610294	0.66666	0.327586	0.902439	0.611111
11	0.625	0.606666	0.172414	0.829268	0.388889
12	0.551471	0.586667	0.189655	0.682927	0
13	0.639706	0.753333	0.603448	0.804878	0.333333
14	0.654412	0.733333	0.482759	0.707317	0.333333
Patterns with target ≥ 50%	11(78.57%)	12(85.71%)	3(21.42%)	13(92.85%)	3(21.42%)

Table 7 Results with P, Q,R, S & T(% variations) individually applied as a beat representation(2G Modes)
2G-Tx Testing

S.No	P	Q	R	S	T
1	0.025	1	0.023809	0.454545	0.2
2	0.05625	0.985075	0.738096	0	0.025
3	0	0.955224	0.714286	0.636364	0.1
4	0.0125	0.970149	0.904763	0.636364	0.05
5	0.0125	0	1	0.545455	0.125
6	0.0375	1	0.809525	0.636364	0.025
7	0	0.970149	0.738096	0.545455	0.025
8	0.0125	0.940298	0.738096	0.727273	0
9	0	0.970149	0.952381	0.727273	0.025
10	0.0125	0.686567	0.857143	0.727723	0
11	1	0.731343	0.190476	1	1
12	0.55	0.731343	0	0.909091	0.65
13	0.29375			0.909091	0.425
Patterns with	2 (15.38%)	11 (91.66%)	9 (75%)	11 (84.61%)	2 (15.38%)

target(≥ 50%)					

2G-Tx Testing show variations 15.38%, 91.66%, 75%, 84.61% and 15.38% respectively in P, Q, R, S and T amplitudes when tested individually

Table 8 Results with P, Q, R, S & T (% variations) individually applied as a beat representation(3G- Rx Modes)
3G Rx Training

S.No	P	Q	R	S	T
1	0.313433	0.140844	0.065789	0.75	0.666667
2	0.716417	0.464789	0.328948	1	1
3	0.880597	0.732394	0.43421	0.625	0.666667
4	0.38806	0.59155	0.328948	0.5	0.333333
5	0.313433	0.309859	0.302632	0.625	0.416665
6	0.119403	0.12676	0.052626	0.25	0.083332
7	0.597014	0.647887	0.447368	0.5	0.583335
8	0.283583	0.28169	0.289473	0.375	0.249272
9	0.089553	0.197183	0.210527	0.125	0.083332
10	1	1	1	0.625	0.083332
11	0	0	0	0	0
12	0.537313	0.59155	0.43421	0.5	0.583335
13	0.022388	0.39466	0.394737	0.625	0.583335
14	0.074627	0.169014		0.375	0.416665
Patterns with target ≥ 50%	5 (35.71%)	5 (35.71%)	1 (0.076%)	9 (64.28%)	6 (42.85%)

3G-Rx Training show variations 35.71%,35.71%,0.076%,64.28%and 42.85% respectively in P, Q, R, S and T amplitudes when tested individually

Table 9 Results with P, Q, R, S & T (% variations) individually applied as a beat representation(3G-Rx Modes),3G Rx Testing

S.No	P	Q	R	S	T
1	1	0.117647	0	0.992481	1
2	0.940408	0.117647	0.443478	1	1
3	0.957195	0	0.513043	0.977444	1`
4	0.088213	0.411765	0.791304	0.015038	0
5	0.332447	0.823529	0.747826	0.157895	0.227273
6	0.494729	0.75882	0.773913	0.015038	0.242424
7	0.281634	0.705882	0.834783	0.022556	0.257576
8	0	0.588235	0.773913	0	0.106061
9	0.996139	0.823529	1	0.12782	0.333333
10	0.932779	1	0.930435	0.120301	0.424242
11	0.825984	0.76476	0.921739	0.142857	0.363636
12	0.819009	0.76476	0.965217	0.142857	0.424242
13	0.819009	0.823529	0.947826	0.142857	0.378788
Patterns with target ≥	8 (61.53)	9 (69.23)	11 (84.61)	3 (23.07)	3 (23.07)

50%					

3G-Rx Testing show variations 61.53%, 69.23% ,84.61 ,23.07% and 23.07% respectively in P, Q, R, S and T amplitudes when tested individually

