

# Gaussian Membership Function used for Voice Recognition in Fuzzy Logic



Shruti Agarwal, Anshika Agarwal, Prabhakar Gupta

**Abstract**—Gaussian Membership function of a fuzzy set is a generalization form which is used to classify the human voice either based gender or age group. Membership functions were introduced by Zadeh in the first paper on fuzzy sets in the year 1965. In this paper we describe Gaussian membership function which we used to implement the simulation or classification of the human according to their age in fuzzy logic. A Gaussian Membership Function (MF) is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1.

**Keywords**- Gaussian Membership Function, Voice Recognition, Maximum Frequency, Standard Deviation, Coefficient of variation

## I. INTRODUCTION

Fuzzy logic is define with the term “degree of membership”. Fuzzy Logic is an approach to computing based on “degrees of truth” means it neither takes the value completely true or completely false. It takes the value in the 0.1, 0.1, 1.1 etc. The idea of fuzzy logic was first developed by Dr. Lofti Zadeh of the University of California at Berkeley in the year 1960s. There is a reason to introduce the fuzzy logic is used to solve the problems which takes value in between the 0 and 1. Dr. Zadeh introduces this idea when he faces some problem on computer understanding of natural languages. Natural languages is very important we this is the language which considers the most other activities in life which easily converted the terms into 0 and 1[1]. This is very important technique which is used to solve the reasoning problems, binary or Boolean logic problems also. Except this there are also another problems exist in the problem which is solved by Gaussian membership function in fuzzy logic. We use this methodology in the recognition of human voice according to their age. But we can also implement this technique to classify the gender dependent emotion recognition, airspace, artificial neural network and many more problems which exist in the universe which takes the value between the 0 and 1. T

he whole process is that to classify any system is to fuzzify the problem it means select the linguistic variables and convert the crisp values into the linguistic values then use membership function on the fuzzy engine then defuzzify the system it means covert the linguistic variables into the crisp values.

## II. LITERATURE REVIEW

In paper [10], they used two types of models for the voice recognition which namely as Language model and acoustic model.

Acoustic is the word which means something relate to the sound. The main purpose is that to calssify the voice according to their gender. There are many phonetic words of acoustics which are present in the front-end signal of the voice. A model which contains different files holding some statistical representations that assigned a label of the speech which is called as phoneme. There is another method with is used in the acoustic model which is denoted by hidden markov model. Hidden markov model is the model which is used to show the main procedure of the system which covers the internal procedure of the system. An Acoustic model is the model which is applied by taking a large database of speech and by applying different algorithm that helps in creating the statistical representation of each phoneme.

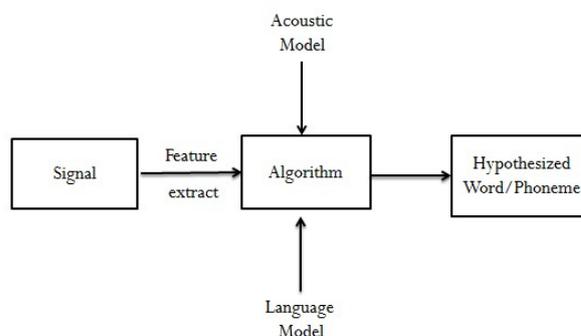


Fig 1: Speech Recognition Architecture

In paper [11], they classify the voice on different age group like child, teen age, young, adult, senior which increases the performance and efficiency of the system and also its accuracy. They use two different techniques to solve this problem which namely as Gaussian Mixture Model and Support Vector Machine. To extract the features they use Mel Frequency Cepstral Coefficient. With the help of these methodologies they improves the performance of the system that is used for the identification of human voice according to their gender and their age. In paper [12], they work on the vowels which are spoken by children.

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They perform the classification of children's voice and the technique which used is divide and conquer. The database is separated on the base of vowels. They use vowel base age estimation technique which is applied on the database to classify the children's voice according to their age.

### III. FUZZIFICATION

Fuzzification is the process which is used to convert the crisp values into the linguistic variables. Fuzzification is the first step which is used to classify or recognize the pattern in fuzzy logic. In the fuzzification process we have to select the linguistic values on which we apply the membership function in the fuzzy inference engine.

