

Research on the Simulation of SAR Image Based on Creator and Vega

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Abstract: In this study, a real-time image simulator system of Synthetic Aperture Radar(SAR) was designed based on software platform of Visual C++, Multigen Creator, and Vega, in the background of Virtual Reality. The principle of SAR image was introduced, the process and key technologies of designing Radar image simulation system based on Virtual Reality were discussed, and the simulation results was given at the end of the paper. The simulation results show that this system can simulate various parameters SAR image efficiently, and has an assisted function to the evaluation of simulation of Radar system.

Keywords: Virtual Reality, SAR, RadarWorks,Vega.

Introduction

Radar system simulation plays an important role in radar system test, identification and training. After the two World War, the rise of the aerospace industry, there is an urgent need for complex aircraft ground simulation test[1]. Virtual reality technology provides a good foundation for simulation of Radar system. It uses computer graphics and image technology to construct the three-dimensional model of the simulation object and reproduces the real environment to achieve very realistic simulation results[2]. Virtual reality technology for the development of weapons and equipment, tactical training and drills provides a very effective and economical means, which has a very significant economic benefits and has become one of the most important high-tech means in the military field.

SAR imaging principle

Synthetic aperture radar (SAR) often uses a small antenna, which is translated in many positions along a straight line, and sends a signal at each location to receive the radar echo signal of the corresponding position and stored. After moving a distance, the stored signal is very similar to the signal received by each unit of the actual linear array antenna. Therefore, with the same operation as the actual linear array antenna, the effect of long antenna aperture can be obtained [3]. Using the pulse compression technology to obtain the high range resolution, and using the synthetic aperture principle to obtain the high azimuth resolution, thus it obtains a large area high-resolution radar images. Radar range resolution is determined by radar transmitting signal bandwidth and radar azimuth resolution is determined by the bearing to the Doppler bandwidth. The main system parameters affecting the SAR imaging are factors like peak wavelength, pulse repetition rate, transmission power, transmitting and receiving polarization modes, pulse width, side angle and flight speed.

Developing software profile

Virtual reality technology can be divided into Scene modeling and Scene driving. Scene modeling mainly includes Model design and implementation, scene construction and generation, texture design, special effect design, which creates realistic 3D model and constructs realistic texture and the special effects. Scene driving mainly includes scenario-driven model, scheduling process, distributed interactive, real-time big scene processing, which reproduces realistic simulation environment at high speed and real-time response interactions.

The Multigen-Paradigm's Creator is powerful, interactive software of virtual reality modeling. It provides powerful vector modeling and polygon modeling, large area terrain generation function such as precision and it also contains a series of API library functions, which enables users to read, write, and create PLT format file [4]. Creator can efficiently generate real-time 3D model database, greatly reduce the development difficulty and shorten the development cycle.

Vega software is used to develop an interactive, real-time visualization simulation application software platform. Its most basic functions are to drive, control, manage virtual scene, support rapid complex visual simulation program, and quickly create all kinds of real-time interactive 3D environment. Vega provides a friendly graphical interface, the complete C language application program interface, rich relevant practical library function and a number of optional modules, which can meet a variety of special requirements of the simulation. Vega can greatly reduce the programming source code, making easier the software maintenance and optimization of real time performance, therefore improving the work efficiency.

Constructing 3D model

3D model is divided into two classes[5]: natural scenery and artificial scenery. Natural scenery includes the earth, mountains, water, etc. RCS (Radar Cross Section) which can be showed by the backscatter scattering. Creator provides a natural material library containing 150 kinds of natural materials. The texture mapping to the model through the query can produce a real radar images. Artificial scenery includes buildings, bridges, aircraft, etc. Vega is querying the backward scattering coefficient and combining the information to accomplish RCS computing scene.

The natural scenery modeling mainly includes five steps:

(1) Planning the terrain database: to achieve the goal by clear simulation, and to make sure the existing real-time system hardware environment and software platform can meet the requirements. (2) Preparing the terrain data: collect necessary terrain data to build and make the necessary format conversion. (3) Creating a test terrain: use a small part of the original elevation data as sample, create a test database, terrain and in real-time system platform for targeted testing. (4) Improving the terrain model: after the success of the test, map texture and characteristics of the data in the target area. (5) Testing and optimizing: in the real time simulation system, it runs in the texture mapping and other characteristics of the data of terrain model database, test its performance, and optimizes according to the results of the inspection. In order to obtain better performance, it should reduce the number of polygons and

reorganize the hierarchy of model database; In order to obtain better visual effect, it can adjust the texture and material properties, making it more real.

