Distinguishing unhealthy potted tree using Blocked NDVI derived from NIR video

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ABSTRACT: This study was made to distinguish trees with risk of collapse from healthy trees which grows along road. In Japan, the health conditions of trees have been judged by such as visual diagnosis and palpation by experts. However, they are inefficient because, they require a lot of time and expense. Hence, a system of efficient and making quantitative judgement is urged. In this study, distinguishing deteriorated trees from healthy trees by comparing difference of NDVI transition was verified. In addition, we verified the phenomenon of deterioration about potted trees before withering leaves which can't be distinguished visually, and can be confirmed by decreasing in NDVI. Five similar potted Conifers were taken a video with near infrared camera a day. In order to clarify healthy and unhealthy subjects, some subjects to be forced to deteriorate. As methods of made deteriorate, the trunk was scratched and it was applied herbicide. Frames of observation object were extracted from videos and divided into several blocks. Moreover, NDVI average value of each block were calculated, the transition of each block were shown, and comparing. As results, each NDVI of healthy subject block showed the similar trend while it increased or decreased depending on the conditions such as the weather. However, NDVI of deteriorated subject blocks were shown trend of decrease, the phenomenon of deterioration was confirmed. In this study, the phenomenon of deterioration about potted trees which couldn't be distinguished visually, and could be confirmed by decreasing in NDVI.

1. INTRODUCTION

This study was made to distinguish trees with risk of collapse from healthy trees which grows along road. In recent years, in Japan, trees growing alongside roads have remarkably deteriorated. The health conditions of trees have been judged by such as visual diagnosis and palpation by experts, but it is inefficient, because they require a lot of time and expense. Hence, a system of efficient and making quantitative judgement is urged. Therefore, in this study, distinguishing deteriorated trees from healthy trees by comparing difference of NDVI transition was verified. In annual or deciduous canopies, NDVI is highly correlated with morphological changes (green biomass or leaf area index) that affect seasonally changing photosynthetic capacity. In evergreens, where canopy structure is relatively stable over the year, NDVI changes little with season (Gamon, et al, 2015). Thereby, the hypothesis that transition in NDVI of forcibly withering trees is different from that of a healthy trees was made. In addition, we verified the phenomenon of deterioration about potted trees before withering leaves which can't be distinguished visually, and can be confirmed by decreasing in NDVI.

2. EXPERIMENT METHODS

2.1 Methods of observation

Five similar potted Conifers were taken a video with near infrared camera a day from May 14 to July 8. Observation were taken using a near infrared camera mounted on a tripod fixed to the cart while moving the cart from left to right as shown in Fig.1. In order to clarify healthy objects (No.1, No.2, and No.4) and unhealthy objects (No.3 and No.5), latter objects to be forced to deteriorate. As methods of made deteriorate, the trunk was scratched and it was applied herbicide on May 14. In case of the potted trees were observed at a sunny place, decreasing trend of NDVI couldn't be captured, because NDVI of deteriorated potted trees were increased caused by influence of sunlight (Hida, et al, 2018). Thereby, the observations were conducted with the entire potted conifers and camera in the shade.

2.2 Methods of NDVI calculation

Frames of observation object were extracted from videos and divided into 13-by-4 blocks as shown in Fig.2, and NDVI average value for each block was calculated. As methods to extract frames showing the object, each frame showing observation object on May 14 were used as a reference. After that, feature points between the frame of the captured from other videos and the reference frame were extracted, optimal frames for comparison were extracted by using the Hamming distance as the similarity measure. The extracted frames were made geometric transforms by affine transformations to correct distortion caused by shooting conditions such as camera tilt. Affine transforms is

one of the functions that can stretch, shrink, warp, and rotate an image are called geometric transforms, and it is any transformation that can be expressed in the form of a matrix multiplication followed by a vector addition (Bradski, G., et al, 2008). In addition, the objects were divided into 6 parts in the vertical direction as shown in Fig.3, and the average value of NDVI of adjacent blocks were calculated. Thereby, NDVI of objects that could not be completely corrected and they were somewhat distorted in the horizontal direction were compared.

