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AI Cargo Recognition and Management at Busan Port Smart Logistics Center

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Contents

01. Introduction

"Automated Warehouse System"

- Quickly development in automated warehouse trend.
- The automated warehouse improves the operation efficiency.
- The expected development of the warehouse automation in the future.

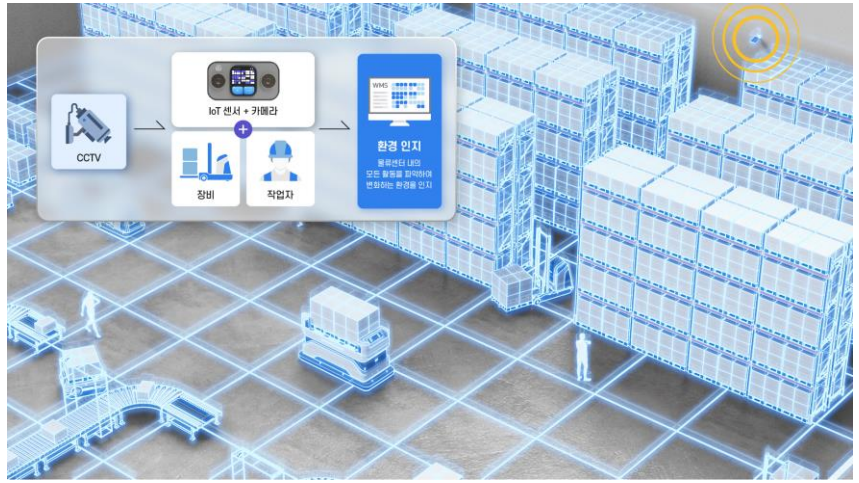


Figure 1: Smart warehouse concept

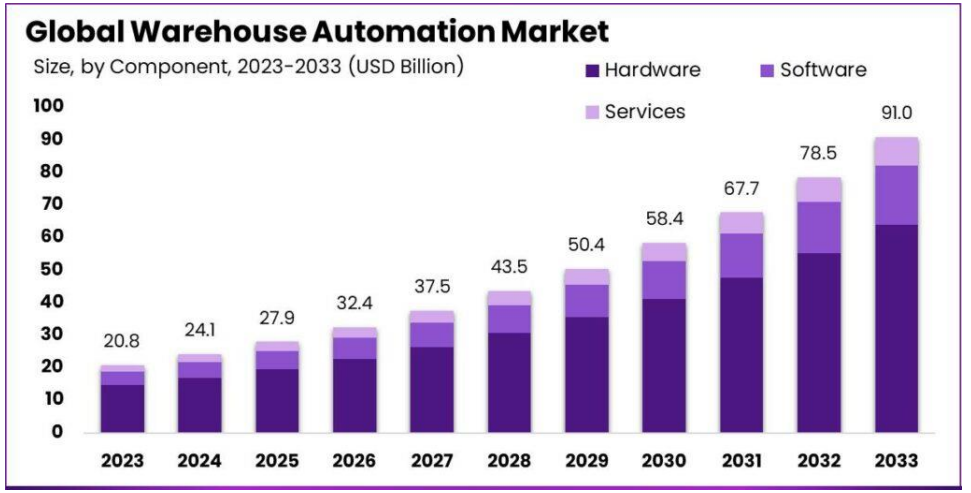


Figure 2: Smart warehouse concept (Source 1)

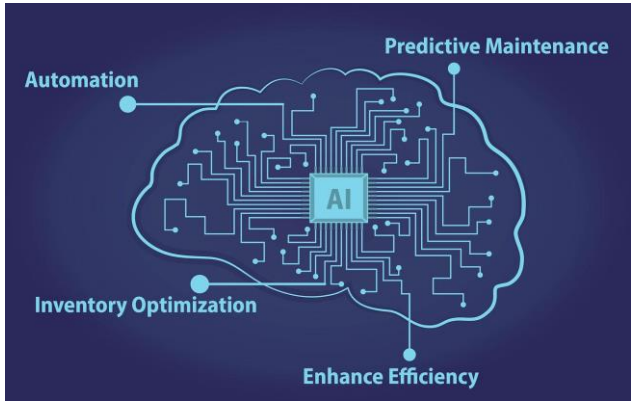
01. Introduction

"Smart Technology"

- Automated Guided Vehicle
- IoT technology
- AI and machine learning
- Computer Vision
- Navigation technology

AGV

IoT system



AI technology

Computer Vision

Figure 3: Smart technology

01. Introduction

"Computer Vision"

- Application in inventory management and fulfillment.
- Safety application to detect and avoid the object around the vehicle.

=> Based on the requirement and the quality of the computer vision in automated warehouse, this topic proposed the application of YOLOv8 for inventory management.