Fuzzy inference engine is the central part of the whole process which is used to recognize the human voice according to their age group. And also in the fuzzy inference engine we apply fuzzy if-then rules through which we get the output by using the process defuzzification

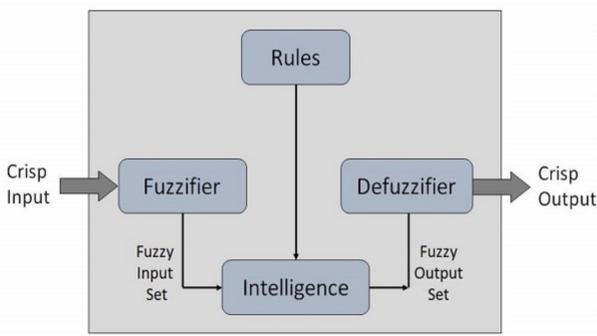


Fig2: Fuzzification Process

### IV. FUZZIFICATION

#### A. Gaussian Membership Function

Gaussian membership function is the function which is used for the classification of the voice according to their age group and gender dependant. Gaussian membership function is applied on many problems which exist in the universe. The function name if the Gaussian membership function is defined by its own name `gaussmf()`. This function is not same as the gaussian probability distribution. Gaussian Membership function has always a value 1. This is the syntax which is used to define the gauss membership function.

`y = gaussmf(x, [sig c])`

This is the formula which is used to calculate the values which is applied for Gaussian membership function to recognize the voice according to their age group.

$$\mu_{A_i}(x) = \exp\left(-\frac{(c_i - x)^2}{2\sigma_i^2}\right)$$

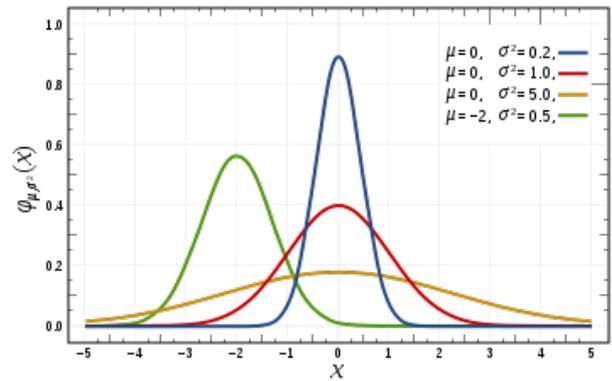


Fig3: Gauss membership function curve[13]

In fig3 it shows the curve which comes after applying the Gaussian membership function name as `gaussmf()`. In this graph the coloured line shows the standard deviation of each input value which we enter in the fuzzification process.

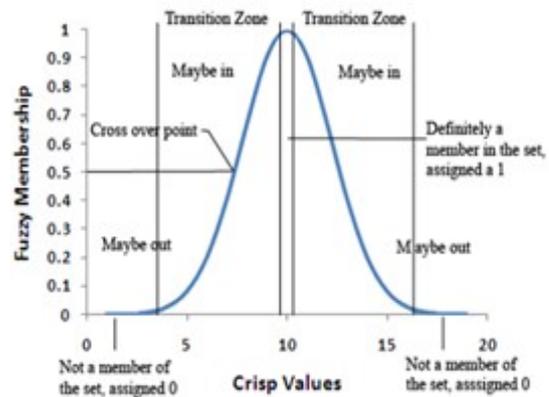
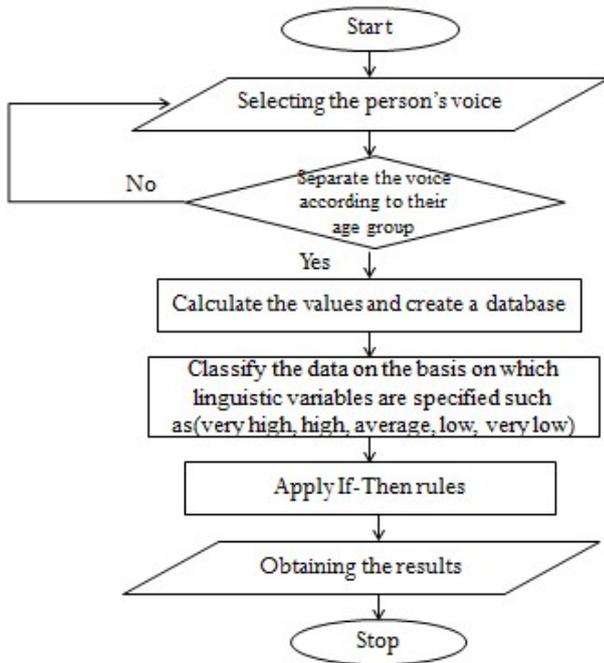


Fig4: Fuzzy Gauss membership function [13]

Gaussian membership function is very efficient method which is used to classify the voice according to their gender and age based voice recognition. Gaussian membership function is applied on the fuzzy inference engine by applying fuzzy if-then rules. The variables which is taken is also known as linguistic variables that is represented by a membership function if there is some uncertainty arises in the result of imprecision and vagueness. Gauss membership function is used in which problems in which there is some ambiguity or confusion in the system. This membership function is very beneficial we have some overlapping or vagueness in the system.

