Analyzing the impedance of reflection coefficient of S-parameters S11 and S22 using vector network analyzer & recognization of hand gesture using DTW

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Abstract— **VNA is commonly used to analyze the network in frequency series and data record by incident and reflection of the small antenna which distributed parallel, the main propose of this research to classify gesture movement based on the reflection coefficient variations of a small antenna. The near field is distributed the hand gesture movement results in unique variations of antenna's i/p –o/p impedance which can be used to recognize gesture movement of the hands .The two parallel antenna operating at 890 MHz -2.4GHz which is implemented in this research work and VNA is also compatible with this frequency 2.4GHz to collect data in form of S-parameters. First, some movement of hand like boxing, hopping, rowing, and many more gestures are performed and recorded, by measuring S11 and S22 through the antenna. To classify the hand movement based on S11 and S22 variation with the time series, for this dynamic time warping is used. By DTW we find the nearest optimal path of gestures in time series and found the average classification with more accuracies. In this research, we calculate the best impedance matching between the gestures.**

IndexTerms— **Dynamic time warping (DTW) , Vector Network Analysis (VNA), i/p-o/p impedance, gesture movement, optimal path.**

I. INTRODUCTION

The advance research of sensor technologies allows engineers to use devices to interfacing with human activities. Focusing on hand gestures has been interest of everybody in today's generation because everyone wants to interface with devices without touching of it like in from of wave motion. Due to increases of advancement they want to do work effectively and smarty in less consuming of time. So these application are human computer interface, computer gaming, biomechanics research, controlling virtual reality, and smart environments also in biomedical science. For example, gesture recognition system may also used as rehabilitation instrument to improve the sensibility of hand for people recovering from physical accidents or physical disabilities [1][2][3][4][7]. For deaf people it also used in sign languages for better communication. Mostly research on topic of gesture recognition, the designers always design the system according to the way of performing the gestures, which depending on different portions of gestures of a person. A VNA is used to record measurement in the indoor, open hallway environment [8][9]. Both transmitting and receiving antennas are connected to VNA by 3 m long coaxial cables [11][12]. Our research goal is used to recognize gesture in time series and find the shortest path between two time series sequences. Dynamic time warping (DTW) is widely used to gesture recognizing in time series sequences. It compute the best results of all test for best matching of i/p -o/p impedance of given gestures. By DTW, it define between two signals and choosing proper signal for analysis and recognition .all test are done in real and time series. First, make a Yagi–Uda antenna consists of a 10 parallel thin rod elements in a line. Where, all gestures are performing with Two Yagi-Uda antennas (Transmitter & Receiver) kept 15 cm distant. Connect to VNA to collect the data in S-parameter of reflection and incident coefficient of S11 and S22 [13]. There is a single driven element and single Reflector and the antenna works on 2.4GHz frequency which is very suitable for VNA frequency and collected data at fixed frequency i.e., 2.4GHz, with respect to time (10sec). This collected data is used by DTW algorithm in MATLAB. So, the aim of this research is to compute the gesture recognition and find the nearest path of two time series sequence and effectively improving the gesture recognition in real time series.

II. PROBLEM FORMULATION

VNA is essential tool used for collecting S-parameter (Scattering parameter) of reflected or incident coefficient in high frequency. The frequency range is between 30 KHz -2.4GHz [5][6]. It is difficult to measure total voltage and current at higher frequency, S-parameter. This parameter is very much familiar measurement such as gain, loss reflection /incident coefficient and its impedance. DTW is used to recognize gesture movement and the shortest path of time series. The use of DTW is to recognize hand gestures, in automatic system in cars, rooms, close- open door, turn on-off light or up – down of music volume .In the medical facilities it use as robotic nursery in future[14][15][6]. In our work we considered the input and output impedance. The impedance analysis provides higher measurement accuracy and stability but it requires a costly impedance analyzers so it is suitable only for lower frequency which is used for best impedance matching [20]. DTW is the technique used to find an optimal alignment between two given time dependent sequences. To determine an optimal path one should test every possible warping path between A and B, Each pair of element of sequences A and B, one must obtain the cost matrix .Due to find the optimal path

we can used to this for gesture recognition . By the DTW algorithm we can find the nearest optimal path and its gesture to recognize it which is so similar to known gestures [17][19].