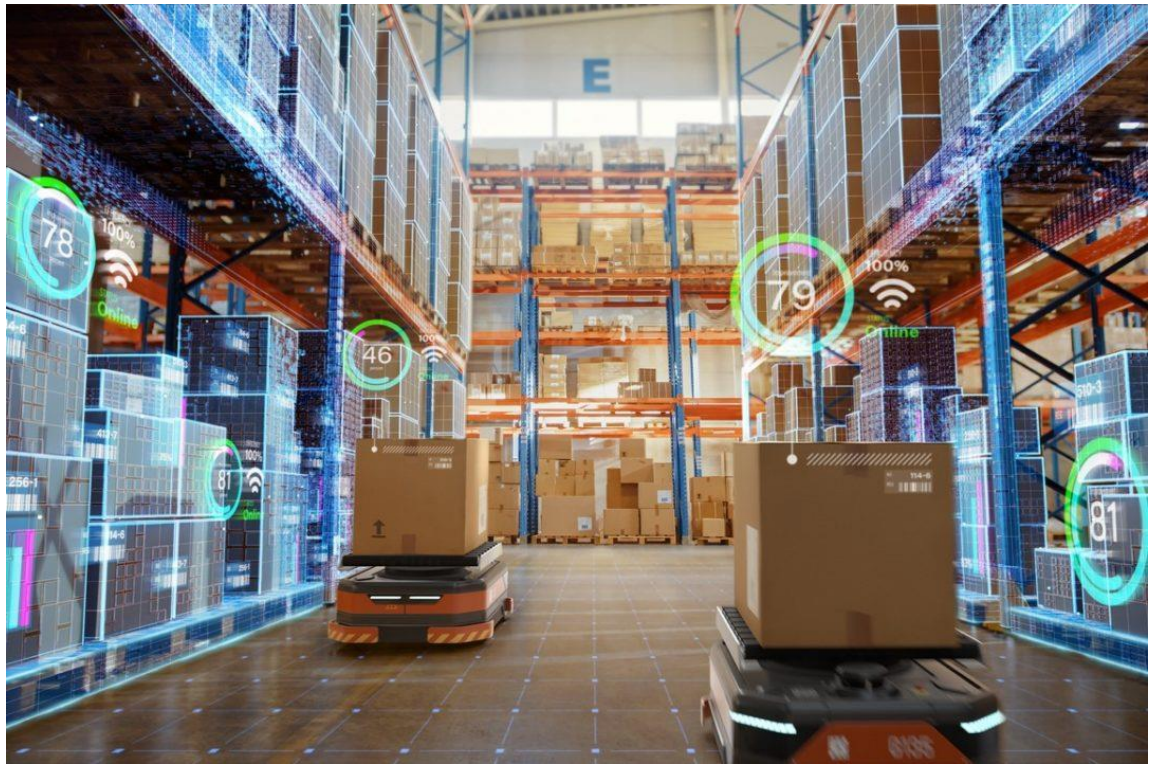


Figure 4: Computer vision application

02. Methodology

"Detection model"

- YOLO (You Only Look Once) is a popular deep learning model used for object detection in images and videos.
- YOLO's key advantage lies in its speed and efficiency, allowing it to achieve high accuracy while maintaining low latency.

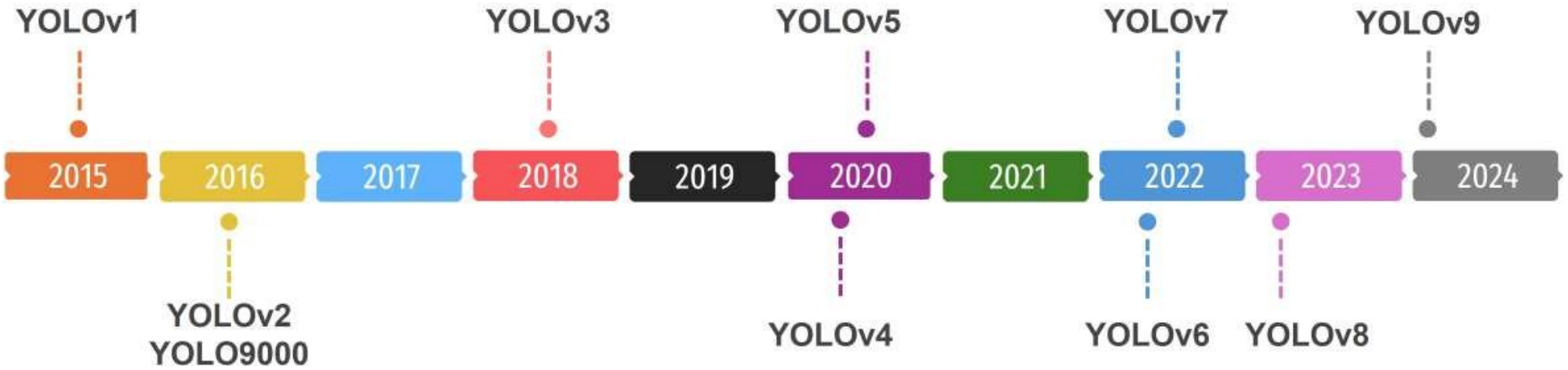


Figure 5: You Only Look Once (YOLO) model timeline

02. Methodology

"Detection model"

- In this application, YOLOv8 is proposed.
- The YOLOv8 architecture is introduced in Figure 6
- YOLOv8 is developed based on YOLOv5, which utilizes a single convolutional neural network (CNN) to detect objects and can run inferences in real time