Table 10 Results with P, Q, R, S & T(% variations) individually applied as a beat representation(3G Tx Modes),3G Tx Training

S.No	P	Q	R	S	T
1	0.885496	0.735294	0.307693	0.181817	0.166669
2	0.755725	0.860294	0.487179	0.545452	0.233334
3	0.709923	0.764706	0.25641	0.727278	0.266669
4	1	0.691176	0.128205	0.454548	0.166669
5	0.671755	1	1	1	0.333334
6	0.648855	0.713236	0.179488	0	0
7	0.687023	0.632353	0.128205	0.181817	1
8	0.908397	0.654412	0	0.454548	0.233334
9	0.687023	0.882353	0.564104	0.454548	0.166669
10	0.885496	0.654412	0.076922	0.090913	0.033334
11	0.893129	0.860294	0.487179	0.545452	0.233334
12	0	0.912401	0.71795	0.727278	0.333334
13	0.938931	0	0.641026	0.181817	0.1
14	-	0.933824	0.74359	0.545452	0.166669
target ≥0.5	12(92.30%)	13(92.85%)	5(35.71%)	6(42.85%)	1(0.071%)

3G-Tx Training show variations 92.30%,92.85%,35.71%,42.85%and 0.071% respectively in P,Q,R,S and T amplitudes when tested individually

Table 11 Results with P, Q, R, S & T(% variations) individually applied as a beat representation(3G TxModes),3G Tx Testing

S.No	P	Q	R	S	T
1	0	0	0.347826	0.065789	0.921569
2	0.75	0.05	0.195652	0.013158	0.980392
3	0.125	0	0	0	1
4	0	0.15	0.065217	0.039474	0.960784
5	0.25	0.1	0.369565	0.052632	0.941177
6	1	1	0.934782	1	0.196078
7	0.875	0.900001	0.847826	0.986842	0.215686
8	0.5	0.850001	0.869565	0.986842	0.039216
9	1	0.80001	0.999999	1	0
10	0.875	0.750001	0.97826	1	0.176471
Patterns target ≥ 50%	6 (60%)	6 (60%)	5 (50%)	5 (50%)	5 (50%)

3G-Tx Testing show variations 60%,60%,50%,50%and 50% respectively in P, Q, R, S and T amplitudes when tested individually.

Total patterns used in training and testing are shown in Table 12

Table 12

S.NO	Individually applied patterns P,Q,R,S & T	Number of patterns	Collectively applied patterns P,Q,R,S & T	Number of patterns
1	2G-Rx Training	70	2G-Rx Training	14
2	2G-Rx Testing	69	2G-Rx Testing	12
3	2G-Tx Training	70	2G-Tx Training	15
4	2G-Tx Testing	63	2G-Tx Testing	13
5	3G-Rx Training	69	3G-Rx Training	14
6	3G-Rx Testing	65	3G-Rx Testing	13
7	3G-Tx Training	69	3G-Tx Training	13
8	3G-Tx Testing	50	3G-Tx Testing	10
Total patterns		525		104

.

