AcousticShield
DESIGNS

January 25, 2005

Mr. Lakshman One
School of Engineering
Science Simon Fraser University
Burnaby, BC
V5A 1S6

Re: ENSC 440 Functional Specification for an Electronic Counter Sniper System

Dear Mr. One:

The enclosed document, *Functional Specification for an Electronic Counter Sniper System*, outlines functional requirements of our product. AcousticShield Designs is currently designing a system that would aid military and law enforcement personnel in quickly and accurately locating the origin of a gunshot.

The purpose of this document is to record the functional specifications for the Electronic Counter Sniper System and is not intended to explore the technical aspects of the design process. The requirement analysis performed is an evaluation of the array of functionality that the system will need.

AcousticShield is an ENSC440 project group, consisting of one fourth year and three fifth year students: Marko Gasic, Sandeep Brar, Balraj Mattu, and Ehsan Dallalzadeh. If you have any concerns or questions regarding this proposal, please contact me by email or by telephone at 604 340-8603.

Sincerely,

Marko Gasic

Marko Gasic,
President and CEO
AcousticShield Designs

Enclosure: *Electronic Counter Sniper System: Functional Specification*

Functional Specification

Acoustic Counter Sniper System

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Issued Date: February 22, 2005

EXECUTIVE SUMMARY

Asymmetric warfare is an unfamiliar term to most of us. For members of our armed forces and civil services however, asymmetric warfare has become the embodiment of a new generation of threats faced in peacekeeping and domestic anti-terrorism operations. No longer is the field of battle dominated by large cohesive armies exhibiting a balance of force, instead, mobile groups or in many cases individuals threaten large, mechanized, and usually much less mobile military formations. The inherent mobility and capability for easy concealment is what allows these individuals to inflict great damage on the much larger force.

AcousticShield aims to develop an Electronic Counter Sniper (ECS) system that uses the acoustic response of a gunshot to identify the precise location of the shooter immediately after the shot is taken. By denying the shooter anonymity and enabling quick and accurate localization, our system will enable military and law enforcement personnel to quickly and effectively locate and respond to such attacks. By making a response much more likely and effective, we believe that our system will act as a significant deterrent in prevent these types of attacks in the first place.

With this document, AcousticShield proposes and outlines the functional specifications for the ECS system described above. Our group consists of 3 fifth year and one fourth year engineering science students with skills in systems integration and programming required to make this project a reality.

Table of Content

1. Introduction

The purpose of this document is to record the functional requirements for the Electronic Counter Sniper. Everything in this document is subject to change and/or refinement during the development process.

The purpose for the Electronic Counter Sniper device is to accurately detect the acoustic signature of a gunshot and to locate the origin of the shot within seconds of the event.

The task of developing such a device is divided into three stages: the signal retrieval stage, the signal processing stage, and finally the user output stage.

1.1   Glossary

A/D: Analog to digital

ECS: Electronic Counter Sniper

CCD: Charged Coupled Device

DSP: Digital Signal Processing

PC: Personal Computer

1.2   Intended Audience

This document is intended to be a functional guideline for the designers and engineers within *AcousticShield.* It also serves to inform potential customers or investors the intended product specifications as experienced by the end user. Its intention serves as ensuring that the product developed by *AcousticShield* meets the specified requirements for appropriate production.

1.3   Conventions

The following notations will be used throughout this document:

[R#]   A requirement

[UC#]   A Use Case

All functional requirements of the device are for the prototype development stage of the product only unless otherwise specified.

