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Voice Based Wheel Chair Movement Using N-Average Wavelet Algorithm

Banumathi .A .C[1], Dr. E. Chandra[2]

[1]Research Scholar, Department of Computer Science, Mother Teresa Women's University, KodaiKanal, India

[2]Professor & Head, Department of Computer Science, Bharathiar University, Coimbatore, India

Abstract: ***Many of the people are suffering from the permanent or temporary or birth disability. For the case of difficult or impossible walking, they can make use of wheelchair. To drive a wheel chair using Tamil voice commands for physically handicapped and aged peoples. The ANFIS is proposed to train the Tamil characters and run the wheel chair. A special feature selection algorithm called N-Average wavelet is proposed to select the best features. By applying the N-Average Wavelet algorithm a result has been achieved with an accuracy of 99% for Tamil commands and maximum elapsed time is about 0.5 second.***

Keywords: Adaptive Neuro Fuzzy Inference System(ANFIS), Mamdani & Sugeno Fuzzy Algorithm

1. Introduction

Voice recognition is the ability of a machine or program to identify words and phrases in spoken language and convert them into an understandable form [1]. Voice is recognized by considering its various attributes such as its energy, trajectory of utterance, speaking mode and different speaker utterance. Voice Recognition of limited simple words can be done by traditional method, whereas ANFIS algorithm is used for the purpose.

In voice recognition first phase is preprocessing which deals with a voice signal which is an analog signal at recording time, which varies with time. To process the signal by digital means, it is necessary to sample the continuous signal into a discrete valued (digital) signal. The preprocessing stage in voice recognition systems is used in order to increase the efficiency of subsequent feature extraction and classification stages and therefore to improve the overall recognition performance. Commonly the preprocessing includes the sampling step, a windowing and a noise removing step. Sampling is the process at the end of the preprocessing. The compressed and filtered voice frames are forwarded to the feature extraction stage. The next stage is to extract the set of features from voice signal. The extracted features are ranked and convert the feature values into normalized feature values, then the normalized feature values are send to the Adaptive Neuro Fuzzy Interference System (ANFIS) algorithms. In the field of Artificial Intelligence there is need for a model which is capable of processing the complex input data and solving different kinds of task. Followed by the results, accuracy and elapsed time calculated for the performance analysis [2].

2. Proposed Methodology

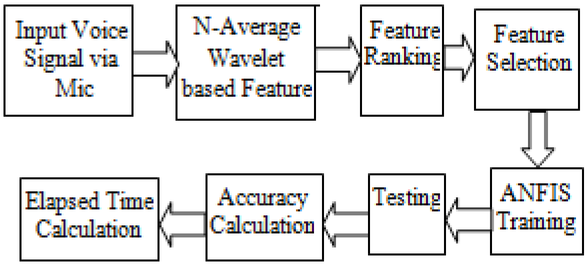


Figure: Proposed Block Diagram

3. Adaptive Neuro-Fuzzy Inference System

ANFIS was introduced by Jang [5]. ANFIS is used for modeling, controlling, and parameter estimation intimation in complex systems [6]. ANFIS is a combination of artificial neural network (ANN) and fuzzy inference system (FIS). Combining the ANN and fuzzy-set theory can provide advantages and overcome the disadvantages in both techniques. The ANFIS model can be trained without relying solely on expert knowledge sufficient for a fuzzy logic model. The ANFIS model has the advantage of having both numerical and linguistic knowledge. ANFIS also uses the ANN's ability to classify data and identify patterns. Compared to the ANN, the ANFIS model is more transparent to the user and causes less memorization errors. Consequently, several advantages of the ANFIS exist, including its adaptation capability, nonlinear ability, and rapid learning capacity [7].

ANFIS constructs a fuzzy inference system (FIS) whose membership function parameters are derived from the training examples. The most commonly used fuzzy inference systems are Mamdani and Sugeno. The main difference between Mamdani and Sugeno is that the output membership functions of the Sugeno system are either linear or constant [5]. However, the output membership functions of the Mamdani system can be triangular, Gaussian, etc. In this study, the Sugeno-type fuzzy inference system was used, because the Sugeno-type system is more computationally efficient than the Mamdani type. The Mamdani type is more reliant on expert knowledge. However, the Sugeno type is trained by real data.

In order to explain the ANFIS architecture, we assumed that there are two inputs: x and y. Two fuzzy if–then rules for a first-order Sugeno fuzzy model can be expressed as follows:
Rule 1: If x is A_1 and y is B_1, then $f_1 = p_1$ x+ q_1 y+ r_1,
Rule 2: If x is A_2 and y is B_2, then f_2= p_2 x+ q_2 y+ r_2,
where A_i and B_i are the fuzzy sets, f_i is the output, and p_i , q_i , and r_i are the design parameters that are determined during the training process. The ANFIS architecture used to implement the two rules is shown in Figure 3.

