IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 11, November 2015

Formation of RADAR Images and Their Fusion Using Wavelet Transform

Yogesh V.Chandratre[1], Rajesh R.Karhe[2]

M.E.Student, Electronics and Telecommunication Dept., Shree Gulabrao Deokar COE Jalgaon, India[1]

Assistant Professor, Electronics and Telecommunication Dept., Shree Gulabrao Deokar COE Jalgaon, India[2]

Abstract: Nowadays image analysis is not only applicable in medical field but also it is most effectively used in the fields such as Military monitoring system, land examination, to track geostationary position, weather analysis etc. to get all these information we require images and which are captured by using RADAR technology we have focused on detailed discussion of RADAR image formation and its different technologies which are used to get RADAR images and their fusion using wavelet transform.

Keywords: RADAR, SAR, RAR, DWT, Active radar, Passive radar, Swath, Nadir Point.

I. INTRODUCTION

RADAR stands for radio detection and ranging which is based on behavior of electromagnetic waves proposed by Maxwell it is available in variety of sizes and different specifications this radar is used for various applications such as remote sensing it means to sense something from remote place from the sensing object purpose of remote sensing is to collect information on an area from distant location actually remote sensing is process of acquiring information about Earth's Surface without being in contact with it, air-traffic control, long range surveillance, early warning system. Radar system is heart of missile guidance system.

The operating principle of RADAR consist of radiation of pulse in free space through antenna. Antenna transmits electromagnetic energy propagated at light velocity these electromagnetic waves scattered from all objects on its way and detection of these objects done by using frequency and duration of transmitted pulse and which gives the following parameters:

i)Magnitude
ii)Phase
iii)Time interval between transmitted and scattered pulse.
iv)Polarization
v)Doppler Frequency

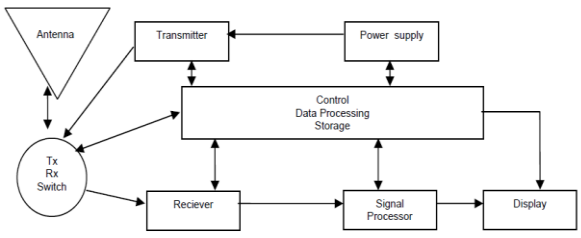

Figure1. Structure to process signal and to get all parameters

Figure1. describes method to process signals to obtain different parameters of radar system.

A) Basic Radar System:

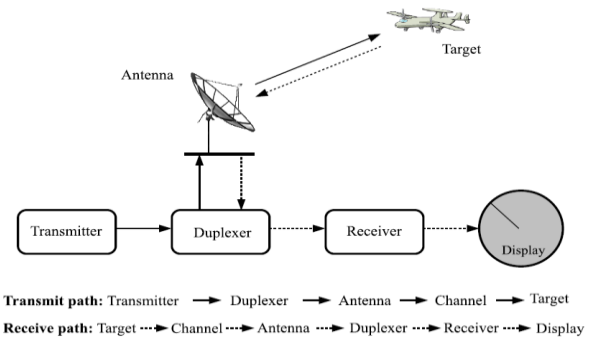

Figure2. Basic Radar System

Figure2. showsRADAR System which is basically a art of detecting Radio echo signals reflected from target objects and their direction and range and obtaining parameters to get results.

RADAR works on the principle of measuring distance from echos there is one transmitter and synchronized receiver transmitter transmits radio pulses towards object and receiver receives reflected signals called as echos from objects. Depending on the Design of Tx and Rx radars are classified as Monostatic Radars in which Tx. and Rx are collocated and the radar in which Tx., Rx are separate is known as Bistatic radar.

Following are Some Important radar Parameters

The range to a detected object can be calculated as

$$R = \frac{ct}{2} \quad (1)$$

Where,
R= Range from RADAR to object
c=Velocity of light
t=Processing Time

The Wavelength of Propagated Waveforms is:

$$\lambda = \frac{c}{f} \quad (2)$$

DOI 10.17148/IJARCCE.2015.41171

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 11, November 2015

Where
λ= Wavelength of propagated energy
f=Frequency of Sinusoidal Oscillator.

