Featured Articles

Use of AI in the Logistics Sector

Case Study of Improving Productivity in Warehouse Work

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OVERVIEW: Attempts are being made to increase the efficiency of work improvements through more widespread application of IT to work systems. However, as each new improvement is added or improvements are made with respect to environmental changes, it requires manual changes to the system, leading to increases in work improvement costs. Hitachi has developed an AI system that uses big data such as work performance information, to understand worksite improvements and environmental changes and issue appropriate work instructions. It has conducted a demonstration test, which confirmed the effectiveness of this system for improving distribution warehouse work. In the future, Hitachi will continue to work on expanding the AI system to a wide range of Social Innovation Business in areas such as manufacturing and distribution.

INTRODUCTION

AS information technology (IT) has advanced in recent years, IT systems have been introduced in a variety of work to improve efficiency. In the future it will be important to make further improvements to work efficiency that take site improvement activities and site environmental changes into consideration. However, conventional work systems are controlled by pre-designed programs, and system engineers have had to redesign the systems whenever new improvement activities needed to be applied to work systems. Moreover, work procedures and settings have had to be changed whenever changes in the work environment necessitated operations that were different from the current conditions. Such frequent system changes have been expensive and have made it difficult to issue efficient work instructions rapidly to respond to new improvement activities or environmental changes.

This article describes the development of an artificial intelligence (AI)-driven work system that uses big data from work performance information gathered on a daily basis by the work system, to issue appropriate work instructions by understanding worksite improvements or environmental changes. The AI-driven work system was subjected to demonstration testing at a distribution warehouse to determine its effectiveness, and these test results are also described.

AI-DRIVEN WORK SYSTEM USING HITACHI AI TECHNOLOGY/H

Hitachi AI Technology/H (hereafter referred to as H) is an original AI system that the Research & Development Group at Hitachi, Ltd. developed as a means of achieving an AI-driven work system. This chapter describes the features of the AI-driven work system developed based on this technology.

Deriving Work Improvement Proposals Originating from Data

H is an AI system used for data analysis to automatically calculate relationships between key performance indicators (KPIs) and the explanatory variables related to them. Specifically, it generates hundreds of thousands of feature values by comprehensively combining explanatory variables on an exploratory basis, and describes the relationships between the KPIs and these feature values in the form of equations. For example, taking site work efficiency as the KPI and work behaviors (people, locations, things, quantities, etc.) as the explanatory variables, it can generate

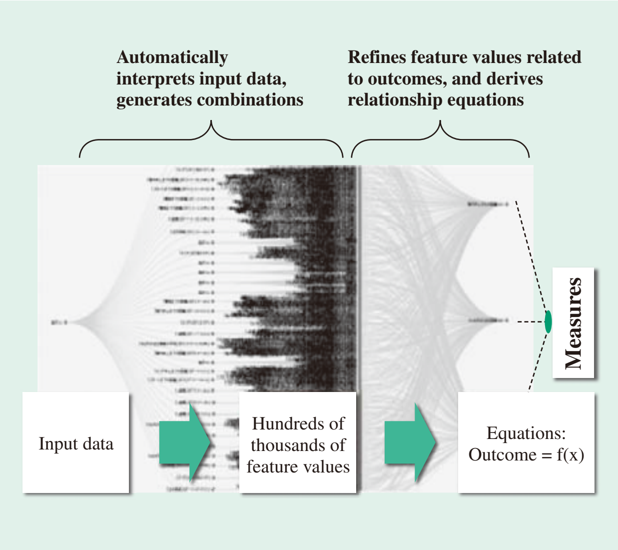

Fig. 1—Overview of H.
H generates feature values from input data (explanatory variables) comprehensively combined on an exploratory basis and describes their relationships to the outcomes (KPIs) in the form of equations.

numerical models of behavioral characteristics related to work efficiency. These models can be used to derive proposed measures for work improvements that originate from the data (see Fig. 1).

Understanding Human Ingenuity and Reflecting It in Work Instructions

Fig. 2 shows the configuration of the AI-driven work system. Site workers perform work according to the work instructions output by the work system, and the results of the work done by the workers are collected daily by the work system. The AI-driven work system uses the work results collected by H to derive work improvement proposals, and reflects them in the work instructions.

The site workers work according to the work instructions output by the work system, however, to work efficiently, they often add their own ingenuity or improvements to the work based on their own experience. H recaptures and analyzes the results created from worker ingenuity and improvements, to select the results that generate higher efficiency and reflects them in subsequent work instructions. By understanding site workers' ingenuity and improvements and repeatedly reflecting them in work instructions on a daily basis, H makes it possible to continually improving work efficiency through mutual cooperation between humans and AI.

