A Study on GIS Data Extraction Using Simulated ROCSAT-2 Image

Chih-Li Chang[1], Chi-Nan Wu[2], Wei-Chen Hsu[2], Kuo-Hsing Hsiao[2], Tzu-Yi Liao[2], and Jeng-Shing Chern[3]

National Space Program Office, 8F, 9 Prosperity 1st Road, SBIP, Hsinchu City, Taiwan [1,3]

Energy & Resources Laboratiories/ITRI, Bldg. 24, 195-6 Sec. 4, Chung Hsing Rd.

Chutung Hsinchu, Taiwan [2]

CLChang@nspo.org.tw[1]

Abstract: The study demonstrates the data extraction capabilities from the simulated ROCSAT-2 image by manual delineation. The GIS data are able to identify as fifteen categories of the classes I & II for the simulated ROCSAT-2 and SPOT image data. The areas of the paddy are identified almost the same results for both cases, but the arid farmland are identified differently about 30%. The ROCSAT-2 case can be also identified as seven more categories of the class III, but SPOT-4 case cannot.
Keywords: GIS, ROCSAT-2.

1. Introduction

ROCSAT-2 is planned to launch around the end of 2003. Some applications of ROCSAT-2, including GIS application, were simulated before the commissioning.

The GIS data are identified as categories of the classes I, II and III by manual delineation for the simulated ROCSAT-2 and SPOT image data. Due to 2-meter-resolution of the ROCSAT-2 image data, the ROCSAT-2 case can be identified as seven more categories of the class III, but SPOT-4 case cannot. The categories are graveyards, country roads, other narrow road, parking lots, power equipment, ditches, and bare lands.

Since ROCSAT-2 is superior to SPOT-4 on the GIS data extraction of land use/cover from this study, it would be very important source of the image data for GIS applications in Taiwan.

2. Approaches

A set of IKONOS data with associated ground control points (GCP) and digital elevation model (DEM) were acquired, and the rectified and fused 1-meter-resolution ortho-image data were generated. A 2-meter-resolution ROCAT-2 color image data was then simulated and re-sampled by convolution with the sensor model of the point spread function (PSF). The other set of SPOT-4 image data at the same location was acquired in ortho-rectification for comparison.

The data of the GIS information were extracted on screen from both fused and enhanced ortho-image data by manual delineation, based on a classification system of Taiwan. To extract and compare the GIS data from the simulated ROCSAT-2 and SPOT image data, the procedure is summarized as the following:

1. Acquire the 1-meter black & white and 4-meter color image data of IKONOS, and 10-meter black & white and 20-meter color image data of SPOT.
2. Validate the existing 40-meter X 40-meter DEM
3. Pick up GCPs from 1:5000 ortho-photo maps
4. Fuse the black & white image with colors
5. Rectify the IKONOS images with DEM &GCPs into ortho-images
6. Enhance the image
7. Convolute the fused IKONOS image with PSF model to generate the ROCSAT-2 simulated 2-meter image in 1:10,000 scale
8. Fuse and enhance the SPOT image
9. Extract GIS data by an experienced researcher and generate a GIS map in 1:10,000 scale for both the simulated ROCSAT-2 and SPOT image data based on a classification system of Taiwan with 22 categories.
10. Compare the results for both cases.

3. Experiments and the Results

1) ROCSAT-2's PSF

To simulate 2-meter-resolution image from a 1-meter-resolution image, a ROCSAT-2's PSF was developed.

The CCD detector senses the radiance not only from the pixel at the light of sight, but also from the surrounding pixels. The contribution of radiance is constituted as a sensor model called point spread function (PSF). [1]

The Rocsat-2's PSF is derived from AVHRR's. [2] The value of PSF at the edge of the pixel for the AVHRR's PSF model is 0.5.

The digital response from the sensor is the convolution of CCD sensor model and the radiance input. IKONOS image is served as "radiance input" in this study.

AVHRR's PSF model is coded as a 20X20 matrix in Table 3.1 for the area of 1.0X1.0 km^2. Then a

reduced size of 5X5 matrix is derived. The 5X5 matrix is used as the ROCSAT-2's PSF model for area of 5X5 m^2 as Table 3.2. It is noticed that the maximal value of PSF is 85.76% for ROCSAT-2's model decreased from 94% of AVHRR's PSF model at the center of the pixel, and 48.52% decreased from 50% at the edge of the pixel.

