Industrial Safety Management System Based on Deep Learning Using YOLOv5

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***Abstract*—Looking at the accidents that occur at the industrial site, there are many accidents that occur because the safety helmet is not worn and the worker is not confirmed to fall. To efficiently cope with these accidents, we propose a system that detects a worker's not wearing a helmet and falling over by analyzing images of industrial sites input by CCTV using deep learning techniques based on YOLOv5.**

***Keywords*—safety management system, deep learning, Yolo, AI, Industrial Safety**

I. INTRODUCTION

Safety accidents are constantly occurring at industrial sites, causing casualties. Nevertheless, the current situation is that a proper safety management system has not been established.

Safety accidents at industrial sites occur in the moment of instantaneously inattention even though the safety manager provides sufficient safety education and checks worker's attire such as whether to wear safety helmet several times.

Therefore, if the information on dangerous situations such as not wearing safety protectors[1] and falling down is transmitted using CCTV, it is possible to sufficiently recognize the dangerous situations of blind spots that the safety manager cannot check, so that a more effective and immediate response can be made.

In this paper, we propose an industrial safety management system based on deep learning using YOLOv5 that can recognize dangerous situations with CCTV in the event of not wearing protective equipment in industrial sites.

II. RELATED STUDIES

A. Technology that recognizes, analyzes, and processes images using algorithms[2]

The images received from CCTV is analyzed in real time based on deep learning (DCNN). Through this, it provides a real-time notification function to the operator by tracking the detected and classified object and detecting whether a set event has occurred.

This technology can be applied to various fields such as screening control, intelligent transportation system, and industrial safety management.

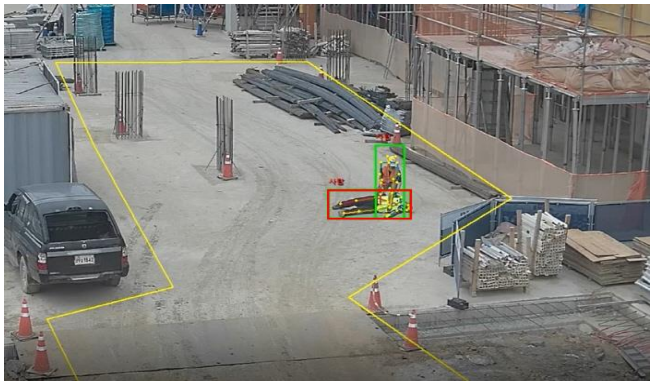

Fig. 1. A technology that recognizes, analyzes, and processes images using algorithms

B. Industrial safety solutions with vision AI technology[3]

If the worker is not wearing a safety helmet, a notification may be given in real time to warn the manager and the worker. By detecting and notifying dangerous situations that may occur frequently in industrial sites, risk factors leading to secondary and tertiary major disaster accidents can be reduced.

Fig. 2. Industrial safety solutions with vision AI technology

C. Differentiation from previous studies

In the case of previous studies, it is a system that only determines whether safety equipment is worn through deep learning-based object detection and informs managers.

This paper aims to implement a system that detects whether deep learning-based safety equipment is worn or not and notifies workers of dangerous situations in real time through the YOLOv5 model, which has improved learning speed compared to the previous version.

III. System Structure

Figure 3 shows the structure diagram of the deep learning-based industrial safety management system using YOLOv5 to be developed in this paper.

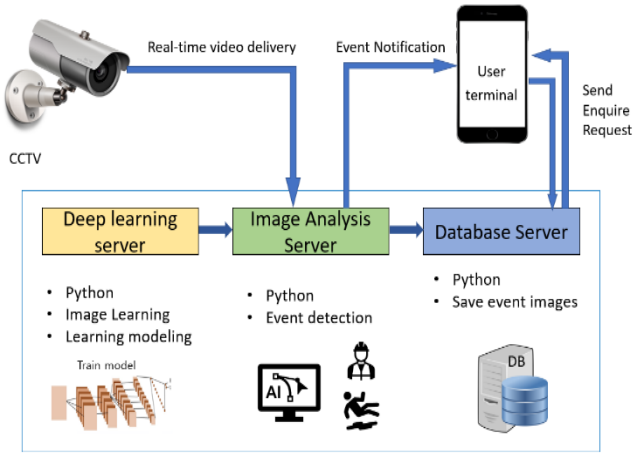

Fig. 3. Structure disgram of deep learning-based industrial safety management system using YOLOv5

The deep learning-based industrial safety management system using YOLOv5 consists of CCTV, user terminal, deep learning server, image analysis server, and DB server.

The deep learning server performs learning modeling on the image of the worker not wearing a helmet or falling down, and the image.

The image analysis server analyzes the image with the YOLO model and sends a notification event to the user terminal when a dangerous event occurs.

