

# Extraction of rivers and streams on the satellite images

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## ABSTRACT

Mapping of the rivers and streams in the image source is important for mapping of the river and riparian zones. This research is focused on the extraction of the rivers and streams on the satellite images. Nakdong River was selected as the study area and the RapidEye imagery was used for this research. First of all, the NDVI image was generated from the given RapidEye imagery. And then, the ISODATA, one of the unsupervised classification algorithms, was applied to classify the objects of the rivers and streams and any other objects in the image. After the application of the ISODATA classification algorithms, the process of merging classes was implemented to extract the rivers and streams on the RapidEye imagery.

Keywords : ISODATA Classification, RapidEye, NDVI, River, Stream

## 1. Introduction

A river is defined as a natural stream of water flowing in a definite course or channels. In general, the rivers and streams have the different shape and sizes, and the small rivers and streams join together to become larger rivers.

Eventually, all the waters of the rivers and streams run into an inland body of water such as a lake or the oceans. Although waters of the rivers and streams make up only about 0.2 percent of all the fresh water on Earth, they play an important role for the human activities and lives.

Thus, mapping of the rivers and streams is significantly important and necessary for the identification of the watershed area where the rivers and streams are connected each other. The multispectral image source data such as the satellite images or multispectral aerial orthoimages are useful for the identification of the rivers and streams in the images, since, using the multispectral images, the large area on

Earth can be easily observed and the specific bands of the multispectral image can be useful for imaging of the specific objects such as the man-made structures, vegetations, waters and etc. In this research, one scene of the RapidEye was used to extract the rivers and streams. Figure 1 shows the study area (Nakdong River) in the RapidEye image. In Figure 1, the main stream of Nakdong River and several small streams can be seen in the image.

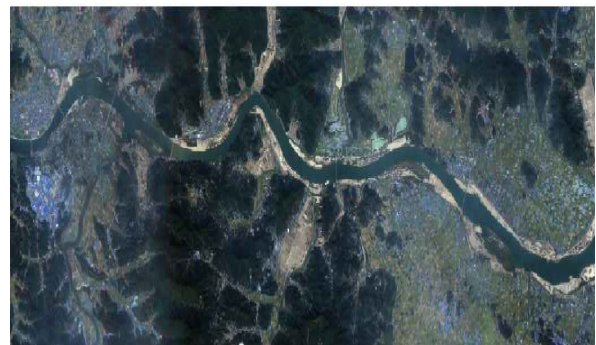


FIGURE 1. Study area in the RapidEye image

Since water resources such as the shorelines, the rivers and streams, the watershed areas play an important role in environmental transportation and region planning, natural disasters and etc. and the utilization of the remote sensing data is useful for the mapping tasks of the riparian zones, mapping of the water resources using the remote sensing data has been implemented by the multiple researchers. Prakash and Gupta (1998) used the

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remote sensing and GIS technologies for the identification of the various land-use classes and time-sequential changes in land-use patterns on the satellite images. Hu et al. (2007) used the decision tree methods for extraction of the water body from the flood affected region. Di et al. (2003) used the mean-shift segmentation to extract the shoreline and water body from the IKONOS imagery. Shah et al. (2011) extracted the rivers from the satellite images using the multiple image processing algorithms such as color histograms, k-mean clustering, hill climbing algorithm, thresholding and segmentation algorithms. In this research, we extracted the water body of the rivers and streams from the RapidEye imagery by using one of the unsupervised classification methods.

## 2. Methodologies

### 2.1 NDVI Image

For the extraction of the water body on the satellite image, we generated the NDVI (Normalized Difference Vegetation Index) image from the original RapidEye imagery using the Red band and NIR (Near Infrared) band. The NDVI is used to measure and monitor plant growth, vegetation covers, and biomass production from the multispectral satellite imagery (USGS, 2012). Figure 2 shows the NDVI image generated using the original RapidEye imagery.



