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Voice Identification System Using Neuro-Fuzzy Approach

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Abstract
This paper presents the design and development of voice identification technique using neuro-fuzzy approach. The system is based upon the fusion concept of artificial neural network with fuzzy logic. The goal of this technique is to identify the voice of human being accurately in different pitches and tones, for these purpose different parameters of speech and surrounding environment are taken into consideration while inputting voice with the help of microphone. Artificial neural network uses back propagation algorithm under supervised learning approach to stimulate parameter like pitch strength, environmental condition, and medical condition of the person. Fuzzy logic deals with determining the unclear input of voice quality and helps in final decision making for voice recognition.

Keywords
Neuro-Fuzzy System, Voice Recognition, Artificial Neural Network, Fuzzy Logic, Type -2 Fuzzy Inference.

I. Introduction

In the present day, sophisticated expert system has taken over traditional computer based information systems. The real time applications are presenting more challenges to undertake critical task involving human expertise. Voice identification presents challenge to recognize the human voice accurately. This application is highly suitable in criminal investigation as well as to stop music piracy. Here the task is to develop such system that could hear like a human expert of voice recognition and give out accurate results. In order to achieve this, two major branches of soft computing namely artificial neural network and fuzzy logic are taken into consideration. By hybridizing these two branches it is possible to generate an expert system in a given domain area [2] – [5]. Artificial neural network incorporates human like learning approach using mathematical functions and algorithms. A feed forward artificial neural network is used with back propagation algorithm having supervised learning approach which leads to proper training of artificial neural network. Fuzzy logic [7] is a multi valued that accepts a range of value for different acoustics produced during voice interpretation. The hybridization is carried out by development of code libraries for artificial neural network and fuzzy logic in C# language. Readymade software packages like ANFIS and DENFIS are available in MATLAB but they lack depth of fuzzy membership function as, fuzzy logic becomes generalization of crisp logic. Hence the capability of fuzzy logic is extended to type -2 fuzzy logic[2] to enhance decision making process for voice identification system [8-10].

II. Methodology

For voice identification, there are three major parameters that affect the voice quality and the sound produced, they are tone, noise and pitch. The tone of a person might get changed due to age or tone might be altered due to medical conditions like cough and cold. The parameter noise relates to external noise produced while inputting voice through microphone, Noise can occur due to environmental effect like echo or reverberation or external unnecessary sound. The parameter pitch relates to volume frequency. If the pitch is higher, then possibility that the voice is of female increases and if pitch is lower, then possibility that the voice is of male increases. To determine pitch level Speech API was used.

1. Fuzzification

The process of fuzzification of three parameters namely; tone, noise and pitch are carried out using triangular fuzzy membership function that associates linguistic variables with fuzzy numbers. Fuzzification is the process of converting crisp analog voice signal to a given range of interval [1]. This range is again separated into different sub-range with the help of type 2 fuzzy logic [6], [11], [13]. Each interval can be recognized using linguistic variable that associates to a fuzzy number as presented in table 1.

Table 1 : Mapping of linguistic variable with fuzzy number

Linguistic Variable	Associated Fuzzy Number
No Voice:	F0 = (0.0,0.0,0.0)
Very Poor Voice:	F1 = (0.0,0.0,0.1)
Poor Voice:	F2 = (0.0,0.1,0.2)
Very Low Voice:	F3 = (0.1,0.2,0.3)
Low Voice:	F4 = (0.2,0.3,0.3)
Slightly Audible Voice:	F5 = (0.3,0.4,0.5)
Audible Voice:	F6 = (0.4,0.5,0.6)
Above Audible Voice:	F7 = (0.5,0.6,0.7)
High Pitch Voice:	F8 = (0.6,0.7,0.7)
Very High pitch Voice:	F9= (0.8,0.9,1.0)
Noise:	F10=(1.0,1.0,1.0)

2. Artificial Neural Network

Based on the linguistic variable as input for artificial neural network, which were fuzzified into fuzzy number in the interval 0 to 1, input and output broad category for artificial neural network is determined. Artificial neural network is composed of three major layers of neurons. The input layer takes input and the output layer produces output, in between input and output layer there can be on or more hidden layer in which back propagation learning algorithm is applied, which actually backtracks until correct output is generated [14]. The input broad category for voice identification system consists of three basic parameters that were taken into consideration earlier namely tone, noise and pitch. The output parameters are associated persons, which matches to their appropriate voice. The sample system generated consisted of three persons namely x, y and z. Different audio samples were gathered from them under different conditions, which were used as training sets to train artificial neural network under supervised approach of learning. Fig. 1 presents artificial neural network with

the help of simulation carried out in Java NNS.

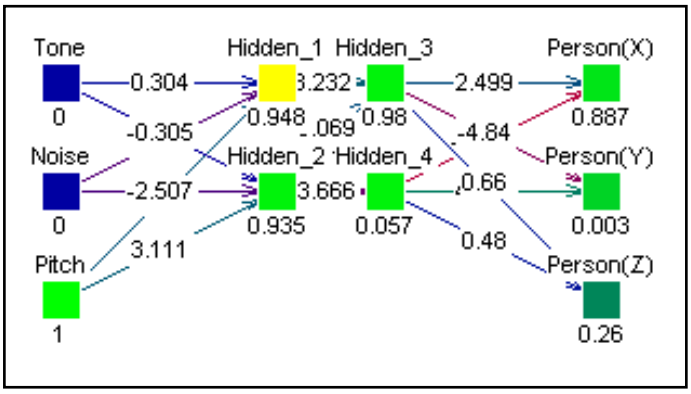

Fig. 1: Artificial Neural Network for Voice Identification

The back propagation algorithm transfers output of hidden layer to the output layer with the help of activation function [12]. Higher the threshold value more is the accuracy of result produce by the artificial neural network, but it also increases the training time duration. The threshold value is generally chosen between intervals 0 to 1, for voice is identification system the selected threshold value is 0.6. The artificial neural network designed for voice identification system after training generates following results on execution.

Table 2: Input parameters for artificial neural network

Voice No	Tone	Noise	Pitch
1	0	0	1
2	0.2	0.9	0.3
3	0.6	0.2	0.8

Table 3 : Output parameters for artificial neural network

Voice No	Person(X)	Person(Y)	Person(Z)
1	0.887	0.003	0.26
2	0.007	0.93	0.18
3	0.16	0.13	0.89

From table 2 and table 3 it is clear that voice 1 belongs to person(X), voice 2 belongs to person(Y) and voice 3 belongs to person(Z).

III. Future Enhancement

A type-2 fuzzy interface can be added to GUI so that there is interaction possible between man and machine. Based on voice identification, computer can perform various tasks as required by their owner. Physical level data entry can be removed and hence reduce man power effort and save time. Voice identification system can be applied in robotics, military equipments, automobile industry and many other areas. In consideration to security voice identification can be thought of as an option along side with biometric devices.

IV. Conclusion

On the basis of the result obtained by simulation of artificial neural network, it is possible to conclude that the voice of a person can be recognized with accuracy using neuro-fuzzy approach. In future same system can be enhanced for more number of people and can be applied in the field of music, acoustics, geothermal sounds, frequency analysis of various biological species, criminal investigation and other major areas of research which incorporates sound as the basis of their study.

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Author's Profile

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