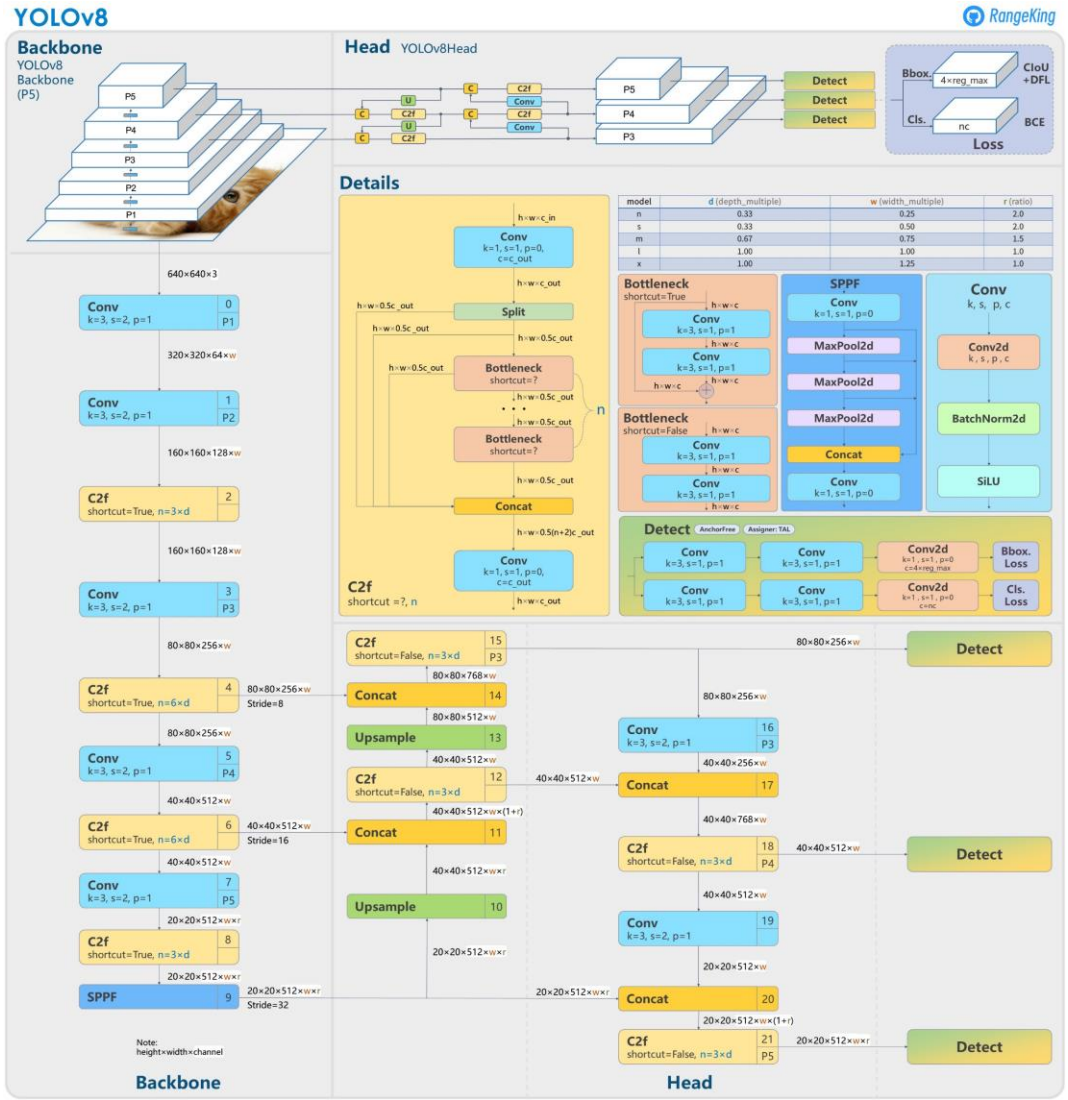


Figure 6: YOLOv8 outperformance architecture

02. Methodology

"Training workflow for object detection model"

- The training workflow for the object detection model involves six steps, which will be introduced sequentially.

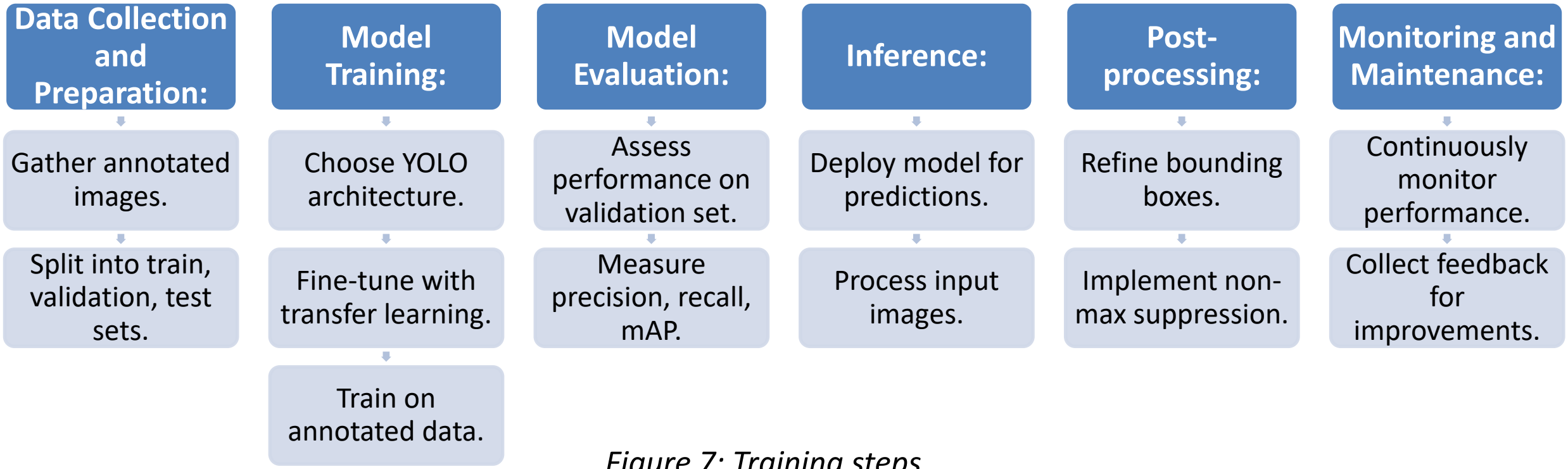


Figure 7: Training steps

02. Methodology

"Warehouse Management System Concept"

