A proposal of fog computing infrastructure for inventory management with images

Tsukasa Kudo[1]
[1] Faculty of Informatics, Shizuoka Institute of Science and Technology, Japan
kudo.tsukasa@sist.ac.jp

1. Introduction

The inventories of machine parts are often stored in bulk containers (hereinafter, containers), and there is a problem that it is difficult to count their quantities from the outside. For this problem, I proposed a method for automatically estimating inventory quantities from container images using deep learning, and showed when using a regression model, inventory quantities could be estimated with an accuracy of approximately ± 5 [1]. However, as for deep learning, since it is necessary to prepare a large amount of training data, improving operational efficiency is required to apply it to factories with more than a thousand containers.

In this paper, I propose a fog computing infrastructure for monitoring containers with a fixed surveillance camera and discriminating whether the specified inventory is sufficient. This discrimination function can be constructed by a binary classification model of deep learning, which is a simple model; and, training data of the model, namely images with discriminated information, can be collected during operation. This makes it easy to prepare the training data.

2. Proposal for inventory satisfaction discrimination infrastructure using fog computing

Figure 1 shows the construction of the fog computing infrastructure proposed in this paper. In the fog node, change in the images of the surveillance camera is detected, and the frames before and after the change are stored in "Video DB (Database)". Amount of change in the image of each container at the time is calculated to detect changes in the inventory quantities. For each changed container, inventory satisfaction is discriminated, then the time and discrimination result are transferred to the server.

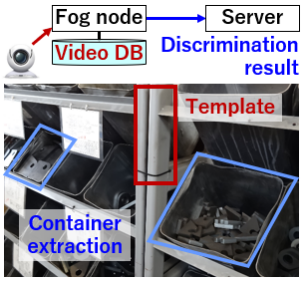

Fig. 1. Construction

As shown with "Container extraction" in Fig. 1, each container is extracted from a pre-specified position in the image. And if necessary, the position is corrected by a fixed and characteristic part (Template). As for the change, we show an example of a detection experiment using marbles in a bowl in Fig. 2. The difference image (c) was obtained by taking the absolute difference on the RGB brightness before and after the change and converting it into a binary image for each pixel with the specified threshold. The white area shows the changed part.

As shown in Fig. 3, inventories of parts in bulk containers are managed with the ordering point system, in which part is replenished when its amount falls below the specified amount (Order point) to remain the specified amount (Safety stock) when acceptance. So, the discrimination is made with a binary classification model: whether the amount exceeds the Order point (Satisfaction) or below (Lack). For this model, images of each container are collected in advance by the above-mentioned way, and labels indicating "Satisfaction" and "Lack" are added to perform supervised learning. Then, when the image of a container is changed, the satisfaction discrimination is performed to judge the necessity of replenishment of the part.

3. Effects of using fog computing

As for the discrimination result, since the theoretical inventory is calculated by the inventory management system, and its accuracy can be improved by comparing both. That is, when there is a difference between them, reprocessing using video data stored in "Video DB" of the fog computing infrastructure is possible. For example, it is possible to perform re-estimation using previous or after frame of video, or to request human intervention by presenting video.

This work was supported by JSPS KAKENHI Grant Number 19K11985, and a research grant of Toukai Foundation for Technology.

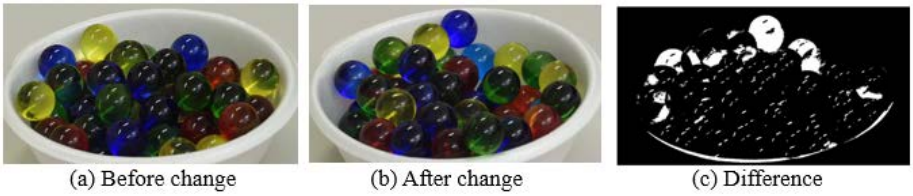

Fig. 2. Detection of change in video frames

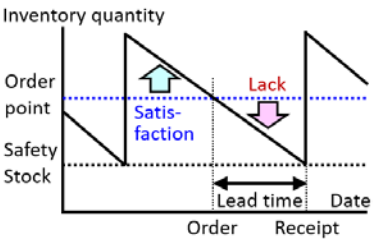

Fig. 3. Ordering point system

References

[1] Kudo, T., and Takimoto, R.: CG Utilization for Creation of Regression Model Training Data in Deep Learning, Procedia Computer Science (in press).