2. System Overview

The Electronic Counter Sniper system, a product of AcousticShield Designs is an acoustic sniper localization system. **Error! Reference source not found.** below illustrates the conceptual design of the system.
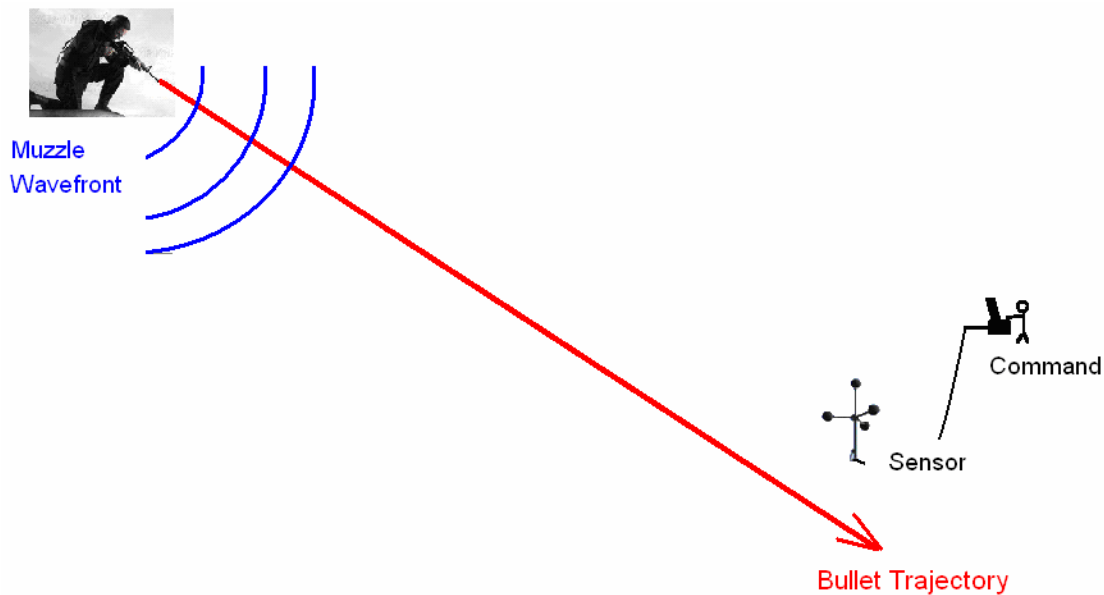

Figure 1: Sniper localization system concept

The system consists of three functional components as follows:

- Retrieval of the incident signal
- Processing of the incident signal
- User Output

Concerns for each of the stages are described below.

In the signal retrieval stage, filtering of environmental noise may be necessary to ensure only useful signal information is processed. Again, the detector's sensitivity to external noise is essential to creating an accurate product.

In the signal processing stage, a device with high precision must be used to distinguish changes in the detected signal. If a gunshot is detected, the information will be sent to the user output device.

The user output stage must accurately describe the origin of the gunshot and display it on an easy to navigate GUI.

3. Use Case Description

3.1   Actors

Operator – is a person who is the user of device.

Sniper – is a candidate for releasing the gunshot.

3.2   Description of the Use Case

UC001   Firing a Gunshot

Pre – Condition(s): Sniper is in a position to fire in an area where the Electronic Counter Sniper system.

Post – Condition(s): The gunshot is detected by the system and shown on the user interface.

1:	The use case begins when the sniper enters the environment.
1.1:	The Sniper aims and fires at a target.
1.2:	The ECS System distinguishes the noise to be a gunshot.
1.3:	The system indicates to the operator the origin of the shot.

Exception(s): Any deviation from this path might result in an error.

4. General System Requirements

AcousticShield Designs ECS system detects the sound of the bullet and calculates the location of its origin. In order for this device to operate diligently, a number of general specifications are required.

4.1   Physical Requirements

R01   The device shall be portable.

The system, including the detection, processing and display units shall be portable. Dimensions of the entire system, including a carrying case, shall not exceed 1.5m x 1m x 0.75m. These dimensions allow for system transport by a single field vehicle such as Hum-Vee. System weight shall not exceed 50kg.

R02   The device shall be field deployable.

System shall be field deployable in operational situations. A two member team with basic training on the operation of the device shall be able to unpack, assemble and calibrate the device in no more that 30 minutes.

R03   The casing shall be capable of enduring field use.

The harsh environment of combat field use requires that device casing as well as any peripheral equipment be composed of such materials and construction so as to resist impact, environment (rain, snow, and ice), dust contamination and rugged use for a period of at least 5 years.