- Below system is proposed to make the application, which is the integration of the IoT sensor, Database and the Warehouse management system

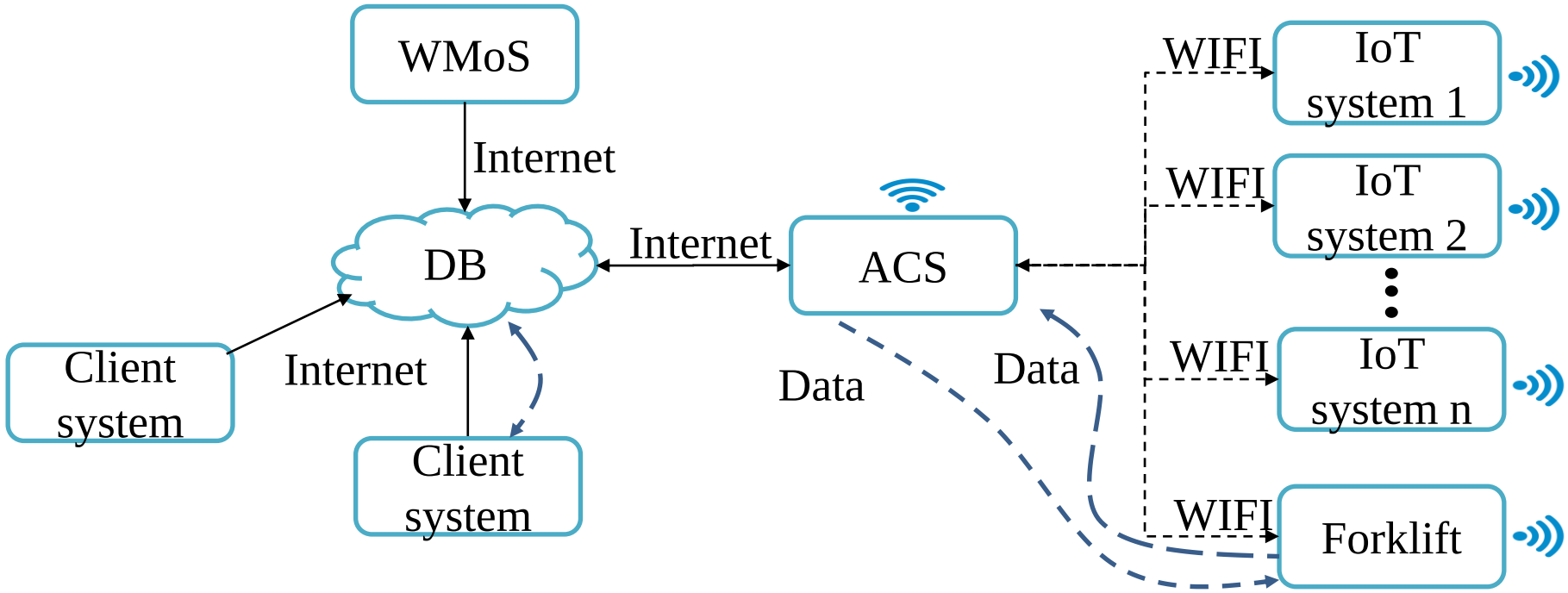


Figure 8: The general concept of the application in warehouse

03. Experiment

“Device Design”

