



THE UNIVERSITY
OF BIRMINGHAM



MICROWAVE INTEGRATED SYSTEMS LABORATORY

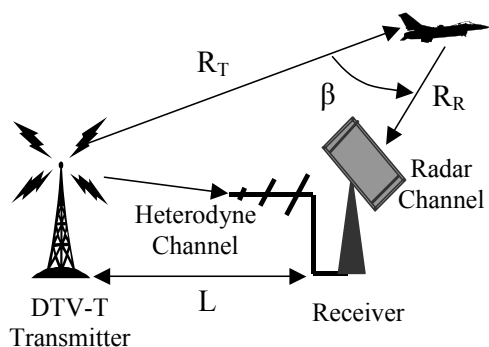
Digital Television-Based Radar

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Project Overview

Over recent years there has been growing interest in bistatic radars, in particular bistatic radars with non-cooperative transmitters (NCT). This technology utilises existing broadcasting, communications and navigation transmitter systems to build bistatic radars. The most attractive feature of bistatic radars with NCT is that the receiver is completely passive. In a hostile environment this is highly desirable as the receiver may be used covertly. Another advantage is that there is no need to build transmitters, or allocate an appropriate frequency band for the radar. As a result, the system could be built cost effectively.

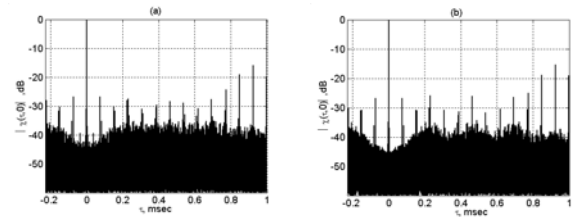
TV stations are potential candidates for NCT. These stations have a high radiating power, a vast coverage area and a wide bandwidth that provides about 20m range resolution.



DTV-T based radar

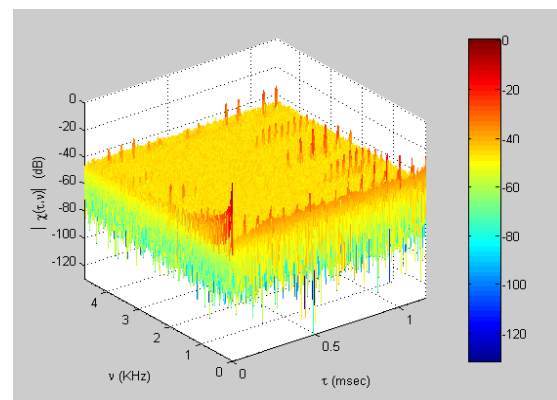
A number of research efforts studying bistatic radar have used analogue television (ATV) as the NCT. Currently, ATV is being replaced by digital video broadcasting standards. This catalyzes a new set of studies: bistatic radar based on digital television-terrestrial (DTV-T) as the NCT.

Fundamental differences between the transmitting signals in ATV and DTV require new research in this area - which is the subject of this research.



