CERTIFICATE

It is certified that the work presented in this dissertation entitled **"Genetic algorithm based ECG signal De-noising using EEMD and Fuzzy Thresholding",** in partial fulfillment of the requirement for the award of the degree of **Master of Technology in Signal Processing and Digital Design** submitted by **Snekha (Roll No.2K12/SPD/20)** to the Department **of Electronics and Communication Engineering**, is a record of the student's work carried out under my supervision and guidance.

The work embodied in this dissertation has not been submitted in any Institute/University for the award of any other degree to the best of my knowledge.

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ABSTRACT

ElectroCardioGram (ECG) signal records electrical conduction activity of heart. These are very small signals in strength with narrow bandwidth of 0.05-120 Hz. Physicians especially cardiologist use these signals for diagnosis of the heart's condition or heart diseases. ECG signal is contaminated with various artifacts such as Power Line Interference (PLI), Patient–electrode motion artifacts, Electrode-pop or contact noise, and Baseline Wandering and ElectroMyoGraphic (EMG) noise during acquisition. Analysis of ECG signals becomes difficult to inspect the cardiac activity in the presence of such unwanted signals. So, de-noising of ECG signal is extremely important to prevent misinterpretation of patient's cardiac activity.

Various method are available for de-noising the ECG signal such as Hybrid technique, Empirical Mode Decomposition, Un-decimated Wavelet Transform, Hilbert-Hung Transform, Adaptive Filtering, FIR Filtering, Morphological Filtering, Noise Invalidation Techniques, Non-Local Means Technique and S-Transform etc. All these techniques have some limitations such as mode mixing problem, oscillation in the reconstructed signals, reduced amplitude of the ECG signal and problem of degeneracy etc.

To overcome the above mentioned limitations, a new technique is proposed for de-noising of ECG signal based on Genetic Algorithm and EEMD with the help of Fuzzy Thresholding. EEMD methods are used to decompose the electrocardiogram signal into true Intrinsic Mode Functions (IMFs).Then the IMFs which are ruled by noise are automatically determined using Fuzzy Thresholding and then filtered using Genetic Particle Algorithms to remove the noise. Use of Genetic Particle Filter mitigates the sample degeneracy of Particle Filter (PF).EEMD is used in this thesis instead of EMD because it solves the EMD mode mixing problem. EEMD represents a major improvement with great versatility and robustness in noisy ECG signal filtering.

Keywords: ECG de-noising, Genetic Particle filter, Ensemble Empirical Mode Decomposition, Fuzzy Thresholding and SNR

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LIST OF ABBREVIATIONS USED:

ECG	ELECTROCARDIOGRAM
EMD	EMPIRICAL MODE DECOMPOSITION
EEMD	ENSEMBLE EMPIRICAL MODE DECOMPOSITION
IMF	INTRINSIC MODE FUNCTIONS
PF	PARTICLE FILTER
GA	GENETIC ALGORITHM
GPF	GENETIC PARTICLE FILTER
SNR	SIGNAL-TO-NOISE RATIO
RMSE	ROOT MEAN SQUARE ERROR
EMG	ELECTROMYOGRAM
NLM	NON LOCAL MEAN
PLI	POWER LINE INTERFERENCE
HHT	HILBERT-HUANG TRANSFORM
HS	HILBERT SPECTRUM
SF	SPECTRAL FLATNESS
NADA	NOISE-ASSISTED DATA ANALYSIS
MATLAB	MATRIX LABORATORY
SPF	STANDARD PARTICLE FILTER
FT	FUZZY THRESHOLDING

GM	GEOMETRIC MEAN
AM	ARITHMETIC MEAN
DWT	DISCRETE WAVELET TRANSFORM
LMS	LEAST MEAN SQUARE
FPGA	FIELD PROGRAMMABLE GATE ARRAY
GA-PF	GENETIC ALGORITHM PARTICLE FILTER
SA	SINOATRIAL
AV	ATRIOVENTRICULAR