#### B. Proposed Approach-





**Fig5: Proposed Approach to classify the voice according to their age group**

In fig4 it shows the proposed approach of my work. First we select the voice of different age group then we select that voice if the collection is correct the move to next step otherwise we go to step1 again.

After complete the step 3 we calculate the values and create a database then classify the data according to their age group and decides the linguistic variables such as very high, high, average, low, and very low. After deciding the linguistic variables and creating the database we have to apply the fuzzy if-then rules and then obtaining the results.

**V. DEFUZZIFICATION**

Defuzzification is the process which is used to convert the linguistic variables into the crisp values. Defuzzification is also known as defuzzifier which help in getting the output. Without defuzzification we can't get the output. Defuzzification is the last step of the whole process which is used to map the fuzzy set into the crisp set.

There are many different methods for defuzzification methods such as [4]:

1. Center of Sums Method (COS)
2. Center of gravity (COG) / Centroid of Area (COA) Method
3. Maxima Methods
  - a. First of Maxima Method (FOM)
  - b. Last of Maxima Method (LOM)
  - c. Mean of Maxima Method (MOM)

**VI. MAMDANI-TYPE FUZZY INFERENCE**

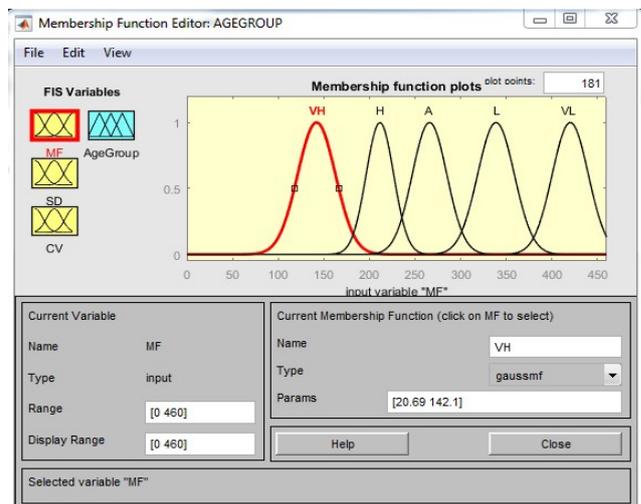
Mamdani Fuzzy inference is one the most common and important methodology which is used in the fuzzy logic control system. This is the first methodology which is used to control the system which is developed to use the fuzzy set theory. This methodology is proposed by Ebrahim Mamdani to experiment to control a steam engine and boiler by symphonizing the set of linguistic control rules which is

getting from expertise. Lofti was published a paper in the year 1973 on the topic fuzzy algorithm for complex systems and decision processes which helps the ebrahim to apply their technique.

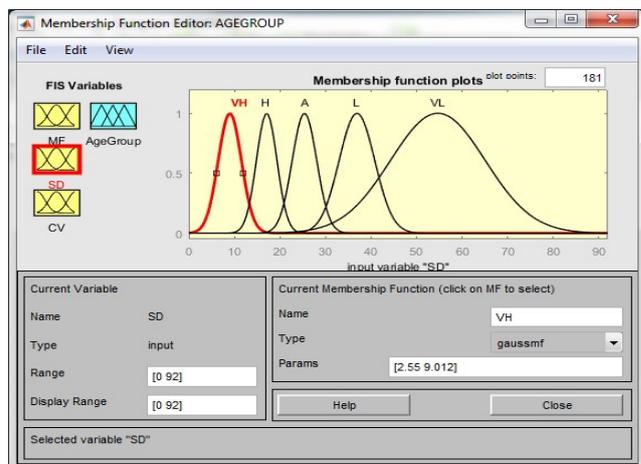
It is defined as a toolbox, which helps in getting the output by using Gaussian membership function on some fuzzy sets. After the aggregation process, there is a fuzzy set for each output variables that demands the defuzzification process.

**VII. SCREENSHOTS**

We use Gaussian Membership function for the recognition of voice according to their age group. We have the database of different voices of different age group and on the basis of that database we recognize the voice according to their age group. We calculate the frequencies, standard deviation and Coefficient of variation of each voice through the oscilloscope, which helps in to classify the voice according to their age group. We are taking five age groups- Infancy, Childhood, Adolescence, Adulthood, and Senior Citizen. We select five linguistic variables such as very high, high, average, low and very low.