The database server stores and retrieves event images.

When a user terminal receives a dangerous event, it accesses the database server, checks the video through real-time monitoring, and takes action quickly.

IV. System Design

A. Functional definition

The functions of the deep learning-based industrial safety management system using YOLOv5 to be developed through this paper can be defined as shown in Table 1.

Table 1. Functional Definition

Classification	Functions	Physical entity
Operators information management	Operator login	Server
	Operator logout	
	Register operator information	
	Change operator information	
	Delete operator information	
User information management	User login	Server, User terminal
	User logout	
	Register user information	
	Change user information	
	Delete user information	
Server image data management	Store and monitor image data	Server
	Analyze hazardous images	Server
	Recognize and monitor hazardous image	Server, User terminal
	Extract hazardous images	Server
User terminal image data management	Initial screen output	User terminal
	Receive hazard alerts	
	Monitor on-site images	

B. Control Flow

Figure 4 shows the control flow between components of the industrial safety management system based on deep learning image analysis.

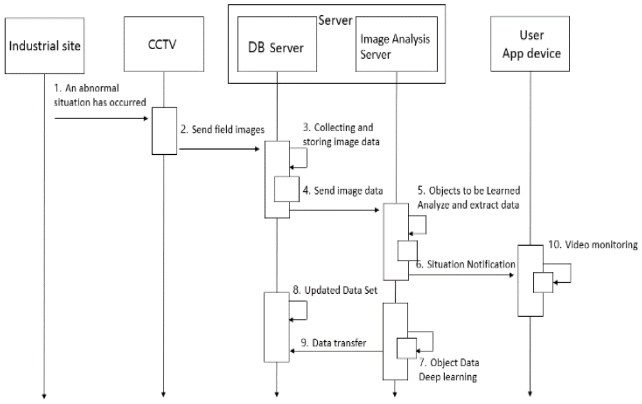

Fig. 4. Control flow between components of the system

V. Deep Learning Model Performance Evaluation

Figure 5 shows the performance evaluation results by substituting the dataset into the deep learning model implemented in the virtual environment through this paper. Through the YOLOv5 model, the loss values due to learning and validation were expressed in graphs and evaluated. Through mAP (mean average precision), one of the evaluation indicators of the object detection algorithm, the precision and recall (Recall) was visualized and displayed as a graph.

Figure 6 shows the object detection test result of the learned model.

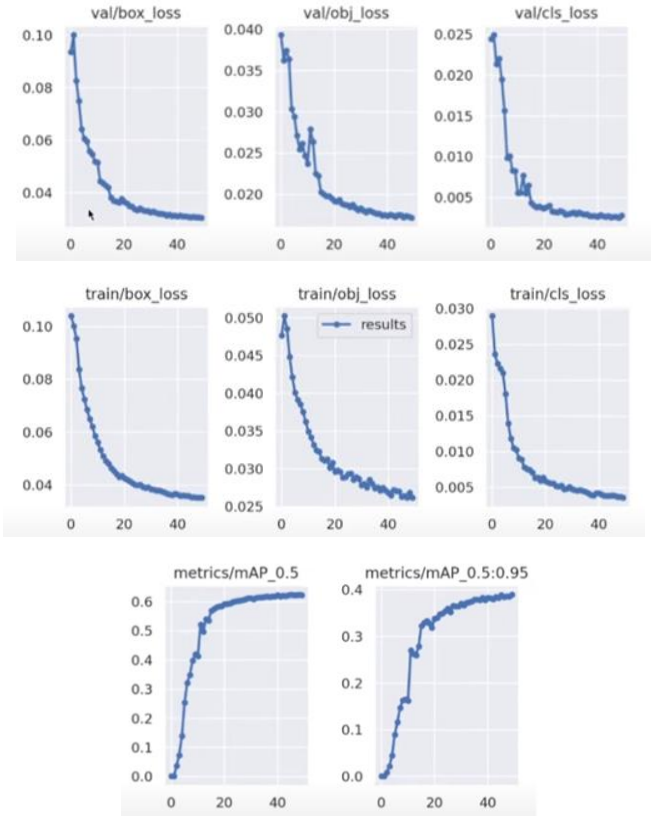

Fig. 5. Evaluation of loss value performance in deep learning model implemented by YOLOv5 in google calab environment

Fig. 6. Deep learning model test results based on YOLOv5 in google calab environment

CONCLUSIONS

In this paper, we proposed an industrial safety management system that monitors risk factors that threaten the safety of workers at industrial sites in real time by image analysis of deep learning algorithms using YOLOv5 and informs on-site safety managers in case of dangerous situation so that they can respond quickly.

In detail, the structure of a deep learning-based industrial safety management system capable of real-time image analysis was proposed, the system function definition and control flow were designed, and the performance of the deep learning model was evaluated.

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