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Spatial resolution enhancement of satellite image data using fusion approach

H Lestiana[1] and Sukristiyanti[1]

[1] Research Center for Geotechnology LIPI, Bandung, Indonesia
E-mail: hilda@geotek.lipi.go.id, hilda.lestiana@gmail.com

Abstract. Object identification using remote sensing data has a problem when the spatial resolution is not in accordance with the object. The fusion approach is one of methods to solve the problem, to improve the object recognition and to increase the objects information by combining data from multiple sensors. The application of fusion image can be used to estimate the environmental component that is needed to monitor in multiple views, such as evapotranspiration estimation, 3D ground-based characterisation, smart city application, urban environments, terrestrial mapping, and water vegetation. Based on fusion application method, the visible object in land area has been easily recognized using the method. The variety of object information in land area has increased the variation of environmental component estimation. The difficulties in recognizing the invisible object like Submarine Groundwater Discharge (SGD), especially in tropical area, might be decreased by the fusion method. The less variation of the object in the sea surface temperature is a challenge to be solved.

1. Introduction

Quantification an object value can be achieved accurately using in situ measurement, but it is costly. The utilization of remote sensing data can estimate and monitor spatiotemporal of the object value [1] and the cost of effective mapping tool [2]. The variability of object size and spatial image resolution is the key to identify objects. Remote sensing technology can recognize the object using the variation of sensors [3]. This technology is indispensable to accurately map and monitor environmental changes. However, the object identification using remote sensing data will have problems when the spatial resolution is not in accordance with the object.

Remote Sensing technology can detect an object and divide it into two variants. First, the object can be identified using visible sensor (visible object) such as land use and land cover. This visible object can be seen with bare eyes. The other is an object that can be identified using another sensor (invisible object) such as temperature, evaporation, evapotranspiration, and salinity. The visible object can be recognized easily with medium to high spatial resolution sensor, whereas the invisible object can be spotted based on spectral properties with low spatial resolution in large area.

There are two types of data captured in the satellite images. They are high (spatial) resolution panchromatic image (HRPI) and low (spatial) resolution multispectral image (LRMI). The HRPIs are good data for identifying spatial detail while LRMIs are suitable for detecting features based on their spectral properties. Due to its technical limitation, many sensors do not capture both high spatial and spectral images at the same time [2]. This paper illustrates how fusion methods can enhance spatial resolution using a combination of high spatial with multispectral images of the satellite data.

2. Fusion Method

The fusion approach is one of methods to solve the problem, to merge resolution, to improve the object recognition, to improve image enhancement and analysis technique, to obtain richer content than any inputs, and to increase the objects' information by combining data from multiple sensors and to optimize the combination of spatial details and feature information[3]. Data fusion is an efficient technique to maximize the availability of images from different satellite sensors that have different spectral and spatial resolution [2,3]. The fusion technique resample the low spatial resolution (LRMI) using the high spatial resolution data (HRPI) to produce the same pixel size [1]. The integrated between HRPI and LRMI data produce high resolution multispectral image (HRMI).

3. Fusion Application

The application of fusion images can be used to estimate the environmental component that is needed to monitor in multiple views, such as evapotranspiration (ET) estimation [1,4,5], 3D ground-based characterisation [6], smart city application [7], design and simulate maritime surveilence scenario with define sensor and vessel trajectories [8], urban environments [9], and water vegetation [2].