To determine range of we should determine Density of propagated energy which is given as:

$$\text{Density of Energy} = \frac{P\tau Gt}{4\pi R^2} \quad (3)$$

The Gain of Antenna is given as:

$$A = \frac{Gr\lambda^2}{4\pi} \quad (4)$$

Where,
Gr = The gain of Received Aperture
λ^2= Radar Signal Wavelength Squered

Gain of Transmitter Antenna is Given as:

$$G_T = \frac{4\pi}{\theta^2} \quad (5)$$

Where,
G_T= Tx Antenna Gain
θ = Angle of Incidence.

II. TYPES OF RADAR

There are two main types of Radar

-Active Radar which emits microwave pulses towards the direction of target and then store scattered energy.

-Passive Radars are those which gets radiation level of objects in their natural environments.

RADARs mainly classified on the basis of its output .

A) Imaging Radar:

Sensors of imaging Radar measures two dimensions of co-ordinates to obtain picture of area which is covered by radar beam. Imaging radar forms a picture of object or area which is used to map the Earth surface, surface of other Planet and targets for Military system. This Imaging Radar is classified as

i)Real Aperture Radar(RAR):

It is active and non-coherent Radar which are controlled by physical length of Antenna it is active Radar because it emits little pulses of energy towards target. Reflection of energy from larger ranges comes back towards radar after larger time which is the range direction in the image. When next pulse is transmitted from radar will be moved forward by small distance now slightly different terrain will be imaged. Theses sequential strips of terrain will be recorded side by side to build azimuth direction.

Figure 3 Shows method of capturing of image using real aperture radar in which distance between point A and B is called as swath width and the distance between any point and radar is known as its slant range whereas ground range for any point is distance between nadir point and respective point. Nadir point is the straight point below radar on ground.

Initially this radar was used in formation of radar images but it has an drawback that in this image resolution is determine by its antenna length to reduce the bandwidth of emitted signal the length of antenna must be at least several times of wavelength and it is practically not possible to design such antenna each time.So to overcome this drawback an advanced imaging radar is invented which is named as Synthetic Aperture Radar(SAR).

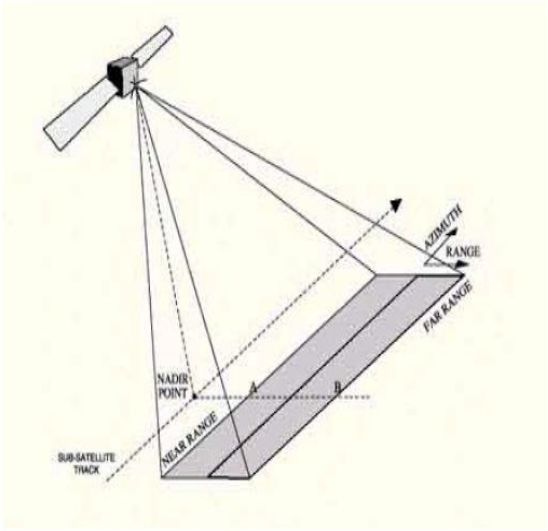

Figure 3.The Strip of terrain to be imaged from point A to Point B

2. Synthetic Aperture Radar(SAR):

It is another method of Radar image formation. In this system includes coherent active radar which generates high resolution images which is integration of consecutive and coherent signals are transmitted and received by a little mobile antenna which is moving along the orbit and magnitude and phase are used to process the above signals.

In SAR system large number of pulses are transmitted these pulses gives larger image with high resolution. Sensors or this system operates in microwave region of the electromagnetic spectrum which is as shown in figure below.

In SAR system microwave sensors are used because Earth's surface in microwave region is almost transparent it is the region where wavelength is longer than 1cm which even penetrate into small undisturbed water drops so SAR system is capable to work efficiently in the presence of cloud, fogs and rain whereas it is SAR doesn't have limitation of day or night for its working. Optical remote sensing system can't work in above like conditions. As far as imaging is concern high resolution in the direction of azimuth is a main aspect of image. Resolution in azimuth direction is strongly depends on beamwidth and distance to target. Big antennas with short wavelengths will give good resolution. It means resolution is depends on i)Antenna size ii)Wavelength.