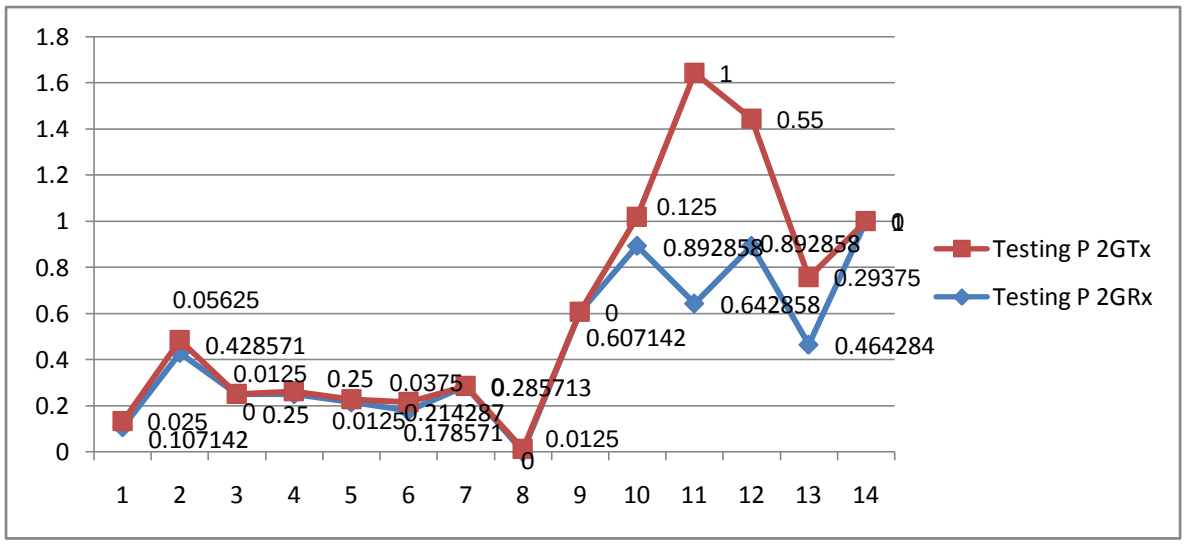


Fig. 4 2G-Rx Testing shows higher values of P amplitude for eleven patterns out of fourteen

Modified Elman produces output as per input data sensed. Output is recorded and normalized. The outputs are presented in graphical form in Fig.4-13 for various modes as mentioned in respective figures. Vertical axis represents normalized output and horizontal axis plots the nth number of pattern.

The number of patterns to train the network as per the process shown in the flow chart are presented in Table 12. There is the number of patterns shown in columns for each category of the patterns including collective and individual-patterns

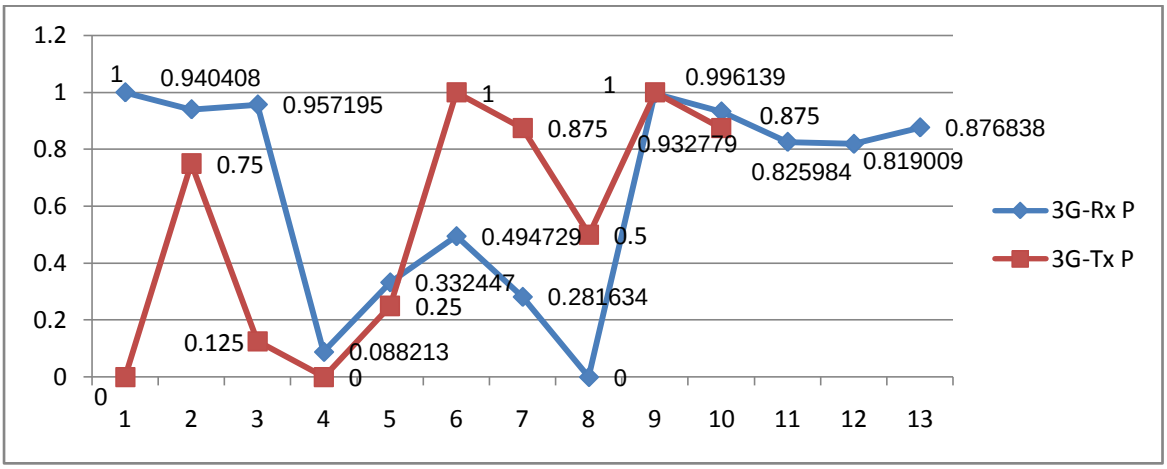


Fig. 5 Amplitude of P values in 3G-Rx Testing mode is higher in six values out of ten