**Fig6: Membership Function Editor for input MF**



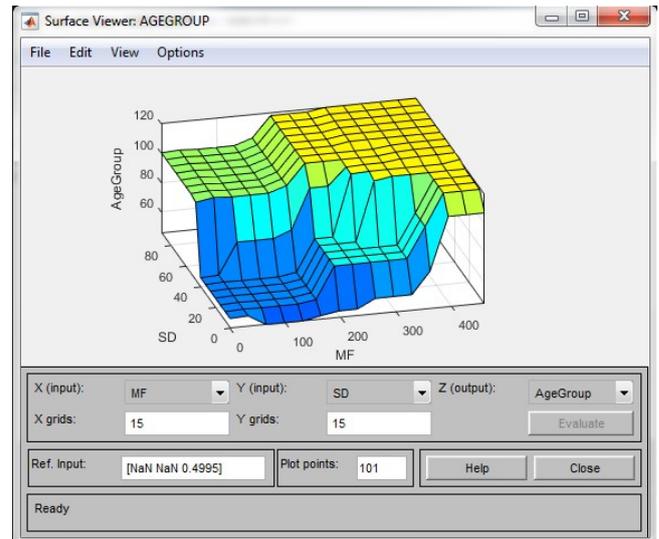
**Fig7: Membership Function Editor for input SD**



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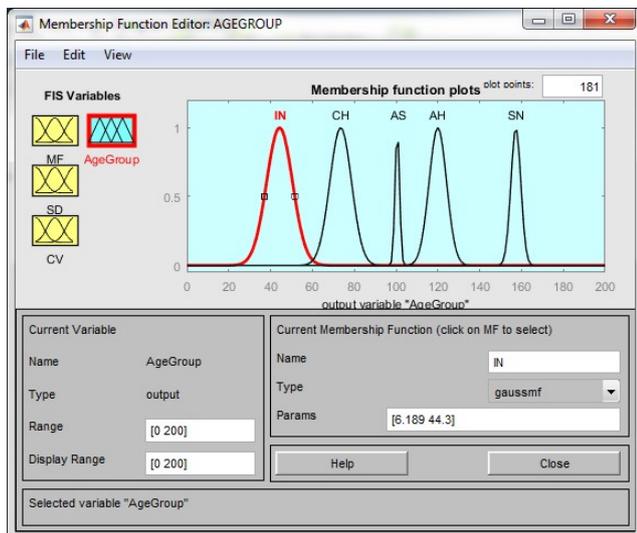


**Fig8: Membership Function Editor for input CV**



**Fig11: Surface Viewer of Age Group**

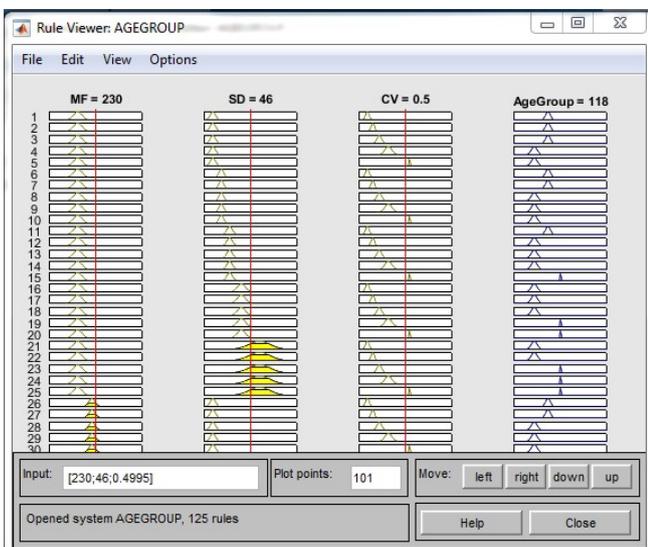
In the above images of results it is shown that there are the variations in each membership function editor which calculates the value of age group with the help of evalfis function in fuzzy logic. In fig 12 it is shown that the curve of each age group are different which helps in to classify the voice according to their age group. In fig 13 it shows the rule viewer editor which defines how the values are calculated with the help of fuzzy if then rules. In fig 14 it shows the surface viewer of the age group between the values maximum frequency and standard deviation.



**Fig9: Membership Function Editor for output Final Age group**

## VIII.CONCLUSION

The conclusion of this paper is that we use Gaussian membership function which is used to classify the voice according to their age group. In this paper we describe how the Gaussian membership function use to recognize or classify the voice according to their age group. The function name of gaussian membership function defines by its own name. There is one popular membership function is Gaussian membership function which is used very efficiently and it is very comfortable with the vagueness of the values. This membership function is easy to understand and easy to implement on the fuzzy toolbox.



**Fig10: Fuzzy Rule Viewer of Age Group**

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