An Extraction and Accuracy Assessment of Dead Tree Using Object-Based Classification

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Key words: Dead Tree Management, Object-Based Classification, UAV, Optimal parameter

SUMMARY

Recently the importance of dead tree management having been killed by insect pests in the world is being emphasized, and monitoring researches based on remote sensing technology have been progressed actively for effective dead tree management accordingly. At now, dead tree management has been carried out by utilizing image data having been acquired from airplanes or satellites, but a lot of difficulties in constant dead tree management occur owing to problems such as data acquisition cycle and resolution etc. This study manufactured high-resolution images based on UAV merits to manage dead tree by pests which was one of forest disaster, and executed extraction of dead tree by utilizing the images. Also, optimal parameter to corresponding images was extracted by carrying out repeated experiments so as to apply object-based classification fit to high-resolution image classification. As a result of having extracted dead tree by using Scale 55, Shape 0.1 Color 0.9 Compactness 0.7 Smoothness 0.3 which was an optimal parameter, accuracy of 85.2% was secured. This means that constant monitoring on dead tree-occurring areas by using UAV image data, and it is judged that the outcomes could be utilized as a basic data to manage dead tree including control of insect pests plan etc.

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1. INTRODUCTION

Occurrence frequency of natural disasters has been increasing while abnormal climate has been changed due to global warming lately. Forest disasters are generating various damages such as pest infection in addition to forest fires and landslides. Trees having been infected to pests are being transferred to surroundings, and are expanding to all regions because forest resources are moved due to logging etc. Regarding such dead trees, continuous management shall be made because they could destroy the ecosystem of whole forest. Forest pest diseases having occurred in our country representatively include pine wilt disease and oak wilt disease Pine wilt disease was occurred first at Busan in 1988, and it belongs to pest disease having been existed yet. Oak wilt disease was occurred first at Seongnam in 2004, and occurrence is on the small scale compared to pine wilt disease.

In our country, Korea Forest Service and Korea Forestry Promotion Institute execute researches on dead trees by pests and management work. To monitor dead trees, hyperspectral imagery and multispectral imagery which are acquired from satellites are being used. These images are being used effectively because monitoring on large scale regions could be made. These image data has demerits such like not being effective economically when intending to acquire datum in selected period. Also, correct grasping could be made owing to problems on resolution.
Thus, this study tries to extract dead trees based on UAV which can get datum on selected period and regions so as to manage dead tree management by pest diseases. Object-based classification techniques which is judged to be suitable to high-resolution image classification (Van der Sande, 2003) to extract dead trees, and accuracy assessment was carried out through comparative verification with actual datum regarding extracting results on dead trees.

1.1 Preceding research analysis

Various methods were suggested to execute dead tree management effectively because field survey accomplishment was restrictive according to topographical characteristics of forest.
Kim et al.(2011) analysed changing shape on dead trees by using NDVI regarding damaged trees by pine wilt disease based on images having been acquired through ADC, a ground sensing equipment, and got accuracy classification of 73.5% by carrying out classifications on infected trees and normal ones.
Kim et al.(2015) carried out time series extraction by using hyperspectral imagery on dead trees having been damaged by pine wilt disease occurred in our country, and analysed spread characteristics of infected trees through spatial statistical analysis based on distribution of infected trees.

If looking into preceding researches, researches of intending to use hyperspectral imagery by which minute spectral representation is available and LiDAR etc. so as to do forest management was progressing. In addition, researches on object-based classification techniques were proceeding while high-resolution images were suppled.

Lee et al.(2011) executed land cover classification by carrying out object-based classification technique based on high-resolution aerial photo images through digital aerial photography. As a result of doing comparative analysis with land cover mapping using land cover mapping by using aerial photos, IKONOS images, and orthographic images of corresponding regions, utilizing possibility on land cover mapping of aerial photos was proved because more detailed classification by high-resolution aerial photo images was possible than satellite images.