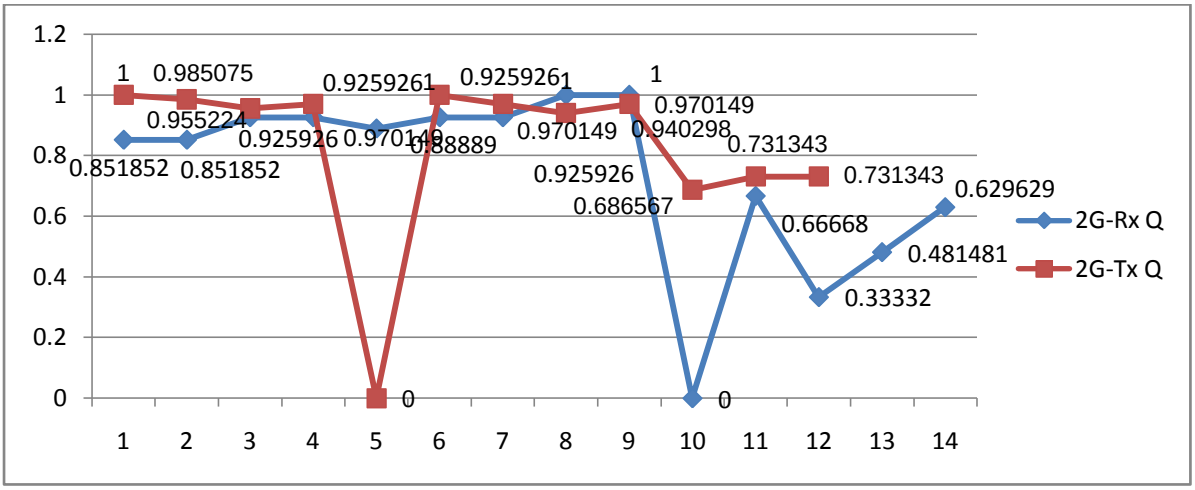


Fig. 6 Q amplitude is higher in 2G-Rx **Testing** in three patterns out of twelve

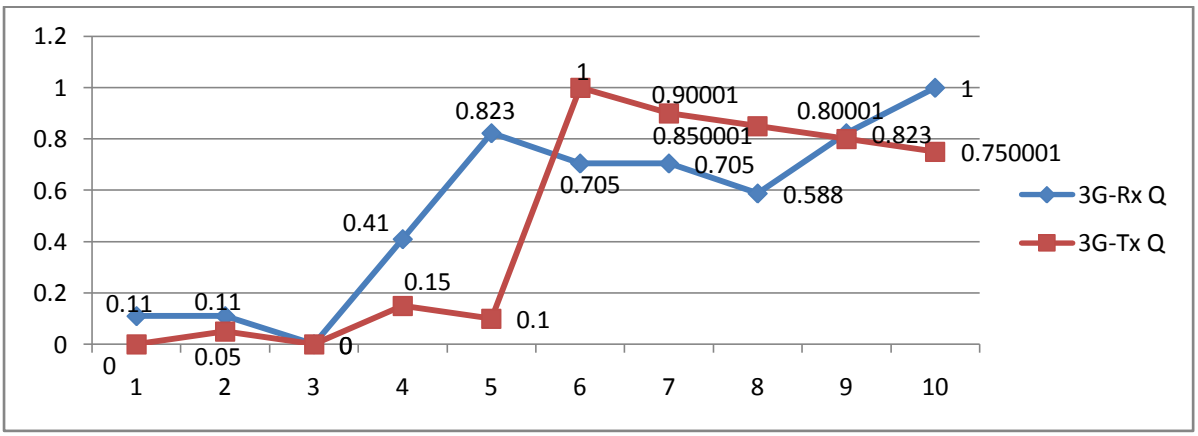


Fig. 7 Amplitude of Q value in ECG beats is higher in seven patterns out of ten in 3G-Rx Testing; in one case the values are equal.

