

Assessment of noise induced hearing loss (NIHL) of mine workers in a bauxite mine using fuzzy logic

D.P.Tripathy^{a)}

D.S.Rao^{b)}

Department of Mining Engineering

National Institute of Technology, Odisha, 769008, India

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Abstract: *Noise induced hearing loss is a noticeable problem in mining industry and is mainly caused due to constant exposure to noise. In this paper, an attempt has been made to conduct audiometry survey of 200 mine workers of a major bauxite mine of Odisha, India. Data of miners exposed to noise (≥ 85 dB A) were included and tested for noise-induced hearing loss (NIHL) by using Digital Audiometer. Audiometry results showed that 2.3% miners were affected by NIHL in the age group of 38 to 55 years. Further a Graphical User Interface (GUI) model was developed to predict NIHL by using noise level, frequency and exposure to noise. GUI model showed that the high level of exposure to noise is directly proportional to percentage of NIHL.*

1. INTRODUCTION

This work concentrates on the highly mechanized bauxite mining sector in eighteen different locations (belt tension carriage, crusher, dozer, drill machine, drive house, shovel, dumper 50T, Dumper 55T, excavator, grader, hopper, pay loader, rock breaker, shovel, wheel dozer, cable belt conveyor, canteen, and maintenance garage). The general plan followed for completion of this work included testing of a representative sample of miners from the mine using digital audiometer and audiometric evaluations were performed to quantify possible noise-induced hearing problems.

Now-a -days fuzzy inference systems have found their place in all domains of life due to simple representation of knowledge necessary to crack the problems. An effort has been made in this paper to develop a fuzzy inference system for predicting the NIHL by noise pollution on miners.

2. FUZZY INFERENCE SYSTEM

Fuzzy set theory is a generalization of traditional set theory and provides a means for the representation of imprecision and vagueness that has been successfully applied to many real world problems in various branches of science and engineering^{3,4}.

The main paradigm of fuzzy rule-based system is the fuzzy algorithm in a simple rule-base. The rules represent the relationships between the inputs and outputs of a system. Conceptually, a fuzzy rule-based system consists of five functional blocks as shown in Fig. 1.

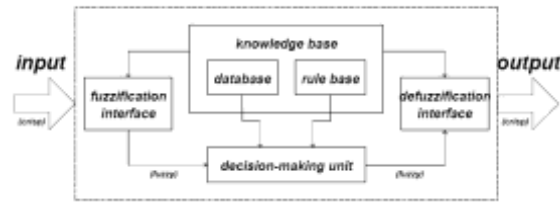


Fig.1 - Structure of Fuzzy Rule Based System

3. METHODOLOGY

3.1 Annoyance survey

The subjective response to machinery noise was measured by means of an annoyance survey. A total of more than 200 questionnaires were distributed and completed questionnaires were collected.

4. RESULTS AND DISCUSSIONS OF AUDIOMETRIC TEST

The percentage of miners affected with NIHL is presented in the Table 1.

Table 1- Percentage of miners effected with NIHL

Workers age	No. tested	Low frequency (0.5,1,2kHz)	High frequency (4 and 8 kHz)	No. of NIHL	n% of the group	Noise induced permanent threshold shift
20-29	36	0	0	0	0	<25
30-39	38	0	1	1	2.63	>25 and <30
40-49	58	0	1	1	1.72	>25 and <30
50+	78	0	2	2	2.56	>25 and <35
All age	200	0	4	4	2.0	

From the audiometric test (PTA) conducted on miners 2.3 % were effected with NIHL. Pure tone audiometric thresholds displayed only slight trends towards increased threshold levels with increasing exposure groups and noise levels. Audiometric results and responses obtained from the questionnaire are found to be nearly equal.

4.1 Results of Fuzzy Inference System

Prediction of hearing loss was performed based on the Membership functions and 216 fuzzy rules that were defined using 3 different attributes. This study results indicated the effectiveness of hearing loss is almost same in Mamdani fuzzy inference system and Sugeno (Takagi-Sugeno-Kang) fuzzy inference system.

4.2 Results & Discussions

The observed hearing impairment was most probably related to the noise level, frequency and exposure to noise. Comparison of the model results with the findings of audiometry are

represented in the Table 2. This study results indicated the effectiveness of hearing loss is almost same in Audiometry, Mamdani fuzzy inference system and Sugeno (Takagi-Sugeno-Kang) fuzzy inference system.

Table 2 - Comparison of the model results with the findings of Audiometry

S.No	Age group (Years)	Probability of NIHL		
		Findings of Audiometry	Model results	
			Mamdani	Sugeno
1	20-29	5 dB	Not significant	Not significant
2	30-39	30 dB	Slight	Slight
3	40-49	30 dB	Slight	Slight
4	50+	35 dB	Slight	Slight

5. CONCLUSION

The main thrust of the present work has been to develop a fuzzy model for the prediction of NIHL as a function of noise levels, frequency, and exposure to noise. From the annoyance survey and the audiometric test, it is clear that 2.5% and 2.3 % miners were affected. A GUI model was developed to predict the NIHL using Mamdani fuzzy inference system and Sugeno (Takagi-Sugeno-Kang) fuzzy inference system. The study results indicated the effectiveness of hearing loss in annoyance survey, Audiometry are almost identical to results of the developed GUI model. Hence Mamdani and Sugeno can be used for predicting the hearing loss.

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