Training of YOLO Neural Network for the Detection of Fire Emergency Assets

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Abstract -

Building assets surveys are cost and time demanding and the majority of current methods still rely on manual procedures. New technologies could be used to support this task. The exploitation of Artificial Intelligence (AI) for the automatic interpretation of data is spreading throughout various application fields. However, a challenge with AI is the very large number of training images required for robustly detect and classify each object class.

This paper details the procedure and parameters used for the training of a custom YOLO neural network for the recognition of fire emergency assets.

The minimum number of pictures for obtaining good recognition performances and the image augmentation process have been investigated. In the end, it was found that fire extinguishers and emergency signs are reasonably detected and their position inside the pictures accurately evaluated.

The use case proposed in this paper for the use of custom YOLO is the retrieval of as-is information for existing buildings. The trained neural networks are part of a system that makes use of Augmented Reality devices for capturing pictures and for visualizing the results directly on site.

Keywords -

YOLO; Neural Network; Asset inventory

1 Introduction

Facility Management (FM) is the most costly phase of the building lifecycle, accounting for up to 80/90% of total costs [1]. For this reason, improving efficiency of FM processes can lead to significant savings. To establish an asset management system, component inventory has first to be conducted [2][3]. But, this process still relies on manual procedures that make it time-consuming, expensive and prone to errors and omissions. Construction industry is increasingly moving through digitization, consequently is growing the awareness about the value of integration of new technologies such as AI, in process automation. Component inventory is an area that could certainly benefit from this. The automatic acquisition of geometric and semantic data of built assets has been pursued, principally through point cloud collecting technologies, photogrammetry and image processing. But computer vision, especially object detection using artificial intelligence (AI) has seen limited exploitation in that field, despite being aggressively pursued in others engineering fields: from autonomous driving to automated fruit picking. AI systems, and more specifically Deep Learning frameworks, generally require large datasets for training [4][5]. A challenge about this is that it is never obvious what the minimum number of pictures is for developing a well-performing neural network. You Only Look Once (YOLO) networks [6][7][8] are state-of-the-art real-time object detection and classification systems, demonstrating to be fast and accurate. The aim of this research is to investigate and detail the training process for customized YOLO Convolutional Neural Networks (CNNs).

This first development of a customized NN is part of an on-site application project which allows to automate surveys using mixed reality. NNs are exploited for automation of object detection while localization is performed by means of sensors and algorithms embedded in the augmented reality device. On site collected data can be immediately verified through the use MR device that shows information overlapped to real world and the possibility of adding semantic data directly on site avoiding long post processes phases.

2 Scientific Background

There is an increasing need to have structured and semantically enriched "as-is" 3D digital models of buildings in order to handle, more efficiently, maintenance, restoration, conservation or modification. Especially, as far as existing buildings are concerned, it is necessary to develop an efficient approach to generate a semantically enriched digital model. Various digital tools for building capture and auditing are available, such as 2D/3D geometrical drawings, tachometry, laser scanning or photogrammetry, but they need increased modelling and planning efforts of skilful personnel. Approaches that