Na et al.(2014) executed land cover classification on DMZ region by using more proper object-based classification techniques than pixel-based classification techniques. This proved a fact that it could be used as a basic data to do forest management on DMZ region by executing classification through Nearest Neighbourhood among supervision classification after using RapidEye image and DEM.
Lee et al.(2014) evaluated accuracy of object-based classification technique by manufacturing land cover mapping of Nakdong river area based on object-based classification techniques and executing a comparative analysis together with land cover mapping suggested by Ministry of Environment. Also, to review utilization of UAV having been used in various fields lately, following researches have been progressed.

Shin et al.(2015) carried out land cover mapping based on object-based classification technique on high-resolution images having been acquired through UAV and suggested utilization possibility of UAV images because classification accuracy of 91% appeared as a result of doing a comparative verification with RapidEye image.

Kim (2015) got classification accuracy of 85% by carrying out crop classification through object-based classification technique after using high-resolution images having been acquired through UAV (Unmanned Aerial Vehicle) which could construct information on users’ selected period and region speedily, and suggested a fact that UAV was able to do monitoring on selected period and regions resultantly.

1.2 Selection of research sites

To select research sites fit to dead tree abstraction, Gyeonggi Province, Gangwon Province, Gyeongsang Province areas where occurrence of dead trees was made frequently was selected based on statistical datum of Korea Forest Service primarily. Detailed regions were selected based on map of damage in Gyeonggi, Gangwon, Gyeongsang Provinces, and areas where acquiring actual datum was available to verify accuracy of abstracted dead tree datum were considered. Also, Andong area of Gyeongsangbuk Province appeared most suitable when considering no-fly zone such as government, military zone, and airport etc.

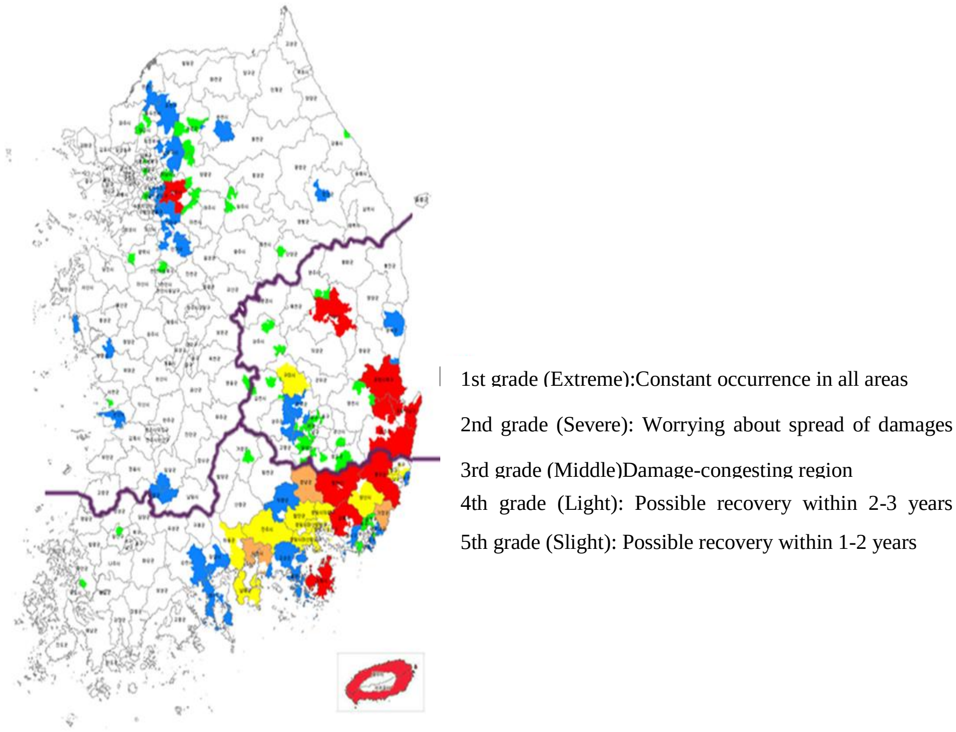

Figure 1 Map of damage caused by Dead Tree (Korea Forest Service, 2015.01)

1.3 Selection of research sites

This study tries to abstract dead trees by using judged object-based classification technique when executing classification which uses high-resolution images. For doing so, image division was carried out by applying object-based classification technique.

