RESEARCH ABOUT VIRTUAL SAR SYSTEM

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ABSTRACT: In this paper we propose computer virtual SAR system. This system can produce dynamically SAR images not only in various kinds of incident angle wavelength and polarimetric ways of sensor, but also in different phases of ground object vegetation variation. Using this system, we can replace field works, save time and expenses, and avoid the risk arose by wrong decisions and operations.

1 INTRODUCTION

As real-time, high-fidelity visual scene simulation has become ubiquitous in the training, modeling and simulation, meanwhile as radar becomes more and more sophisticated and test flights more and more expensive, there is an increasing need to simulate the output of different types of radar as well as simulate radar performance.

Next, due to the limitations of equipment and processing techniques, most of operations performed in the air during the a series of processes from transmitting wave to producing image will inevitably introduced unpredictable system and random error into radar image For example, transfer dissipative aircraft motion error and operation error will result in the uncertainty of SAR image. These uncertainty bring difficulties to image processing information extraction and the mechanism research of remote sensing(Ge Y, 1999).

So, we propose one kind of virtual SAR system. This system integrates multi-technique which include Virtual reality and simulation techniques etc. into one. It can satisfy these needs and solve these problems above mentioned.

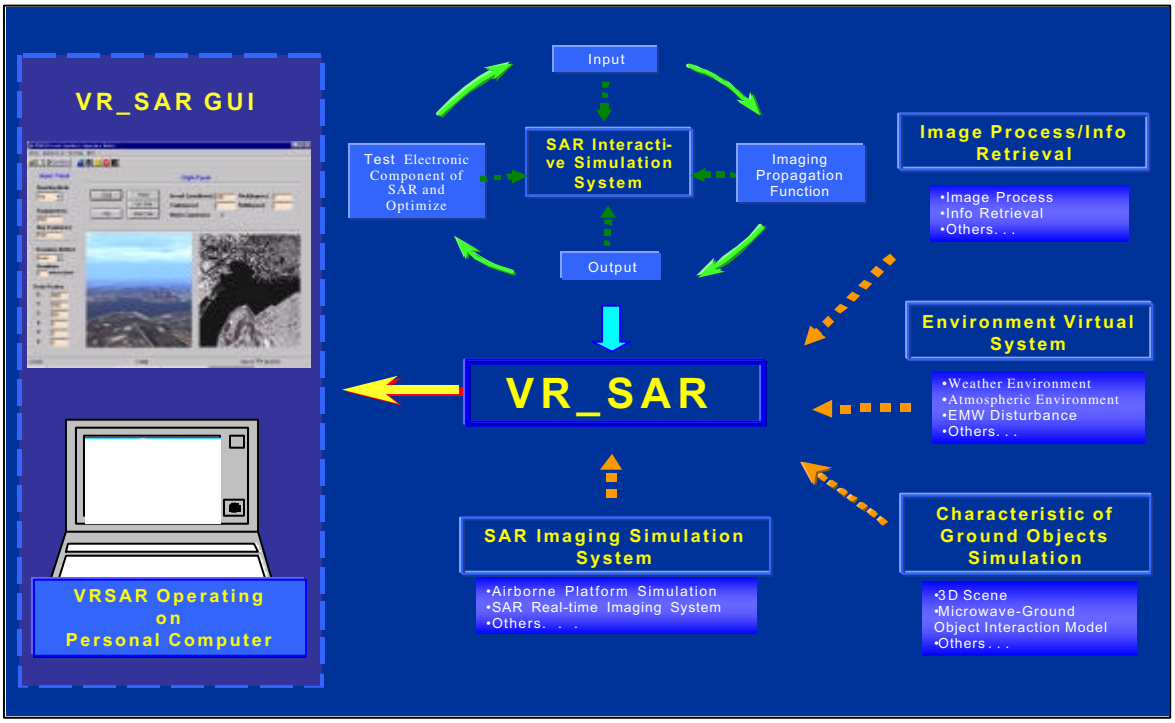
In what follows, we first illuminate the characteristics of virtual SAR system. Next, the components of Virtual SAR system will be described. Then, How to implement the system will be discussed in section 4 The conclusion remarks on virtual SAR system are presented in the final section.

2 CHARACTERISTICS OF THE VIRTUAL SAR SYSTEM

The system we have proposed is based on the propagation function of SAR imaging system. It can simulate coherent video signal, and operate by interactive transparent way. The user can selects a desired imaging radar mode and specifies important mode-dependent radar parameters such as frequency, polarization, antenna beamwidth, min/max range extent, min/max scan angle, scan time, Pulse Repetition Frequency (PRF) and FFT size. The simulated SAR image is not a simple COPY for the ground object or vegetation but the expression of physical mechanism of interesting areas. So we can dig out much more knowledge from the image. It can be able to be fused with other remote sensing images. Meanwhile this system can be applied to research novel algorithm of imaging process, new imaging system such as strip-map scanSAR and spotlight etc.

