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Thème

Enhancing Industrial Object Detection with synthetic Data for Deep Learning Model Training

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Dedication

I dedicate this humble work to my dear parents, as a symbol of my immense gratitude for having them and for their support and encouragement since my childhood. Thank you for believing in me and allowing me to dream big. You are my role models.

In memory of my grandmother, Yema Zina, who was the epitome of a strong woman and taught us the value of family.

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May they find in these words all my affection and love, for they hold a special place in my heart

Abstract

The advent of the 5th industrial revolution has brought forth a new era of robotics, emphasizing the importance of autonomy for these intelligent machines. A crucial aspect of autonomy is the ability of robots to perceive and understand their surroundings. In this report, we explore the significance of environmental awareness for robots operating in industrial settings.

To address this challenge, a deep learning detection model is proposed as a solution to enable robots to detect and recognize industrial objects in their vicinity. The model has been trained using a combination of real and synthetic data, with a significant emphasis on synthetic data generated using Unity. The use of synthetic data offers several advantages, including scalability, cost-effectiveness, and the ability to simulate a wide range of scenarios. By leveraging deep learning techniques, the model achieves high accuracy in object detection, empowering the robot with the ability to navigate and interact efficiently within its environment.

This report presents the methodology employed for training the deep learning model, along with the evaluation of its performance in real-world scenarios. The results demonstrate the effectiveness of the proposed approach in enhancing the autonomy and object detection capabilities of industrial robots.

The findings of this research contribute to the advancement of robotics in the 5th industrial revolution, enabling robots to operate more autonomously and efficiently in complex industrial environments.

Key words : Deep learning , Detection Models, Computer Vision, industry 5.0 , Industrial Objects Detection, Synthetic Data Generation.

Résumé

L'avènement de la 5e révolution industrielle a engendré une nouvelle ère de robots mettant l'accent sur l'autonomie de ces machines intelligentes. Un aspect crucial de cette autonomie réside dans la capacité des robots à percevoir et comprendre leur environnement. Dans ce rapport, nous explorons l'importance de la conscience environnementale pour les robots évoluant dans des contextes industriels.

Pour relever ce défi, un modèle de détection par apprentissage profond est proposé comme solution pour permettre aux robots de détecter et reconnaître les objets industriels à proximité. Le modèle a été entraîné en utilisant une combinaison de données réelles et synthétiques, avec une emphase significative sur les données synthétiques générées à l'aide d'Unity.L'utilisation de données synthétiques présente plusieurs avantages, notamment l'évolutivité, la rentabilité et la possibilité de simuler une large gamme de scénarios. En exploitant les techniques d'apprentissage profond, le modèle atteint une précision élevée dans la détection des objets, dotant ainsi le robot de la capacité de naviguer et d'interagir efficacement dans son environnement.

Ce rapport présente la méthodologie utilisée pour l'entraînement du modèle d'apprentissage profond, ainsi que l'évaluation de ses performances dans des scénarios réels. Les résultats démontrent l'efficacité de l'approche proposée pour améliorer l'autonomie et les capacités de détection des objets des robots industriels.

Les conclusions de cette recherche contribuent à l'avancement de la robotique dans la 5e révolution industrielle, permettant aux robots d'opérer de manière plus autonome et efficiente dans des environnements industriels complexes.

Mots clés : Apprentissage profond, Modèles de détection, Vision par ordinateur, industrie 5.0, Détection d'objets industriels, Génération de données synthétiques.

List of Acronyms

AI : Artificial Intelligence

CNN : convolutional neural network

COCO : Common Objects in Context

FPN : feature pyramid network

IoU : Intersection over Union

mAP : mean Average Precision

R-CNN : Region-based Convolutional Neural Network

R-FCN : Region-based Fully Convolutional Network

RoIs : regions of interest

RPN : region proposal network

SPP : spatial pyramid pooling

SSD : Single Shot MultiBox Detector

SVM : support vector machines

YOLO : You Only Look Once