To secure accuracy when abstracting dead trees by applying object-based classification technique, a parameter fit to corresponding images shall be selected. The parameter was on scale, shape, colour, compactness, smoothness, and optimistic parameter was selected through step-by-step repeated experiments.

Based on selected parameter, dead trees and normal ones were classified, and accuracy evaluation was carried out after abstracting point datum on dead trees.

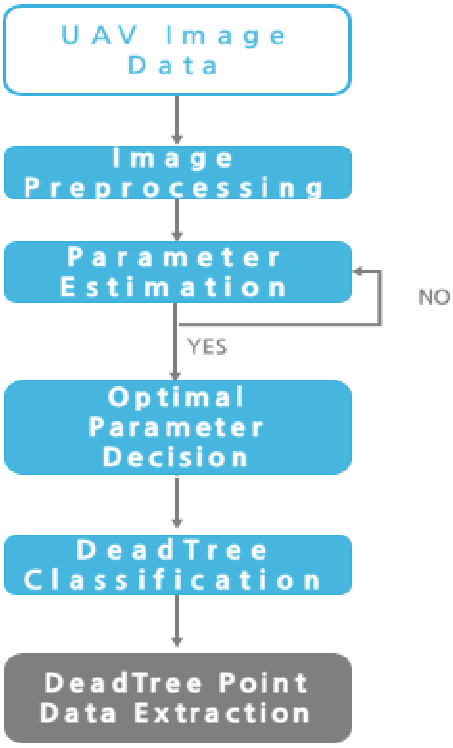

Figure 2 Study Flow Chart

2. Dead Tree Parameter Estimation

2.1 Scale parameter estimation

To enhance abstraction accuracy of dead trees, 5 parameters such as Scale, Shape, Colour, Compactness, Smoothness which are suitable to corresponding images shall be used. Lee et al.(2007) proposed optimal weight combining method by analysing relevant relations on the parameter to do image division, and did accuracy estimation. However, Lee stated that uncertainty of accuracy verification occurred as much as the numerical value of Scale was increased, and the standard could be different according to differences of utilized images and subjectivity of users.
This study selected optimal parameter by executing repeated experiments so as to calculating suitable parameter for images having been acquired from UAV. This study used eCognition Developer of Trimble which could use object-based classification technique.

Repeated experiments to calculate the parameter were composed of three phases. In the first phase, repeated experiments were executed by applying the parameter which was decreased by 20 units per one experiment with the start of Scale parameter 100. Regarding Scale initial numerical value of the first phase, it was set up by considering the expressed size of general trees to images and preceding researches. In the second phase, repeated experiments were executed by applying the parameter which was decreased by 10 units, and the experiment was carried out by applying decreased parameter by 5 units in the third phase. At this time, only regions where trees were existed among generated objects through repeated experiments by each Scale were merged. Based on its results, Scale numerical value which operated most close area was selected as optimal value when comparing calculated area based on forest type map having been provided from Korea Forest Service by calculating and comparing total area of existing trees.