3 THE COMPONENTS OF VIRTUAL SAR SYSTEM

The integrated system consists of five parts: SAR simulation imaging system; environment virtual system; image processing and information retrieval; characteristic of ground objects simulation; SAR interactive simulation system. Figure 1 shows the framework of Computer 3D Virtual SAR System.



4 TECHNIQUE APPROACHES FOR IMPLEMENTING VIRTUAL SAR SYSTEM

In general, technique approaches for implementing virtual SAR system include two methods. The first is based on database of ground object. The other adopts to simulate coherent video signal method.

4. 1 The Method Based on Database of Ground Object

This technique is based upon the ground real situation map or remote sensing materials or the existed radar image according to the imaging mechanism of radar image to produce different frequency wavelength polarimetric ways radar images which are applied to various occasion.

The selected physical model used in radar image simulation is point scattering model. The selected mathematics models are the radar imaging equation, the radar equation and the gray equation respectively. These functions will be looked up in some references. Figure 2 shows the flow chart of radar image simulation.

The data sources for SAR simulation image include radar system parameter database of geography information and database of ground scattering characteristic. The database of geography information includes DEM and database of land use. The database of ground scattering characteristic includes diversified ground objects scattering characteristic s at different time and different radar parameters, that is, S or S^0.

When radar imaging, the ground is divided into grid cells according to the size of resolution cell. Each cell of image pixel is corresponding to each ground cell. Based on the imaging mechanism of radar image and scattering characteristic of ground objects, we make use of the radar equation and the gray equation to calculate the gray value of ground object of each cell according to point scattering model, and then form radar image. For gaining a better radar image, we should consider the geometry characteristics of radar image, for examples, foreshortening and layover and etc (Shu,1997).

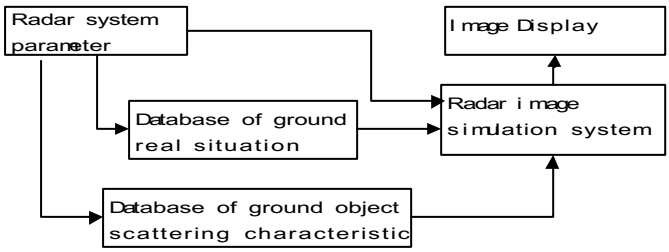


Figure 2:The Flow Chart of Radar Image Simulation

This method to simulate SAR image is sample and easy because it omits the calculation of scattered field of

object. It is capable of grasping the difference of images produced with different parameters(incident angle wavelength and polarimetric ways) under complex conditions. This predictability can help the integrated system to choose optimal system parameters (Shu, 1997). But SAR simulated image produced by this method is not a real SAR image, but is a pseudo SAR image.

4. 2 The Method of Simulating Coherent Video Signal

The definition of the method of simulating coherent video signal is to recur coherent video signal including amplitude and phase realistically, and recur the complete process of this signal from transmitting to receive via atmospheric propagation and being scattered by ground object.

The differences from the former method are as follows. First, the full process of simulating image is based on the propagation function of SAR imaging system. Next, the back scattering coefficient is calculated by the interactive model between SAR coherent signal and ground object and not calculated by the coincidence relation of ground cells material texture database and back scattering database. Last, as result of the system based on propagation function, so we can test the capability change of SAR electronic component, and optimize the design of SAR system. In Virtual SAR system, we have adopted this method.

Here, we give an example about simulation of point object and multi-point object. The flight platform can determine the phase center coordinates of antenna $A(X,Y,Z)$ for each phase. Here, X axis signifies flight direction of flight platform corresponding to ground object when ground object lies in the center of wave beam. Z signifies the direction perpendicular to ground surface. We assume the position of transmitting antenna as A1 and the position of receiver antenna as A2. C signifies light speed. The each delay is calculated as follows:

$$t_d = \left(\left|P - A1\right| + \left|P - A2\right|\right)/C \qquad 1$$

So we can get the formula below.

$$Sr(t) = Sx(t - t_d) \qquad 2$$

Where $Sr(t)$ is echo signal of antenna; $Sx(t)$ is transmitting signal of antenna.

As for multi-point object, we can first simulate each point and multiply itself ground reflection coefficient $R1, R2...Rn$. After we calculate echo signal of each point, we add all of echo signal of point and then we can get echo signal of multi-point object. The formula of simulating ground object in time domain is below:

$$Sr(t) = R1 * Sx(t - t_{d1}) + R2 * Sx(t - t_{d2}) + \ldots + Rn * Sx(t - t_{dn}) \qquad 3$$

Comparing the former method, it needs to do a great deal of calculation for gaining the distribution of scattered field of object. So it is complicated and time-consuming. But we can research the detection and identification of object in relation to its geometry further using the method.

5 CONCLUSION AND PROSPECT

In this paper, we put forward the conception of Virtual 3D SAR integrated system and expound the advantages of Virtual 3D SAR system. Then we display some functions of this system. Though some of research works are in the preliminary stage in the whole framework , we trust that the 3D virtual SAR system will be able to bring about great change to remote sensing technology.

At the same time, here we should realize definitely that due to the complication, diversity and variation of natural world, it also means that the task of computer simulation SAR system is time-consuming and very hard.

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