Multi-Static TDOA Radar

Abstract

I graduated from the University of Aberdeen with a degree in electronics and electrical engineering. As part of the finial year of my degree I completed an undergraduate thesis where I considered the concept of a multi static passive radar system capable of tracking commercial civil aircraft using transmitters of opportunity. This entry will cover some of the basic principals of a passive radar system. Using an example system the basic principles of a multi-static TDOA passive radar system will be explained.

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Acronyms

SESAR	Single European Sky ATM Research
RADAR	Radio Detection and Ranging
TDOA	Time Difference of Arrival

Introduction

As part of the finial year of my degree at the University of Aberdeen I completed an undergraduate thesis. In my thesis I considered the concept of a multi static passive radar system capable of tracking civil aircraft using transmitters of opportunity.

I aim to use this journal as a means of exploring the ideas outlined in my thesis and expanding upon them. Using this journal I will break down my thesis and re-examine the background, principals, motivations, benefits and applications of a multi static passive radar system.

Multi-Static TDOA Radar

In this entry I will cover some of the basic principals of a passive radar system. Using an example system the basic idea of the proposed passive radar system will be

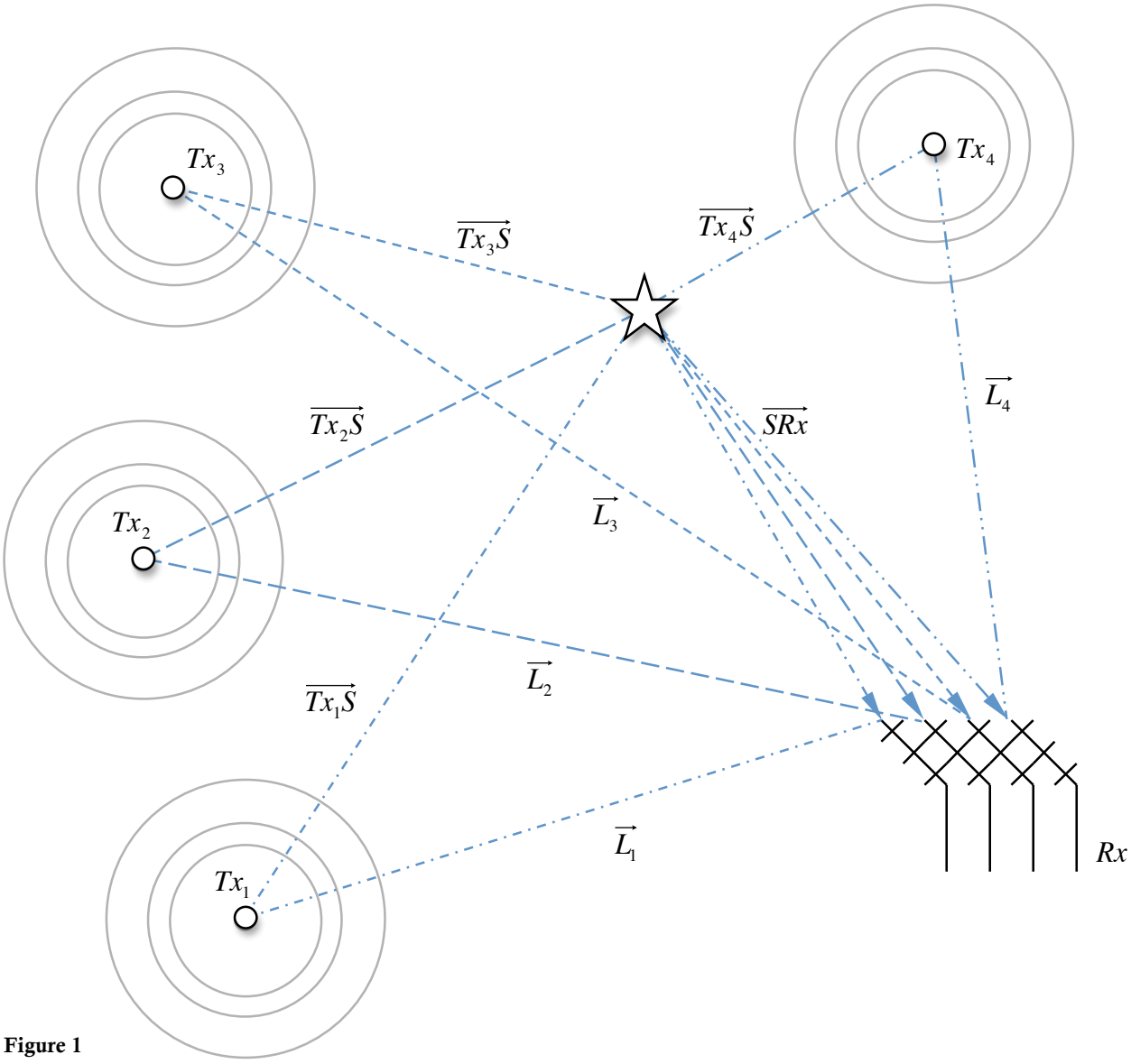

Figure 1

explained. The basic outline provided in this post will be built upon in the future.

Figure 1 details the proposed operation of a multi-static TDOA radar system. This example multi-static system consists of four transmitters, a target and a receiver. A single receiving station monitors the direct signals from the transmitters and indirect, multi-path signals from potential targets. The direct path signals $\vec{L_i}$ propagate directly from every transmitter to the receiver. Multi path signals from each of the transmitters $\overrightarrow{Tx_iS}$ are reflected by the target S and intercepted by the receiver. The path the reflected signal follows from the target to the receiver is common for all transmitters $\overrightarrow{SRx}$.

The signals are modulated in such a way that signals from different transmitters are easy for the receiver distinguish. The time difference of arrival (TDOA) is the delay between the multi-path signal and the direct path signal from the same transmitter. The timing is recovered from the signals through the correlation of the two signals. Using these timings, solutions for possible target locations can be generated.

A basic break down of the main processes in the system is presented in Figure 2.

