# STUDY ON TOPOGRAPHIC MAP UPDATING WITH HIGH RESOLUTION AIRBORNE SAR IMAGE

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**ABSTRACT:**

Currently the topographic map in scale of 1: 10000 is going to be updated in a lot of regions in China. SAR has unique advantage in map updating of those regions where are usually rainy and cloudy. At present the resolution of the airborne S.AR already reaches even over 1m. With the improvement of the imaging technique, SAR has been ready for map updating in scale of 1: 10000. This article researches on updating the topographic map element by high resolution of airborne SAR. First the mechanism of the SAR imaging is analyzed, second SAR image is done some preprocessing (such as radiometric correction and geometric correction), the texture and feature of SAR image are researched on and what kind of topographic map element could be extracted by means of high resolution airborne SAR is test, finally it's clear that high resolution airborne SAR could extract many kinds of topographic map element: airport, railway, road, river, lake, pool etc. This research makes the well technique foundation of using high resolution airborne SAR to update topographic map in scale of 1: 10000.

## 1. 1. INTRODUCTIONS

Topographic map is the basic data for national departments and various projects, which could offer lots of information [Kang T.J. 2006]. With the fast development of economic construction and the rapid step of urbanization construction, the topographic environment changes with each passing day, especially the ground feature. But newly-built roads, aqueducts and the changes of various landuse status made speed of the topographic map updating slowly, so it is an important to carry on the revision of topographic map.

Nowadays the topographic map by scales of 1: 10000 is going to be updated in many regions. Aerial photogrammetry is the traditional method for updating topographic map by middle and small scale, but the speed of data obtains is slow, the cost of photogrammetry is high, even in parts of this place, just as Yunnan province, Guizhou province, Sichuan province, where the weather is not well, usually rainy and cloudy, the optical image couldn't obtain. With the technology of remote sensing developed rapidly, there is a kind of new method for mapping and updating the topographic map. SAR as a top observation technology which appeared in 20 century, could acquire the image in day and night, and look through clouds, smoke and fog, even penetrate ground material. Now the resolution of the airborne SAR image could be close to optical image's resolution, as a result, using high resolution airborne SAR images to update topographic map elements is possible.

## 2. CHARACTERISTIC OF THE SAR IMAGING

The mechanism of the SAR imaging is different from the optical imaging. The optical image is obtained by photographing and scanning of optical sensor, which is passive to receive the reflected electromagnetic wave from the ground material. However, as an active system, SAR could transmit and also receive the microwaves. After the microwaves interact with ground material, SAR image records the scattered microwaves from ground material, and could invert the physical characteristic of ground material, like: target shape, material, surface roughness, surface electrical properties, and so on. Due to receive the echo, antenna of SAR needs to side-glance, in this way, the area where SAR could image is larger than photogrammetric area. So it would cost less than traditional method. In a word, it's a suitable method for updating topographic map by using high resolution of airborne SAR.

## 3. EXPERIMENT METHOD

Image data is the most important part of the whole updating task. The SAR image process is nearly the same with the remote sensing image process. The image process includes the follow steps: data import, speckle suppression, radiometric correction, ortho- rectification, texture analysis[Zhao. Z. 2004].

After the basic image process, SAR image is changed to DOM as the prepared data. Then overlay of the SAR image to the DLG, manually generation of the changes of the polygons and lines, overlay of the "changes" layer with the map's layers, creation of the new updated layer.