Table 3.1 AVHRR's PSF model

1 km

1	5	8	11	17	21	25	28	30	30	30	30	28	25	21	17	11	8	5	1
5	9	13	20	26	31	35	38	40	41	41	40	38	35	31	26	20	13	9	5
8	13	20	28	34	40	44	48	50	50	50	50	48	44	40	34	28	20	13	8
11	20	28	36	43	49	54	57	59	60	60	59	57	54	49	43	36	28	20	11
17	26	34	43	50	56	62	66	68	69	69	68	66	62	56	50	43	34	26	17
21	31	40	49	56	63	69	73	76	77	77	76	73	69	63	56	49	40	31	21
25	35	44	54	62	69	75	79	82	83	83	82	79	75	69	62	54	44	35	25
28	38	48	57	66	73	79	84	87	88	88	87	84	79	73	66	57	48	38	28
30	40	50	59	68	76	82	87	90	92	92	90	87	82	76	68	59	50	40	30
30	41	50	60	69	77	83	88	92	94	94	92	88	83	77	69	60	50	41	30
30	41	50	60	69	77	83	88	92	94	94	92	88	83	77	69	60	50	41	30
30	40	50	59	68	76	82	87	90	92	92	90	87	82	76	68	59	50	40	30
28	38	48	57	66	73	79	84	87	88	88	87	84	79	73	66	57	48	38	28
25	35	44	54	62	69	75	79	82	83	83	82	79	75	69	62	54	44	35	25
21	31	40	49	56	63	69	73	76	77	77	76	73	69	63	56	49	40	31	21
17	26	34	43	50	56	62	66	68	69	69	68	66	62	56	50	43	34	26	17
11	20	28	36	43	49	54	57	59	60	60	59	57	54	49	43	36	28	20	11
8	13	20	28	34	40	44	48	50	50	50	50	48	44	40	34	28	20	13	8
5	9	13	20	26	31	35	38	40	41	41	40	38	35	31	26	20	13	9	5
1	5	8	11	17	21	25	28	30	30	30	30	28	25	21	17	11	8	5	1

1 km

Table 3.2 ROCSAT-2's PSF model

0.00	**0.19**	**2.45**	**0.19**	**0.00**
0.19	**24.09**	**48.50**	**24.09**	**0.19**
2.45	**48.52**	**85.76**	**48.52**	**2.45**
0.19	**24.09**	**48.50**	**24.09**	**0.19**
0.00	**0.19**	**2.45**	**0.19**	**0.00**

2) Results

To classify the land use/cover from the image, a system of classification was developed. The classification system of Minister of Interior in 1993 and the classification system of USGS are the main references for the classification system. The system includes ten categories for class I, forty-five categories for class II, and nity-three categories for class III. Twenty-two categories are selected in total for this study. The categories are identified from the ortho-image data by an experienced researcher.

The SPOT image is delivered in ortho-image, and ROCSAT-2 image is simulated in ortho-image according to the steps 1~7 of the procedure, as stated in the previous chapter. The researcher can identify fifteen categories, including rice, non-rice crop, forest, grass, national way, city way, house, school, gas station, river, equipment for water resources, lake, constructing land, industrial equipment, and sport land, both in the SPOT image as Fig 3.1 and ROCSAT-2 simulated image as Fig 3.3. The GIS data are extracted and showed as Fig 3.2 & Fig 3.4, respectively.

The researcher can identify seven more categories, including graveyards, country roads, other narrow road, parking lots, power equipment, ditches, and bare lands, only in the ROCSAT-2 simulated image.

The parcels of paddy are also identified in this study. The government agent collected database of the parcel as Fig 3-5. The Simulated ROCSAT-2 image for paddy is showed as Fig 3-6. The results of identification from the simulated ROCSAT-2 image are showed as Fig 3-7.

3) Discussions

1. Since the IKONOS GEO product was processed for the system correction, the transformation of the image introduced some errors into the product.

2. The DEM database with grid system of 40-m x 40-m is a main error source. DEM is more accurate for the plain than non-plain area.

4. Conclusions

To simulate the GIS application, we generate the ROCSAT-2 simulated image first. The researcher then extracted the GIS data from the image. The results are compared with the SPOT case. Some significant conclusions are below.

1. The pixel number of land parcel are 4~5 for SPOT and 26~27 for ROCSAT-2 in Taiwan. The number for the fused ROCSAT-2 image is even up to 425. It becomes an effective method to update paddy by ROCSAT-2 image data.

2. The both image data can be identified as fifteen categories of classes I and II. The major difference is the category of the arid farmland. Two cases differ about 30%.

3. Land use/cover can be only identified as categories of class III, such as line elements of country roads, ditches and irregular patterns such as power equipment, graveyards, parking lots for the simulated ROCSAT-2 image.

4. The total accuracy is 78.08% for SPOT and 90.64% for ROCSAT-2. The value of $\hat{k}$ is 0.55 for SPOT and 0.81 for ROCSAT-2. The accuracy value of the simulated ROCSAT-2 image is better than the SPOT image for the crop identification. Since accuracy of 90% is acceptable for operation, the identification of the paddy with the ROCSAT-2 image data will be one of the important applications.

5. Since ROCSAT-2 revisits Taiwan twice (one in the day time and the other in the night time) per day with 2-meter-resolution. It will provide most image data to extract the GIS data for Taiwan area.