The artificial scenery modeling steps are as follows:

(1) Obtaining modeling data: make sure the appearance of the entity, geometry accurate. The data mainly comes from the entity's design drawings, field measurement and the actual operation, etc. The source texture mainly comes from entity material database, the actual photos, rendering, etc. (2) Determining the hierarchical structure of the solid model. Creator is used to adopt a tree hierarchy to organize and manage models. When modeling, it must first carried out in accordance with the entity structure hierarchical decomposition. (3) Visual modeling: in accordance with the identified model hierarchy and a given physical data, it uses a tool for visual modeling in the software step by step. (4) Removing redundancy polygons: describe data often exists on the surface of the solid model redundancy phenomenon, the redundancy polygons here refers to the entities outside a invisible part model. (5) Using texture mapping: use texture images instead of the model can reduce the details of the polygon trees and complexity, thus improve the speed of image rendering output.

In the process of modeling applied to key technologies include:

(1)LOD technology: LOD (Level of Detail) technology is established on the same object model of the several different levels of detail. The higher the degree of detail is, the more detailed the model shows, and number of polygons required increases accordingly. Running in real time, the details of the model showed are determined by the point of view and the object's distance.

(2)Examples of technology: In the simulation scenario, using a large number of the same entity, such as number, housing, will greatly increase the storage space. Instance technology can solve this problem, the same geometry can share the same model data by the creator's toolbox tools it can put these models in different places, only needing one entity data storage space.

(3)Texture mapping technology: with only body and the structure, realistic simulation environment can not be realistic. Using the surface texture mapping can increase the physical sense of reality. The texture information not only can increase the sense of reality, but also can carry the material information. It corresponds with material texture mapping by using TMM tools. Creator of each material parameters are given for different radar backscatter coefficient, as shown in Fig.1, documents for the beach material information, different radar parameters are given after the corresponding to the scattering coefficient.

Angle of incidence			Average backscattering coefficient	
{	0,	0, 0)	:	-100
{	0,	0, 0.352941)	:	-51.0907
{	0,	0, 0.705882)	:	-49.5845
{	0,	0, 1.05882)	:	-48.7031
...				
{	5,	3, 88.9412)	:	0
{	5,	3, 89.2941)	:	0
{	5,	3, 89.6471)	:	0
{	5,	3, 90)	:	0

Frequency:	X (8-12 GHz)	Polarization:	VV
	L (1-2 GHz)		VV
	S (2-4 GHz)		VH
	C (4-8 GHz)		HV
	X (8-12 GHz)		HH
	Ku (12-18 GHz)		
	K (18-27 GHz)		

Fig.1 file material

First the number of columns for the transmission frequency, "0" stands for the l-band, "1" stands for s-band, "2" stands for the C band, "3" stands for x-band, "4" stands for the Ku band "4", and "5" stands for the K band. Second as polarization mode, "0" stands for VV way, "1" stands for the VH, "2" stands for HV, "3" stands for the HH. Third as incident Angle, the range is of $0^\circ \sim 90^\circ$. After a colon followed by the corresponding parameters corresponding to the scattering coefficient, unit for dbsm. In texture mapping at the same time, the material properties assigned to the entity, query, calculation of radar imaging by target RCS. For the natural scenery, the radar can gain by using the method of direct query entity RCS; After gaining these parameters for the artificial scenery, radar, couplead with the scene information through calculation to obtain the RCS.

Visual simulation driven design

Vega's development includes two parts: a graphical interface and API function library. Graphical interface under the basic parameters and can modify the system characteristics, make whole definition process intuitive, convenient and reduce a lot of code to write. Imaging of radar simulation module is mainly used RadarWorks module. API function library can complete control of user demand, realize the human-computer interaction.

The graphical interface parameter Settings, Basic module Settings, First join the Vega Creator built model, and then set the main parameters, including the system parameters, the graph state, window, channel parameters, environmental parameters and model parameters such as initial position, the movement way, point position.

