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The Land Cover Estimation with ALOS Satellite Image Using Neural-Network

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Abstract

On May 12th 2008, large earthquake occurred in Sichuan, China. We analyze this disaster damage by using satellite images from ALOS, Japanese satellite. The land cover classi cation is operated by the image captured on AVNIR-2. The AVNIR-2 images can not be monitored frequently because of the cloud and solar irradiation, so near earthquake center area is covered by clouds. The goal of this paper is to classify land cover using PALSAR images. PALSAR can observe in 350km wide area independent on weather. The PALSAR is a single band sensor, and the inputs consist of many pixels by using nearest pixel values, and the supervisor signal is the estimated classes by AVNIR-2.
Keywords ALOS, PALSAR, AVNIR-2, the earthquake in Sichuan

1 INTRODUCTION

The large earthquake occurred on May 12th 2008 in Sichuan, China. This earthquake caused over 90 000 deaths, which had a magnitude 8. By the way, the satellite was launched for the land observation from Japan on 2006. This disaster damage is analyzed by using pre- and post-images, sent from PALSAR mounted on ALOS[1]. The PALSAR images are able to be observed a wide area ground shape however, it is di cult to gure out the land utilization with it because this sensor has only 1 band.

In this paper, we estimate the land cover classi cation with the image captured on AVNIR-2, mounted on the same satellite. Since AVNIR-2 has four bands sensor, the classi cation is easier than PALSAR.

In the cover classi cation from PALSAR, the classi cation result from AVNIR-2 is adopted as supervisor signal.

Now, there are two purposes of the classi cation from AVNIR-2. At rst, the raw AVNIR-2 data contains the many information. Therefor, the AVNIR-2 is classi ed to 8 classes to reduce it. Second, in the wide area PALSAR data, more sample data is included to enhance the classi cation accuracy.

In the classi cation with PALSAR, the number of the input layer has a problem, because the PALSAR has only one band sensor. We propose that the input signal employs not only one pixel but also near pixel values.

2 PALSAR IMAGE SUMMARY

PALSAR (Phased Array type L-band Synthetic Aperture Rader) is the active image sensor independent on weather. The center frequency is 1,270MHz (L band). The active sensor has advantages that these can observe the area covered with cloud in many season, or midnight, so the capture frequency is higher than passive e.g., optical sensor.

The ScanSAR mode was bought to need wide area because the detail position of the earthquake center was not able to be checked, though PALSAR is provided the three modes. The data has the following properties: band width is 14MHz, Polarization is HH, O -nadir angle is 27 1 , and spatial resolution is 100m[2]. The image size is 3 700 $\times$ 3 900 pixels, and the swath width is 370km. In an PALSAR image, the dark pixel depicts atness surface, e.g. water or airstrip, because the radar from satellite re ects in the opposite direction. On the other hand, the bright indicates the backscatter from the architectures in urban area. The mountain is expressed as contrast.

Figure 1 shows the PALSAR image in earthquake center. Being compared with Google maps, (1) in Figure 1 shows the Zipingpu dam, and (2) shows Guan Xian. Thus, PALSAR is suitable to survey the surface structure. Using this character, pre-image (in 2008/1/3) is compared with post-image (in 5/20) and checked on the damage refer from the Google maps, or the book[3].

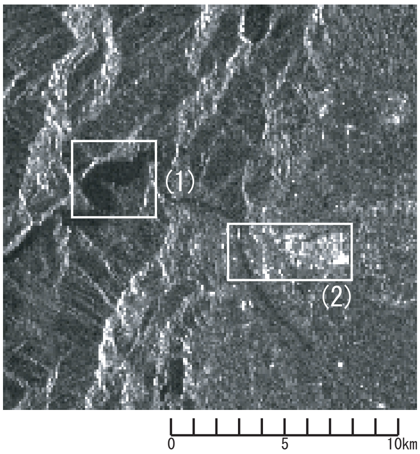


Figure 1: The data of the neighborhood of earthquake center (2008/5/20)

