



THE UNIVERSITY
OF BIRMINGHAM



MICROWAVE INTEGRATED SYSTEMS LABORATORY

Change detector based on SS-InBSAR with GNSS NCT

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Project Overview

This project is part of research into the development of a high resolution GNSS sensor for land and ocean monitoring that is being carried out at the Microwave Integrated Systems Laboratory (MISL), the University of Birmingham.

SS-BSAR

Surface-Space Interferometric Bistatic Synthetic Aperture Radar (SS-InBSAR) is a subclass of BSAR. The main application area of this phenomenon is the use of Global Navigation Satellite Systems (GNSS) -such as GPS, GLONASS and Galileo- as Non-Cooperative Transmitters (NCT). Benefits of such a system include:

- Cost effectiveness.
- Around the clock operation in any part of the world, irrespective of weather conditions.
- Small size, portable receiver.
- Passive operation mode.
- High spatial resolution due to aperture synthesis from the transmitting satellite.
- Low probability of blacking down.

Aim

The aim of the research is to perform a comprehensive study of a surface change detector based on SS-InBSAR with NCT, using the European Space Agency's Galileo satellites.

The concept of SS-InBSAR is shown in Figure 1. The basic components are the space segment consisting of GNSS NCTs and the ground segment

consisting of a two-channel radar receiver with two spatially separated antennas pointing at an observation area. Each of the two antennas picks up signals reflected from the observation area to form its own 3-d image of that area. By comparing 3-d images generated from two different satellite positions at different times, surface changes at the observation area can be monitored at a high update rate. The sensitivity to surface changes depends on the separation of the two antennas (or baseline), and the geometry of the system as shown in Figure 2 and Table 1.

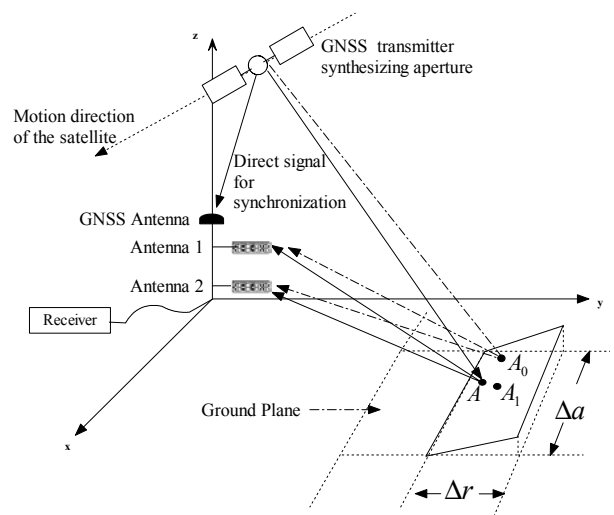
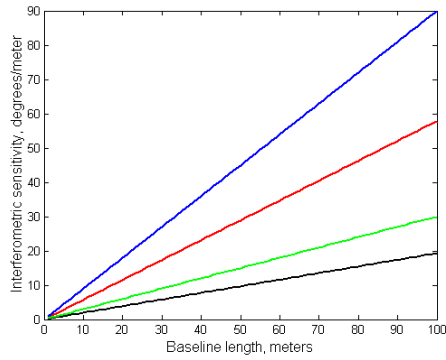


Figure 1: SS-InBSAR concept

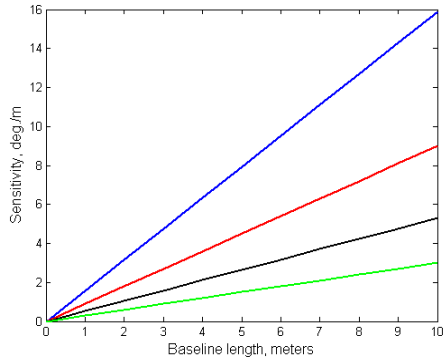
Research Objectives

The key objectives of this research are to:

- Develop a theoretical model of the SS-InBSAR change detector.
- Simulate the behaviour of the theoretical model.
- Perform experiments (Figure 3) and compare the results with derived theoretical and simulated results.
- Evaluate the potential performance of this change detector.
- Develop the system prototype.



(a)



(b)

Figure 2: SS-InBSAR sensitivity for a) horizontal, b) vertical separation of the receiving antennas.

Table 1: Simulation parameters.

Curve colour	Target elevation angle (deg)	Target distance from the receiver (km)
Blue	20	1
Red	45	1
Green	45	3
Black	20	3



Figure 3: Equipment used for SS-InBSAR change detector experiments

Applications

SS-InBSAR can be used for a number of applications. Some of these include:

- Volcanic studies.
- Tectonic studies.
- Landslide prediction.
- Avalanche prediction.
- Slope stability monitoring for railways and highways etc.

For example, a major application of SS-InBSAR can be found in monitoring slope stability at the sides of railways (Figure 4). This way, landslide occurrence can be predicted. The benefits of this application include

- 1) Reducing railway repair costs
- 2) Ensuring the normal flow of traffic in the railway network
- 3) Reducing the risk of human injury.

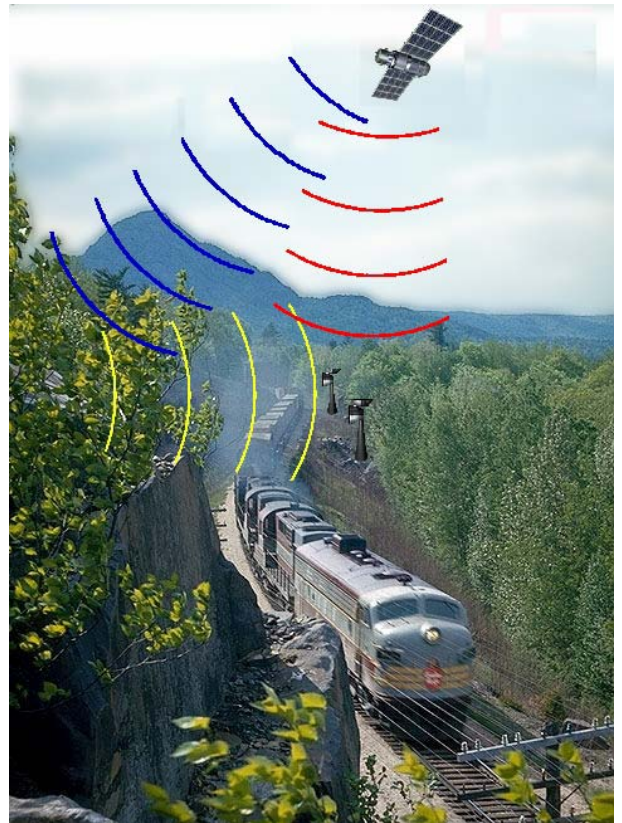


Figure 4: SS-InBSAR for railway slope stability