Wavelength can managed easily by changing frequency of transmitted signal.

Antenna size is big issue to increase resolution in RAR system antenna size should be very high sometimes antenna size is bigger than aircraft which is not practically

DOI 10.17148/IJARCCE.2015.41171

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 11, November 2015

implementable there should be something which will synthetically increase the aperture size. In advanced RAR or SAR beamwidth is inversely proportional to antenna aperture hence large aperture will give narrow beamwidth and which improves resolution now issue is how to get large aperture synthetic aperture is collection of successive pulses transmitted and reflected in sequence and aperture is created this aperture is synthesized as long as target is within radar beam.

Figure 5 shows aperture synthesis which involves number of small aperture whose synthesis gives large aperture.

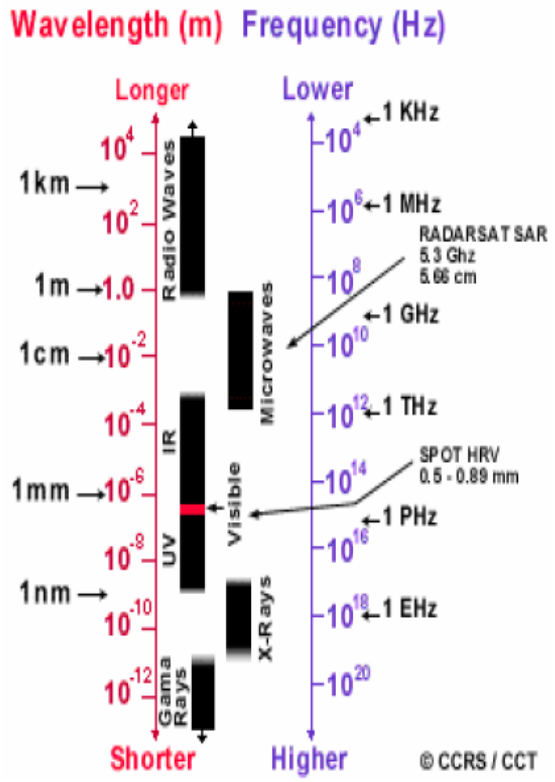

Figure 4. Electromagnetic Spectrum

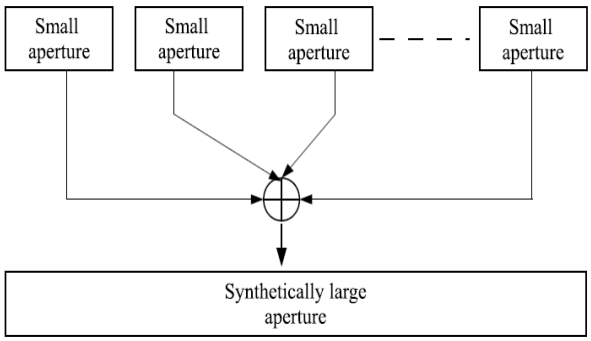

Figure 5 Formation of Synthesized large aperture

A) *SAR Application*:

SAR system is most widely used in Military application nowadays it is widely used as ground imaging radars the ability to mirror earth surface for displaying topography is prime use of SAR used in some of civilian application are discussed below.

i) Military Services:

SAR can day and night imaging so it is used in surveillance targeting of selected point. It helps to identify military staff. It is also useful in non-proliferation of nuclear, chemical and biological weapons.

ii) On the Ocean:

SAR is useful on ocean which detects changes occurs due to man-made accidental spills or natural,it is used to detect ships and backscattered from ocean surface to detect wind or current fronts, natural seepage from oil deposits. Scientistsalso uses the SAR images for their ocean researches. At high latitudes SAR images are useful in detection of ice state like its concentration, thickness and leads.

iii) On the Land:

Wavelength of SAR system can penetrate into cloudy and most problematic areas to monitor such areas SAR images are most useful. It is also used to capture information of greenery land in particular area of Earth.

B) *Fusion of SAR Images using wavelet transform*:

In digital image processing fusion is the process in which two or more images are mixed with each other by using special techniques this single fused image gives more accurate information in one image.

