# The Comparison of Visual Interpretation & Digital Classification of SPOT Satellite Image

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**Abstract**

The land use type of Korea is high-density. So, the image classification using coarse resolution satellite image may not provide land cover classification results as good as expected. The purpose of this paper is to compare the result of visual interpretation with that of digital image classification of 20 m resolution SPOT satellite image at Kwangju-eup, Kyunggi-do, Korea.

Classes are forest, cultivated field, pasture, water and residential area, which are clearly discriminated in visual interpretation. Maximum likelihood classifier was used for digital image classification. Accuracy assessment was done by comparing each classification result with ground truth data obtained from field checking.

The classification result from the visual interpretation presented an total accuracy 9.23 percent higher than that of the digital image classification.

This proves the importance of visual interpretation for the area with high density land use like the study site in Korea.

Keyword: classification accuracy assessment, SPOT, visual interpretation, image classification

## I. Introduction

Remote sensing is the science and art of obtaining information from data using a remotely located sensing device - e,g., aircraft, satellite -. Development of aerospace and computer science accelerate the information extraction techniques in remote sensing(McCloy,1995).

Information extraction can be made by human or computer. <Table 1> provides a comparison between human and computer information extraction. As seen in table, human and computer methods supplement each other(JARS, 1993).

High-density land use activities is done in the land of Korea. It may deteriorate the classification accuracy of coarse resolution satellite image like Thematic Mapper(30m).

<Table 1> Comparison between human and computer information extraction

| Method | Merit | Demerit |
|---|---|---|
| **Human (Visual interpretation)** | · Interpreter's knowledge are available<br>· Excellent in spatial information extraction | · Time consuming<br>· Individual difference |
| **Computer (Digital processing)** | · Short processing time<br>· Reproductivity<br>· Extraction of physical quantities or indices is possible | · Human knowledge is unavailable<br>· Spatial information extraction is poor |

Therefore, the purpose of this study is to compare the classification accuracy between visual interpretation of 20m resolution enhanced SPOT color image and digital classification of the same image.

## II. Materials and Method

### 1. Study Site

A 20m resolution SPOT XS image, which was scanned in July 1, 1996, was used in this study. The study site is Mokhyun watershed at Kwangju-eup Kyunggi-do and the area is 20.90$Km^2$, 44,403 pixels(See <Fig. 1>).

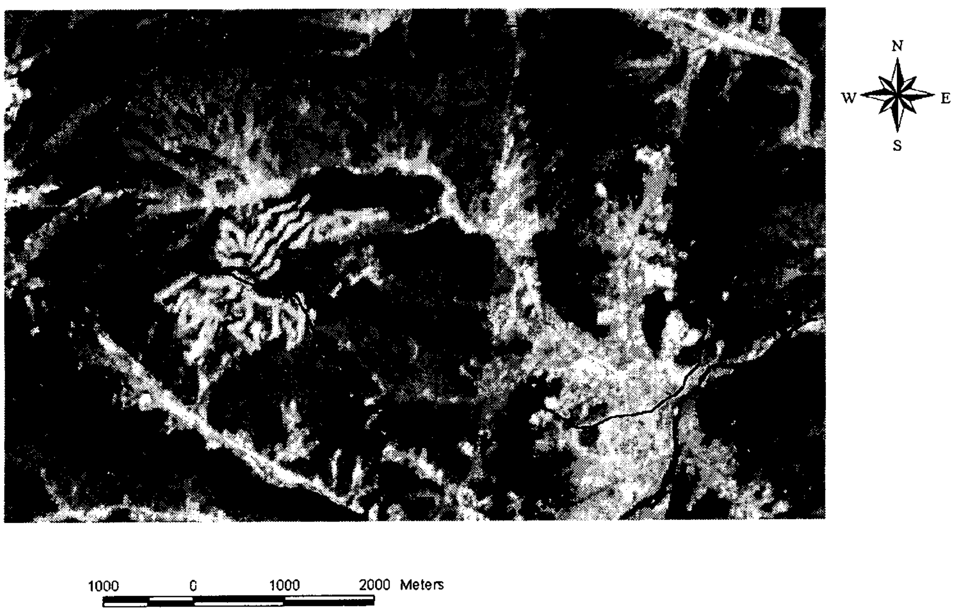
SPOT was first launched in February, 1986 by the French Government. SPOT has two HRV(High Resolution Visible imaging system) sensors with stereoscopic and oblique pointing functions. <Table 2> shows the characteristics of SPOT HRV.

