

AI Vision Module for Defect Identification in Manufacturing Process

Hyunju Oh
Smart Manufacturing Research Center
GERI(Gumi Electronics & Information
Technology Research Institute)
Gumi, Korea
hjoh@geri.re.kr

Wanjin Ko
Smart Manufacturing Research Center
GERI(Gumi Electronics & Information
Technology Research Institute)
Gumi, Korea
kwj@geri.re.kr

Abstract—The AI vision module is a key piece of equipment required for intelligent vision auditing and is used to improve defect identification in the manufacturing process of participating companies. Participating companies PNT and Aju Steel are operating roll-to-roll manufacturing processes in the secondary battery and metal processing fields, respectively, and require technology to automatically detect defects linked to data collected in related manufacturing processes. Therefore, by utilizing the equipment built within the same business, we are contributing to the social change response and production competitiveness improvement of participating companies by achieving the goal of AI-based defect recognition of 97% or more.

Keywords—AI, Vision, Smart Manufacturing

I. INTRODUCTION

The demand for improving the profitability of small and medium-sized unit parts manufacturing companies due to social changes and technological innovations is increasing.

Recently, the manufacturing industry is facing a crisis as sales decrease → profitability deterioration → cost reduction pressure → parts company management deterioration → industrial ecosystem deterioration continues.

Existing foreign machinery and systems are very expensive, but if they are domestically produced, the system can be built at a 20% to 30% lower price, and the import substitution effect is also expected to be large.

The manufacturing industry enables direct and indirect economic activities such as product production, distribution, and sales, facility investment, and research and development, and is a major industry that has a significant impact on the growth of the national economy.

Korea has grown its economy through an export-oriented strategy centered on manufacturing, and the proportion of manufacturing in exports is also very high.

The proportion of added value of manufacturing to GDP in the 1960s was about 6%, but it has expanded to about 30% since 2012, and its proportion is higher than that of manufacturing powerhouses Germany and Japan. The manufacturing sector's share of total product exports has remained at 90% since the 1980s, with manufacturing accounting for most of Korea's exports.

Due to the decline in the working-age population and the weakening of the domestic manufacturing industry, Korea's global competitiveness in the manufacturing industry is weakening day by day.

Digital Twin is a technology that precisely replicates the physical system of the real world into a virtual space, enabling real-time monitoring, simulation, analysis, and prediction.

According to Gartner in 2021, digital twins have gone beyond the 'hype cycle' and entered the full-scale application stage, and the application rate and ROI (Return on Investment) in the manufacturing field are particularly notable. In the manufacturing industry, digital twins are used as a means to maximize operational efficiency through 'digital mirroring' throughout the product life cycle, beyond simply viewing the status of equipment. For example, specific results have been reported, such as predictive maintenance of equipment failures or reducing waste by simulating process bottlenecks in advance. In addition, digital twins enable the minimization of human intervention and are becoming the core of automatic decision-making systems in increasingly complex production environment.

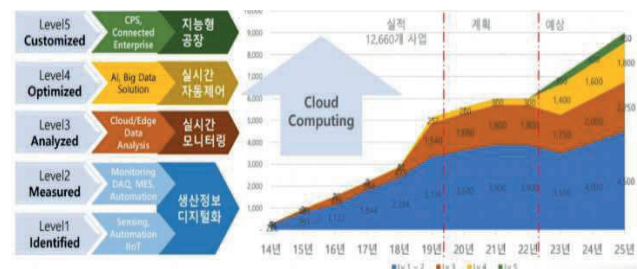
II. RELATED WORK

In line with the direction of local government industrial development policy, investments by local companies in the semiconductor and secondary battery sectors are increasing (based on 2023-2024).

In particular, as the advancement of intelligent information technology is accelerating the advancement of equipment, it is necessary to develop technologies that can lead to the intelligence of existing traditional equipment based on Data, Network, and AI (DNA) technology.

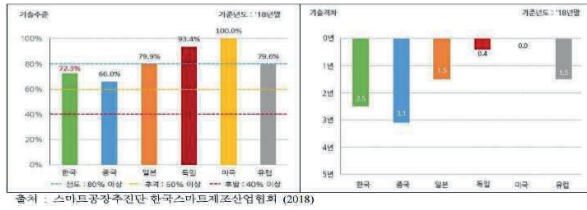
The Smart Manufacturing Innovation Promotion Team has supported the distribution/expansion of smart factories since 2014.

'Level 1' and 'Level 2' of smart factories are where information produced in factories is digitized, 'Level 3' is where real-time monitoring of the factory is possible, 'Level 4' is where the factory can be automatically controlled in real time, and 'Level 5' is the completion stage of the smart factory.



As of the end of 2018, Korea's smart manufacturing technology is at 72.3% of that of the United States, the country with the highest level, and is in the catching up group with a technology gap of 2.5 years. The level of smart manufacturing technology by country is 93.4% in Germany, 79.9% in Japan, 79.6% in the EU, 72.3% in Korea, and 66.0% in China compared to the US.

The technological gap by country with the leading country, the US, is 0.4 years in Germany, 1.5 years in Japan and the EU, 2.5 years in Korea, and 3.1 years in China.



III. METHODOLOGY

The specifications of the AI vision module we want to build are as follows.- Sensor Data: Real-time collection of temperature, pressure, vibration, position, etc.

Item	Specification
data processing pc	Jetson AGX Orin / 275 TOPs / Ubuntu 20.04 / Built-in Ethernet / Standalone operation possible
Vision Camera	Industrial high resolution camera / 2.4MP / 159FPS / USB 3.0 support
AI Labelling SW	Self-developed GUI-based labeling SW + detection model integration

The system configuration diagram and user flowchart are as shown below.



The AI auto-labeling system verification procedure will improve reliability through a verification process that repeats in the order of input image, AI labeling, detection model inference, result report, verification, and log storage.

IV. CONCLUSION AND FUTURE FESEARCH DIRECTIONS

The test is planned to be carried out in the following process: determining integrated test items and creating a checklist, reviewing technology and giving prior approval by the quality manager, configuring appropriate test data for each test item, reflecting some actual operating environment data, executing step-by-step according to the defined procedure and checklist, recording results and deriving issues, reporting error items and creating countermeasures, and ending the test after

reviewing the overall results. However, since it is still before the equipment is delivered, the plan is to first install it in one target company and then proceed after delivery.

ACKNOWLEDGMENT

This research was supported by the Ministry of Trade, Industry and Energy(MOTIE) and the Korea Institute for Advancement of Technology(KIAT) through the “Support for Mid-sized Enterprises and Regional innovation Alliances (R&D, RS-2024-00421022)” program.

REFERENCES

- [1] Soyoung Hwang, Performance Analysis of Lightweight AI Frameworks for On-Device Vision Inspection, 2024.
- [2] KISTI ISSN 2635-5728, Small and Medium Enterprise Digital Transformation (DX) Support Strategy, 2022.
- [3] Namho Kim, Hyunju Lee, Heeja Jeong, Janggoon Lee, Automatic detection system for surface defects of home appliances based on machine vision, 2022