4.2   Power Requirements

R04   The device shall operate on standard 110/220 VAC main line power. The production device shall be capable of operating on a 12V DC power supply, both from an external source (vehicle battery) as well as from a backup battery power supply that shall last for a minimum of 5 hours.

4.3   Performance Requirements

R05   Device shall operate from a stationary location such as checkpoints, posts and bases.

R06 False positive rate shall be less than 10%

There shall be less then 10% chance that a non-qualified sound signature triggers a positive identification and warning.

4.4 Environmental Requirements

R07 The device shall be capable of operating in environments containing other electronic devices. Neither the receiver signal nor the processing unit shall interfere with other equipment in the environment. The device shall not emit EMF radiation beyond acceptable levels specified for a FCC class B device and shall be capable of receiving any interference EMF radiation.

R08 Production device shall be capable of operating in temperatures of -40 to 55 degrees C. Device shall be tolerant to rain, snow dust and other contaminants as per indicated standard specifications. (See section 9)

5. Detection Module Requirements

Detecting a clean (low noise) signal is essential to determining whether or not the noise can be distinguished as a gunshot. Since the change in the reflected signal from the skin will be very small, the detector must be chosen to appropriately match the transmission module's signal. The detection requirements are listed below.

R09 The detector shall detect incoming signals at the transmission frequency only.

R10 The detector shall have a high rejection ratio for the out-of-band signals to minimize the effect of interference.

R11 The detector shall be able to strengthen the incoming signal and achieve a signal-to-noise ratio of greater than or equal to 60db [6] for further analog-signal processing.

R12 Device shall have a detection range of up to 1000m

A 1000 m detection range is at the edge of effective distance of most field use sniper rifles, any shots originating from more than 1000m distance are deemed to be ineffective.

R13   Device shall have angular accuracy of detection greater than 10° in both the XY and Z coordinates. Any indicated location that is within 10° of the actual shot origin location shall be considered successful identification.

R14   Device shall have a probability of detection >80%.

For every actual shot taken within the range of device, there shall be an 80% or grater chance of the device successfully identifying the origin of the shot as per R12.

6. Processing Module Requirements

Processing the variations of the detection stage will have the most impact on the accuracy of the overall device. Not only does this stage have to be time efficient, it must be accurate as outlined in the performance specifications.

R15   Module shall not be sensitive to temperature variations

R16   Should be able to sample input signal atleast 11KHz [As per experimental data]

R17   The processor should be able to process a signal with the signal to noise ratio as described in the detection module requirements.

R18   The processor should be able to process the input signal no more than 5 seconds [6].

7. User Interface Requirements

The user interface shall display on the useful information regarding the location of the origin of the gunshot and nothing else that may disturb the operator. The result should be displayed in a manner that is easy to understand even for an individual that has never used the system before.

R19 The device shall display coordinates of the gunshot result in all dimensions of the spherical coordinate system

R20 The device shall be very easy to navigate

R21 The device should be bright enough to view the results in highly illuminated conditions

R22 The device should have a self diagnostics to ensure proper operation.

R23 The device should have a fast and convenient help mechanism built in.

R24 The device shall be aesthetically pleasing – no distracting color schemes.

8. System Test Plan

To ensure that AcousticShield Designs ECS system produces very accurate and reproducible results, several phases of testing will need to be conducted. The prototype will be tested with a pre-recorded sound of a typical gunshot, played through a speaker to be positioned in various locations within the operational range of the device. The testing environment will be such that it simulates acoustics of field use

The tests will be considered a success if the device is able to identify the location of the shot and distinguish a gunshot from similar noises. The accuracy of the device will be as described by in the system requirements.

9. Standards Requirements

Standards requirements for the ECS System will be similar to those found in already produced products of this type. The system shall conform to any additional physical requirements as required by appropriate MIL-Spec equipment standard applicable to field deployable electronic surveillance equipment. This standard includes specifications on altitude, temperature and other environmental parameters. System enclosure shall conform to the NEMA 6P standard where not superseded by MIL-Spec standard.

10. Documentation

R25   A technical user's manual will be provided in English

R26   A walk through video will be provided showing how to set up and use the ECS System.

