



**DESIGN AND DEVELOPMENT OF AN INTELLIGENT  
HEARING ABILITY LEVEL ASSESSMENT SYSTEM  
USING SOMATOSENSORY STIMULI**

by

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Professor Lakshmi Narayanan K who had given dreams to  
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## LIST OF ABBREVIATIONS

AABR	Automated Auditory Brainstem Response
AAEP	Automated Auditory Evoked Potential
ABHS	Abnormal Hearing Subject
ABR	Auditory Brainstem Response
AEP	Auditory Evoked Potential
AHG	Abnormal Hearing Group
ANOVA	Analysis of Variance
AR	Auto Regressive
ARMA	Autoregressive Moving Average
ARX	Autoregressive model with an Exogenous Input
ASHA	American Speech Hearing Association
BAEP	Brainstem Auditory Evoked Potential
BFF	Box-counting Fractal Feature
BP	Backpropagation
BM	Box-counting Method
CA	Classification Accuracy
DFA	Detrended Fluctuation Analysis
DFFF	Detrended Fluctuation Fractal Feature
EEG	Electroencephalography
ENN	Elman Neural Network
EP	Evoked Potential
ERP	Event Related Potentials
FD	Fractal Dimension
FFT	Fast Fourier Transform
HTR	Hearing Threshold Response
HPR	Hearing Perception Response
HFF	Higuchi Fractal Feature
HM	Higuchi Method
HL	Hearing-threshold Lower
HU	Hearing-threshold Upper
HPL	Hearing Perception Level
ISEF	Independent Spectral Energy Feature

ISENF	Independent Spectral Entropy Feature
ISEENF	Independent Spectral Energy Entropy Feature
ISI	Inter Stimulus Interval
ICA	Individual Classification Accuracy
LLAEP	Long Latency Auditory Evoked Potential
MFNN	Multilayer Feedforward Neural Network
MLAEP	Middle Latency Auditory Evoked Potential
MMN	Mismatch Negativity
MA	Moving Average
NHG	Normal Hearing Group
NHS	Normal Hearing Subject
NN	Neural Network
PSO	Particle Swarm Optimization
PSO NN	Particle Swarm Optimization Neural Network
SBC	Spectral Band Combination
SBC EF	Spectral Band Combination Energy Feature
SBC ENF	Spectral Band Combination Entropy Feature
SBC EENF	Spectral Band Combination Energy Entropy Feature
SD	Standard Deviation
SPL	Sound Pressure Level
SNR	Signal to Noise Ratio
STFT	Short Time Fourier Transform
TEAOE	Transient Evoked Oto-acoustic Emissions
VEP	Visually Evoked Potentials
WT	Wavelet Transform

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## LIST OF SYMBOLS

$\delta$	Delta band
$\theta$	Theta band
$\alpha$	Alpha band
$\beta$	Beta band
$\gamma$	Gamma band
$\mu\text{V}$	Micro volt
T	Temporal Lobe
$p$	poles
$z$	zeros
Hz	Hertz
dB	decibel
HL	Hearing level
$\Omega$	Ohm
ms	Milli second
$\mu\text{s}$	Micro second
K $\Omega$	Kilo ohm
$a(k)$	AR coefficient
$k$	Gain factor
$N$	Data length
$X_i^j$	AEP signal corresponding to the $i^{\text{th}}$ frame of the $j^{\text{th}}$ channel
H(z)	Transfer function

$Xn_i^c$	Normalized data value
$X_i^c$	data to be normalized
$X_{\min}$	Minimum value
$X_{\max}$	Maximum value
$d(z)$	Characteristic equation
$p, q$	real roots, pair of complex roots
$M_{\max}, M_{\min}$	Maximum and Minimum magnitude of the roots
$H_u, H_l$	Upper and Lower hearing threshold factors
$X_i$	$i^{th}$ Swarm particle
$V_i$	Velocity of $i^{th}$ swarm particle
$P_i$	Best previous location of $i^{th}$ swarm particle
$P_g$	Best global location of $i^{th}$ swarm particle

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