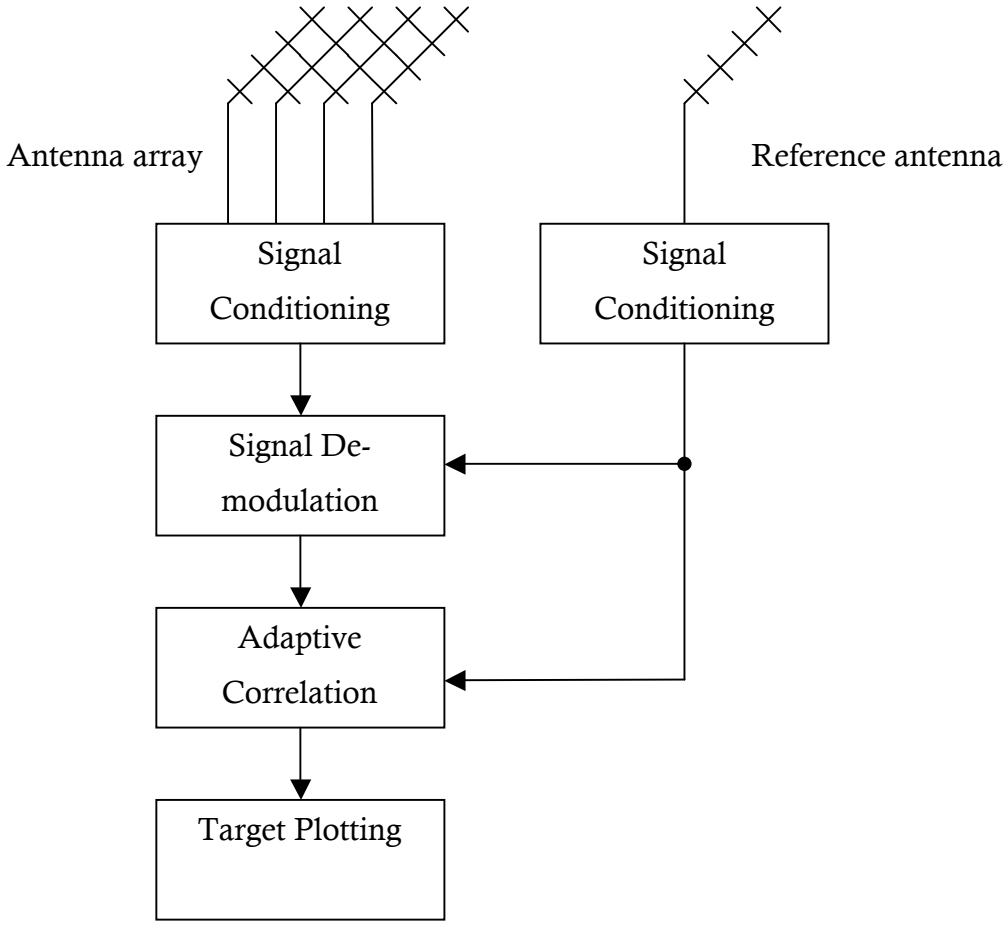

Figure 2

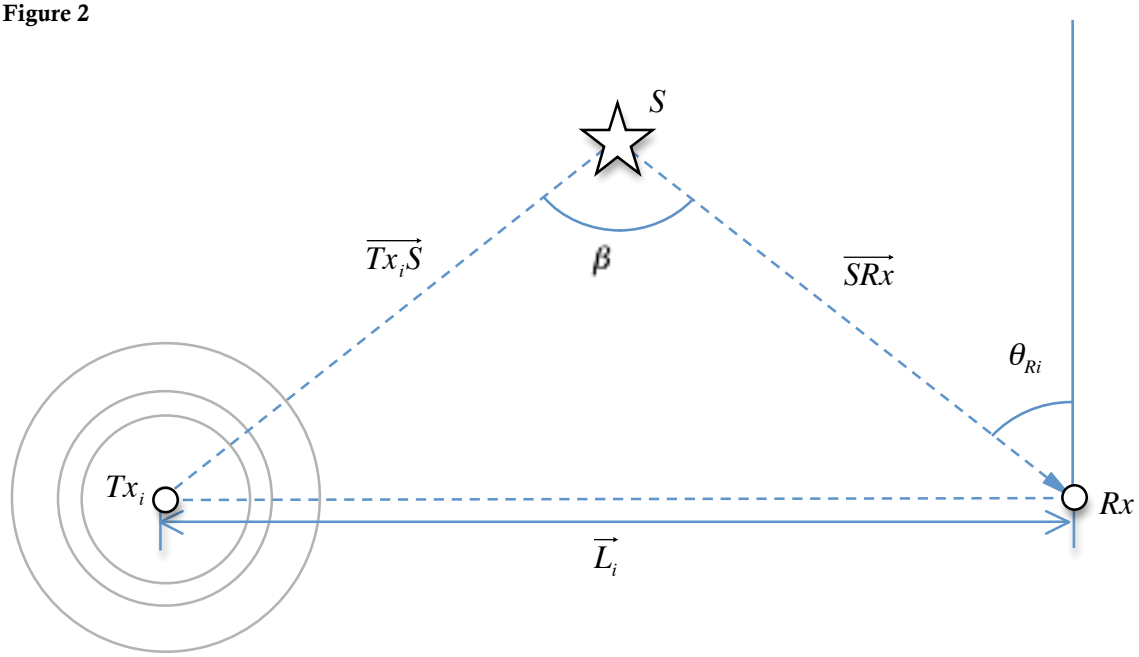

Figure 3

Figure 3 illustrates a simple bi-static radar system consisting of a transmitter Tx_i, a

target S and a receiver Rx. A distance separates the transmitter and receiver $|L_i|$. The sum of the distances between the target S and the transmitter $|\overrightarrow{Tx_iS}|$ and the distance between the target and receiver $|\overrightarrow{SRx}|$ is the range of the bi-static radar. By measuring the time difference of arrival t of the reflected path via the target relative to the direct path signal from the transmitter the relationship between the direct path $\overrightarrow{L_i}$ and the bi-static range T_i can be determined as demonstrated in Equation 1.

Equation 1

$$T_i = \overrightarrow{L_i} + t_i c ,$$

where c is the speed of propagation of the signal through air.

Knowing the bi-static range allows the target to be positioned somewhere on an ellipse. The sum of the distances from the points of the ellipse to the transmitter and receiver is equal to the bi-static range T_i.

Contact Me

I would appreciate any feedback on my work, positive or negative. I would be especially interested to hear for people in industry or academia as I am currently looking for an opportunity in engineering. I am particularly interested in digital signal processing, FPGAs, algorithm design, MATLAB and system design. By far the easiest way to contact me is by e-mail andrew@chiprate.co.uk. A PGP public key for this address can be found at www.chiprate.co.uk in the *contact me* section.