R27   The user manual shall include step-by-step use of the ECS System

R28   Contacts will be available with the product package

11. Schedule

The following chart outlines our projected schedules for each segment of the project. The main goal of this schedule is to ensure a proper prototype and the paperwork can be completed within allotted time frames.
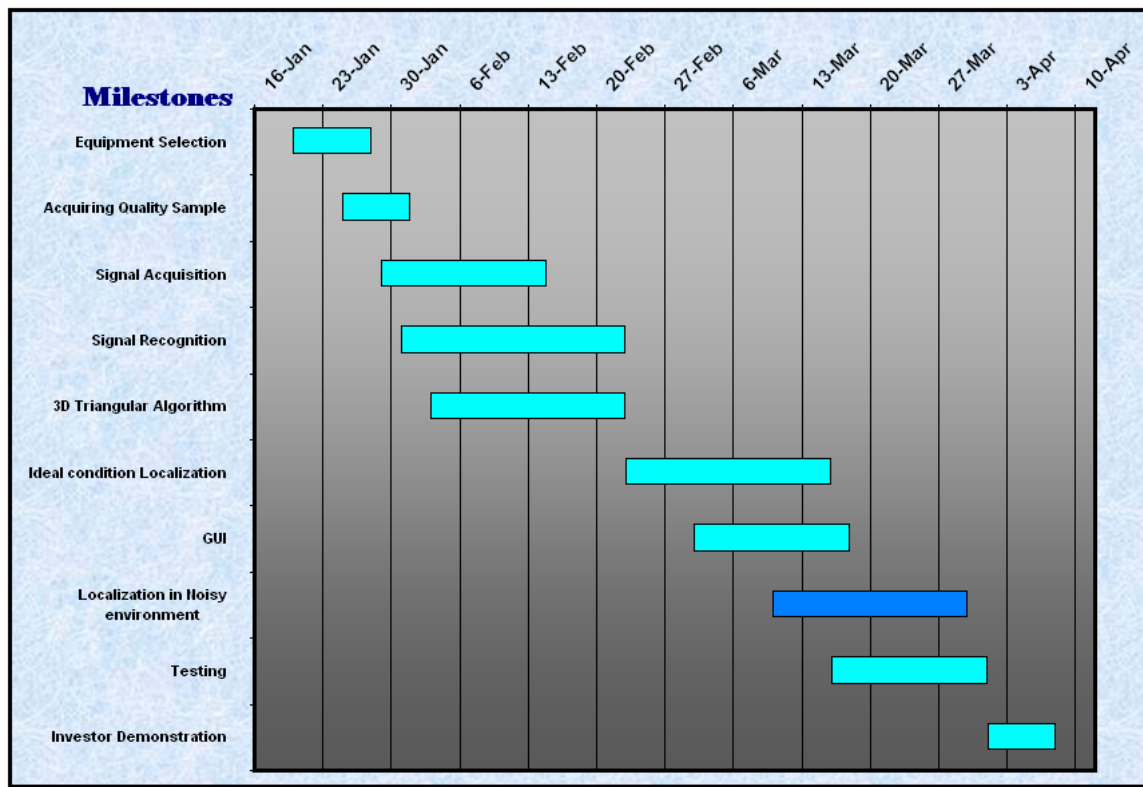

Figure 2: Gantt Chart

12. Conclusion

This document outlines the functions, requirements and standards that must be completed for the Electronic Counter Sniper system to be a beneficial tool in law enforcement and threat deterrent products. Given these specifications, we are confident that we will satisfy at minimum our prototype requirements by the middle of April 2005.

13. References

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[5] G.L. Duckworth, J.E. Barger, S.H. Carlson, D.C. Gilbert, M.L. Knack, J. Korn, R.J. Mullen. "Fixed and wearable acoustic counter-sniper systems for law enforcement". BBN Technologies: Cambridge, MA. [1998]

[6] Srour, Nino. "Army Acoustics Needs. DARPA Air-Coupled Acoustic" US Army Reserch Laboratory: Adelphi, MD. [1999]