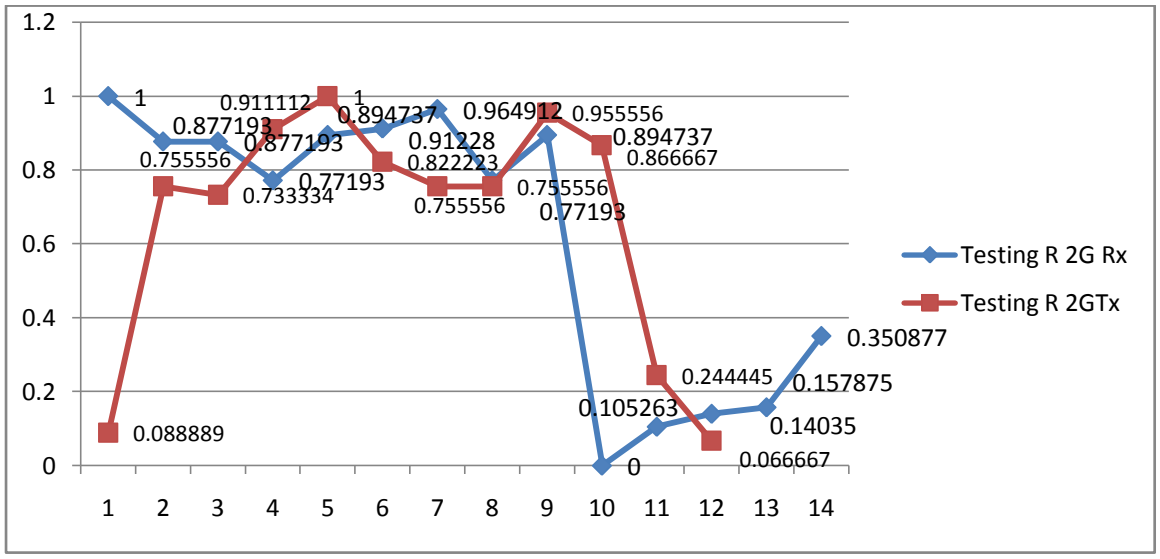


Fig. 8 Amplitude of R value in ECG beats is higher in seven patterns out of twelve in 2G-Rx Testing

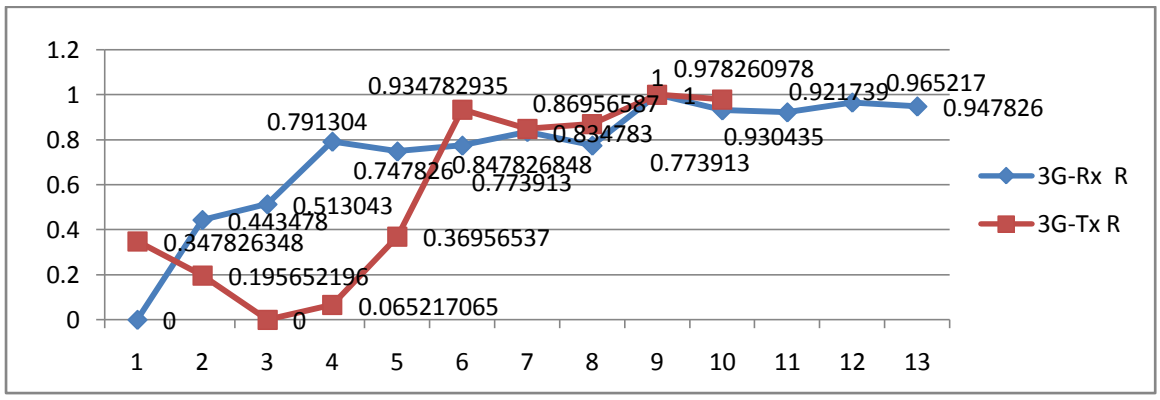


Fig. 9 Amplitude of R value is higher in 3G-Rx Testing for four values out of ten

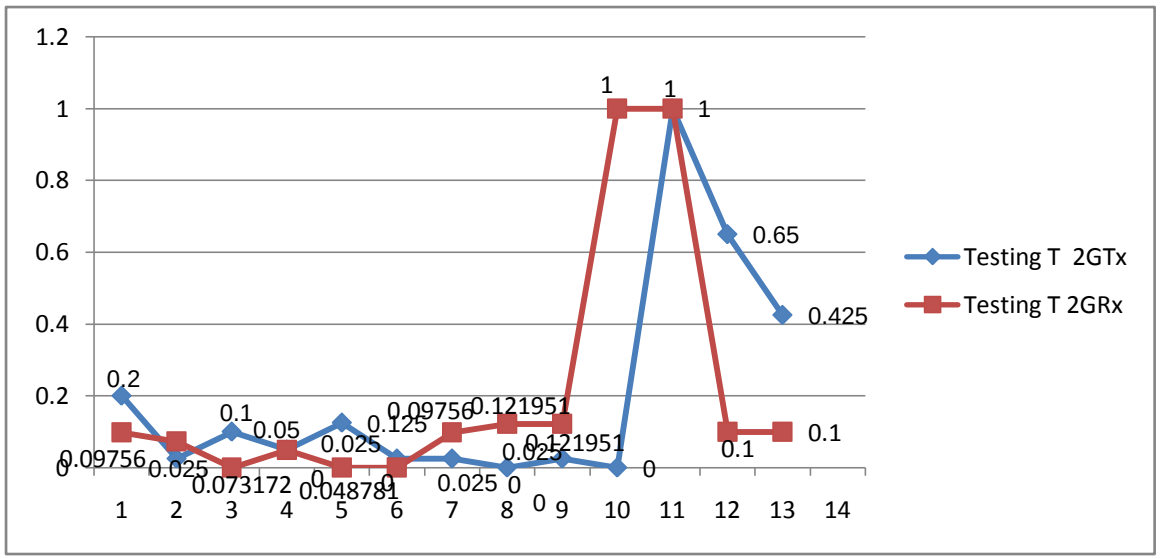


Fig. 10 Amplitude of T value in ECG beats is higher for five patterns out of thirteen in 2G-Rx Testing; in one case the variations are the same.