5. Acknowledgement

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6. References

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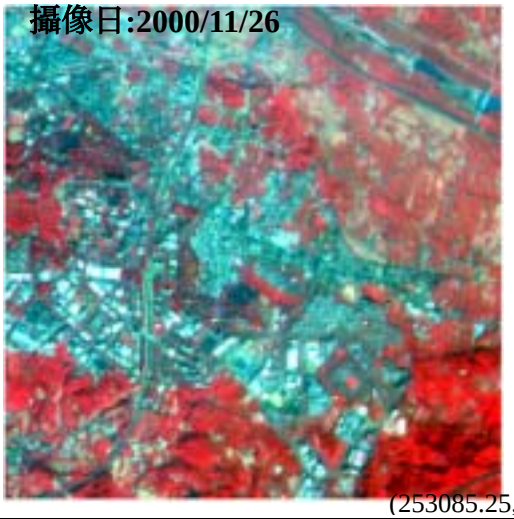


(253085.25,2739483.75)

Fig 3-1、SPOT image

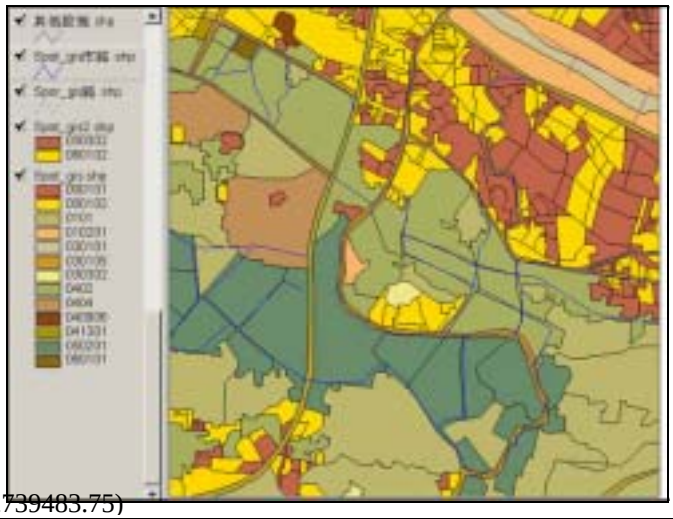
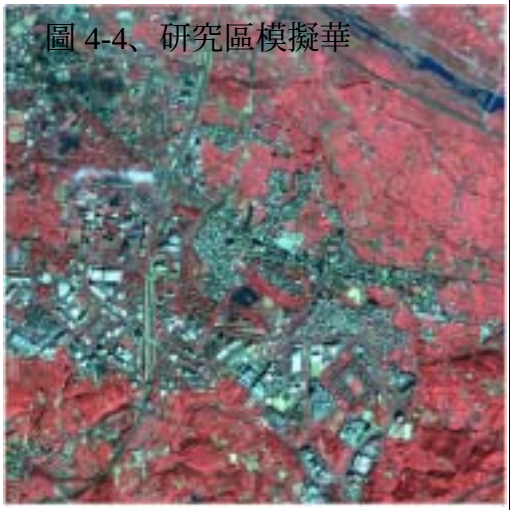


Fig 3-2、GIS data extract from SPOT image



(253085.25,2739483.75)

Fig 3-3、Simulated ROCSAT-2 image

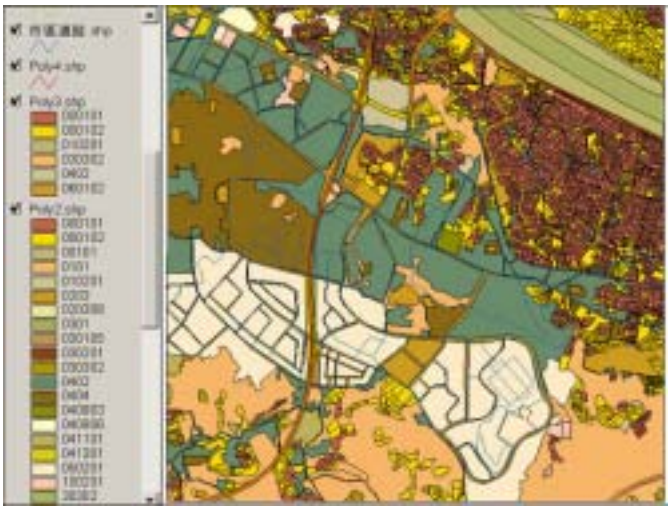


Fig 3-4、GIS data extracted from Simulated ROCSAT-2 image

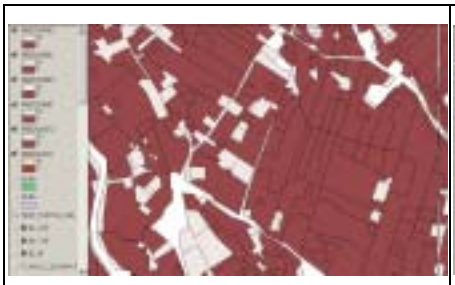


Fig 3-5 Database of parcel

Fig 3-6 Simulated ROCSAT-2 image for paddy

Fig 3-7 Parcel extraction from Fig 3-6