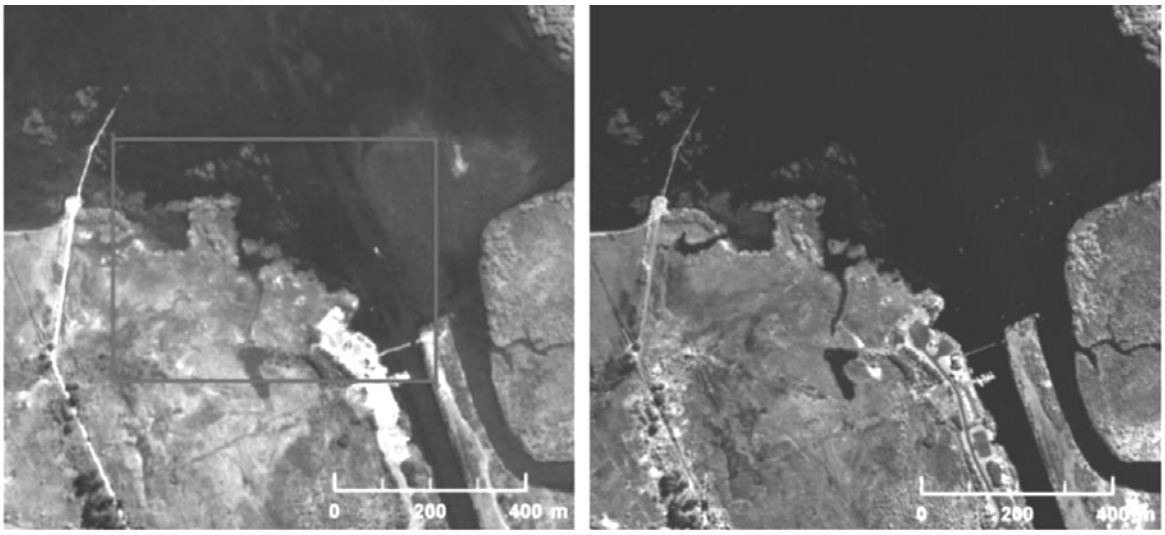

Figure 1. The original image from Quick Bird satellite sensors [2] (a) The Sub-scene of the true colour composite Low Resolution Multispectral Image (LRMI) (b) and High Resolution Panchromatic Image (HRPI).

Figure 1 and 2 show an example of comparison among Sub-scene of the true colour composite Low Resolution Multispectral Image (LRMI), High Resolution Panchromatic Image (HRPI), Optimised High Pass Filter Addition HRMI, Subtractive Resolution Merge HRMI, and Brovey Transformation HRMI from QuickBird images [2].

The Sub-scene of the true colour composite Low Resolution Multispectral Image (LRMI) (a) and High Resolution Panchromatic Image (HRPI) (b), is the original image from Quick Bird satellite sensors. The fusion technique is applied to detect features using spatial and spectral centric approach based on resolution merge, and this image enhancement is used for land cover mapping (Figure 1). The c, d, and e picture are the results of enhancement using various algorithm (Figure 2).

