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Image Analysis of Tree-Rings Using Convolutional Neural Networks and the Classification of Infra-red Camera Images by CNN Analysis: A Study on Regional Revitalization by Improving the Reliability of Timber Traceability

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Abstract:

In the timber industry, knowledge and information are not shared, and there is a problem that cooperation from deforestation to lumber distribution is insufficient. A system is needed to display the species, place of origin and quality of timber, and to share various information related to timber used. In this study, we use an annual ring image of a log taken with infra-red camera as an input image and identify individual logs by convolutional neural networks (CNN[1,2)]), which is an image recognition technology. This paper reports on the method of creating learning and verification data and the recognition accuracy.

Keywords:

Deep learning; Annual ring image identification; Wood traceability; Individual wood identification; IoT implementation

1. Introduction:

“Wood resource recycling” and “wood traceability” are important to contribute to the revitalization of forestry and forest sustainability. Wood is cut from forests, and the material (log) is turned into wood products, which are used in various forms as housing and civil engineering materials. There is an increasing demand for displaying material logs from forests to product shipments. However, under the present circumstances, construction umber products are traded in the wholesale market based on the experience and intuition of the middleman, and even between the middleman and the contractor, accurate information on the country of origin, tree species, history, performance, quality, etc. Of the lumber product is available. It is a situation that cannot be said to be transmitted. In recent years, as

consumer needs for housing quality and performance have increased, clear timber products such as legal timber and forest certified materials are required (Forestry Agency[3], 2019). However, at present, consumers have no way of confirming the lumber products they are using, and it is difficult to obtain accurate information, However, at present, consumers have no way of confirming the lumber products they are using, and it is difficult to obtain accurate information, against this background, the source and history of timber have been clarified, and traceability in timber distribution, that is, traceability in timber, has been attracting attention, So far, attempts to build a wood traceability system have been carried out by methods such as QR codes and electronic tags that describe wood information, However, when the QR code is attached to wood as shown in Fig.1, thee is a risk that QR code will fall off during movement or storage, and there problems such as the QR code becoming unreadable in the dryer. In addition, the QR code has the disadvantage that the amount of information that can be recorded is small and cannot be written. On the other hand, in the field of individual identification, as shown in Fig.2, RFID (Radio Frequency IDentifier) tags, which are contactless IC tags, and FRID readers are active in all scenes such as tracking management and anti-camouflage. Currently, RFID tags with timber information written in freshly cut cedars are being inserted, and information exchange technology is being applied through short-range wireless communication. However, when applying RFID technology, there are still issues of data creation time and cost increase. Furthermore, it may be extracted and used illegally.

On the other hand, it is known that the generation of annual timber rings is affected by the surrounding environment and weather conditions. Since the end of the log contains information on annual rings, dimensions and shape, this information has long been used to identify the age and species of wood. Therefore, in this research, we use a typical deep learning convolutional neural network (CNN), which is often used in image recognition, to analyze the image of annual rings on logs and make it possible to identify trees.

Fig.1 QR code that became unreadable

Fig.2 Product management by RFID technology

Taken from BULLETIN OF DAITO BUNKA UNIVERSITY[4] (2021), Vol.59, pp.201-205, at 201.

2. Methodology:

This paper outlines a model that recognizes annual ring images by CNN. The network structure was input layer-Conv16-MP-Conv32-MP-Conv64-MP-Conv64-MP-Conv64-MP-FC500-FC200-FC100-FC50-Softmax (2 classes). Here, MP was set to maximum pooling 2 × 2, FC was set to fully connected layer, activation function was set to Rectified Linear Unit (ReLU), and the filter size was set to size 3 × 3 in all layers. The learning was performed with the number of learning times being 10. As a preprocessing of the data image, first, the original annual ring image was cut out in a circle with the center position of the annual ring as the center of the circle. After that, the cut out image was resized to 224 x 224 pixels as the input of CNN, and the input image size was unified. The output of CNN is set to two-class classification that distinguishes between the annual rings to be specified and other annual rings.

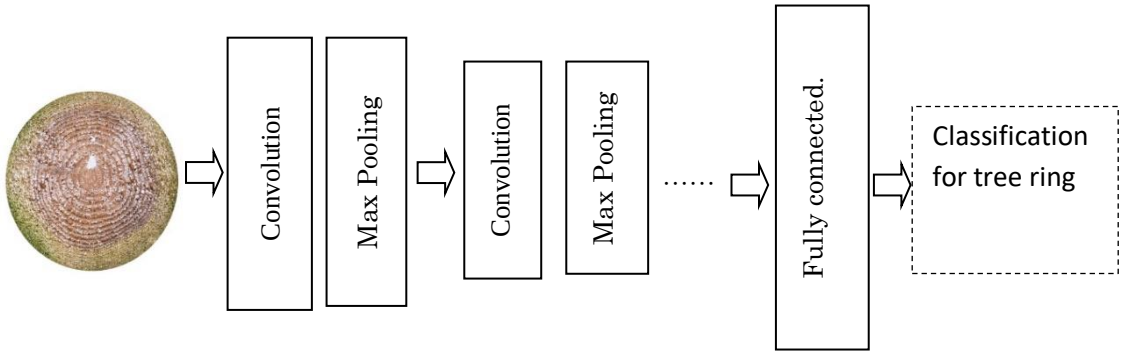

Fig.3 Annual ring classification by CNN: Taken from BULLETIN OF DAITO BUNKA UNIVERSITY[4] (2021), Vol.59, pp.201-205, at 202.

3. Result:

Table 1 shows the classification results of the verification data. From Table 1, the correct answer rate of the annual rings to be specified was 100%, the correct answer rate of the other annual rings was 99.0%, and the correct answer rate of the annual rings not included in the learning data was 90.6%. That is, the misrecognition rate of annual rings that are not included in the learning data is about 10%. When actually certifying wood, if you intentionally bring in wood from another place, or if you unintentionally mix it in with work, it will be misrecognized by about 10%, but you want to identify it at the time of training. It is thought that the correct answer rate will increase by increasing the number of images other than annual rings. We will improve the accuracy rate by further examining the number of training data and the number of data sets for verification.

Table 1. Classification result of verification data

Classification	Classification value	Number of correct answers	Number of incorrect answers	correct answer rate
Expanded image depending on the annual ring identify	1	969	0	100.0%
Expanded image by other annual rings	0	98	1	99.0%
New image without expanded other than the above	0	193	20	90.6%

Taken from BULLETIN OF DAITO BUNKA UNIVERSITY[4)] (2021), Vol.59, pp.201-205, at 203.

4. Discussion and Conclusion:

In this paper, we confirmed the effectiveness of the annual ring image recognition method by CNN. Furthermore, we reported how to create a data set for learning and verification and verified the recognition accuracy. However, it is relatively easy to recognize because the training data and verification data were created by image processing using one image for one cut end of a log/wood cut. In the future, we plan to increase the number of images in one log and verify it.

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