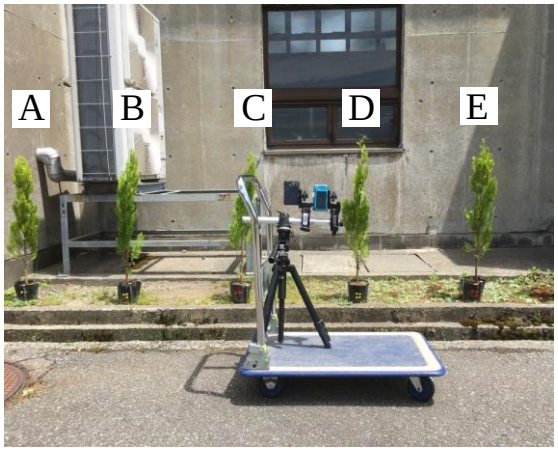

Fig.1 Shooting situation

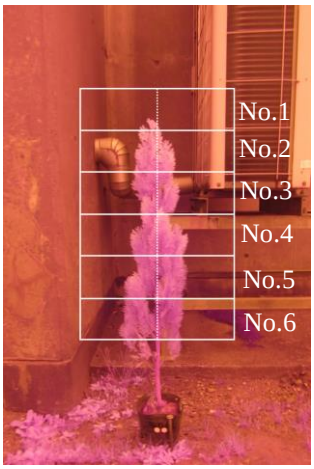

Fig.2 NIR image dividing into 6 block.

2.3 Threshold processing

The infrared images of frames were focused in order to the background other than leaves that affects the observed NDVI was removed. Some luminosity values of leaves, branches, and structures such as concrete were obtained from near infrared images (8 bits) of frames that showed healthy subjects which observed on May 14, June 6, and July 8, and each average value, maximum value, and minimum value were calculated. Fig.3 shows the luminance values of leaves and background in near infrared images. The maximum luminance value of the leaf was about 173, and the minimum value was about 92. The maximum luminance value of concrete was about 92, but the average value was as low as about 76 compared with the average of leaf, it was deleted relatively by threshold processing. However, the maximum value of the branch was larger than that of the leaf and the minimum value of the branch was smaller than that of the leaf, branch could not be sufficiently removed. As a result, in this study, the luminance value of the leaves in the IR image was set to 90 to 175, and threshold processing was performed.

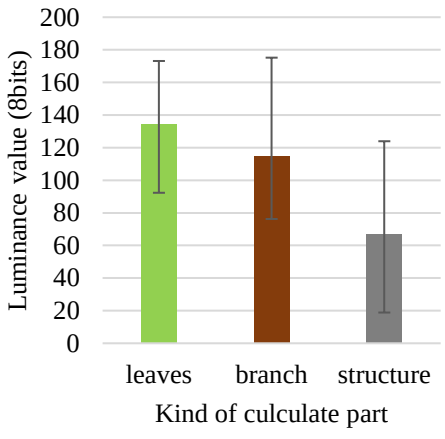

Fig.3 NDVI transition observed at a sunny place

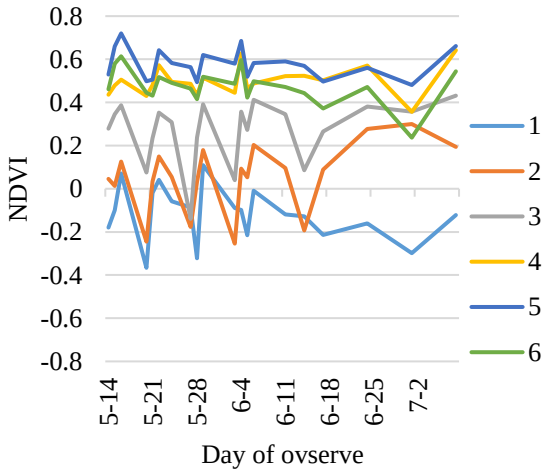

Fig.4 NDVI transition of A Conifer (healthy)