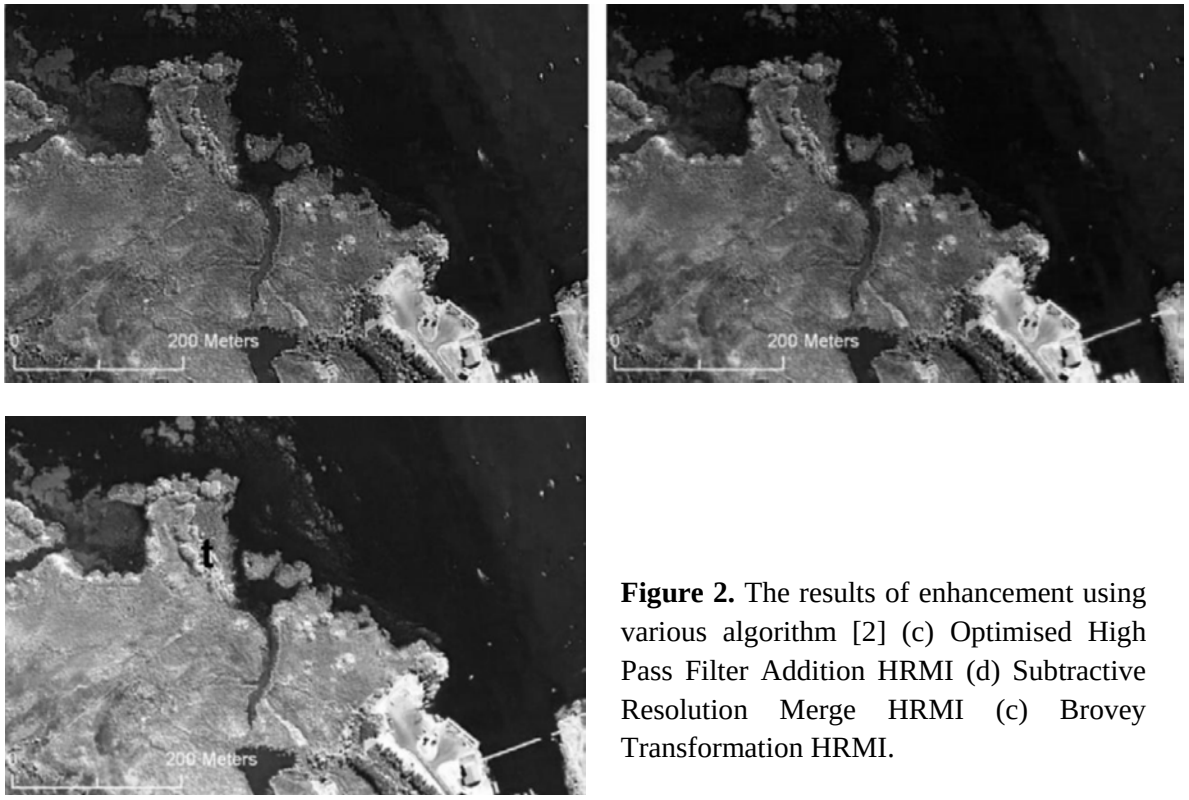

Figure 2. The results of enhancement using various algorithm [2] (c) Optimised High Pass Filter Addition HRMI (d) Subtractive Resolution Merge HRMI (c) Brovey Transformation HRMI.

Figure 3 shows the fusion technique of combination between visible and invisible objects. This application detects features in both urban dan rural areas, based on panchromatic (PAN) and thermal infrared (TIR) sensors. The sensors combination has generated new information that cannot be found from each sensor. The detail information about the land cover only can be shown by PAN sensor but this sensor is not related to the surface reflectance. The TIR is related to the surface reflectanace and can show the distribution of the surface temperature.The new information from this fusion technique can show the distribution of land cover related to temperature [3].

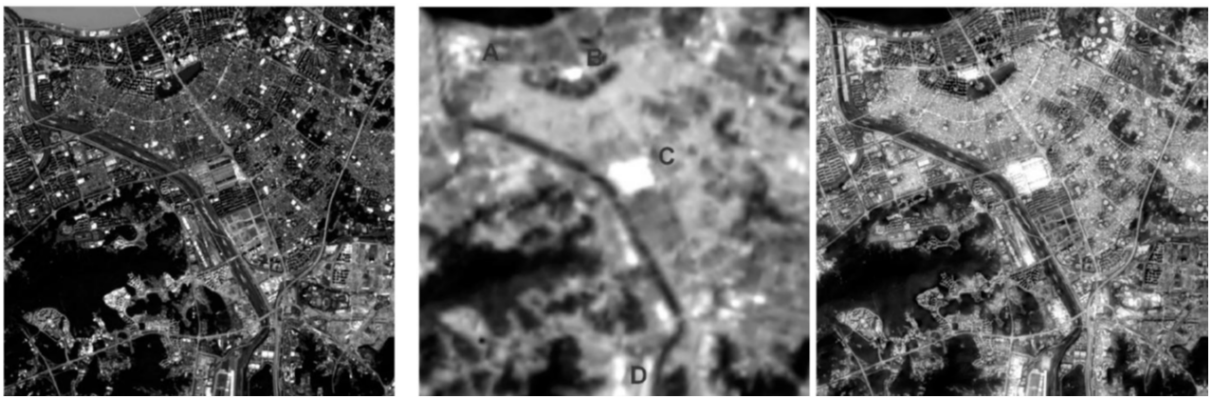

Figure 3. The combination between visible and invisible sensors [3]. (a) The Panchromatic image (b) Thermal Infra Red image (c) The new information from this fusion technique can show the distribution of land cover related to temperature (The A, B, C and D are respectively a sport complex, an amusement park, a fish market and an airport).

4. Future Research Challenge

The images from thermal sensor are valuable sources of spatial information for water resources inventory, and it has been proven on many occasions around the world [3]. The thermal images are the invisible radiation pattern of objects that are converted into visible images on passive sensors remote sensing. The temperatures have some different types and scales of condition in the waters, and can be used in fisheries, marine resources, physical condition and its phenomenon such as upwelling, ocean current, and submarine groundwater discharge (SGD).

Based on the the fusion application method mentioned above, it shows that this method has been successfully applied to visible objects in land area. Land area that has a high variety of object information can increase the variation of environmental component estimation. In water area like the ocean, the environment has a few object variation.

In tropical area, the SGD is still difficult to be identified because the anomaly temperature is not extreme and the scale is very detail. The low spatial resolution of thermal band of Landsat satellite has failed to recognize it [10]. The difficulties in recognizing the invisible object like sea surface temperature, especially in tropical area, might be improved using fusion method. The less variation of the object in the sea is a challenge to be solved.

5. Conclusions

The visible objects in land area have been recognized easily using fusion method. The variety of object information in land area can increase the variation of environmental component estimation. The difficulties in recognizing the invisible object like Submarine Groundwater Discharge (SGD), especially in tropical area, was noticed. The improved method using fuse approach in the less variation object like in the sea will be a challenge for the future research.

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