Fuzzy Logic Based Model for Stabilization of Loudness in Audio System

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Abstract- ASC (Automatic Sound Control) system is intelligent sound control systems that automatically stabilized the audio system's Loudness according to Ambience Sound and Listener Distance, and help to improve the intelligibility of speech in the presence of sound disturbing factor. In this paper we have designed the model forloudness stabilization using FLC (Fuzzy Logic Controller)which used fuzzy approach to facilitation of decision making in the decision supports system and provide foundation for approximate reasoning using imprecise proposition based on fuzzy set theory. It has many applications in TV/Radio, microphone, music system etc. and wide area for research to improve the sound quality in tough condition.

Keywords- ASC, FLC, Ambience Sound, Listener Distance.

I. INTRODUCTION

Audio system in TV/radio, music system play important role in human life. With the help this system they get lot of information, news and entertainment. But some time we face difficulty to listen news or information due to surrounding noise or we skip some portion of news and entertainment due to varying distance from source to listener. Due to this, it's become irritating task to manually adjustment of System loudness again and again. Hassan Mohammed et al [1] present automatic sound control models which maintain the sound according to level of ambience sound especially in TV/radios/mobile phone. Another Automatic Sound Control System developed by Chris Goult et al [2] in which they maintained sound level according to distance of listener to speaker. But the present model stabilized the System loudness according to surrounding noise and variation of distance between speakers to listener together. Through this, they keep a stable loudness in our home, office or in a limited area and improve sound clarity in opposite condition.

A. SYSTEM LOUDNESS AND IT'S EFFECTING PARAMETER

i. Loudness

Sound Loudness is a perception of ear to listen something through his senses. It can be measure in dB and it can feel by listener in term of linguistic value such as soft, loud, pleasant, painful etc. A method "Rule of thumb" represents a phone scale for loudness that is double the sound loudness for increasing every 10 phone scale [3]. System Loudness depends on two physical factors acoustic power of the source present in environment, and the distance between source to listener [4].

ii. Ambience Sound

Ambience Sound also denoted as is natural sound which created by different thing happening around the world. It produce by all type living creature, people cloud, vehicle noise, generator noise, wind noise, constructor work, band noise etc. some time it provide well felling but some time it make irritate. It can be measure in dB scale [5].

iii. Listener Distance

Sound wave continues speared over the area so as increasing the distance of Listener, System Loudness continue decrease. The distance affects the sound pressure (amplitude) by1/r and affects the sound energy (Intensity) with$1/r^2$ [6],where r is distance.

iv. MODELLING USING FUZZY LOGIC

Fuzzy logic based control model is a mathematical model that analyzes input value logically [7] and exceed from classical set theory fuzzy set theory. It can be found in a growing number of consumer products from washing machine to speed boots, from air condition units to handhold auto focus cameras [8]. The Fuzzy system structure developed by several steps which are input, fuzzification, inference engine, defuzzification and identified certain rule to apply on these steps for find output. In the first steps the input variables are mapped by sets of membership functions known as "fuzzy sets". In 2nd steps, fuzzification process occurs and the input values translated in to fuzzy value. 3rd steps, known as inference engine in which fuzzy inputs are processed according to the rules set and producing fuzzy outputs [8, 9]. In last step defuzzification occur and fuzzy value translates into analog output. Fuzzy Model base project description and structure are shown in table 1 and figure 1 respectively.

B. PROJECT DESCRIPTION

Input Parameter	2
Output Parameter	1
Intermediate Parameter	0
Rule Blocks	1
Rules	9
Membership Functions	11

Table 1: Project Statistics

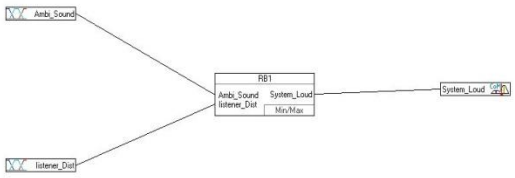

Fig.1: Fuzzy Logic model structure for Stable Loudness

C. INPUT PARAMETERS

All input parameter and their property for design a fuzzy model are listed in table 2.

Table 2: Group of "Inputs" Parameter

Sr. No.	Input Parameter	Type	Unit	Min	Max	Default	Term Names
1	Ambi_Sound		dB	20	100	40	soft pleasant hard
2	Iistener_Dist		M	0	20	7	close middle far

D. INPUT PARAMETER "AMBI_SOUND"

Ambience Sound is first input parameter that is representing as Ambi_Sound. It made by three membership functions, which are soft, pleasant, and hard as shown in figure 2.

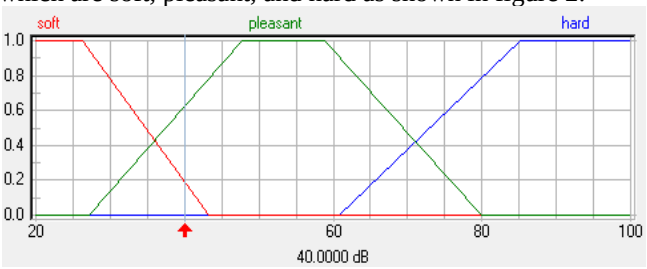

Fig.2: MBF of "Ambi_sound"

Input Parameter "Listener_Dist"

Listener Distance is second input parameter that is representing as Listener_Dist. It made by three membership functions, which are close, medium and far as shown in figure 3.

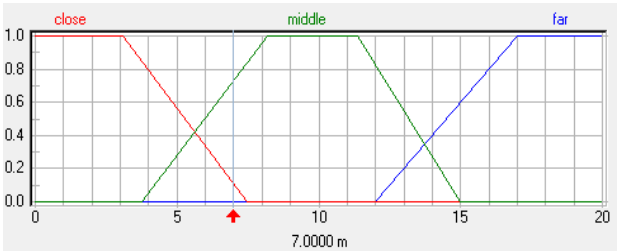

Fig.3: MBF of "Listener_Dist"

E. OUTPUTS PARAMETER

Output parameter and their property for design a fuzzy model are listed in Table 3.