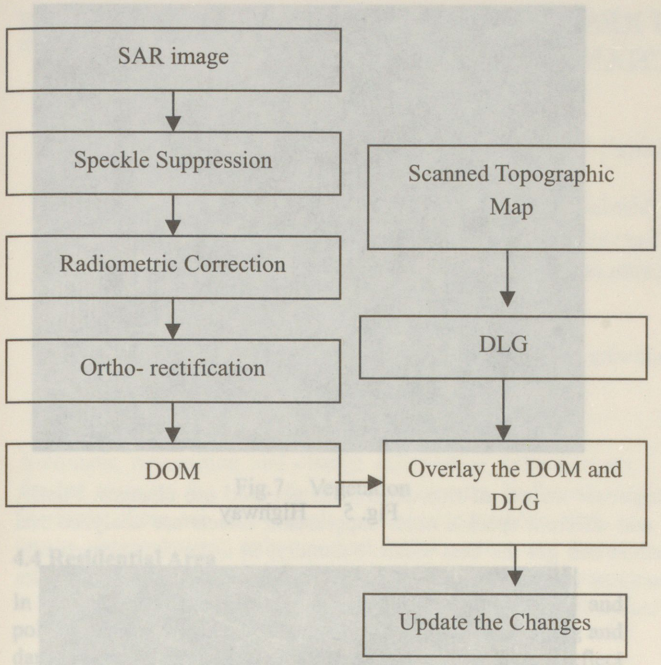


Fig 1. Flow chart

### 3.1 Speckle Suppression

Because the special mechanism of the SAR imaging, there is speckle noise in the SAR image, which limit radiant resolution, and make it difficult to interpret the ground material, so it is a big problem to use the image data. Before other process, the first step is to suppress the speckle. The commercial software ERDAS Imagine is used to filter the speckle out from the SAR image in this research. Compared with various kinds of filter method, Lee-Sigma filter is better than other filters in speckle suppression.

### 3.2Radiometric Correction

The SAR image radiometric correction includes two steps:

(1) Amplitude image data transforms from 32 bit to 8 bit. This transform could lead the data compression, so as to increase the speed of process and display.

(2) Histogram statistic in order to make the output of dynamic area wide. For the sake of improving the definition of the image and ensuring the target information not losing, it is necessary to stretch the output of dynamic area. The ordinary way is to do liner stretching on the image, so as to display the detail of the image.

### 3.3 Ortho- rectifications

After the above process, it needs to do the Ortho- rectifications to the SAR image. First transform range image to ground range image. Because of the side imaging, the other special feature of the SAR image is that the original data image is the range image. The ground material of near-range is compressed, and the ground material of far-range is stretched [Shu.N, 2003]. So it is necessary to do this transform.

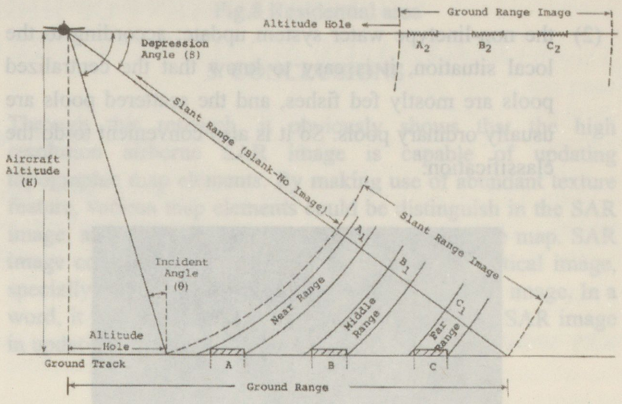


Fig. 2. Radar image presentation, the geometric connection of the range image and ground image.

The transform formula:

$$R_s = R_g \times \cos \qquad (1)$$

or

$$R_g = \sqrt{R_s^2 - H^2} \qquad (2)$$

Where $R_g$ = the ground range
$R_s$=the slant range
H=the aircraft altitude
$\beta$ = the depression angle

The next step is to do the geometric correction. The traditional method is to use two order polynomials which assist with ground control point. It is mostly fit the smooth place. At the base of the geometric correction, using the DEM to do the Ortho- rectifications. After these steps, the DOM is generation. Finally mosaic the corrected image by ways of image coordinate in order to match the topographic map.

### 3.4 Overlay the DOM and DLG

The last step is to overlay of the SAR image to the DLG, manually generation of the changes of the polygons and lines. Overlay of the "changes" layer with the map's layers, creation of the new updated layer.

## 4. RESULT

In this research, the test SAR images are from Sichuan province. The resolution of SAR image is 1m. Target texture is clear in the AIRSAR data, and hierarchical information is abundant. Through the test, some kinds of topographic map elements could extract from the SAR image [Rignot.E, 2003].

### 4.1 Water System

The water system can classified into two kinds by its shape: the linetype water system, like river and canal; the non-linetype water system, like lake and pool.

(1) the linetype water system update: the colors of water and bank displaying in the image are different, so it's easy to determine the position of water edge and find the changes of the place.

(2) the non-linetype water system update: according to the local situation, it is easy to know that the centralized pools are mostly fed fishes, and the scattered pools are usually ordinary pools. So it is also convenient to do the classification.