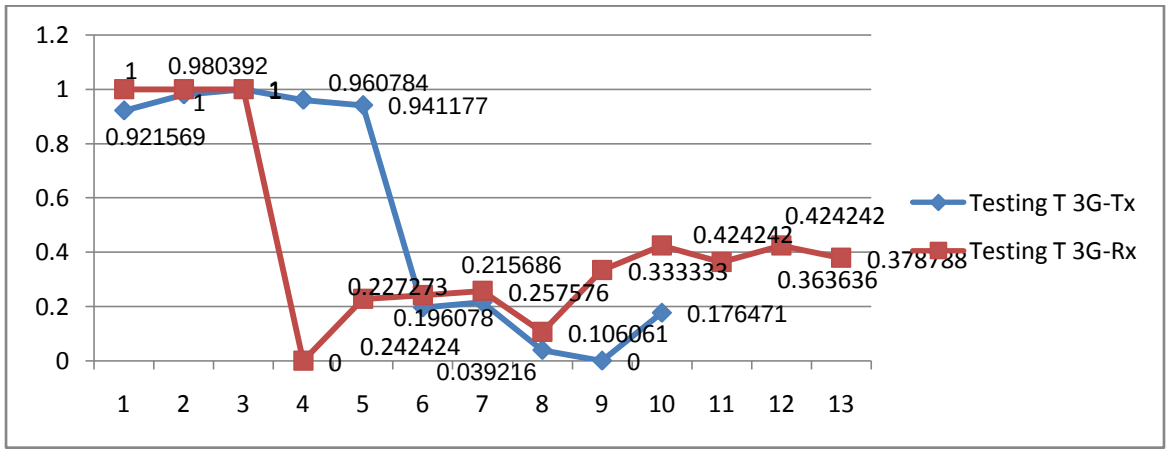


Fig. 11 Amplitude of T value in 3G-Rx Testing shows higher value in seven patterns out of 10; in one case the variations are the same.

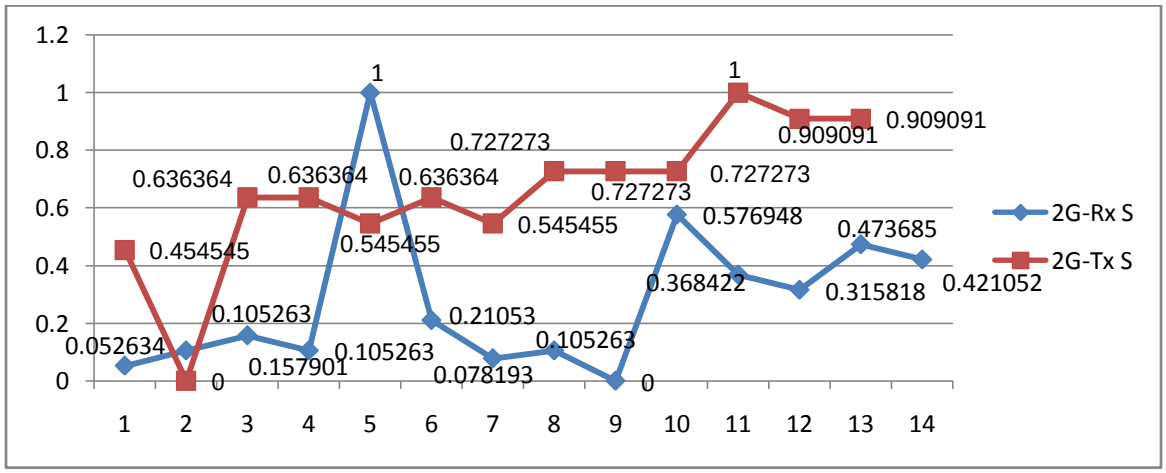


Fig. 12 2G-Rx Testing shows values higher in two amplitudes of S value in ECG beat out of thirteen

