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Frequency Hopping Technique Used In Synthetic Aperture Radar

Arpit Rawat
Department of Electronics and Communication Engineering, Indore, Madhya Pradesh, India

ABSTRACT

Synthetic aperture radar technique is basically used in military and surveillance purpose to obtain high resolution images both in range and cross range. Frequency hopping technique is used for supressing interference, making interception difficult by external agency and providing multiple access capability due to its hopping principle it is very difficult to detect and monitor the signal by the jammers.

Keywords: Synthetic Aperture Radar, Pulse Repetition Interval, Frequency Hopping, Signal to Noise Ratio

I. INTRODUCTION

Synthetic Aperture is when a narrow pulse in range is created (or synthesized). To create such pulse, signal is frequency-modulated. Therefore, the signal frequency changes in time. This is also called chirp signal and depending on whether frequency increases or decreases in time, signal is up-chirp or down-chirp. [3, 6]

In optic sensors, when sensor is closer to target, more details are revealed. But in SAR systems the azimuth bandwidth is independent of range (or distance from target). The exposure time is proportional to range and azimuth FM rate is inversely proportional to range, therefore the signal bandwidth which is product of azimuth FM rate and exposure time remains independent of range. Also, unlike other remote sensing sensors where larger sensor gathers more details from target area, in SAR systems the smaller antenna means smaller beamwidth which means less exposure.

II. METHODS AND MATERIAL

1. SAR Processing

SAR is constructed by moving a real aperture or antenna through a series of position along the flight track. For imaging radar system about 1500 high power pulses/second are transmitted towards a target or an imaging area with each pulse having a pulse width of 10-50 as the radar moves a pulse is continuously transmitted at each position and as the pulse strikes the target the energy of the radar pulse is scattered in all directions with some reflected back to the antenna and the returned echoes are recorded in echo store. Since the radar is moving relative to ground, the return echoes are Doppler shifted. If the Doppler shift is positive, if the radar moves away from the target and if the Doppler shift is negative, if the radar appears towards the target.

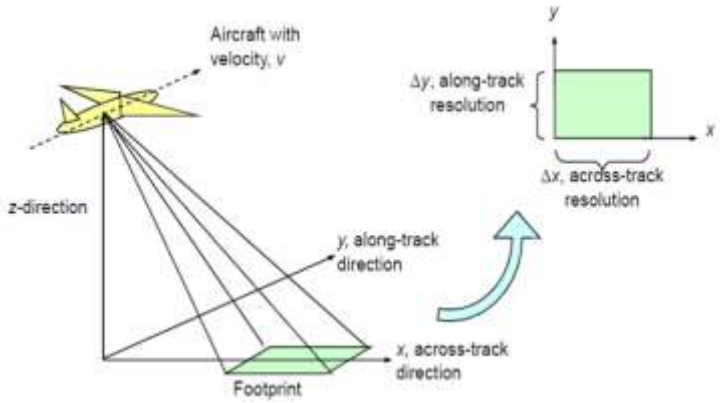


Figure 1. Footprint illuminated by SAR [4]

2. Data acquisition in Range and in Azimuth

The below figure shows how data is acquired across a range swath. The radar beam has a some beamwidth which is called the “elevation beamwidth”. The beam illuminates an area or a region which is the footprint of radar on the ground between “near range” and “far range”. At a certain propagation time, the pulse is transmitted as a wave front, between the two dashed lines. The pulse got expanded outward in concentric spheres, at the speed of light. The lower dashed arc shows the pulse at the instant it reaches the ground, at a

time t1 after it leaves the transmitting antenna. At time t2, a fraction of millisecond later, the tailing edge of the pulse passes the "far range" point. Therefore at each point on the ground between near range and far range is illuminated by the bean for duration of Tr. As the sensor moves along its path, pulses are transmitted and received by radar. The pulses are then transmitted every "1/PRF" of a second, where PRF is Pulse Repetition Frequency. Since the sensor moves with the speed of Vs., Doppler Effect has to be taken into account. The received signal has the same waveform as the transmitted signal, but is much weaker and has a frequency shift because of sensor's moving. The shift is governed by the speed of platform. The Transmitted pulses are evenly spaced. When the radar is not transmitting it receives echoes reflected back from ground surface.