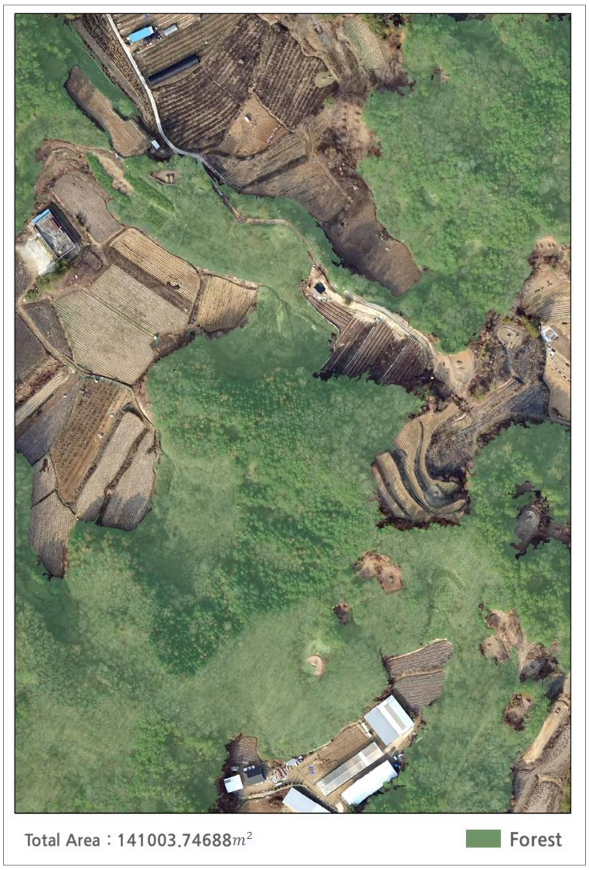

Figure 3 Forest Based Map

As a result of calculating tree areas based on forest map having been provided from Korea Forest Service, it appeared to 141003.746881m^2.

To do repeated experiments for the purpose of deciding Scale numerical value, comparison between forest area which became the standard and the area of operated object area was executed. When it was Scale 100 in the first phase, 141802.665773$m^2$was calculated, and 141545.452363m^2 was made in Scale 80, 141141.946978m^2 in Scale 60, and 140806.916475m^2 in Scale 40.

Figure 4 Area by Scale Parameter (Left 100, 80, 60, 40)

After having done the first phase experiment, a fact could be known that the area is formed differently according to the operated size of the object. As much as the numerical value increases, it affects influences to the size of operated object, and the area where is judged as being similar to judged area as existing trees is included simultaneously, so the change of area turns up to occur. When comparing with the area of forest map, Scale could be grasped as existing between 40~ 60.

In the second phase, the experiment was progressed on the basis of 40 and 60 range. As a result of the second phase experiment, 140905.98114m^2 was calculated when Scale numerical value was 50. In the third phase, experiments on Scale numerical value existed between 50~60 were progressed, and Scale optimal numerical value was decided to 55 because 141001.23353m^2 was calculated from Scale 55.

2.2 Shape, Colour parameter estimation

As much as Shape numerical value is increased, object is created by considering special element, and operation is made based on operating object by considering spectral element as much as Colour numerical value is increased. Also, Shape and Colour have characteristics of always becoming 1 as inverse proportion relation. To calculate numerical values of Shape and Colour, simultaneous experiments shall be executed.

Numerical values of Shape and Colour are calculated based on repeated experiments in the second phase, and optimal numerical value is decided based on whether the operated object expresses information correctly at the same point. In the first phase, object is operated by applying numerical values of (Colour 0.9 Shape 0.1) (Colour 0.5 Shape 0.5) (Colour 0.1 Shape 0.9), and repeated experiments are executed by increasing and decreasing each 0.1 based on results of the first phase in the second phase.

Figure 5 Objects Created by Shape, Colour Parameter

From Shape 0.1 Colour 0.9 as the result of (1), objects are created by considering spectral characteristics primarily because the numerical value of Colour is high. Regarding created objects, a fact that the object is created by colour such as dead tree (red colour) and normal trees (green colour) etc. could be grasped.

From Shape 0.5 Colour 0.5 as the result of (2), the object is created by considering spectral element and spatial one equally. In case that pattern and texture etc. are judged similar by excluding large spectral differences, a fact could be known that one object is created regardless of colours.

From Shape 0.9 Colour 0.1 as a result of (3), one object is created in case of expressing similar spatial element because the portion of considering spatial elements such as pattern and texture etc. are high.

According to corresponding results, compatibility is confirmed as much as the numerical value of Colour is high, and results of the second phase experiment on Colour 0.7 and 0.8 subsequently are same as follows.

(1)

(2)

Figure 6 Objects Created by 0.7, 0.8 Colour Parameter

As a result of doing experiment, Colour 0.7 and 0.8, single object is created in case of occurring vivid spectral differences because the numerical value of considering spectral element is high, but it is judged as being unfit because the region expressed with black colour owing to the shade and dead trees are created as same object sometimes.

Through this experiment, spectral element shall be considered primarily according to characteristics of dead trees. Based on experimental results, Shape 0.1 Colour 0.9 appeared to be optimal numerical value. Basic value of eCognition, application software of this research was selected as optimal numerical value because Compactness and Smoothness which are the element of Shape when the numerical value of Shape is 0.1 do not affect large influences to object creation (Definiens, 2007).