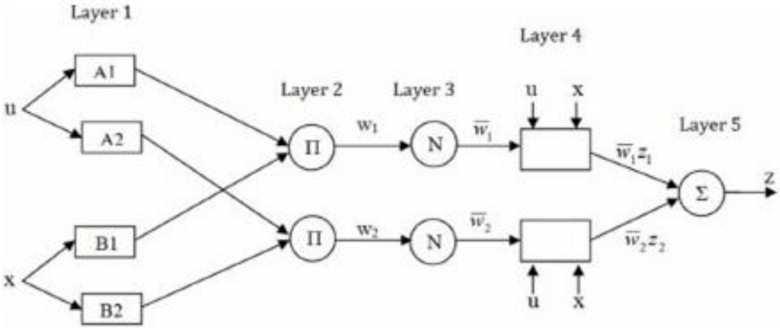


Figure 3: The architecture of the adaptive neuro-fuzzy inference system (ANFIS) model with two inputs, one output, and two rules

Wavelets
A wavelet is a wave-like oscillation that is localized within the sense that it grows from zero, reaches most amplitude, and then decreases back to zero amplitude again. It thus includes a location wherever it maximizes, a characteristic oscillation amount, and conjointly a scale over that it amplifies and declines [5] ,[6]. Wavelets may be employed in signal analysis, image processing and information compression. They are helpful for searching for scale information, whereas still maintaining some degree of time or space vicinity.[3]

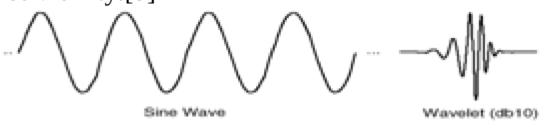
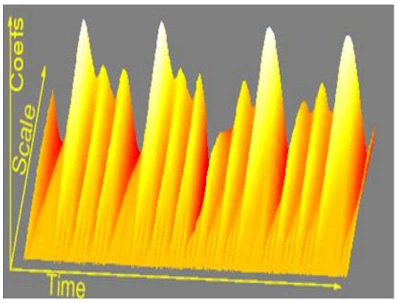


Figure 3: Sine Waveform & Wavelet

4. Introduction to Wavelet Families

Several families of wavelets that have proven to be especially useful are included in this toolbox. What follows is an introduction to some wavelet families. There are fifty three types of wavelets are there; such as, Haar, Daubechies, Biorthogonal, Coiflets, Symlets, Morlet, Mexican Hat, Meyer, Other Real Wavelets, Complex Wavelets. Apart from the fifty three wavelets we selected haar, db1, sym3, coif1, bior3.1, rbio3.1 wavelets for the better feature values. From the 10 voice signal, Energy feature extracted for all 6 wavelets. The feature values are normalized then ranked. The normalized feature values are sending to the Adaptive Neuro Fuzzy Interference System (ANFIS) algorithms and then the performance is analyzed [4].

Properties of Wavelets
Simultaneous localization in time and scale: The location of the wavelet allows to explicitly representing the location of events in time. The shape of the wavelet allows representing different detail or resolution.



Sparsity: For functions typically found in practice, many of the coefficients in a wavelet representation are either zero or very small.

Linear-time complexity: Many wavelet transformations can be accomplished in O(N) time.

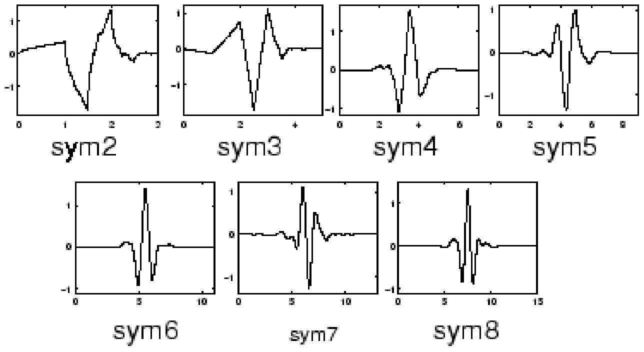
A**daptability**: Wavelets can be adapted to represent a wide variety of functions (e.g., functions with discontinuities, functions defined on bounded domains etc.).Well suited to problems involving images, open or closed curves, and surfaces of just about any variety. Can represent functions with discontinuities or corners more efficiently (i.e., some have sharp corners themselves).

