Research on Prediction of the Heat Release Rate of a City Fire Utilizing Image Analysis Technology

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HIMOTO Keisuke (Ph. D.), Head, Urban Development Division, Urban Planning Department

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1. Introduction

In order to promptly grasp the hazard of a large-scale fire that occurs in a densely populated city area during an earthquake or other natural disaster, it is necessary to be able to predict the heat release rate (a typical index of the scale of a fire) of the fire, based on the information collected from overhead using drones. For that purpose, research, into the development of a heat release rate prediction model is underway utilizing image analysis technology based on a deep layer neutral network, as part of the comprehensive technical development project "Development of Effective Earthquake Disaster Management and Mitigation Technologies for Existing City Areas Using New Technologies, Etc." (FY 2023 - FY 2026). This paper presents an overview of the development of research.

2. Overview of the heat release rate prediction model

In this research, we are engaged in the building of a model for predicting, from the data of images of a fire taken, the heat release rate when the images were taken. Although various frameworks are available for the analysis of image data, this research utilizes a deep layer neutral network. This is to enable the global features of an entire image to be interpreted, by going through multiple layers of computation processing, extracting local features as feature maps in a step-by-step process and integrating the feature maps. The prediction of parameters in a deep layer neutral network generally requires a large-scale dataset for learning, but it is not easy to initially prepare such a dataset. Therefore, we decided to utilize the parameters of an existing pre-trained model called ResNet by modifying them.

The figure shows the results of comparison, regarding a fire created by burning alcohol fuel, between the heat release rate of the fire measured from the analysis of components of the combustion gas generated (measured value) and the heat release rate predicted from the image data (predicted value). Although the conditions are relatively simple in which a single source of fire is installed at the center of the screen, the changes in the heat release rate over time could roughly be grasped in good condition, in which the fire gradually became larger, reaching around 40 - 50 kW at the maximum.

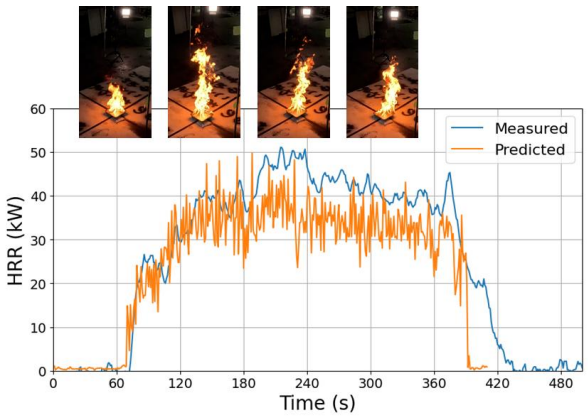

Figure Comparison between the measured value and the predicted value of the heat release rate

3. Conclusion

In the models that have built until the present, images that enable the entire image of a fire to be visible were used as data for learning. However, in actual fires, there may also be a case where combustion continues inside of a building, and such a case does not necessarily match such conditions. In future, while seeking the improvement of the accuracy of the present model, at the same time it is required to expand the target, so that the model will be capable of being applied to even cases where the entire image of a fire is invisible.

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