2.3 Dead Tree Point data extraction

Image division was carried out by using Scale 55, Shape 0.1 Colour 0.9 Compactness 0.7 Smoothness 0.3 which were optimal value having been defined through previous experiments to extract dead trees.

To execute classification based on created objects, Training Sample Data fit to dead trees, normal trees, and other items were selected, and supervision classification was carried out. Dead tree sample was expressed with red colour form in existing areas of vegetation, and selection was made by considering whether dead trees were mixed with green colour which expressed general vegetation to do definite classification.

The object created through object-based classification technique was converted to the ratio about spectral broadband existed inside of the object in order to prevent error classification according to spectral values because of using average spectral values of Red, Green, Blue Band regarding relevant objects. As infected trees had large characteristics in changing width from red wave band (Kim et al, 2013), classification was executed by using the ratio of red and green colours together with NDVI.

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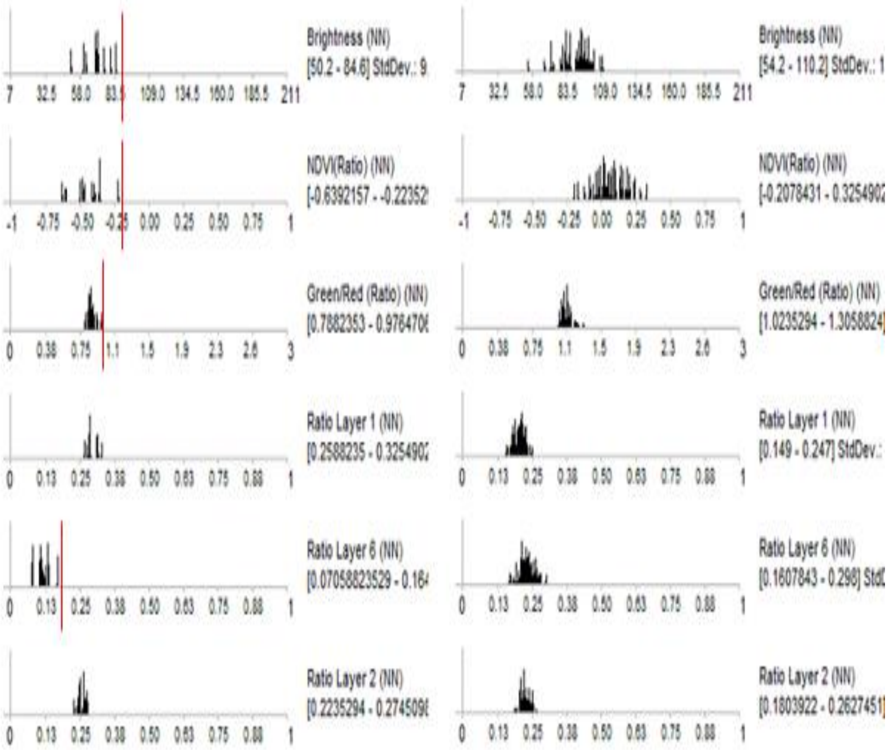

Figure 7 Sample Object distribution

As a result of extracting dead trees by setting up critical value with bases of 0.98 Brightness 67 of – 0.25 Green/Red(wave ratio) in relation with NDVI based on distribution of each sample object, results are as follows.

Figure 8 Dead Tree Extraction

2.4 Accuracy assessment on dead tree extraction

As a result of acquiring actual datum on corresponding experimental sites, existence of total 127 dead trees was confirmed.

Figure 9 Dead Tree Reference Data

The extracted results by using object-based classification technique are outputted with Polygon form. To execute comparison and verification, conversion to Point form is necessary. Based on the central part of each object having been created in images, comparison and verification with actual datum were carried out by creating Point.