Feature Extraction Using Different Wavelets
Feature extraction is that of extracting from the raw data the information which is most relevant for classification purpose, in the sense of minimizing the within- class pattern variability while enhancing the between-class pattern variability. During the feature extraction process the dimensionality f data is reduced. This is almost always necessary, due to the technical limits in memory and computation time good feature extraction scheme should maintain and enhance those features of the input data which make distinct pattern classes separate from each other.

- Symlet wavelet
- Coiflets wavelet

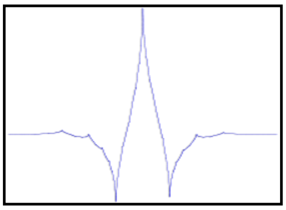
Symlet Wavelet
Symlet wavelets are a family of wavelets. They are a modified version of Daubechies wavelets with increased

symmetry.The different types of symlet waveform are given below



Coiflets Wavelet

Coiflets are discrete wavelets designed by Ingrid Daubechies, at the request of Ronald Coifman, to have scaling functions with vanishing moments.



Feature Selection Using N-Average Wavelet Algorithm:

Step1: Acquiring energy feature values from each audio signal.

Step2: Normalizing the feature values by dividing the individual values by maximum value of each feature.

Let wavelet Features: F1,F2,F3....F53.

n=Number of audio signals considered for training.

$$\frac{F1(1,2\ldots n)}{MaxF1(1,2\ldots n)}$$

Step3: Taking minimum and maximum of individual feature values.

$$F_{min}=\mathrm{Min}(F1(1,2\ldots n))$$
$$F_{max}=\mathrm{Max}(F1(1,2\ldots n))$$

Probably the Max($F1(1,2\ldots n)$) will be 1 for all the feature values.

Step4: Taking difference between the F_{min} and F_{max}

$$F_{Diff=}\ F_{min} \sim F_{max}$$

Step5: Arranging the F_{Diff} for all the 53 features in largest to smallest order and taking the first five maximum features.

Energy values for 10 Input Voice Signals:

Table: Feature values before Normalization

haar	db1	sym3	coif1	bior3.1	rbio3.1	Target
49.70758	49.70758	16.51876	16.52771	25.37883	24.44557	1
49.66484	49.66484	16.56996	16.57294	25.23037	24.21417	2
49.9063	49.9063	16.56431	16.58162	25.46244	24.87006	3
49.65674	49.65674	16.55873	16.56165	25.25736	24.21368	4
49.58814	49.58814	16.53343	16.53605	25.33994	24.10963	5
49.88012	49.88012	16.596	16.60528	25.29236	24.73275	6
49.6616	49.6616	16.58352	16.58337	25.20882	24.104	7
49.85203	49.85203	16.591	16.59792	25.21818	24.80038	8
49.61914	49.61914	16.55747	16.56044	25.31388	23.97441	9
49.59873	49.59873	16.52355	16.52744	25.32167	24.16296	10

Table: Feature values After Normalization (0-1 Scale)

haar	*db1*	*sym3*	*coif1*	*bior3.1*	*rbio3.1*	*Target*
0.996018	0.996018	0.995346	0.995329	0.996716	0.982931	1
0.995162	0.995162	0.998431	0.998052	0.990886	0.973627	2
1	1	0.99809	0.998575	1	1	3
0.994999	0.994999	0.997754	0.997373	0.991946	0.973607	4
0.993625	0.993625	0.99623	0.995831	0.995189	0.969424	5
0.999476	0.999476	1	1	0.99332	0.994479	6
0.995097	0.995097	0.999248	0.998681	0.990039	0.969197	7
0.998913	0.998913	0.999699	0.999557	0.990407	0.997198	8
0.994246	0.994246	0.997679	0.9973	0.994165	0.963987	9
0.993837	0.993837	0.995635	0.995313	0.994471	0.971568	10