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III. OBJECTIVE

- Design Y-antenna to be used as DUT.
- Collect data in form of S-parameters by using of VNA.
- Convert collected data into freq. series sequences to time series sequences by using lab view code.
- Analyze the data and calculate the impedance of the port n/w using i/p and o/p reflection coefficient i.e. S11 and S22.
- Apply DTW algorithm.
- Find the minimal optimal path between the time series sequences and compute its result..

IV. METHODOLOGY

The S-parameter of S11 and S22 coefficient database are taken from VNA hardware in the form of freq. series sequences. The 1200 sample data are collected through the incident and reflected waves of .S-parameters in time series sequences [15][18]. In the table 1 training requirement is also given. The flow diagram in figure1 is use to represent the method for best impedance matching of input and output which is given below:

Table 1: Training Requirement

Process	Description
Gesture	Hopping, Rowing, Boxing, hand rotation and anti –rotation
Tools- 1) Hardware 2)Software	2 parallel antenna , VNA MATLAB
Frequency range	30KHz-2.4GHz
Feature computation	DTW- for best impedance match, shortest path.

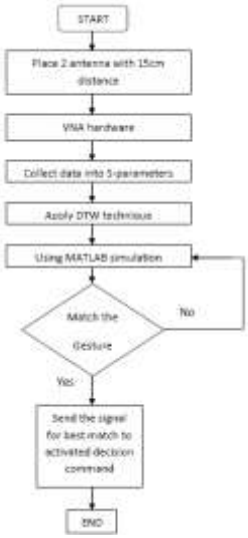

Figure1: Flow diagram of DTW gesture

In this flow diagram the method is following as first we have to start place the two Y-antenna parallel with the 15 cm and perform some gestures in front of it the signal is used in reflected and incident coefficient which attached to two reflector cables. This all process is used as DUT (device under test).

V. RESULT AND DISCUSSION

In this paper the performance of DTW by using the VNA and its algorithm are investigated the performance of the proposed algorithm can be checked by comparing the best matching which obtained by this method and VNA. In this thesis, DUT (antenna) algorithm and VNA have been developed to recognizing of hand movement and its best impedance matching by using MATLAB (R2010a). The results have been attained by executing the program no. of times. In the following section, gesture recognition by S-parameter to calculate its minimal optimal path and impedance due to loss and gain of incident and reflected waves in time series, these gesture are boxing, hopping, and rowing where it data values are used to calculate its nearest path to recognize gestures from known to unknown by data values and i/p and o/p impedance .The performance of DTW by using the VNA and its algorithm are investigated the performance of the proposed algorithm can be checked by comparing the best matching which obtained by this method and VNA. In this thesis, DUT (antenna) algorithm and VNA have been developed to recognizing of hand movement and its best impedance matching by using MATLAB (R2010a). The results have been attained by executing the program no. of times. In the following section, gesture recognition by S-parameter to calculate its minimal optimal path and impedance due to loss and gain of incident and reflected waves in time series, these gesture are boxing, hopping, and rowing where it data values are used to calculate its nearest path to recognize gestures from known to unknown by data values and i/p and o/p impedance. Data collected using VNA in the form of S-Parameters i.e. S11 and S22. This data shows in graph as given below VNA Data

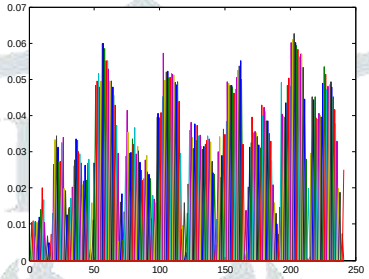

Figure 2 : 1200 data samples of VNA Database

This it has total number of 1200 database of S-parameters by this data we can find the best match and impedance and loss or gain of impedance of the signal of data collected. The collected data of boxing and rowing and the result of their nearest path or best i/p-o/p impedance matching is shown in figure 3 to figure 6 respectively.