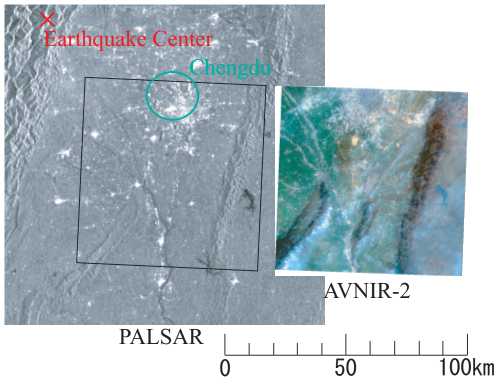


Figure 2: The image of AVNIR-2 and PALSAR. The square in PALSAR is position of AVNIR-2

3 AVNIR-2 IMAGE SUMMARY

AVNIR-2(Advanced Visible and Near Infrared Radiometer type 2) are the passive image sensor because the sun as light source a ects the image. This sensor can observe at 10m spatial resolution. The bands have three, and table 1 shows bands speci cation.

The bought data observes near Chengdu in 2007/3/31; the image size is 7 128 × 7 000 pixels, and swath width is 71 28km. Figure 2 shows the AVNIR-2 image and the PALSAR image.

Table 1: The Bands spec on AVNIR-2

Band1	0 42 m 0 50 m	Blue
Band2	0 52 m 0 60 m	Green
Band3	0 61 m 0 69 m	Red
Band4	0 76 m 0 89 m	Infra Red

AVNIR-2 has a shortage: It depends on weather, or night. Actually, the data near earthquake center can't be utilized due to cloud.

3.1 LAND COVER ESTIMATION USING AVNIR-2

The goal of this paper is to achieve the land cover classi cation using PALSAR in the area not observed by AVNIR-2. The land cover classi cation is estimated by using AVNIR-2. Then the classi cation is estimated with PALSAR. In the classi cation by using AVNIR-2, the neural-network, one of the supervised learning, is used, and then the supervisor signal is picked up manually.

Table 2 shows correspondence of class number and names. In pre-examination, the false classi cation exists in the edge of the river, "Along the river" is adopted. Figure 3 shows the structure of neural network. The input signals are 4 bands for a pixel. The raw data of AVNIR-2 have 8-bit wide and the signals range from 0 to 255, where in fact shows from 35 to 203. A threshold value x_0 has the center of the all bands luminance value: 84. There are 7 neurons in middle layer. There are 8 output signals as a classi cation. The learning coe cient is 0 003, and is 0 85. The supervisor data is set as 1 when it should be classi ed data in pixel, and the other are set as zeros.

Table 2: The classi cation type

No.	Class Name	Color
1	Sand	(yellow)
2	Vegetation A	(dark green)
3	Vegetation B	(light green)
4	Architecture	(red)
5	Along the river	(gray)
6	Mountain	(brown)
7	Water	(blue)
8	Red Soil	(orange)

The learning employs 60 patterns in each class, summation is 480, and the test apples $40 * 8 = 320$ patterns. Table 3 shows the learning result, and Table 6 shows the test result. Any row means the average

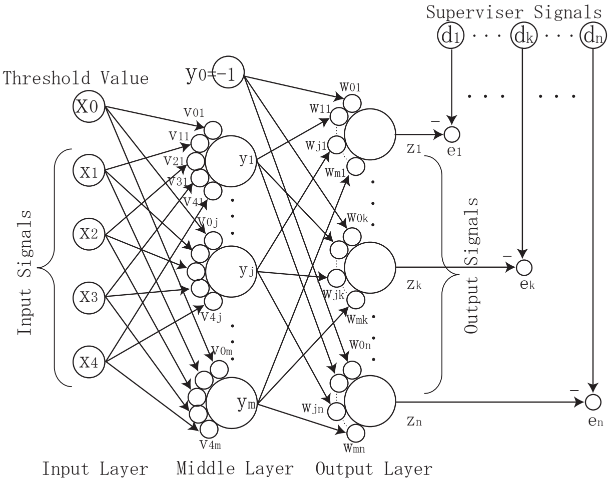


Figure 3: The structure of neural network

of output data for each supervised classes. Figure 4 shows the estimated result. Figure 4(a) is AVNIR-2 image, and (b) is the result. These tables explain how the classi cation has been achieved. For example, No.1: "Sand" and No.6: "Mountain" achieved. However No4: "Architecture" is misclassi ed as No.5: "Along the river" or No.7: "Water". The result is estimated by using all samples. However some areas covered with cloud make false recognition. Therefore, these areas are performed by the estimation using PALSAR.