Table 3: Group of "Outputs" Parameter

Sr. No.	Output Parameter	Type	Unit	Min	Max	Default	Term Names
1	System_Loud		dB	20	90	55	very_low low medium high very_high

F. OUTPUT PARAMETER "SYSTEM_LOUD"

The output parameter is System Loudness that is represented as System_Loud. It made by five membership functions, which are very_low, low, medium, high, and very_high as shown in figure 4.

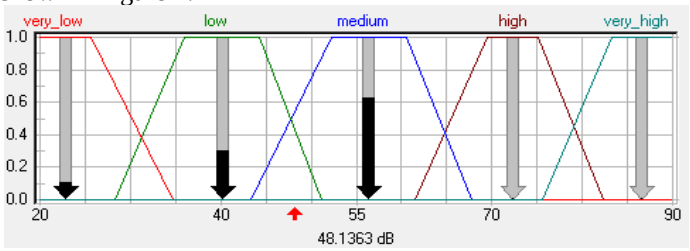

Fig.4: MBF of "System_loud"

II. RULE BLOCK

The rule blocks play an important role to control the functionality of a Fuzzy Logic system. Main function of rule block is to hold the policy, which are created for particular situation and limits the entire rule for same situations. This situation is described in 'IF' Part of rule block and response of Fuzzy system describe in 'THEN' part of rules block shown in table 4. The DoS (degree of support) is used to impact each rule according to its significance. All rule related with Rule Block shown in table 4.

Table 4: Rules of the Rule Block "RB1"

IF		THEN	
Ambi_Sound	**Iistener_Dist**	**DoS**	**System_Loud**
Soft	close	1.00	very_low
Soft	middle	1.00	low
Soft	far	1.00	medium
Pleasant	close	1.00	low
Pleasant	middle	1.00	medium
Pleasant	far	1.00	high
Hard	close	1.00	medium
Hard	middle	1.00	high
Hard	far	1.00	very_high

III. SIMULATION AND RESULTS

In this section a 3D graph has shown in figure 5 which represent the outcome of Simulation process. This process is done using simulation software "fuzyTECH". Developers of this software "INFORM GmbH" and "Inform Software Corporation". Sound Loudness is affected by various parameters, but proposed model shows the effect of two physical parameters that is Ambience Sound and Listener Distance. Sound Loudness is directly affected with the Ambience Sound due to adding with noise signal and affected by speakers to listener distance due to decreasing sound intensity per unit area.

In the figure 5 clearly seen, when Ambience Sound is soft and Listener Distance is close then color intensity is low and System Loudness is very low. As increase the Ambience Sound or increase the Listener Distance or increases both parameter then color intensity become dark and System Loudness got to increase on the basis of policy set in rule block.

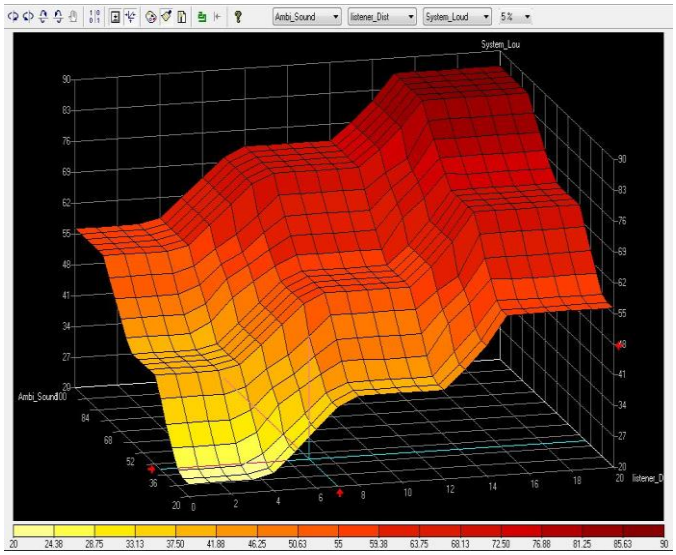

Fig.5: 3D graph for "Ambi_sound" and "Listener_Dist" vs "Sound_Loud".

Table 5: Observation table for fuzzy model

	Input		Output
S. No	**Ambience Sound**	**Listener Distance**	**System Loudness**
1	30.0000	2.0000	25.3588
2	30.0000	7.0000	40.4450
3	30.0000	17.0000	58.7138
4	40.0000	2.0000	36.0700
5	40.0000	7.0000	48.1363
6	40.0000	17.0000	68.5900
7	55.0000	2.0000	40.1512
8	55.0000	7.0000	54.2763
9	55.0000	17.0000	72.3550
10	75.0000	2.0000	51.6838
11	75.0000	7.0000	63.6775
12	75.0000	17.0000	82.5150

In observation table 5 clearly that the System Loudness is directly proportional to the Ambience sound as well as Listener Distance. As the variation occur in Ambience Sound or Listener Distance same as system loudness change according rule block. It increases with increasing Ambience Sound and Listener Distance and decrease with decreasing them.

IV. CONCLUSION

In this paper, we analyzed sound affected parameter and proposed a model based on Fuzzy logic. Present model clear that System Loudness is directly proportion to the input parameter Ambience sound and Listener Distance. It increase with increasing input parameter and decrease with decreasing the input parameter and it make clear sound loudness in noise environment and maintain equal Sound Loudness as walking around. As for future research, this model can be extending to extreme satisfaction with adding more parameter. And make it easy to work in more tough condition.

V. REFERENCES

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