THE REDUCTION OF CONTINUOUS WAVE INTERFERENCE IN GLOBAL POSITIONING SYSTEM COARSE ACQUISITION SIGNALS USING ADAPTIVE NOISE CANCELLATION

by

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A THESIS

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We, the undersigned members of the Graduate Faculty of The University of Alabama in Huntsville, certify that we have advised and/or supervised the candidate on the work described in this thesis. We further certify that we have reviewed the thesis manuscript and approve it in partial fulfillment of the requirements for the degree of Master of Science in Engineering.

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ABSTRACT
School of Graduate Studies
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Degree Master of Science in Engineering College/Dept. Engineering/Electrical & Computer Engineering

Name of Candidate Jared G. Meadows

Title The Reduction of Continuous Wave Interference in Global Positioning System Coarse Acquisition Signals Using Adaptive Noise Cancellation

In this thesis, an approach to reducing continuous wave interference in GPS signals is presented. The GPS coarse acquisition signal is a spread spectrum signal that is spread with Gold codes. The properties of the Gold codes used in the GPS signal structure give the signal small out of phase correlations. These small out of phase correlations make adaptive filtering an attractive solution to the continuous wave interference problem.

Adaptive noise cancellation as a solution is discussed and a filter is developed. The implementation of the adaptive noise canceller in a digital intermediate frequency GPS receiver is then presented and simulated using a software signal generator and a software intermediate frequency receiver. The simulation shows that a receiver using adaptive noise cancellation produces acquisitions in jamming scenarios where an unaided receiver either falsely acquires the jammer, or is unable to acquire the GPS signal altogether.

Abstract Approval: Committee Chair _____

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LIST OF SYMBOLS

Symbol	**Definition**
Δ	Delay used in adaptive noise cancellation
∇_k	Performance surface's k^{th} gradient
$\hat{\nabla}_k$	LMS algorithm's k^{th} estimate of the gradient
ε_k	Adaptive filter's k^{th} error
ξ	Mean Squared Error

Acronym	**Definition**
A/D	Analog to digital
ANC	Adaptive Noise Cancellation
bps	bits per second
BRT	Baseline Receiver Toolbox

To “some important names here”.

CHAPTER 1

INTRODUCTION

The global positioning system (GPS) is used in a variety of applications where accurate user position data is required. While the system is robust, it is susceptible to interference. The nature of the interference could be unintentional, as is the case with harmonics, and can be expected anywhere in the world. Or the interference could be a direct attempt to disrupt the use of the system [1]. Regardless of the source, degraded performance or loss of use could significantly impact daily life.

One type of interference, and the type focused on in this thesis, is continuous wave (CW). CW interference consists of a signal with a single tone; one example being an unmodulated carrier. Initially, the solution may seem trivial, simply place a notch filter at the jammer's location. The correct placement of the notch would require some prior knowledge of the jammer's frequency. However, the receiver must operate in an unknown environment, that is, it must be assumed that the jammer can appear anywhere in the received bandwidth. The requirement that the receiver operate in an unknown environment is the motivation for investigating adaptive noise cancellation (ANC) as a potential solution to the CW jammer problem.

APPENDICES

APPENDIX A

AN EXAMPLE APPENDIX

This is a simple example of an appendix where a figure and table are added to the document. The captions from Figure A.1, and Table A.1 will appear in the List of Figures and List of Tables respectively.

Figure A.1 A simple figure.

Table A.1 A Simple Table.

Column 1	Column 2	Column 3
2	46.109	150
5	46.109	130
6	46.109	130
9	46.109	130
13	46.109	150
15	46.109	130
19	46.109	130

REFERENCES

[1] P. W. Ward, J. W. Betz, and C. J. Hegarty, "Interference, multipath, and scintillation," in *Understanding GPS Principles and Applications*, E. D. Kaplan and C. J. Hegarty, Eds. Norwood, MA: Artech House, 2006, pp. 243–297.