Table 3: Learning result using AVNIR-2

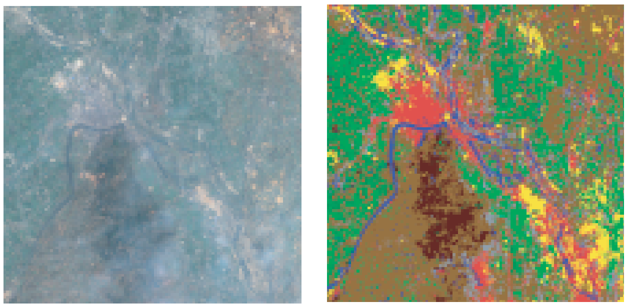
	1	2	3	4	5	6	7	8
1	0.99	0.00	0.01	0.00	0.01	0.00	0.01	0.00
2	0.00	0.98	0.02	0.00	0.00	0.01	0.00	0.01
3	0.01	0.01	0.98	0.00	0.00	0.00	0.00	0.01
4	0.00	0.00	0.00	0.86	0.04	0.00	0.06	0.04
5	0.00	0.00	0.00	0.04	0.91	0.01	0.00	0.04
6	0.00	0.01	0.00	0.00	0.00	0.99	0.01	0.01
7	0.00	0.00	0.00	0.05	0.01	0.01	0.93	0.02
8	0.00	0.01	0.01	0.01	0.04	0.01	0.00	0.93

4 LAND COVER ESTIMATION USING PALSAR

The land cover estimation with PALSAR is performed by neural-network. We estimate it by using one pixel

Table 4: Test result using AVNIR-2

	1	2	3	4	5	6	7	8
1	0.97	0.00	0.01	0.00	0.02	0.00	0.01	0.00
2	0.00	0.96	0.02	0.00	0.00	0.01	0.00	0.01
3	0.01	0.02	0.98	0.00	0.00	0.00	0.00	0.01
4	0.00	0.00	0.00	0.83	0.14	0.00	0.05	0.02
5	0.00	0.00	0.00	0.07	0.79	0.01	0.00	0.09
6	0.00	0.01	0.00	0.00	0.00	0.98	0.01	0.01
7	0.00	0.00	0.00	0.08	0.01	0.01	0.90	0.01
8	0.00	0.03	0.00	0.00	0.18	0.00	0.00	0.78

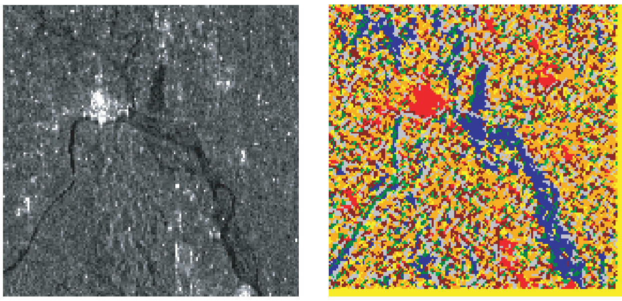


(a) AVNIR-2 Color image (b)Estimated result

Figure 4: The classi cation result using AVNIR-2

of PALSAR image input. However, the classi cation is di cult because of brightness distribution being biased. We consider to use the many pixels are adopted as an input of the neural network. The estimated result with AVNIR-2 is employed as supervisor signal and the axes and resolution are converted with a ne transform to PALSAR. The characteristic positions where these are common in PALSAR and AVNIR-2 were extracted, like river, lake or airport. Then the a ne coe cients are calculated with least-square method using these positions.

