

# Intelligent Sensor System for Humanitarian Demining

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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.

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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.

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*Visvakumar Aravinthan*

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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