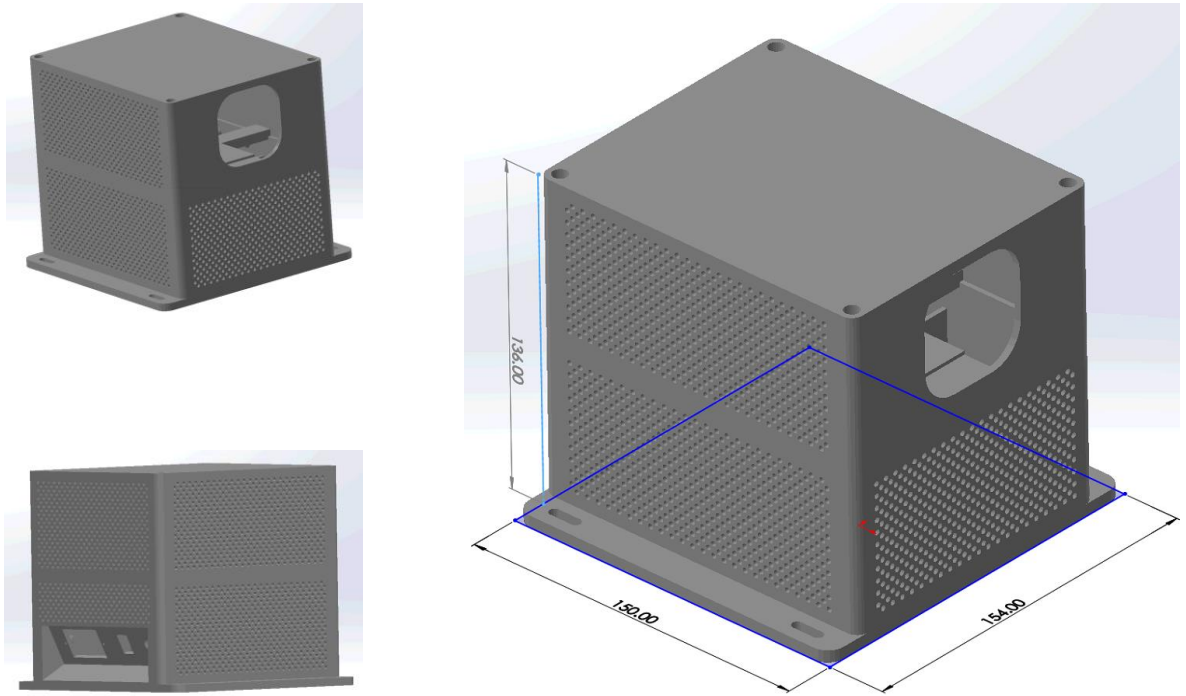


Figure 9. 3D design using Solidworks

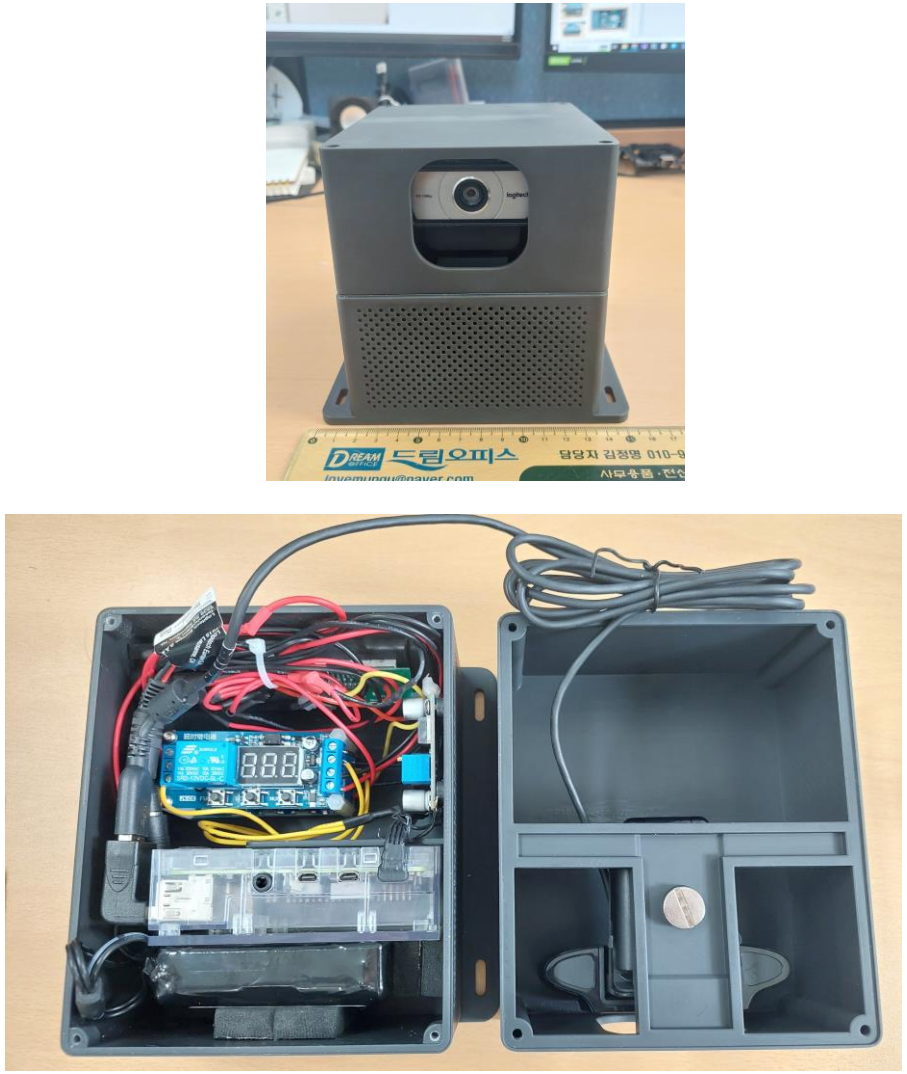


Figure 10. Actual device

03. Experiment

"Software design"

○ To communicate between the system and device. WMoS software is developed. The concept of the software is proposed as:

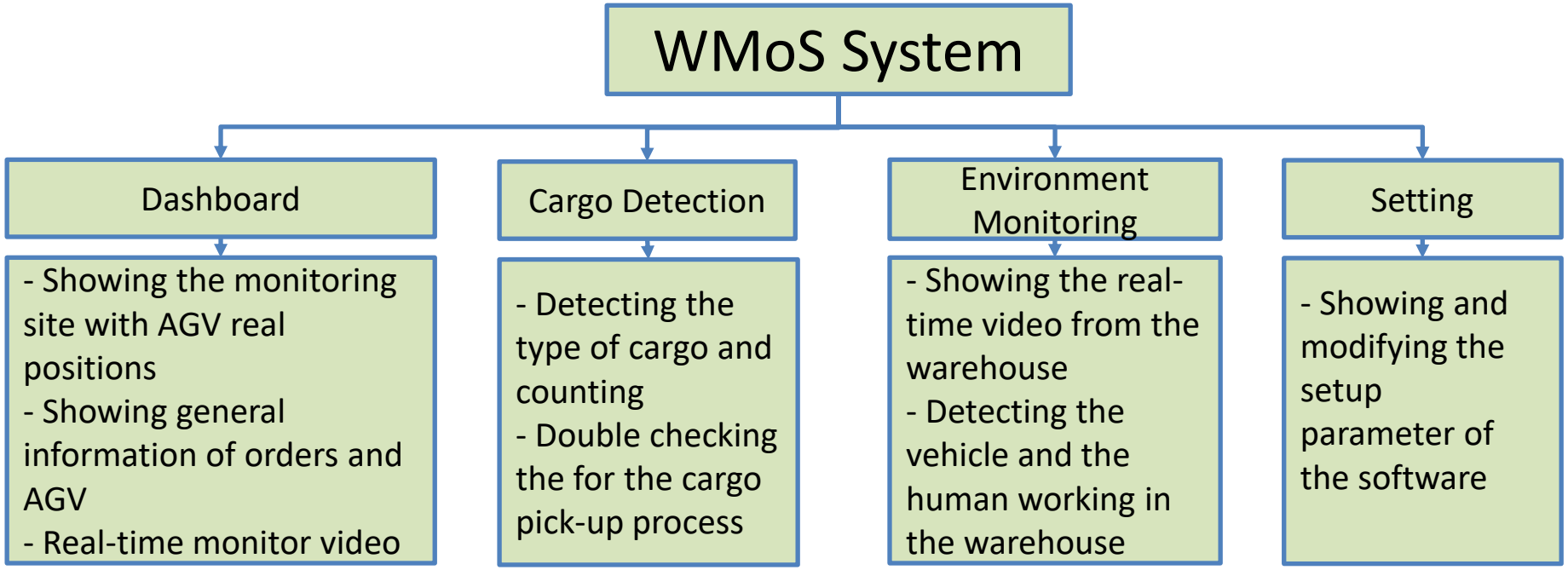


Figure 11. WMoS Software Function Overview

03. Experiment

“Software design”

○ Cargo detection function in software

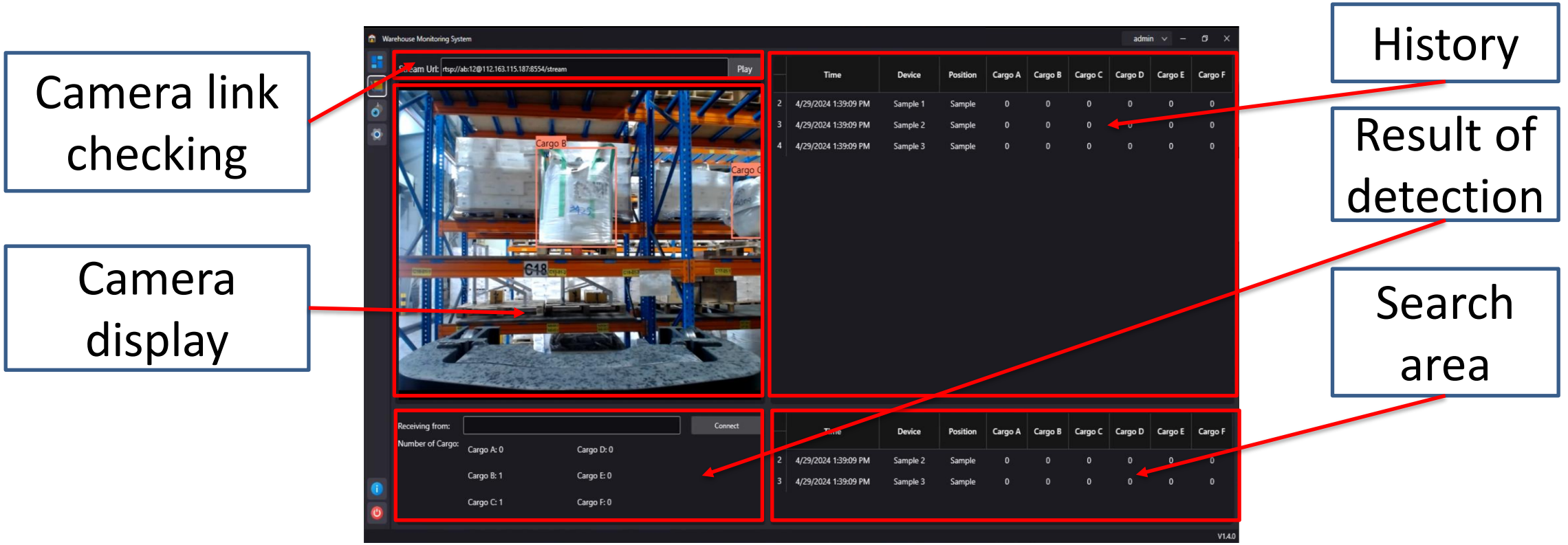


Figure 12: Cargo Detection Tab

03. Experiment

“Experiment Setup”

- The experiment is carried out in KULS warehouse
- The layout out of the warehouse is introduced in Figure…