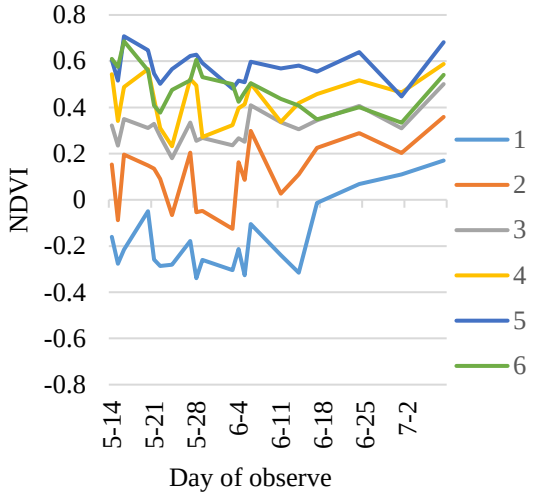

Fig.5 NDVI transition of B Conifer (healthy)

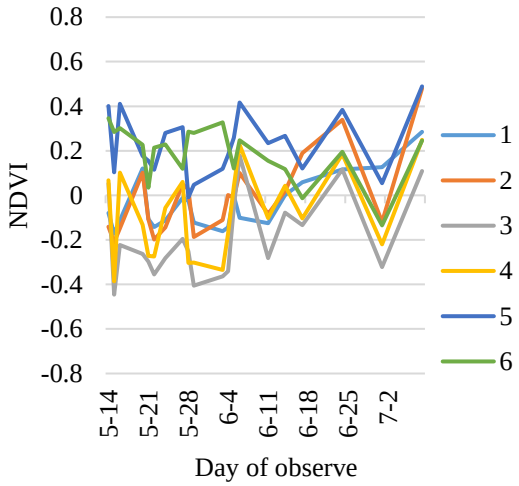

Fig.6 NDVI transition of D Conifer (healthy)

3. RESULTS

Fig.4 shows the blocked NDVI transition of A healthy potted Conifer, Fig.5 shows B, and Fig.6 shows D. The line number in each figure indicates the number of each part obtained by dividing the observation target shown in Fig.2 into 6 parts in the vertical direction. In these figures, every part showed a similar NDVI transition although there was a difference in NDVI on May 14. Among them, in Fig.4, the NDVI of No. 4, No. 5, and No. 6 especially showed the same transition. These parts were the torso parts of the observation target where the leaves were dense, and the gap between the leaves were relatively small, the area of the leaves in the block was large, and background parts were small. Thus, NDVI could be calculated accurately from the leaves parts.

In Fig.5, the NDVI of the No.4, No.5 and No.6 parts which were the torso parts where the leaves were dense, showed similar transitions. Difference such as withering leaves of objects couldn't be confirmed from May 5 to July 11, and objects remained healthy. As a results, the NDVI transition of healthy and similar potted conifers showed a similar trend when the NDVI of parts of leaves could be calculated accurately.

In Fig.6, the NDVI transition of the part of No.5 and No.6 showed similar trend, however NDVI of No.4 part was already low from May 14. On May 14 in Fig.4, the difference between the maximum and minimum NDVI values of these three points was about 0.1, and in Fig.6, the difference is about 0.34, so the low transition can be confirmed. The average NDVI value of the leaves in the part of No.4 was about 0.3, but the NDVI average value of leaf gaps was about -0.34, and the density of the leaves of entire that was small. Therefore, NDVI showed a low transition, because the concrete in the gap between the leaves could not be removed sufficiently by the threshold processing.

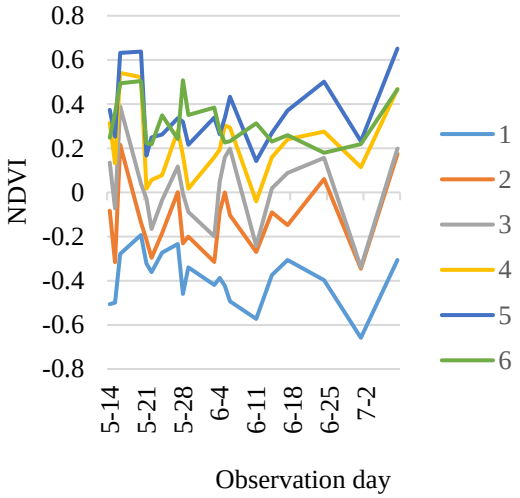

Fig.7 NDVI transition of C Conifer (deteriorated)

