بسم الله الرحمن الرحيم

(قالوا سبحانك لا علم لنا الا ما علمتنا إنك
أنت العليم الحكيم)

صدق الله العظيم

DEDICATION

To the sole of my father

To my mother

For her endless love, support and prayers.

To my beloved fiancé

To my sisters and brothers

To my university

To my teachers and all who taught me a letter

To my best friends and Colleagues.

To all those whom I love

I dedicate this work hoping that it will be of some benefit…….

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ABSTRACT

In this thesis, we propose a new technique for noise filtering in (MRI) Magnetic Resonance Imaging. In medical image processing, medical image are corrupted by different type of noises. It is very important to obtain precise images to facilitate accurate observations for the given application. Magnetic Resonance Imaging scans are the diagnostic tool of choice in medical field. De-noising is always a challenging problem in magnetic resonance imaging and important for clinical diagnosis and computerized analysis, such as tissue classification and segmentation. It is well known that the noise in magnetic resonance imaging has a rician distribution. Unlike additive Gaussian noise, rician noise is signal dependent, and separating signal from noise is a difficult task. Because of this reason noise removal techniques have been customarily applied to improve MR image quality.

In this thesis firstly, a study of MR image denoising filters was made, these filters have been implemented using MATLAB for reduction rician noise. The quality of the output images is measured by the statistical quantity measures: mean square error (MES), signal to noise ratio (SNR), image quality measure (UQI) and method noise. Secondly, technique was introduced to reduce rician noise in magnetic resonance images (MRI) this done by wavelet transform decomposition and sub-bands mixing (inverse wavelet transform) to obtained the proposed technique image. The proposed technique has been implemented using MATLAB program, applied to synthetics and real MR images, the MSE, SNR, UQI and method noise are taken as performance measures. Experimental results are compared with the results of denoising filters that explain firstly at different noise levels and the proposed technique showing superior performance in most causes was analyzed.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF NOMENCLATURE

MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
NMRI	Nuclear Magnetic Resonance Imaging
FMRI	Functional Magnetic Resonance Imaging
MSE	Mean Square Error
SNR	Signal to Noise Ratio
Q	Image quality measure.
CT	Computed Tomography
RF	Radio Frequency
HVS	Human Visual System
OS	Order Statistic (filter)
PDE	Partial Differential Equation
LMS	Least Mean Square
NLM	Non Local Mean
TV	Total Variation
PPMRI	Partially Parallel Magnetic Resonance Imaging
GRAPPA	Generalized Approach to Parallel Magnetic Resonance Imaging
SENSE	Sensitivity Encoding Magnetic Resonance Imaging
TF	Trilateral Filter
ML	Maximum Likelihood
DUDE	Discrete Universal Denoiser
UINTA	Unsupervised Information Theoretic Adaptive filter
1D	One Dimensional
2D	Two Dimensional
ETIS	Three-valued Increment Sign
MMSE	Minimum Mean Square Error
CWT	Continuous Wavelet Transform
DWT	Discrete Wavelet Transform

LIST OF SYMBOLS

F(g)	Gaussian distribution
G	Gray level
Σ	Standard deviation
M	Mean
M	Magnitude image
U	Original image in gray scale
D_h	Denoised operator depending on h
w(x)	Input signal to filtering
z(x)	Output signal filtered
h(t)	Impulse response
F(x,y)	Filterd image at point (x,y)
$S_{x,y}$	Set of coordinates in rectangular sub image
NL[v]	Estimated value
N_k	Square neighborhood of fixed size and centered of pixel k
z(i)	Normalizing constant
H	Parameter acts as a degree of filtering
σ_d	Spatial distance
σ_r	Intensity distance
C	Normalization constant
N(x)	Spatial neighborhood of pixel (x)
X(t)	Original signal
$\Psi_{m,k}(t)$	Discrete analysis wavelet
$\phi_{1,k}(t)$	Discrete scaling
$D_m(k)$	Detailed signal at scale2^m
$A_1(k)$	Approximated signal at scale2^m
H	Low pass filter
G	High pass filter