Figure: Training data Loaded

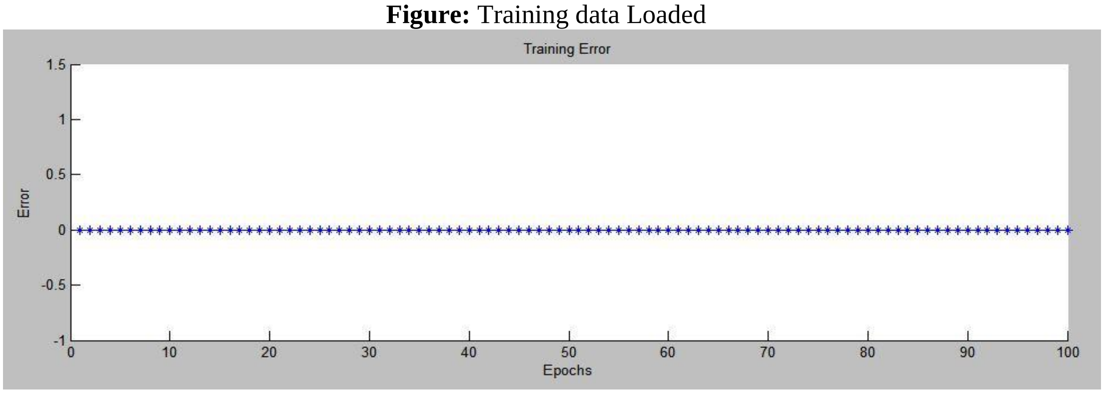


Figure: After training

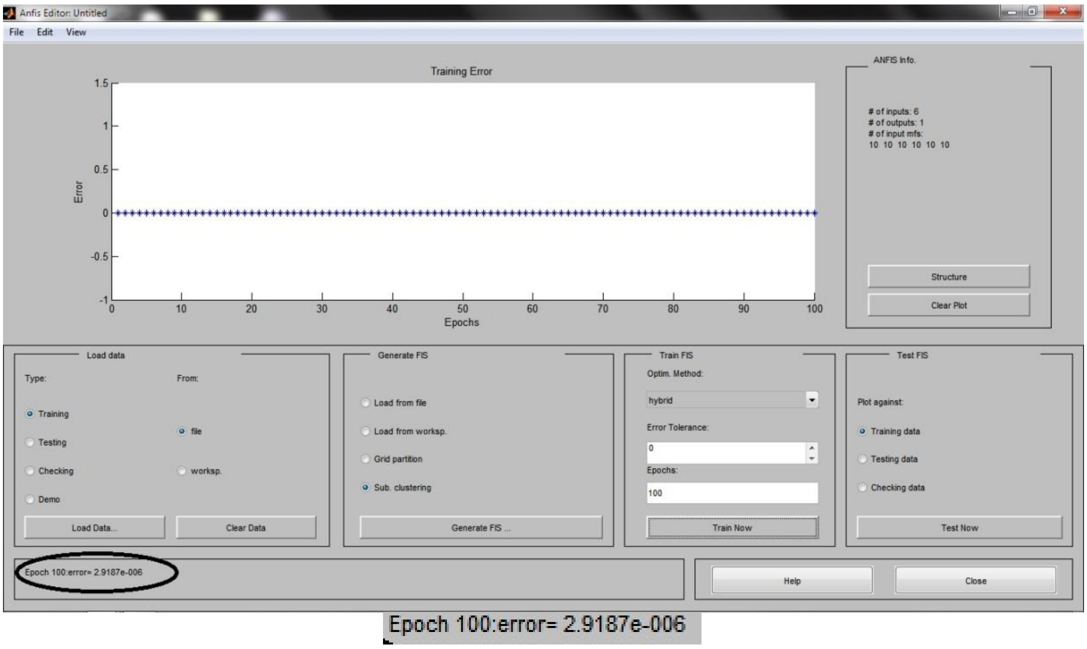


Figure: After training

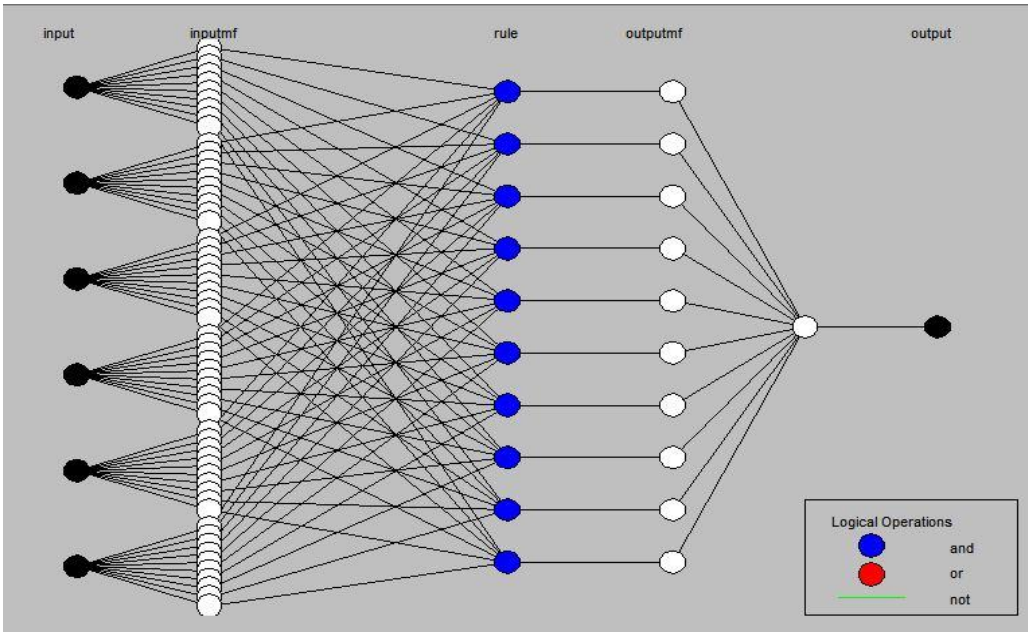


Figure: ANFIS Model Structure

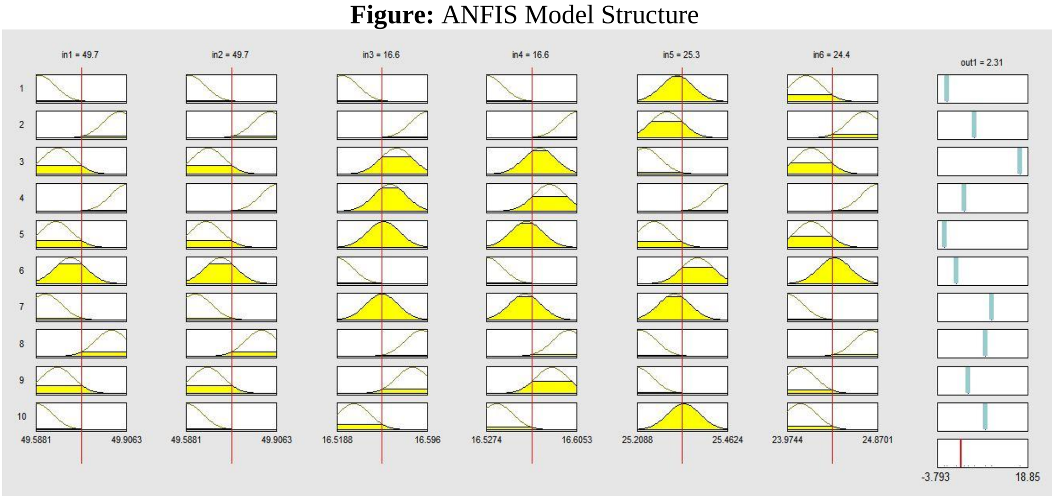


Figure: ANFIS Rule Viewer

5. Results

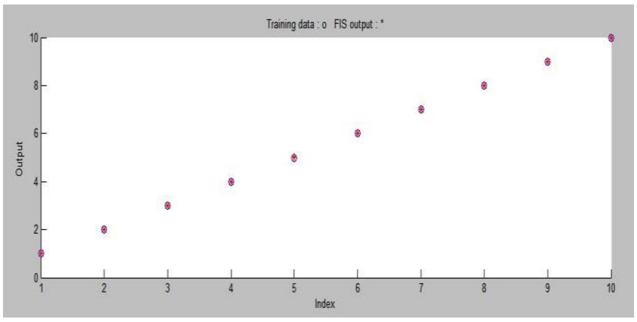


Figure: Trained Data

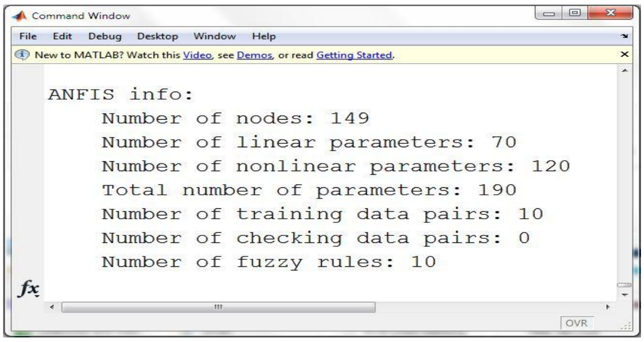


Figure: ANFIS Information

6. Conclusion

A new control system of a voice-controlled wheelchair using Artificial Intelligence (AI) algorithm is proposed. Instruction to the machine through the voice has become inevitable for communication in this current state of technology. The main issue of the continuous voice recognition algorithm is that the complexity is more to find the best match for the given pattern of voice. In our proposed work, Wavelets are used for the feature extraction of the input voice signal; here energy feature is extracted from the given input signal. It has proved more effective feature among all other feature sets. ANFIS model is proposed for voice recognition and were found to achieve highly competitive performance. Our paper brings novel approach to train the Tamil voice signal and move the wheel chair based on the commands by using ANFIS.

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