Its orbit is 830km altitude and 26days recurrent. A scene of HRV has a nadir coverage of 60 × 60 km, but an oblique coverage of 81km square at maximum look angle of 27° .

The Digital image processing was performed on a PC(P-II400), using PCI and ArcView3.1 softwares.

### 2. Geometric correction

Satellite image has distortions which are radiometric distortion and geometric distortion. Radiometric distortion is due to sensor sensitivity, otherwise geometric distortion is due to sun angle and topography etc.




<Fig. 1> The Study Site

<Table 2> SPOT HRV characteristics

| Band | Spectral range($\mu$m) | IFOV |
|---|---|---|
| XS1 | 0.50 ~ 0.59 green | 20 m |
| XS2 | 0.61 ~ 0.68 red | 20 m |
| XS3 | 0.79 ~ 0.89 near-IR | 20 m |
| PA | 0.51 ~ 0.73 | 10 m |

For only system correction was put in operation at ground station, image data needs to be corrected using Ground Control Points(GCP).

Geometric correction is undertaken to avoid geometric distortions from a distorted image, and is achieved establishing the relationship between the image coordinate system and the geographic coordinate system using calibration data of the sensor, measured data of position and attitude, ground control points, atmospheric condition etc.

1) Selection of GCPs

The points which are unchangeable and clearly discriminated (e.g. bridge, cross-roads etc.) were selected in SPOT image after image enhancement. Cartesian coordinates for GCPs was obtained by referring to 1:5000 digital topographic maps.

2) Transformation of Pixel Coordinates

Transformation equation can be expressed in high order polynomial equation. Usually a maximum of third order polynomials will be sufficient for existing remote sensing data(JARS, 1993).

In this study, second-order polynomials was used to correct SPOT image geometrically with fifteen GCPs, and RMS error was less than a half pixel.

3) Resampling

In the final stage of geometric correction a geo-coded image was produced by resampling. In this study, nearest neighbor resampling was used in this study, because this methods unchanged the original pixel data.

3. Image Enhancement

There are several image enhancement techniques - e.g., gray scale conversion, histogram conversion, color composition, color conversion between RGB and HSI, etc. Of these techniques, square-root contrast stretch was performed after RGB color composition for the visual interpretation in this study. It stretches the dynamic range of the low end of the image while compressing its high end. It tends to lend an overall brightening to the resultant image. (PCI, 1998)

4. Land Cover Classification

Land cover classification was performed by two methods; visual interpretation and digital image classification. Enhanced image were used in visual interpretation. Color composition and image enhancement by square-root contrast stretches were performed before image display.

Digital classification was carried out using the MLC(Maximum Likelihood Classifier). The 5 classes defined in this study were urban area, cultivated field, pasture, forest and water. Training sites of these five classes were selected on colour-composite images on the basis of field knowledge. Filtering and enhancement were not applied before accuracy evaluation.

MLC is one of the most widely used classification, in which a pixel with the maximum likelihood is classified into the corresponding class. The maximum likelihood method has an advantage from the view point of probability theory.

