Intelligent Sensor System for Humanitarian Demining

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This thesis was submitted to the department of Electrical Engineering of University of Moratuwa in partial fulfillment of the requirements for the Degree of Master in Science

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University of Moratuwa
Sri Lanka

October 2004

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Declaration

The work submitted in this thesis is the result of my own investigations, except where stated.

It has not already been accepted in substance for any degree, and also is not being concurrently submitted for any other degrees

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Dedication

To my Parents

Thillainadarajah Visvakumar and Arunthavarani Visvakumar

For their guidance, support and care shown towards me

"I've been very blessed. My parents always told me I could be anything I wanted.

When you grow up in a household like that, you learn to believe in yourself."

--Rick Schroeder

Abstract

In any post conflict country, landmines have become a major concern to civilians especially during the resettlement period. Biological Sensors and Metal Detectors are the most common detection technologies used commercially. One of the major drawbacks with the commercially available metal detectors is that they don't have very good discriminating power and in practice they give very high rate of false alarms. Generally the ratio between the detection of a landmine and getting a false alarm varies in the region of 1:100 to 1:1000 depending on the location.

The aim of this study is to introduce an Intelligent Discriminating System so that the false alarms would be reduced. Detailed study on Very Low Frequency (VLF) type Metal Detectors show that, the presence of a ferromagnetic object changes the phase of the signal induced in the receiving coil. This phase change heavily depends on the type of the alloy. This property is used to discriminate ferromagnetic alloys in the proposed methodology.

The field survey shows that the processing speed of the system should be fast and accurate. The aliased signal from the detector receiver coil is used in this study to reduce the processing time. The received signal is further processed using Discrete Wavelet Analysis. The First Level High Frequency Sub-band signal, with Meyer Wavelet, depends highly on the type of material, sweep frequency, and the depth of the material. This processed data is used to classify the object into different classes. Modified version of Adaptive Resonance Theory (ART-1) is used in the classifying process.

The results show that different metals could be classified with 5% significance, same material but different size could be classified with 10% significance and Alloys could be classified into user defined classes; this depends on the templates used in the ART-1. Further by changing the classification algorithm, the objects could be classified into user defined groups.

Acknowledgement

This work would not be possible without the initiation by Dr. Thrishantha Nanayakkara, who introduced me to the wonderful world of demining research by which the mankind could be benefited. His courage and the support made me to achieve my goal. Whenever I get into a problem or hardship, his encouragement made me to rise up and respond to the occasion. My sincere appreciation goes to Dr Nanayakkara for his valuable guidance.

It gives me a great pleasure to acknowledge Prof (Mrs) N Ratnayake (Former Director Postgraduate Studies) for the effort taken by her on awarding the ADB scholarship. Her personnel effort made me to concentrate on my research without financial struggle. I also thank the current Director, Postgraduate studies Dr. N Munasinge and his staff for the support and guidance given to me.

I wish to thank my co-supervisors Prof. (Mrs) Indra Dayawansa and Prof. (Mrs) Delika Dias for the advice, guidance and support given to me. Special thanks to Prof. (Mrs) Dayawansa for making arrangements to use the Telecommunication Laboratory for data acquisition purpose.

I take this opportunity to thank National Science Foundation, Sri Lanka and Asian Development Bank for their financial Support for the project. This has made this dream come true. Further I like to bring forward the following point, as this work is based on developing a new technology for the betterment of the human life and need of a technique for demining in a much faster rate is expressed. The proposed technique if implemented could be of great use. The implementation needs financial and moral support is from Governmental and Non-Governmental organisations which are involved in demining. If the technology is implemented locally, this would be a great boost for demining as well as for researchers, who aim at researches being carried out in Sri Lanka with locally available material and knowledge.

My sincere appreciation to the members of the progress review committee, Prof. Sriyananda (Chairman), Prof Dayawansa, Dr. Perera and Dr. Udawatta, for their comments and guidance which drove me a step further.

I am greatful to Head of Department Dr. Perera and former Head of Department Prof. Lucas for their guidance and special thanks to the technical staff Mr. Leelasiri, Mr Vasantha, Mr. Janaka and Mr. Ashoka for the support given by them to carry out the experiments.

I extend my sincere gratitude to UNDP (Mine Action Unit), Sri Lanka Army, Humanitarian Demining Unit, RONCO and HELO Trust for sharing their expert knowledge and arranging field visits and surveys. This helped me get the first hand knowledge and do my very best towards mankind.

My special thanks to Mr Sivaharan Senior Lecturer, Department of Materials Engineering and the Technical Officer for providing the samples and helping to get the sample composition.

I take this opportunity to thank my friends Aravinthan and Kumarathasan with whom I enjoyed exchanging technical and non technical issues. It was fun working with them. I take this opportunity to wish them the very best in their professional and personnel endeavours.

Last but not least, I wish to express my deepest gratitude to my parents for their unconditional love and support. Thank you for keeping me afloat when I was down and thank you, by always being there when I needed you.

Visvakumar Aravinthan

15th November 2004

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List of Abbreviations

HDU	-	Humanitarian Demining Unit
EMI	-	Electro Magnetic Induction
GPR	-	Ground Penetrating Radar
ART	-	Adaptive Resonance Theory
Tx	-	Transmitting
Rx	-	Receiving
BFO	-	Beat Frequency Oscillator
VLF	-	Very Low Frequency
PI	-	Pulse Induction
R&D	-	Research and Development
UXO	-	Unexploded Ordnance
A/D	-	Analogue to Digital
NIDAQ	-	National Instruments Data Acquisition
MS_2	-	2 cm Mild Steel Sample
MS_5J	-	5 cm Mild Steel Sample
MS_52	-	5 cm Mild Steel Sample at 2 cm depth
JS	-	Jumper Steel Sample
768	-	Medium Carbon Steel
DF2	-	Low Carbon Alloy
Cu	-	Copper Alloy Sample
DFT	-	Discrete Furrier Transform
FFT	-	Fast Furrier Transform
CWT	-	Continuos Wavelet Analysis
DWT	-	Discrete Wavelet Analysis
STM	-	Short Term Memory
LTM	-	Long Term Memory