**FIGURE 2. NDVI Image converted from the original image**

NDVI is calculated using the below Equation (1):

$$\text{NDVI} = (\text{NIR} - \text{Red}) / (\text{NIR} + \text{Red}) \quad (1)$$

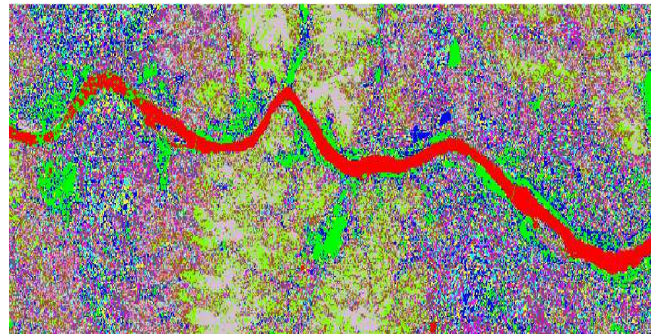
Using Equation 1, the output value has the range from -1 to 1. In general, healthy growing vegetation has low red-light reflectance and high near-infrared reflectance,

and hence, the pixels representing such a healthy and growing vegetation have high NDVI values. NDVI values near zero and negative values indicate non-vegetated features such as barren surfaces (rock or soil), water, snow, ice, and clouds (USGS, 2012). In Figure 2, the pixels representing the rivers and stream has a lower NDVI values than other pixels.

### 2.2 ISODATA Classification

After the generation of the NDVI image, we utilized the classification algorithm to classify the water body and other objects. Classification is a widely used image processing technology in remote sensing such as land use analysis and change detection (Nath and Deb, 2010).

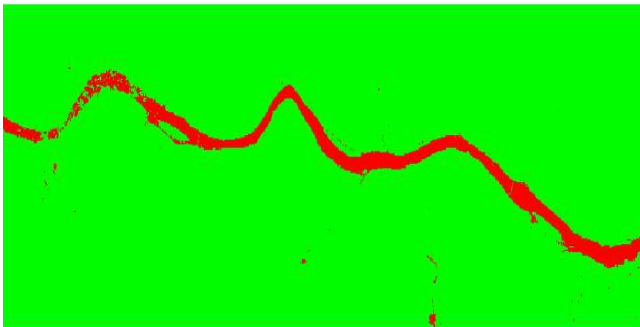
In this research, we utilized the ISODATA (Iterative Self-Organizing Data Analysis Technique) classification, one of the unsupervised classification algorithms, to classify the water body and other objects on the image. The ISODATA algorithm use a set of rule-of-thumb procedures that have incorporated into an iterative classification algorithm (Stow et al., 2003). Many of the steps used in the ISODATA algorithms are obtained from a result of experience gained through experimentation (Jensen, 2005). The ISODATA algorithm is a modification of the k-mean clustering algorithm to overcome the disadvantages of the k-means, and the algorithm includes a) merging clusters if their separation distance in multispectral feature space is below a user-specified threshold and b) rules for splitting a single cluster into two clusters (Schowengerdt, 1997; Jensen, 2005). The algorithm makes a large number of passes through the datasets until the specified results are obtained. In this research, we set the maximum number of clusters as the 20 clusters to be identified by the algorithm. Figure 3 shows the classification results using the ISODATA algorithm.



**FIGURE 3. Classification results using the ISODATA algorithm**

### 2.3 Post Classification

In Figure 3, the rivers and streams are represented by one class (red-color), and other objects such as vegetations, soils and etc. are represented by other classes. Thus, we combined the classes which represent other objects to separate the class representing the water body from the classes representing the other objects. Figure 4 shows the extracted rivers and streams on the RapidEye imagery after the application of the post classification process.



**FIGURE 4. Extracted rivers and stream after post classification**

### 3. Conclusions

In this research, we set the NDVI values as the parameter for extracting the water body of the rivers and streams using the ISODATA classification algorithm.

Since, the pixels representing the water body generally have lower NDVI values than the pixels representing other objects, the NDVI values can be a good parameters for extracting the rivers and streams using the classification algorithms. However, the pixels representing the bare surface (soils and rocks) or the artificial structures (roads or buildings) also have the lower NDVI values. Therefore, in Figure 2, the pixels representing the urban area where bare surfaces and artificial structures are located also have the lower NDVI values similar to the pixels representing the water body.

It causes the misclassification errors in some areas where the water body of the rivers and streams are located nearby the urban areas. In Figure 3 and 4, most regions of the rivers and streams were well classified and extracted, however, in some area where the water body of the rivers and stream are located nearby the urban area, some misclassification errors are occurred on the image.

Therefore, the further research is required for extracting the rivers and streams on the satellite image without those misclassification errors.

### 4. Study Area and Data Sets

In this research, we selected the 40 km length of Nakdong River of South Korea as the study area. The RapidEye imagery used in this research was taken in October 2011.

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