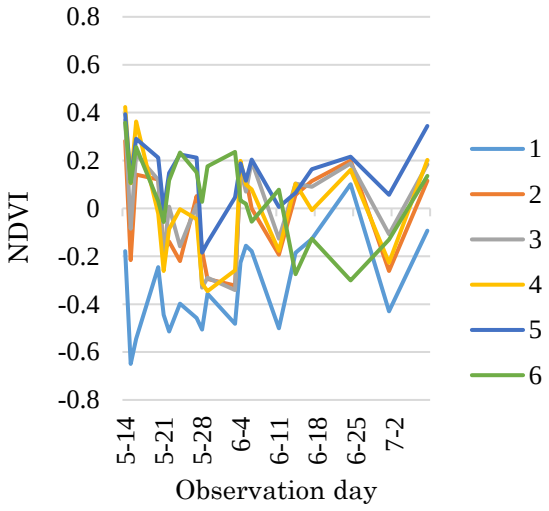

Fig.8 NDVI transition of E Conifer (deteriorated)

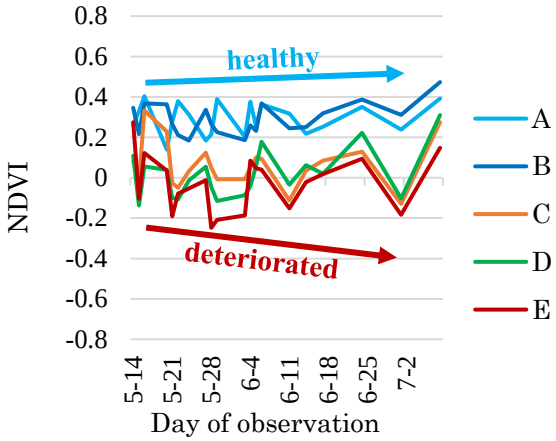

Fig.9 NDVI transition of each entire Conifer

Fig.10 July 1, Visible image of C

Fig.7 shows the blocked NDVI transition of C deteriorated potted Conifer, and Fig.8 shows E. Fig.9 shows NDVI transition of each whole observation object. NDVI shown in Fig.9 was obtained by averaging all blocks that divided each observation object shown in Fig.2 into six. In Fig.9, Comparing the transition of NDVI between the healthy A and B observation objects and the deteriorated C and E objects, NDVI of deteriorated objects were decreased from May 14 to May 21, and difference between both NDVI was occurred. In addition, NDVI of C and E objects showed decrease from June 24 to July 1. Fig.10 shows the visible image of C object in July 1. Comparing June 24 and July 1, greater decline of deteriorated objects could be confirmed during this period, because withering leaves had occurred from end of the deteriorated objects leaves. Therefore, the decrease in NDVI from June 24 to July 1 indicated a deterioration associated with withering leaves. As a result, the decrease in NDVI from May 14 to May 21 indicates a deterioration of observation objects. The decrease in NDVI during this period was a phenomenon of tree deterioration that could not be visually confirmed. In Fig.7, while the NDVI of the entire observation object decreased from June 24 to July 1, and the No. 2 part relatively decreased as -0.06 / day. However, the NDVI of No.1 where the withering leaves occurred at the end of the leaves showed about -0.04/day, which was not clearly decreased compared to the other parts, because the large size of one block, it was not possible to accurately capture the leaf wilt at the end.

4. CONCLUSIONS

In this study, distinguishing deteriorated trees from healthy trees by comparing difference of NDVI transitions were verified using potted Conifer. As results, NDVI calculations were able to be properly performed for blocks including the torso parts of observation objects where the leaves were dense. Hence, the NDVI transition of healthy and similar potted conifers showed a similar trend. The phenomenon of deterioration that could not be visually confirmed on the potted trees and the phenomenon of large deterioration due to withering leaves were confirmed by comparing the NDVI of the whole healthy objects and the NDVI of the whole deteriorated objects. However, threshold processing to remove background affecting leaf NDVI was inadequate. Therefore, the low NDVI of the structure such as concrete was included in the blocked NDVI from the gap of the leaves, and the NDVI of the leaves decreased. Thus, the D Conifer which leaves were not dense was mistakenly distinguished to the group of unhealthy. In future, it is necessary to consider other methods in threshold processing so that only the leaves can be accurately left and the background affecting the NDVI of the leaves can be sufficiently removed.

5. Acknowledgment

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6. References

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