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Artificial Intelligence Based Object Detection for Industrial Applications

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Introduction

The current state of robotics and Artificial Intelligence (AI) allows for the automation of repetitive labor, resulting in significant cost and efficiency gains. As the global economy recovers from the pandemic, demand for labour has outstripped supply, particularly in rapidly growing industries such as logistics and fulfillment. The need for an efficient and flexible supply chain capable of meeting the needs of the individual citizen has been highlighted in these sectors. Automation in goods handling and storage is critical to optimizing the supply chain; these activities include repetitive and time-consuming tasks that add no value to the finished product. As a result, automating these tasks through the use of advanced robotic solutions can streamline the entire supply chain and provide citizens with a higher-quality service. Furthermore, this would free up operators to focus on more complex tasks that are less susceptible to physiologically unfavorable postures. Among the available technologies, interest in automated systems for depalletization is growing all the time. This is because depalletization is a very monotonous, strenuous, and sometimes dangerous task.

Description

Picking stock-keeping units from a pallet and placing them in a handling system, such as a conveyor, is the responsibility of automated depalletization systems. The first depalletization systems were based on fixed positions in space, which meant they had to be programmed for each individual pallet layout. Because industrial scenarios are becoming increasingly unstructured, these systems are quickly becoming obsolete because they do not provide a sufficient level of flexibility [1-3]. As a result, innovative depalletization systems based on computer vision and artificial intelligence are gaining popularity because they can complete the task with the least amount of information. Many vision-based depalletizing techniques have been developed and proposed by the research community in recent years. Traditional approaches considered processing the scene's 2.5D or 3D data using standard techniques primarily based on the extraction of geometric keypoints and 3D vertices or edges with the goal of solving an object matching problem for 3D pose estimation.

Due to the growth of sectors such as logistics, storage, and supply chains over the last decade, demand for robot-based depalletization systems has steadily increased. As scenarios become more unstructured, with unknown pallet layouts and stock-keeping unit shapes, traditional depalletization systems based on knowledge of predefined positions within the pallet frame will be replaced by innovative and robust solutions based on 2D/3D vision and Deep Learning (DL) methods. Convolutional Neural Networks (CNNs) are deep networks that have proven to be effective in processing 2D/3D images, such as in the automatic object detection task, as well as robust to data variability [4,5]. Deep neural networks, on the other hand, require a large amount of data to be trained. When deep networks are used in object detection to support depalletization systems, one of the main bottlenecks during the commissioning phase is dataset collection. The current study compares various training strategies for customizing an object detection model with the goal of minimising the number of images required for model fitting while ensuring reliable and robust performance.

Conclusion

In this work, the authors studied and compared a set of possible approaches that could be followed to achieve the desired performances on a custom AI-based object detection model for depalletization considering a variable training set size, with the goal of creating an automatic vision-based depalletization system featuring the two processing steps described above and capable of manipulating paper boxes. Collecting large datasets in industrial environments is typically a time-consuming activity, implying a significant increase in commissioning time. Regarding the transfer learning procedure, one method could consider fine-tuning a network pretrained on datasets such as ImageNet with the new images collected by the system; however, another method could consider adding another step of fine-tuning in the middle by using images of similar stock-keeping units, which could have been acquired with the same sensor.

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