DEDICATION

To those who empower me when I feel weak,

The kindness since birth until my death,

The light of my eyes

My parents

To Lovers,

My wife, my son 'Abdullah',

and my brothers and sisters

For their abundant support and encouragement, for their patience and understanding, and for their love

To my friends

ACKNOWLEDGMENT

I want to express my thanks and deepest gratitude to my supervisor, Professor Saad Daoud Al-Shamma; for his guidance and help during my research and study at Sudan University of Sciences and Technology. His perpetual energy, enormous efforts and interest in research had motivated all his advices to me. In addition, he was always accessible and willing to help me in this research.

I would like to present my sincere thanks and pray for His Excellency Ambassador of the Republic of Iraq in Khartoum Dr. Samir Alnima for his valuable support and encouragement.

The professors and all the staff in Biomedical Engineering Department deserve my thanks for the scientific and social environment that facilitated the production of this study.

My special thanks to Dr Abdulgader Ibrahim, the medical director of surgery center in Ahmed Gassim hospital for his help and support. My thanks also due to Dr. Ebtisam Ahmed Ali and Dr. Mohammed Mustafa and to Dr. Anas Al-Shareef, Director General and all staff for their cooperation.

My deep thanks and pray for all of my patients who make this thesis possible I wish them all the soonest and complete cure.

I am very grateful to my family for their help, support and encouragement.