5. Accuracy assessment

To determine the accuracy of each classifications, 65 pixels were selected as reference data for comparing ground information with classification results. This reference data was chosen by field checking using 1:5,000 scale digital topographic map

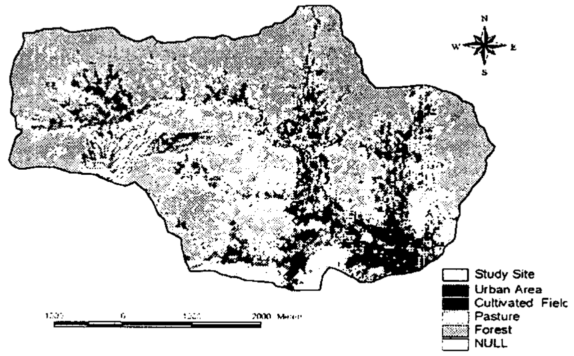
These pixels were selected in differently classified pixels between each classification results. The confusion matrix was used to obtain omission error, commission error and total accuracy ratio.

III. Results and Discussion

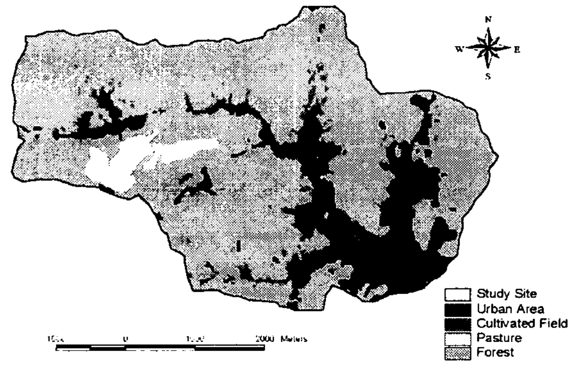
1. Land cover classification

Each classification results is showed in <Table 3>, <Table 4> and <Fig. 2> to <Fig. 4>.

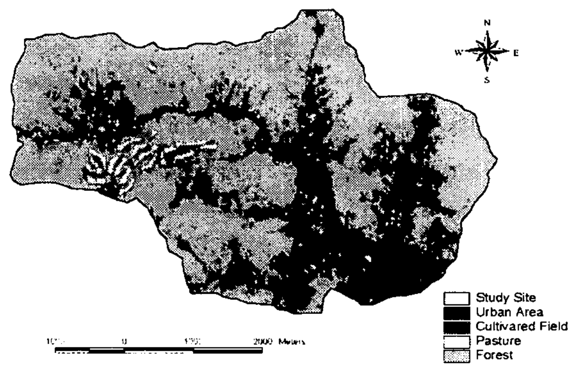
<Table 3> and <Table 4> show the confusion matrix between visual interpretation and image classification without/with null class. In <Table 3>, 73.87% (32,802pixels) of total area were classified same class.




<Fig. 3> Digital Classification with null class




<Fig. 2> Visual Interpretation




<Fig. 4> Digital Classification without null class

<Table 3> Confusion matrix between visual interpretation and digital classification without null class

| | | Visual Interpretation | | | | |
|---|---|---|---|---|---|---|
| | | Urban Area | Cultivated Field | Pasture | Forest | Row Total |
| Digital classification without null class | Urban Area | 3,847 | 211 | 26 | 256 | 4,340 |
| | Cultivated Field | 1,451 | 4,165 | 896 | 8,179 | 14,691 |
| | Pasture | 137 | 181 | 499 | 186 | 1,003 |
| | Forest | 2 | 14 | 62 | 24,291 | 24,369 |
| | Column Total | 5,437 | 4,571 | 1,483 | 32,912 | 44,403 |

<Table 4> Confusion matrix between visual interpretation and digital classification with null class

| | | Visual Interpretation | | | | |
|---|---|---|---|---|---|---|
| | | Urban Area | Cultivated Field | Pasture | Forest | Row Total |
| Digital classification with null class | Urban Area | 2,199 | 14 | 0 | 7 | 2,215 |
| | Cultivated Field | 611 | 3,348 | 569 | 2,828 | 7,356 |
| | Pasture | 14 | 50 | 464 | 52 | 580 |
| | Forest | 0 | 2 | 12 | 18,480 | 18,494 |
| | NULL | 2,613 | 1,162 | 438 | 11,545 | 15,758 |
| | Column Total | 5,437 | 4,571 | 1,483 | 32,912 | 44,403 |

2. Classification accuracy

In order to compare the accuracy of these results, 65 points selected from differently classified pixels were compared of ground truth data. Because, these 65 points are selected from differently classified pixels between visual interpretation and digital classification, the total accuracy for overall area should be higher than this result.