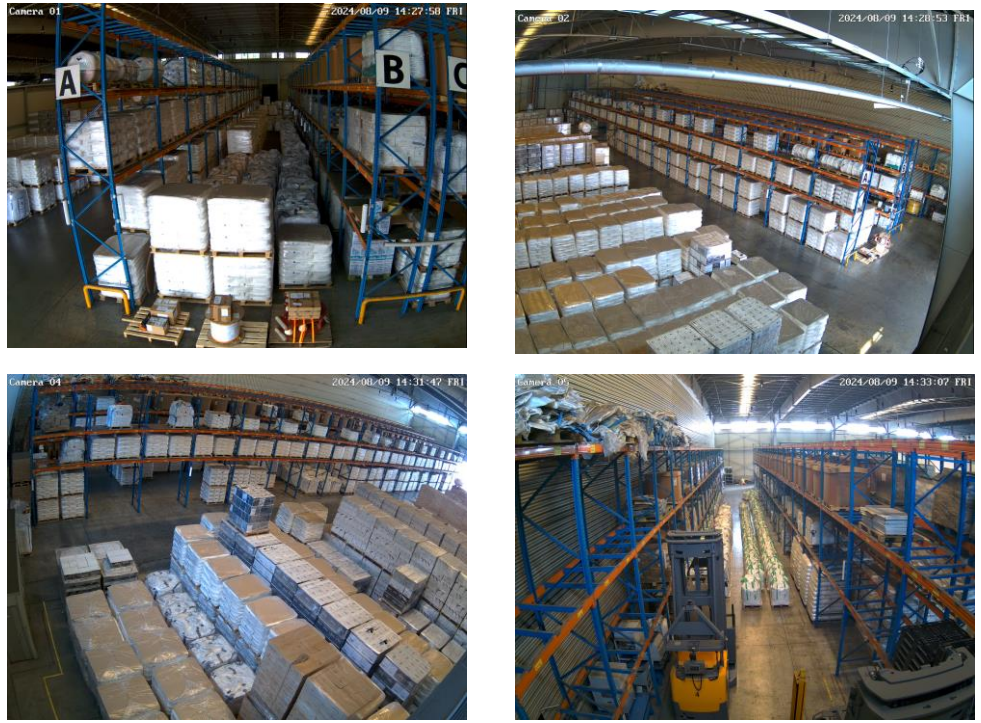


Figure 13. Warehouse CCTV

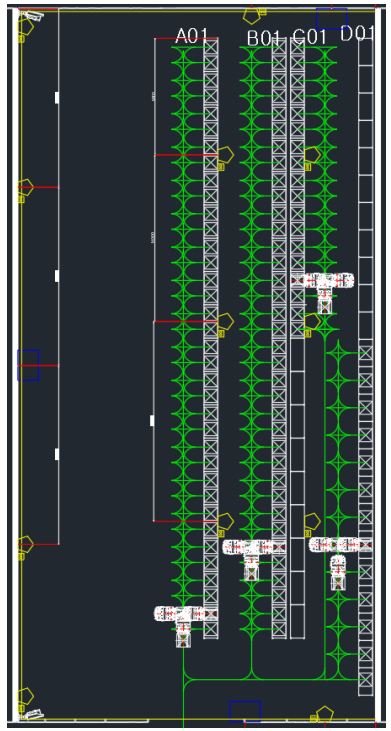


Figure 14. 2D Design

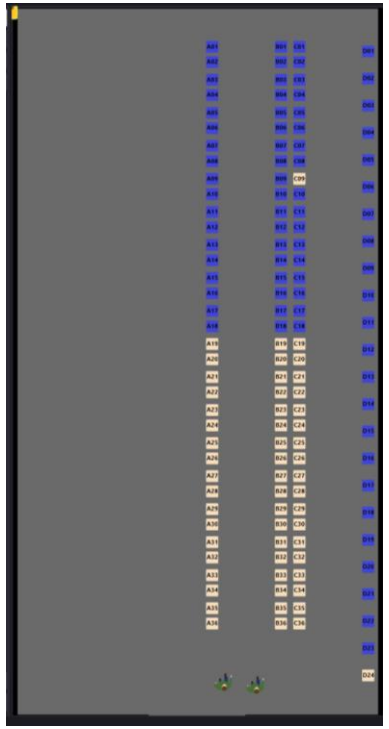


Figure 15. Simulation

03. Experiment

“Experiment Setup”

