



Forward scattering radar for ground targets detection and recognition

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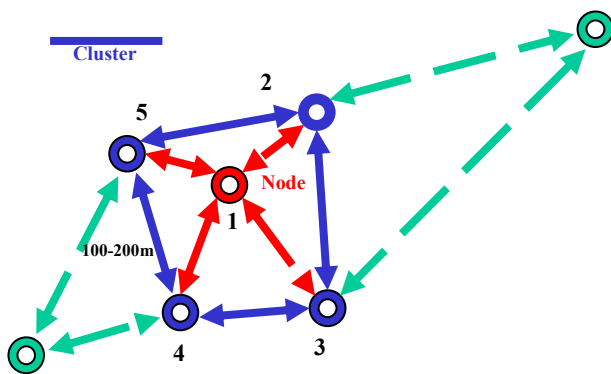


Figure 1: FSR micro sensor network

Project Overview

This project is dedicated to the research and development of a forward scattering radar (FSR) for ground targets detection and recognition, that is being carried out at the Microwave Integrated Systems Laboratory (MISL), the University of Birmingham.

FSR Concept

Forward scattering radar is a subclass of bistatic radar, where the target is crossed the baseline between separated transmitter and receiver.

The FSR configuration well fits into the state-of-the-art concept of micro sensors wireless networks. Radar sensors are placed on the ground surface in random positions with baselines lengths of 100–200 m, probing a controlled area (Fig. 1) for different types of incoming ground targets (people, vehicles, tanks, etc.).

Benefits of such a system include:

- Cost effectiveness.
- Small size, portable equipment.
- Long life battery operation.
- Low radiated power operation mode.

- High reliability of target detection and classification.
- Short deployment time.

Research Objectives

The key objectives of this research are:

- The study of radio wave propagation near the ground surface in the frequency bands used.
- Targets' (human and vehicles) radar cross section estimation and measurement for targets situated on the ground surface.
- Power budget analysis for both communication and target detection channels.
- Potential performance evaluation against the background of receiver noise and clutter with low Doppler frequency, caused by foliage around the nodes' (sensors') position.
- Definition of the optimal operation frequency bands for inter-nodes communication, target detection and target classification.
- Development of quasi-optimal signal processing algorithms for targets detection, resolution in a convoy and recognition.
- Development of the system prototype.

Micro sensor architecture

Each node in the network cluster is a multi-channel, multi-frequency transceiver, in which different frequency bands are used for different tasks (Table 1).

Table 1: Frequency bands used in each micro sensor

Main functions	Recommended frequency, MHz
Internodes communication	70 – 150 (VHF)
Target detection	70 – 150 (VHF)
Target recognition	400 – 900 (UHF)
Nodes positioning	1572.5 (GPS)

The proposed micro sensor architecture (Fig.2) contains a number of receiving and transmitting channels utilizing the different frequency bands.

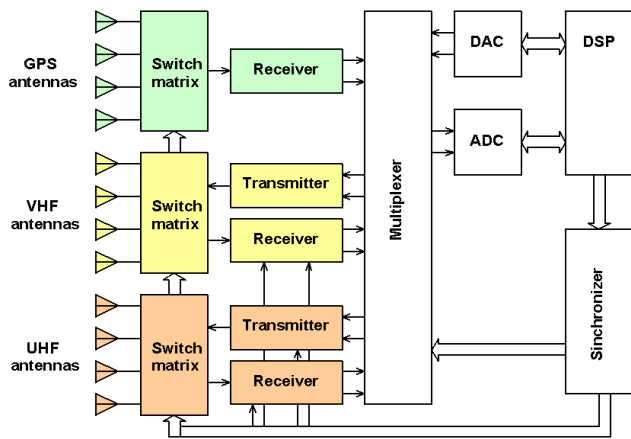


Figure 2: Radar micro sensor architecture

Possible variants of the micro sensor assembly are shown in Fig.3.

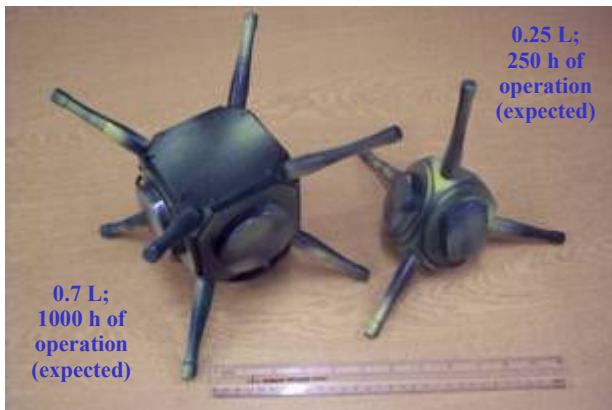


Figure 3: Variants of FSR micro sensor equipment

Different test equipment was developed for measurements in real conditions. One of them (Fig.4) uses 151, 433, and 869 MHz channels in the transmitter and receiver modules.



Figure 4: Multi-frequency test equipment

An example of a real received signal from a human target is presented in Fig.5 (50 m baseline length, 0.3 m antennas heights)

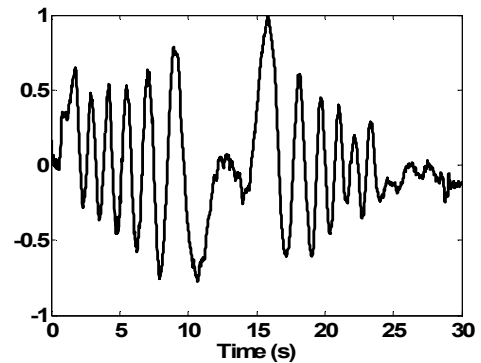


Figure 5: 151MHz measured signal (normalized)

The target's Doppler signature (Fig.5) gives the possibility of estimating the target's speed (Fig.6) and, using this information, the target can be identified.

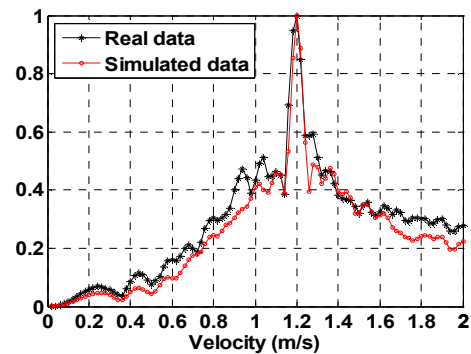


Figure 6: Target (human, 1.2m/s) speed estimation

Future research plan

- Completion of clutter analysis and measurements
- Vehicle speed estimation at low frequency (69 MHz)
- Foliage loss measurements at working frequencies
- Target detection using multi-frequency cross-correlation algorithm
- Demonstration of wired FSR network

FSR micro sensor network applications:

- Alarm security systems.
- Situation awareness systems.
- Road traffic inspection systems.

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