Boxing

In the boxing data has been collected as input and output impedance. Which give the graphs of boxing gestures to recognize it best and shortest path. So, in the boxing its best i/p impedance matching 30-35 and o/p impedance matching is 20-25 by the collected data . its graphs are shown in figure 3 and figure 4with respect to time series.

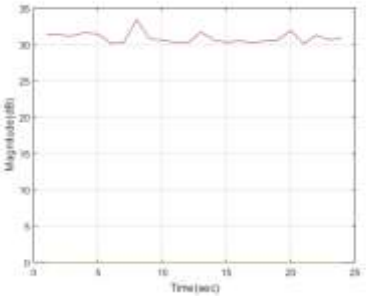

Figure 3: i-p impedance of boxing

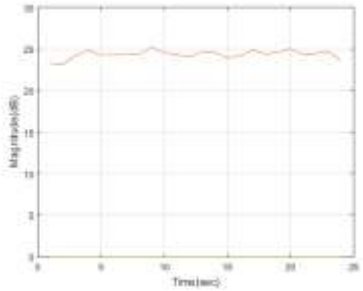

Figure 4: o-p impedance of boxing

Rowing

Rowing is the one of the gesture which is used in rowing like in the competition of boating (sports game) to find accurate and best rowing so by DTW algorithm .We can find best and shortest path between them .The best i/o impedance matching of rowing is 27-33 for i/p impedance match shown in figure 5 and o/p impedance match is 22-32 shown figure 6 with respect to time series.

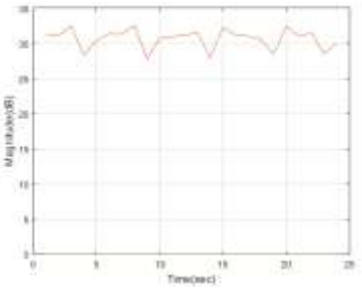

Figure5:i-p impedance of rowing

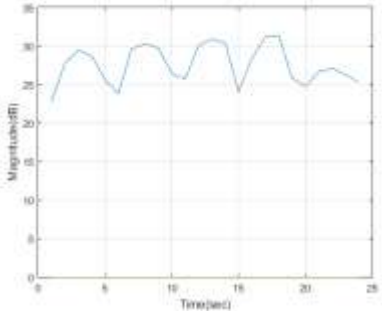

Figure 6:o-p impedance of rowing

The purpose of DTW is to produce warping function that minimizes the total distance between the respective points of the signal. Furthermore, the accumulated distance matrix is used to develop mapping paths which travel through the cells with smallest accumulated distances, the total distance difference between these two signals is minimized. Through this study, optimal warping path was achieved where the test input matched and output matched.

VI. CONCLUSION AND FUTURE SCOPE

This paper has discussed about the hardware VNA and how to collect the data of S-parameter by using as DUT (device under process) that is Yagi-uda Antenna and perform some gesture and by the DTW it used to recognize the best matching and find the optimal path in time series sequences .The shortest path is calculated by the cost matrix which is represented by sokae and chiba band .This technique is in wide range of fields including data mining and information retrieval, bio information, chemical engineering, signal processing, robotics or computer graphics. This includes data types such as text, audio, video in time series. In the field of music information is retrieval. DTW plays in important role in synchronizing music data streams and also been used in the field of computer animation to analyze and align motion data. In the coming time the use this technique will be wide in range: like the gesture based on control system in automobile sector. In this to opening car door and tailgates, turn on and turn down the volume. In the room control system if want to pull down the curtain or on off the light. Other uses in medical field are for Future surgeons may use robotic nurse in Medical sector. And other Gesture based on drones and tanks in Military Sector.

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