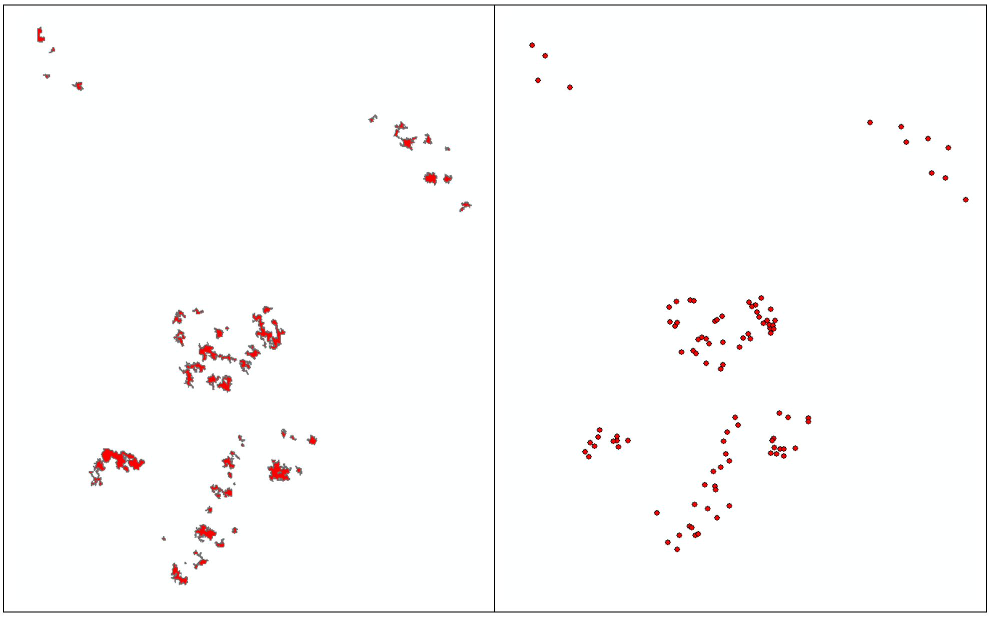

Figure 10 Dead Tree Data Point Conversion

105 dead trees among total 105 ones as a result of Point conversion, but 98 dead trees appear to be existed by excluding 7 error classified dead trees through eye decoding. It is judged that error classification on the object occurs because deviation of applied numerical value, texture and colour of expressed dead trees are made greatly.

Extraction accuracy using object-based classification technique was calculated to 77.1%. However, lowering was turned up owing to creating characteristics into one object because of being regarded as the object having same characteristics in case that dead trees are close as a result of analysing lowered accuracy factors.

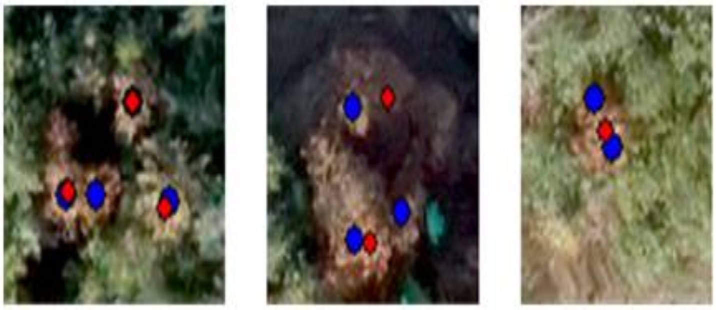

Figure 11 Factors that reduce Accuracy

Extraction data expressed with red colour Point has characteristics of creating surrounding object which is regarded as dead trees into one. In case of actual data, it is judged as showing differences with extracted object numbers while Point is created to each tree.

As a result of recalculating classification accuracy by removing object numbers of actual data to which object of dead tree-extracted data having been created on the basis of central point.

3. SUMMARY

A lot of effort and time are required to be recovered to original state in relation with forest to which damages occurred due to disaster etc. Establishing continuous management system on forestry is required because forestry disaster has occurred constantly owing to pests throughout the world.
This calculated dead tree abstraction and optimistic parameter value based on high-resolution images having been acquired through UAV by applying object-based classification technique. UAV has limitations in extracting insufficient trees in relation with its withering degrees because the image having been acquired from UAV has lower spectral resolution than hyperspectral imagery. However, UAV can execute continuous renewal because of having free, economic efficiency in data acquiring cycle. It is thought that such merits could do great contribution as a basic data in dead tree management by making effective establishment of control plan possible.

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BIOGRAPHICAL NOTES

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