The PALSAR data was corrected with histogram equalization to reduce the bias. The input layer has $16(4 * 4)$, and the output is the same as AVNIR-2. The input value is divided by maximum to [0,1] and the threshold value x_0 is 1. In hidden layer, the 12 neurons are set. The pixel of PALSAR image is more narrow than it of AVNIR-2. The square of one pixel of PALSAR is similar to the square of 10×10 pixles of AVNIR-2. In these area of AVNIR-2, the many classes are contained, where maximum is 100, therefore mixed classes represent ratio. For example, in 10×10 pixels of AVNIR-2, when the 50 pixels is class No.1, the ratio of class No.1 is 0.5. The 16 pixels



(a) PALSAR image (b)Estimated result

Figure 5: The classi cation result using PALSAR

Table 6: Test result using PALSAR

	1	2	3	4	5	6	7	8
1	0.14	0.01	0.12	0.08	0.12	0.33	0.10	0.17
2	0.03	0.08	0.06	0.00	0.18	0.13	0.18	0.16
3	0.04	0.02	0.16	0.06	0.11	0.07	0.09	0.28
4	0.10	0.02	0.03	0.45	0.12	0.12	0.01	0.12
5	0.01	0.03	0.03	0.14	0.27	0.21	0.03	0.18
6	0.11	0.01	0.04	0.01	0.17	0.24	0.03	0.38
7	0.01	0.13	0.01	0.04	0.04	0.02	0.53	0.04
8	0.09	0.03	0.08	0.01	0.14	0.14	0.03	0.19

of PALSAR contains 1600 pixels of AVNIR-2, therefor the ratio 60% correspond to the classes of 960 pixels in AVNIR-2. The ratio of classes estimated with AVNIR-2 are applied as the learning data. The output may not be enhanced near 1.

The sample data is picked over 60% for each class to get over 20 patterns . The learning data employs $10 * 8 = 80$ patterns. Table 5 shows learning result and Table 6 shows the test result. Some classes has positive reaction, though the tests have many false e.g.No4: "Architecture" and No.7: "Water" . The Figure 5 shows the estimated data, (a): PALSAR image and (b): estimated result. The Architecture or Water exists the same position on AVNIR-2.

Table 5: Learning result using PALSAR

	1	2	3	4	5	6	7	8
1	0.66	0.02	0.05	0.00	0.04	0.03	0.03	0.08
2	0.02	0.36	0.03	0.03	0.05	0.02	0.04	0.12
3	0.02	0.01	0.65	0.02	0.03	0.01	0.01	0.17
4	0.02	0.00	0.03	0.72	0.05	0.02	0.00	0.07
5	0.02	0.00	0.03	0.02	0.40	0.04	0.04	0.22
6	0.01	0.02	0.02	0.02	0.05	0.73	0.01	0.14
7	0.02	0.05	0.01	0.05	0.04	0.04	0.54	0.08
8	0.00	0.01	0.07	0.01	0.07	0.01	0.06	0.70

5 CONCLUSION

The PALSAR is single band radar and it is di cult to estimate land cover. However, the area or number of times is larger than the other optical sensor. The land cover estimation using PALSAR has many advantages. For example, the AVNIR-2 can not be observed from the cloud or midnight. However, the PALSAR is able to observe the data independent by on weather. Thus the PALSAR data is stocked larger than AVNIR-2. The ScanSAR mode has wide area and the cost per the area is lower. Actually, the cost of an AVNIR-2 data is the same as the PALSAR.

In this paper, the method to estimate the land cover with PALSAR is introduced. At rst, the classi cation with AVNIR-2 is estimated to pick the samples. As a result, the test data depicted acceptable result. This data is able to apply the land cover estimation with PALSAR.

The second, in the estimation with PALSAR, the many pixels in PALSAR image are employed as input layer. The estimated results with AVNIR-2 are applied as the learning data, where the ratio of classes are learned. As a result, some classes show reaction, though the many classi cation error occur.

The challenge for the future is that the number of input layer has to be adjusted. In PALSAR data, the single or 4 pixels cannot show the characteristic class. the many pixels are considered land cover. Then this result is applied for analyzing the earthquake damage.

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References

[1] Y.Tsuchida, S.Omatu and M.Yoshioka, "The land cover classi cation with PALSAR and AVNIR-2 image" IEEJ C convention, 2009 , GS11-7.

[2] RESTEC, "ALOS product and services", 2007 ,Japan.

[3] CAS , "Concise Atlas of the Wenchuan earthquake area" ,2008/1,Starmap pub ,China.