

GPS Interference Mitigation for Small UAV Applications

by

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Abbreviations

ADC: Analogue to Digital Converter
AGC: Automatic Gain Control
AJ: anti-jam/anti-jamming
AOA: Angle of Arrival
BPF: Band Pass Filter
CECOM: Communications-Electronics Command
CDMA: Code Division Multiple Access
C/No: Carrier to Noise Density Ratio
DAC: Digital to Analogue Converter
DLMS: Delayed Least Mean Square
DOA: Direction of Arrival
DSP: Digital Signal Processing
DSSS: Direct-Sequence Spread Spectrum
EMC: Electromagnetic Compatibility
FFT: Fast Fourier Transform
FIR: Finite Impulse Response
FPGA: Field Programmable Gate Array
GLONASS: Global Navigation Satellite System
GNSS: Global Navigation Satellite System
GPIB: General Purpose Interface Bus
GPS: Global Positioning System
IF: Intermediate Frequency
IP3: Third Order Interception Point
IIP3: Input IP3
INS: Inertial Navigation System
LMS: Least Mean Square
LNA: Low Noise Amplifier
LO: Local Oscillator
MDS: Minimum Detectable Signal
MSE: Mean Square Error
MVDR: Minimum Variance Distortionless Response
NF: Noise Figure

NLMS: Normalised Least Mean Square

OIP3: Output IP3

PCB: Printed Circuit Board

RBW: Resolution Bandwidth

RF: Radio Frequency

SFAP: Space Frequency Adaptive Processing

SFDR: Spurious Free Dynamic Range

SIR: Signal to Interference Ratio

SMA: Sub-Miniature A (type of RF connector)

SNR: Signal to Noise Ratio

STAP: Space Time Adaptive Processing

UAV: Unmanned Aerial Vehicle

VCO: Voltage Controlled Oscillator

VHDL: VHSIC (Very High Speed Integrated Circuit) Hardware Description
Language

WGN: White Gaussian Noise

Abstract

The vulnerability of GPS to interference has been a major concern for both military and civilian applications, including small UAVs. Various signal processing techniques have been developed to improve the reliability of GPS receivers against different types of interference. Among these techniques, null steering is recognized as an effective method to protect GPS against both narrowband and broadband interference. However, due to the requirement of multiple antenna channels, it has mainly been implemented for large platform applications.

This thesis examines the suitability of null steering techniques for small UAV applications and determines the practically achievable anti-jamming ability by implementing a two-element miniaturized adaptive antenna array.

The adaptive antenna array is tested against a 2MHz broadband jamming signal under both laboratory testing conditions and a real jamming environment. Approximately 40dB anti-jamming range was achieved in the laboratory testing conditions. 38dB and 42dB were obtained in a real jamming environment with different antenna configuration. The likely performance limitations and possible further performance enhancements are also outlined in this thesis.

Publications

J. Li & M. Trinkle, “Miniaturized GPS interference canceller for UAV application”, presented at IGNSS-07, December 4-6, 2007. Awarded for “*Best Academic Paper*”.

Statement of Originality

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