- Module setup

Figure 16:Camera setup on AGV


Cargo-A


Cargo-B

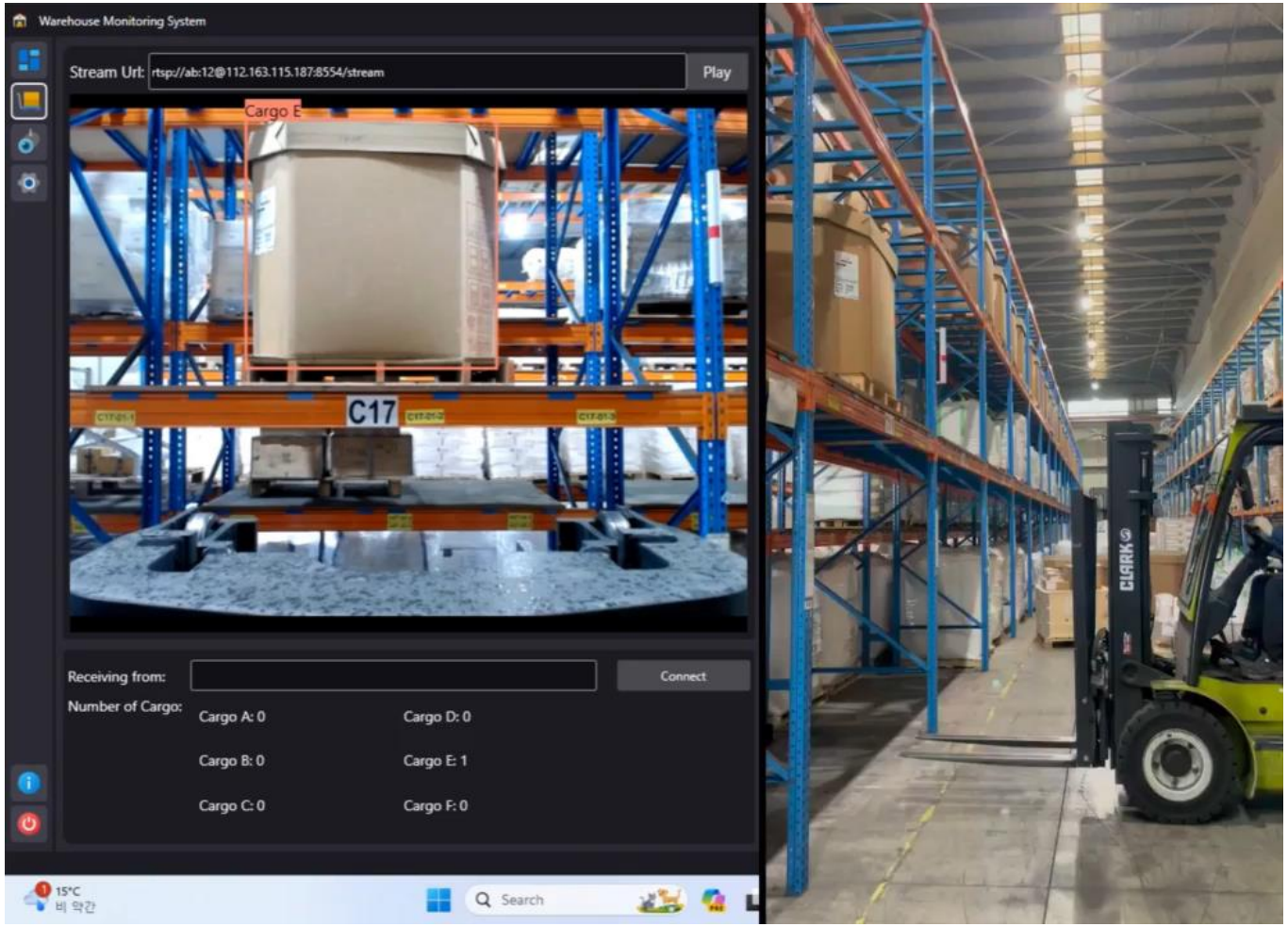

Cargo-C

Cargo-D


Cargo-E

Figure 17: Types of cargo using for training

04. Results



Video 1. Experiment Carried out in Warehouse

04. Results

"Main results"

- Table 1 shows the summary of the detection experiment.

Table 1: Results of cargo detection and counting

No.	Object detection	Detection quantity	Actual quantity	Pass /Fail
1		Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 1 Cargo-E: 0	Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 1 Cargo-E: 0	Pass
2		Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 0 Cargo-E: 0	Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 0 Cargo-E: 0	Pass

No.	Object detection	Detection quantity	Actual quantity	Pass /Fail
6		Cargo-A: 2 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Cargo-A: 2 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Pass
7		Cargo-A: 0 Cargo-B: 6 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Cargo-A: 0 Cargo-B: 6 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Pass

04. Results

“Main results”

Table 1: Results of cargo detection and counting

No.	Object detection	Detection quantity	Actual quantity	Pass /Fail
3		Cargo-A: 0 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 4	Cargo-A: 0 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 4	Pass
4		Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 0 Cargo-E: 0	Cargo-A: 0 Cargo-B: 0 Cargo-C: 4 Cargo-D: 0 Cargo-E: 0	Pass
5		Cargo-A: 3 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Cargo-A: 3 Cargo-B: 0 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Pass

No.	Object detection	Detection quantity	Actual quantity	Pass /Fail
8		Cargo-A: 6 Cargo-B: 2 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Cargo-A: 6 Cargo-B: 2 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Pass
9		Cargo-A: 0 Cargo-B: 10 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Cargo-A: 0 Cargo-B: 10 Cargo-C: 0 Cargo-D: 0 Cargo-E: 0	Pass
10		Cargo-A: 0 Cargo-B: 9 Cargo-C: 0 Cargo-D: 0 Cargo-E: 2	Cargo-A: 0 Cargo-B: 9 Cargo-C: 0 Cargo-D: 0 Cargo-E: 2	Pass

05. Conclusion

- The integration of the YOLOv8 model into AGV system presents a significant advancement for warehouse automation. This approach not only enhances inventory control and order fulfillment but also boosts overall productivity and operational effectiveness.
- The successful implementation of this system represents a critical step towards realizing fully automated warehouse operations, thereby optimizing productivity and operational efficiency in modern logistics environments.

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QUESTIONS
Q&A
ANSWERS