

Evaluating the Performance of Convolutional Neural Network for Classifying Equipment on Construction Sites

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Abstract –

Estimating the productivity of construction operations is one of the most challenging tasks for project managers. Therefore, the construction industry always looks toward new advancements for automating this process. New automated methods for productivity estimation aim to detect the types, locations, and activities of construction equipment based on sensory data. Computer Vision (CV) is one of the most promising automated methods and it provides an affordable opportunity for estimating the productivity since it only requires regular surveillance cameras for data collection, which are available on many construction sites. One of the widely used CV methods for classifying equipment is Histogram of Oriented Gradient (HOG). Additionally, Bag of Words (BoWs) and Local Binary Pattern (LBP) are other types of descriptors widely used for the object classification. However, these methods reduce the dimensions of the image features to train the classifiers for object detection, which may reduce the reliability of the results. Convolutional Neural Networks (CNN), which are a special type of Artificial Neural Networks (ANN) with deeper layer structure, provide a better approach for object detection compared to the conventional methods due to their deeper understanding of the object features. Furthermore, the advancements in Graphical Processing Units (GPU) made this computationally heavy method more applicable in practice. This paper aims to evaluate the performance of CNN for detecting equipment on construction sites. Several configurations of CNN are trained for detecting multiple equipment (i.e. dump trucks, excavators and loaders). The results of these configurations are compared with those of conventional detectors.

Keywords –

Computer Vision, Equipment detection, Convolutional Neural Networks, Sensory data

1 Introduction

Estimating the productivity of construction operations is one of the main concerns of the contractors since it is tied to the schedule and cost of the projects. The construction industry, with the annual revenues of more than \$110 billion in Canada (Statistics Canada, 2016), is always eager to apply new methods and technologies for making the projects more cost-effective while increasing the safety on the sites. Currently, using the Global Positioning System (GPS) is the common practice in monitoring the location of the equipment (e.g. dump trucks, loaders, and excavators.). However, it is difficult to install a GPS receiver on each piece of equipment. On the other side, the availability of the surveillance cameras on many construction sites opens the opportunity for applying Computer Vision (CV) based methods to monitor the productivity of the equipment in addition to monitoring the safety and security of the sites.

Many CV-based methods have been proposed for monitoring the construction equipment, and each method has its benefits and drawbacks. Convolutional Neural Network (CNN) based methods are an emerging practice within the domain of CV. Thanks to the fast-growing advancement of Graphical Processing Units (GPUs), the applications of CNN are increasing within different engineering domains.

This paper aims to apply two comparative analyses. The first analysis compares several conventional CV-based classification methods with CNN-based methods for the classification of dump trucks, loaders, and excavators. In the second analysis, two CNN-based methods are compared using different training and