Fig.3. River

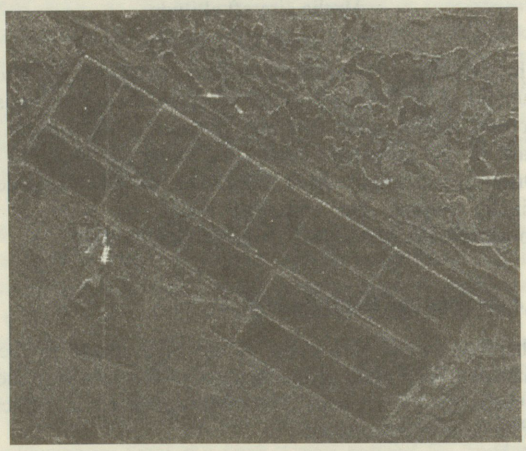

Fig.4. Pool

### 4.2 Road

The railway and highway usually have regular shape and obvious feature, so it is fit to interpret in the SAR image, but the level of the road would be hard to distinguish, it needs to complement until the fieldwork annotation.

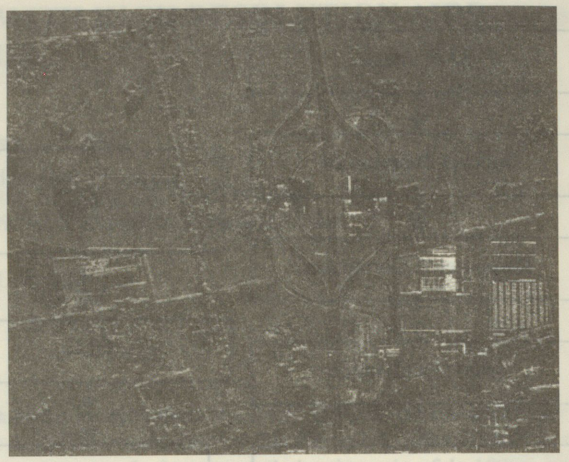

Fig. 5 Highway

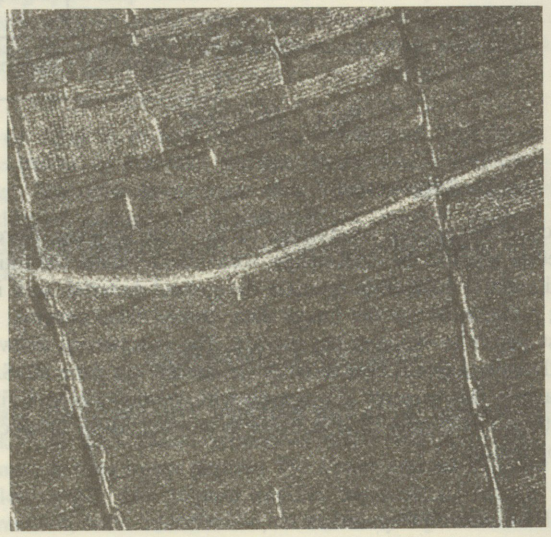

Fig.6 Railway

### 4.3 Vegetation

Vegetation includes cultivated land, forest land, grassland, etc. In the SAR image, different kinds of Vegetation have different texture, as the result, it could be convenient to differentiate them. In color, Paddy field is darker than the dry land, due to different aquifer effect back scattered coefficients. And fruit tree has different scattered feature from cultivated land and grassland. The changes could find easily. But the concrete category also needs to distinguish by filedwork.

Fig.7 Vegetation

### 4.4 Residential Area

In residential area, there are many dihedral angel and polyhedral angle reflectors formed by walls of the building and dams with the ground, so they make the radar beam reflect times without number, so as to enhance the echo. Therefore, the residential area is obvious in the SAR image, and has clear texture.

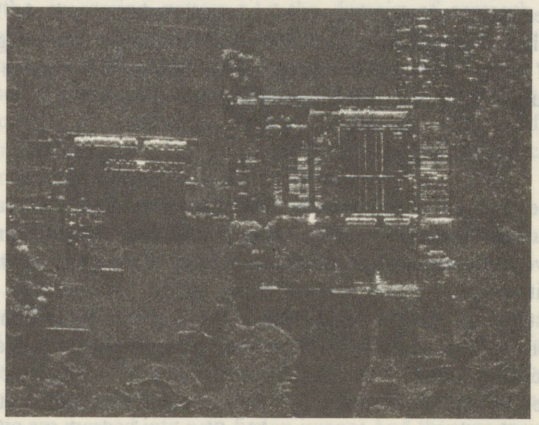

Fig.8 Residential area

## 5. CONCLUSIONS

Through this research, it obviously shows that the high resolution airborne SAR image is capable of updating topographic map elements. By making use of abundant texture feature, various map elements could be distinguish in the SAR image, and changes also could be easily find in the map. SAR image could be the well complementary to the optical image, specially for the place where could not have optical image. In a word, it is feasible to use high resolution airborne SAR image in updating topographic map.

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