<Table 5> to <Table 7> show the classification accuracy by confusion matrix.

One date image was used in this study. For better results, multi-temporal data may enhance the accuracy. And more, it is necessary for overall accuracy to select reference data by random sampling.

Spatial resolution(20m) limits the accuracy of visual interpretation and digital classification for densely populated and high-density land use sites in Korea.

<Table 5> Confusion Matrix of Visual Interpretation

| | **Ground Truth Data** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Classified data** | Urban Area | Cultivated field | Pasture | Forest | Water | Row Total | Comm. Error(%) |
| Urban Area | 1 | 1 | 1 | 1 | 1 | 5 | 80.00 |
| Cultivated field | 3 | 7 | 1 | 1 | 1 | 13 | 46.15 |
| Pasture | 0 | 0 | 0 | 0 | 0 | 0 | NULL |
| Forest | 14 | 8 | 11 | 14 | 0 | 47 | 70.21 |
| Water | 0 | 0 | 0 | 0 | 0 | 0 | NULL |
| Column Total | 18 | 16 | 13 | 16 | 2 | 65 | |
| Om. Error(%) | 97.44 | 56.25 | 0 | 12.50 | 100 | | |

**Total accuracy(%) : 33.85**

<Table 6> Confusion Matrix of Digital Classification without NULL Class

| | **Ground Truth Data** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Classified data** | Urban Area | Cultivated field | Pasture | Forest | Water | Row Total | Comm. Error(%) |
| Urban Area | 0 | 1 | 1 | 2 | 0 | 4 | 100 |
| Cultivated field | 3 | 14 | 10 | 13 | 2 | 52 | 73.08 |
| Pasture | 0 | 1 | 1 | 0 | 0 | 2 | 50.00 |
| Forest | 5 | 0 | 1 | 1 | 0 | 7 | 85.71 |
| Water | 0 | 0 | 0 | 0 | 0 | 0 | NULL |
| Column Total | 18 | 16 | 13 | 16 | 2 | 65 | |
| Om. Error(%) | 100 | 12.50 | 92.31 | 93.75 | 100 | | |

**Total accuracy(%) : 24.62**

<Table 7> Confusion Matrix of Digital Classification with NULL Class

| | **Ground Truth Data** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Classified data** | Urban Area | Cultivated field | Pasture | Forest | Water | Row Total | Comm. Error(%) |
| Urban Area | 0 | 1 | 0 | 0 | 0 | 1 | 100 |
| Cultivated field | 4 | 10 | 4 | 5 | 1 | 24 | 58.33 |
| Pasture | 0 | 1 | 1 | 0 | 0 | 2 | 50.00 |
| Forest | 2 | 0 | 1 | 1 | 0 | 4 | 75.00 |
| Water | 0 | 0 | 0 | 0 | 0 | 0 | NULL |
| Column Total | 6 | 12 | 6 | 6 | 1 | 31 | |
| Om. Error(%) | 100 | 16.67 | 83.33 | 83.33 | 100 | | |

**Total accuracy(%) : 38.71**

## IV. Conclusions

This paper shows the difference between results of visual interpretation and that of digital classification. Three types of classification were used for this. Those are visual interpretation, digital classification with null class and digital classification without null class. The best method in the point of total accuracy is digital classification with null class. However, null value was too much for the actual application of the result.

Total accuracy of visual interpretation is 9.23 percent higher than that of pure digital classification. So, visual interpretation of enhanced color image is important in the area with high density land use like the study site in Korea. Now IKONOS with 1 m resolution image is on orbit. So, it needs to be tested in the land with high-density land use.

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