Radar Works Module parameter Settings, After setting the system main parameters, parameter setting RadarWorks module. Here select radar type is "SAR", the frequency is set to "X", polarization mode for "VV", the largest visual range of RCS is - 30dbsm ~ 10dbsm. Selection for the Stripmap SAR imaging model, radar ground distance to the center of the target Range is set to "2000 m", squint Angle is set to "90". Range in conjunction with the height value observer panel to identify the incidence Angle of radar. Squint Angle and the Range is shown in Fig.2.

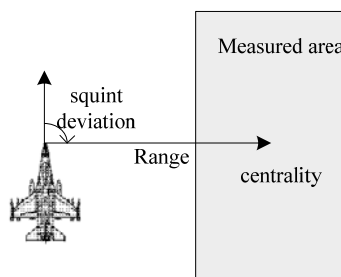


Fig.2 Squint Angle and the Range is shown

There are two kinds of resolution Settings: linear specified and system parameters are calculated and determined. The former directly set in the panel, the latter the formula of the resolution as shown in Eq.1

$$\delta_d = \frac{prf \cdot \lambda \cdot R}{fftsize \cdot 2v \cdot \sin \gamma} \quad (1)$$

In the formula, the pulse repetition frequency, said the wavelength, reaching the ground to the center of the target distance is radar, is FFT points, vehicle speed, is squint Angle. Switch frequency agility is used to control whether the simulation image speckle noise

is added. If set to on, it is not in the simulation image speckle noise. If set to off, then join the Speckle noise in the simulation image, add the amount of Speckle noise is controlled by parameter "Speckle". The above parameters are stored, after the completion of generated ".adf" file, can be in the control program to operate, save a lot of codes.

The simulation results

Simulation effect is shown in Fig.3. The left corner is for radar imaging region. The image shows the area the beam can project to. The area just mentioned has two houses, a submarine and a patrol boat, which can be seen in radar imaging area. Simulation system can produce real-time images of areas SAR scanned.

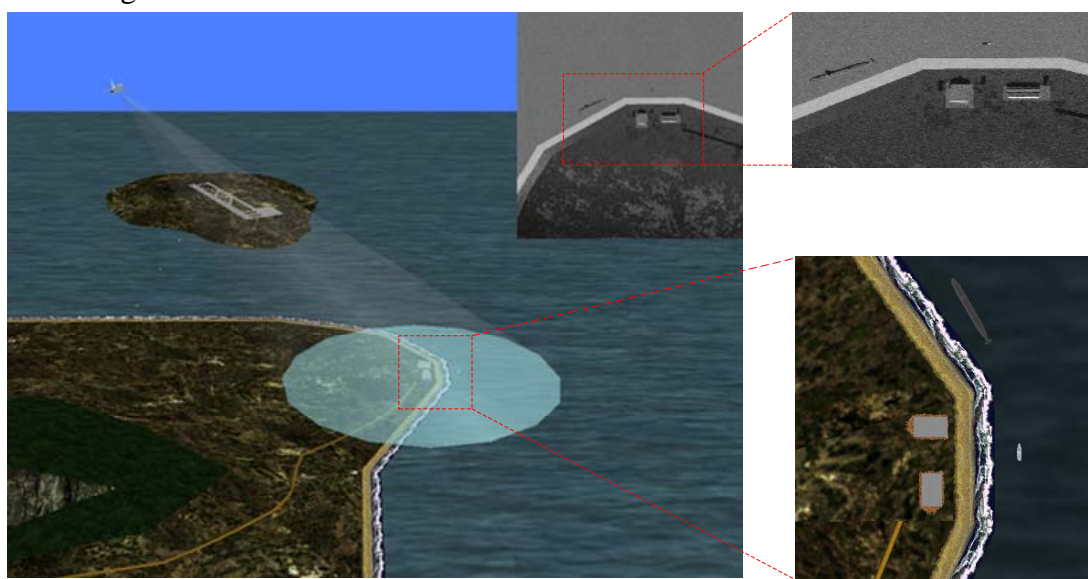


Fig.3 Simulation effect

Conclusion

In this paper, SAR imaging simulation system is designed by applying of virtual reality development software Creator and Vega from the company of Multigen, combined with Visual C++. The simulation results show that this system can reflect various parameters that can influence on imaging radar, and can produce a better simulation of the airborne SAR imaging effect, good real-time performance, which provides a new aid to airborne SAR imaging system performance evaluation.

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