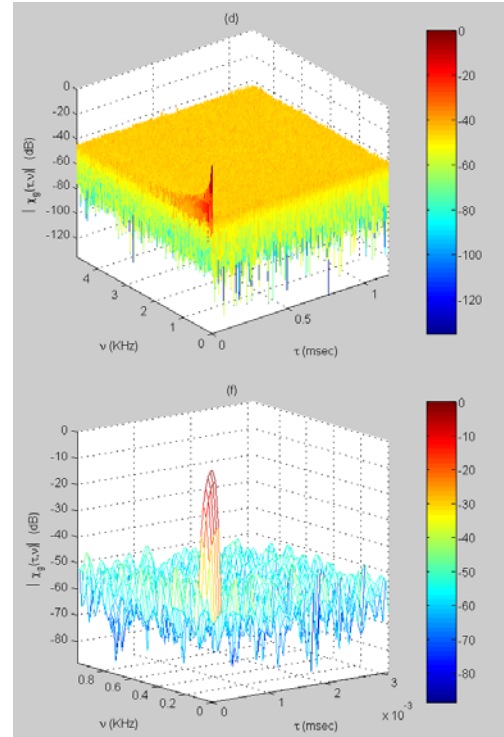
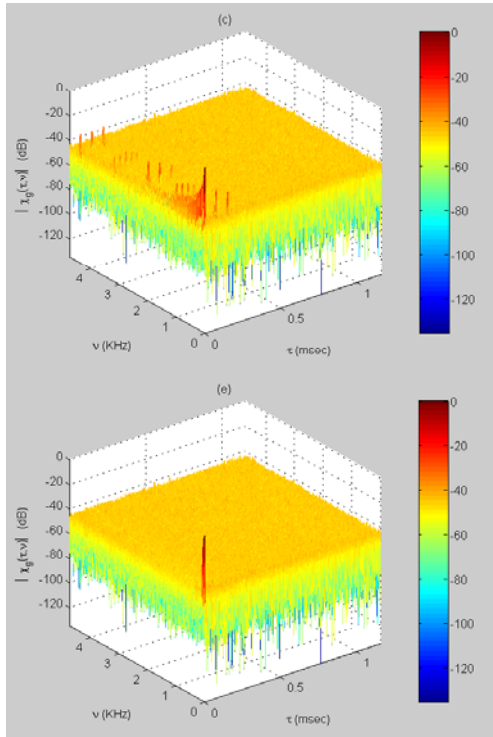
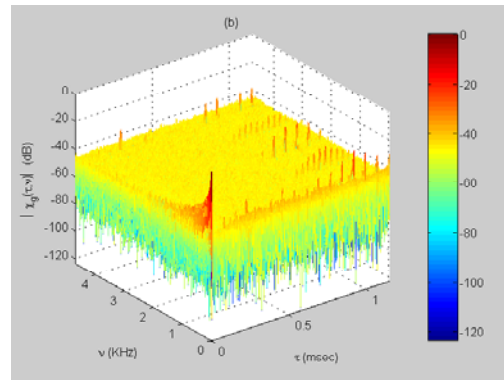
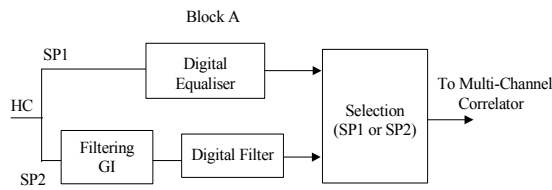
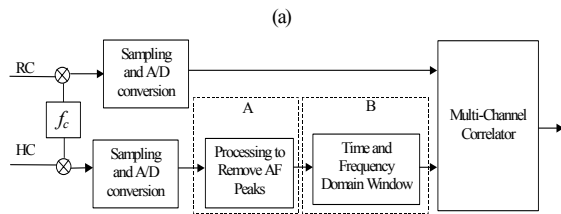
Autocorrelation function of DTV-T signal (a) Experimental, (b) Modelled

The first step in the design of any radar is waveform analysis, which specifies the main system parameters. The universal characteristics of a radar signal are defined by its ambiguity function (AF). This project consists of two distinctive parts: DTV-T signal AF analysis and the methods of improving the AF, via heterodyne channel (HC) signal pre-processing at the receiver side.



AF of DTV-T signal

Using computer simulation and practical experimentation, it was shown that the main part of the DTV-T signal is a perfectly random signal and its corresponding AF has no ambiguities in delay and Doppler domain. However the DTV-T signal also contains some deterministic components [guard interval (GI), pilot carriers (PC)], which introduce a number of undesired peaks in the AF.



(a) Signal processing for AF improvement (b) GAF for SP1 (c) GAF for SP2. (d) GAF, combining SP1 and SP2 (e) GAF, combining SP1, SP2 and windowing (f) Zoomed view of (e)

The presence of these peaks can mask the signal reflected from the targets and/or introduce false targets.

To mitigate the unwanted peaks, two complementary algorithms, based on mismatching between the HC and radar channel (RC) signals, were proposed. The first of these is the power equalisation of PC in the HC signal; the second is the filtering-out of PC components in the HC prior to correlation with the RC. These two algorithms cannot be applied simultaneously as the equalisation and filtering procedure counteract each other. Instead the HC signal is split into two parallel channels consisting of: signal processing1 (SP1), equalisation; and signal processing 2 (SP2), filtering. The modified HC signals from SP1 and SP2 are selected according to a rule, which gives a

generalised ambiguity function (GAF) without any peaks, with only ~13% power loss.

As seen from the AF and GAF of the DTV-T signal, the high sidelobe level surrounding the mainlobe degrades the resolvability of close targets. This drawback is not a problem specific to only DTV-T based radar; therefore to improve this situation as is necessary, a well-known windowing procedure could be applied both in time and frequency domains.

In contrast to ATV, the DTV signal provides range resolution of 20 m. The developed and tested algorithms of signal processing converts the DTV-T signal into an ideal noise-like signal. This makes the DTV-T based bistatic radar a viable possibility for many practical applications.