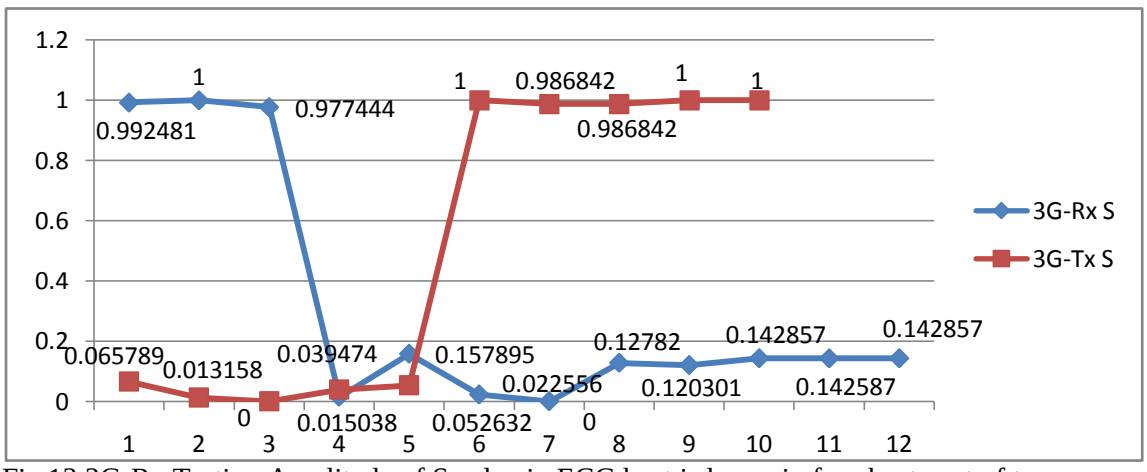


Fig.13 3G-Rx Testing Amplitude of S value in ECG beat is larger in four beats out of ten

5. CONCLUSION

Training and testing of the patterns in the study using Modified Elman show correct classification for all the training patterns. The results are similar when the trained patterns are tested on one hand and the testing patterns not seen earlier by the network are tested on the second instance. All the results are tested on a normalized scale with a minimum value of zero (0) and maximum value of one(1)1. The study concludes as under for the variations in individual amplitudes.Variations in the amplitudes in transmission and receiving signals are an area of research and needs attention. The variations in current study are measured under controlled environment and are represented in Table 14.

Table 14 Variations when P, Q, R, S & T are individually applied during Training & Testing

S.No	Type of pattern	Mode		Comments(≥0.5 target)
1	P	2GRX	5/14	35.71%
		2GTX	2/13	15.38%
		3GRX	8/13	61.53%
		3GTX	6/10	60%
2	Q	2GRX	11/14	78.57%
		2GTX	11/12	91.66%
		3GRX	9/13	69.23%
		3GTX	6/10	60%
3	R	2GRX	9/14	64.28%
		2GTX	9/12	75%
		3GRX	11/13	84.61%
		3GTX	5/10	50%
4	S	2GRX	2/14	14.28%
		2GTX	11/13	84.61%
		3GRX	3/13	23.07%
		3GTX	5/10	50%
5	T	2GRX	2/13	15.38%
		2GTX	2/14	14.28%
		3GRX	3/13	23.07%
		3GTX	5/10	50%

Table15 Results of P, Q, R, S & T when collectively applied during Training & Testing

S.NO.		idle	2G-Rx Trainin	2G-Rx Testing	3G-Rx Trainin	3G-Rx Testir
1	Collectively applied P, Q, R, S & T	28.57%	50%	35.71%	35.71	0.071%
		idle	2G-Tx Trainin	2G-Tx Testing	3G-Tx Trainin	3G-Tx Testir
2	Collectively applied P,Q,R,S & T	28.57%	85.71%	14.28%	0.071%	60%

The variations need to be kept at a minimum as larger variations may cause health hazard.To keep the variations to minimum; authors propose design and fabrication of a low radiation antenna. The study requires collecting data from more people to have a broader outlook into the subject. The study is useful and is in the benefit of the society.

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