3. Matched Filtering

1. It is the correlation of a template signal with an unknown signal, which is the equivalent of convolution of an unknown signal with a time reversed template, to detect the presence of the template signal in the unknown signal.
2. Matched filtering in the simulation is termed as pulse compression as the energy of the received SAR signal converges to or is compressed to the regions of template signal detection.
3. This process is enhanced by the chirp signal used in the transmitted radar signal construction as there is more information embedded for detection.

4. Mathematical Modelling

Frequency hopping technology

The type of spread spectrum in which the carrier hops randomly from one frequency to another is called a frequency hopping spread spectrum (FHSS) **Hop period**: the signal frequency is constant for specified time duration, It is used for military electronic countermeasures, because the transmitted signal that uses frequency hopping which is difficult to detect and monitor.

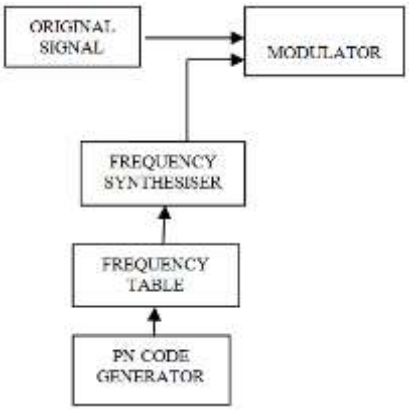
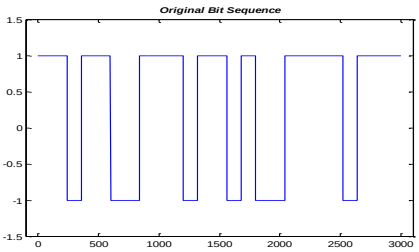
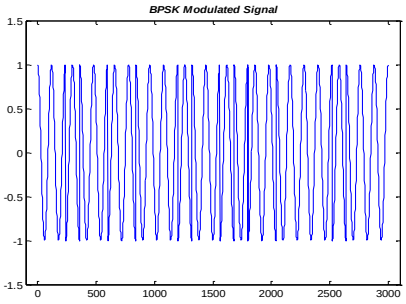


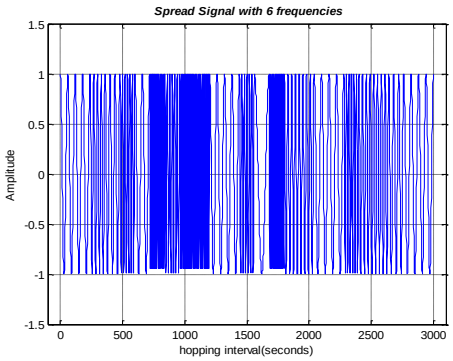
Figure 2. Block Diagram of FH Spectrum

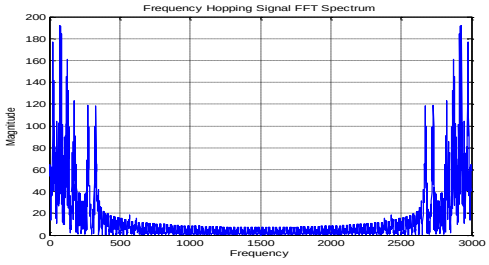
III. RESULTS AND DISCUSSION

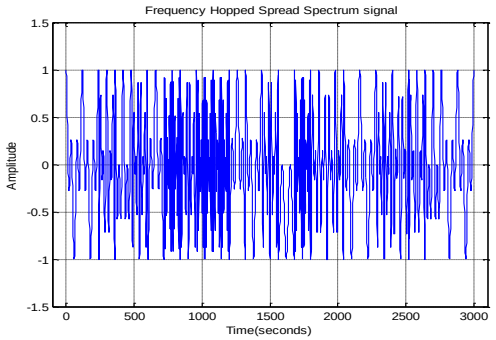
1. Simulation and Results











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V. CONCLUSION

Frequency hopping signal is a constant envelope waveform exhibits the high tolerances against to non-linearity. Jammer could easily predict the signals for the LFM chirps, as well as for frequency hopping signal, but due to the frequency variations in OFDM Signal prevents an accurate prediction

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