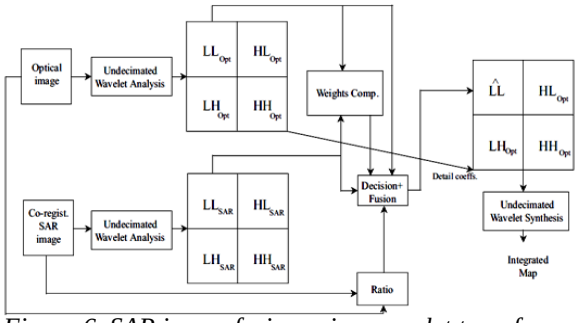

Figure 6. SAR image fusion using wavelet transform

Above figure shows detailed fusion process of SAR and optical images. In which images are converted into wavelets and further that are fused using proper method.
Wavelet transform is first applied on each source image then fusion mapping is generated based on fusion mapping protocol and finally fused image is generated using inverse wavelet transform. Wavelet transformation is powerful tool for multiresolution analysis a set of multiresolution sub-spaces are required as shown in fig.

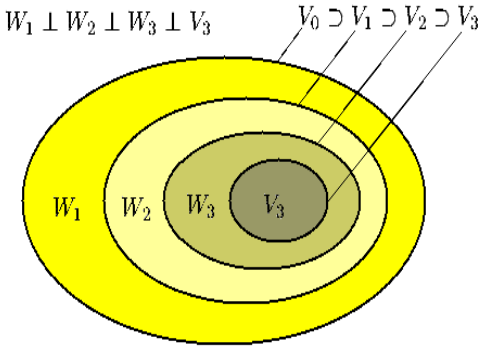

Figure 7. Multiresolution Sub-Spaces

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 11, November 2015

In above sub-space original space V0 can be decomposed into lower resolution sub-space V1, W1 is difference between V0 and V1 similarly V1 can be decomposed into V2 and W2 and so on.

i)Discrete Wavelet Transform:

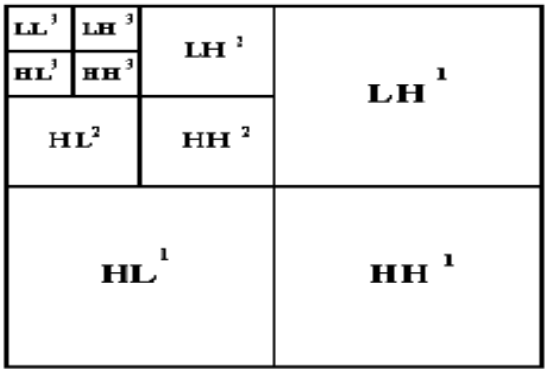

Fig. shows 2D DWT in this 2D image is decomposed into different levels of different frequency band.

Where ,
L- Lower frequency band
H-Higher frequency band

Following are the other methods of wavelet fusion

- Haar
- Daubenchies
- Biorthogonal
- Coiflets
- Symlets

III. CONCLUSION

In this work we have concentrated on SAR images which plays an most important role in assessment of land on earth i.e. one can conclude about quality of surface. These SAR images are also useful in weather forecasting this paper has focused on formation of RADAR images and types of RADAR. When one or more SAR images are captured we can fuse these images into one single image which is used assess more effectively.

REFERENCES

[1] A. Umaamaheshvari, K.Thanushkodi, "Image fusion techniques" IJRRAS 4(1), pp 69-74, July 2010.
[2] Dunsmore, M.:"Bistatic radars", in Galati, G.(Ed.):"Advanced radar techniques and systems"(Peter Peregrinus Ltd, 1993), pp. 890-912.
[3] A.Garzelli "Wavelet-Based fusion of optical and SAR image data over urban area".
[4] Aiazzi B., L. Alparone, S.Baronti& A. Garzelli,2002. Contextdriven"Fusion of high spatial resolution images based on oversampled multiresolution analysis.IEEE Transaction on Geoscience and Remote Sensing, 40(9), in press.
[5] David T. Sandwell "SAR Image Formation: ERS SAR Processor coded in MATLAB.
[6] Daniel S. McFarlin, Franz Franchetti, Markus Puschel and Jose M.F. Moura "High Performance SAR image formation on Commodity Multicore Architecture"