Adaptive Antenna Array Processing for GPS Receivers

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Contents

Statement of Originality

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Abstract

This thesis describes a blind beamforming technique for GPS receivers. It improves the performance of a GPS receiver by mitigating interference and enhancing GPS signals separately and has a three-stage structure.

The technique is based on a linear antenna array and integrates the eigen-decomposition based subspace and multiple independent beamforming techniques. A signal model is carefully constructed. Particular emphasis is placed upon the projection matrix derived from the subspace technique. The effect of interference and phase error on this technique is discussed.

This technique is tested and compared to null steering and MMSE technique using simulated data for a number of interference environments. Furthermore, the proposed technique is applied to real data and shows several advantages over simple null steering.

Abbreviations

ADC:	Analog-to-Digital Converter
AG	Array Gain
AGC:	Automatic Gain Control
AIC:	A Information Criterion
AM:	Amplitude Modulation
BF	Beamformer
BPSK:	Binary Phase Shift Keying
C/A:	Course/Acquisition Code, One Type of PRN Codes
CB:	Citizens Band
CBF:	Conventional Beamformer
CDMA:	Code Division Multiple Access
C/No:	Carrier-to-Noise ratio
CW:	Continuous Wave
DOA:	Direction of Arrival
DS-CDMA:	Direct Sequence Code Division Multiple Access
DS-SS:	Direct Sequence-Spread Spectrum
FM:	Frequency Modulation
FPGA:	Field Programmable Gates Array
GNSS:	Global Navigation Satellite System
GPS:	Global Positioning System
GRET:	GPS RF Environment Testbed
I:	In-phase
IF:	Intermediate Frequency
LMS:	Least Mean Square
LPF:	Low Pass Filter
L1:	L1 Frequency Band, 1575.42MHz
L2:	L2 Frequency Band, 227.6MHz
MaxSINR:	Maximum Signal-to-Interference and Noise Ratio

MaxSNR:	Maximum Signal-to-Noise Ratio
MDL:	Minimum Description Length
MMSE:	Minimum Mean Square Error
MSC:	Multiple Sidelobe Canceller
MSNNR:	Maximum Signal-plus-Noise-to-Noise Ratio
MVDR:	Minimum Variance Distortionless Response
NCO:	Numerically Controlled Oscillator
PRN:	Pseudo Random Noise
P[Y]:	P code, One Type of PRN Codes
Q:	Quadra-phase
RF:	Radio Frequency
RFI:	RF Interference
RHCP:	Right Hand Side Circularly Polarisation
SINR:	Signal-to-Interference and Noise Ratio
SIR:	Signal-to-Interference Ratio
SNR:	Signal-to-Noise Ratio
SV:	Space Vehicle
UAV:	Unmanned Aerial Vehicle
UWB:	Ultra-wideband

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