Rapidly Incorporating Various Types of Big Data

The big data collected by work systems consists of several different types of data such as numerical quantities, times, and product codes, along with text and symbols. So, for all this data to be entered into an analytical system, it must be tagged in advance by experts with knowledge of the industry and business operations, requiring work whenever data is added or changed. H has a function that rapidly enters new additional data without requiring human intervention. The function works by analyzing the statistical distribution of the data and automatically identifying data formats such as quantities, times and product codes in advance. This enables daily worker ingenuity and fluctuation in demand to be automatically entered into the system and reflected in the work instructions in a timely manner (see Fig. 3).

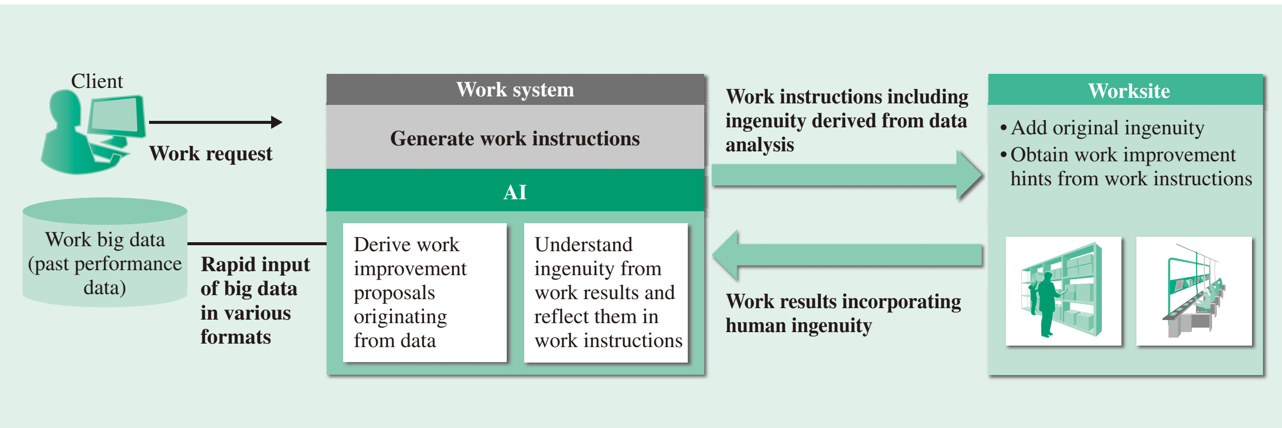

Fig. 2—AI-driven Work System Configuration.
The system enables continual improvement of work efficiency through human-AI cooperation by issuing AI-derived work instructions and a cycle of collecting work results incorporating human ingenuity.

DEMONSTRATION TEST FOR DISTRIBUTION WAREHOUSE WORK

Challenges of Distribution Warehouse Work

As the importance of logistics in the distribution industry increases, improving distribution warehouse work is becoming indispensable for maintaining competitiveness. Specifically, shorter work times are needed for work processes such as receiving and shipping. Receiving consists of receiving products from shippers and storing them at the designated locations in the warehouse. Shipping consists of receiving orders from stores or individuals and picking (collecting) products stored in the designated locations. The aim of this demonstration test was to reduce the work time spent on picking work, which has the highest work cost.

Test Overview

Picking work consists of collecting a specified product from the warehouse in response to a product order from a client. The picking work instructions specify the product to collect and the product's storage location. The worker follows these instructions to travel through the warehouse and collect the specified product. The warehouse management system (WMS) issues the picking work instructions and collects the work results.

Fig. 4 shows the configuration of the AI-driven work system used in the demonstration test. The data flow in the standard work system (WMS) is illustrated by (3) → (4), while the data flow in the AI-driven work system is illustrated by (1) → (2) → (3) → (4).

(1) H reads past work results, and generates mathematical models of the KPIs and work behaviors.

(2) The generated models are used to generate improvement proposals for that day's work instructions. The work instruction improvement proposals are fed back to the WMS.

(3) Work instructions are issued from the WMS.

(4) The work is done as specified in the work instructions, and the work results are collected in the WMS.

In other words, the difference between the standard work system and the AI-driven work system in this test was whether standard work instructions are issued in Step (3), or whether the work instructions devised by H are issued.

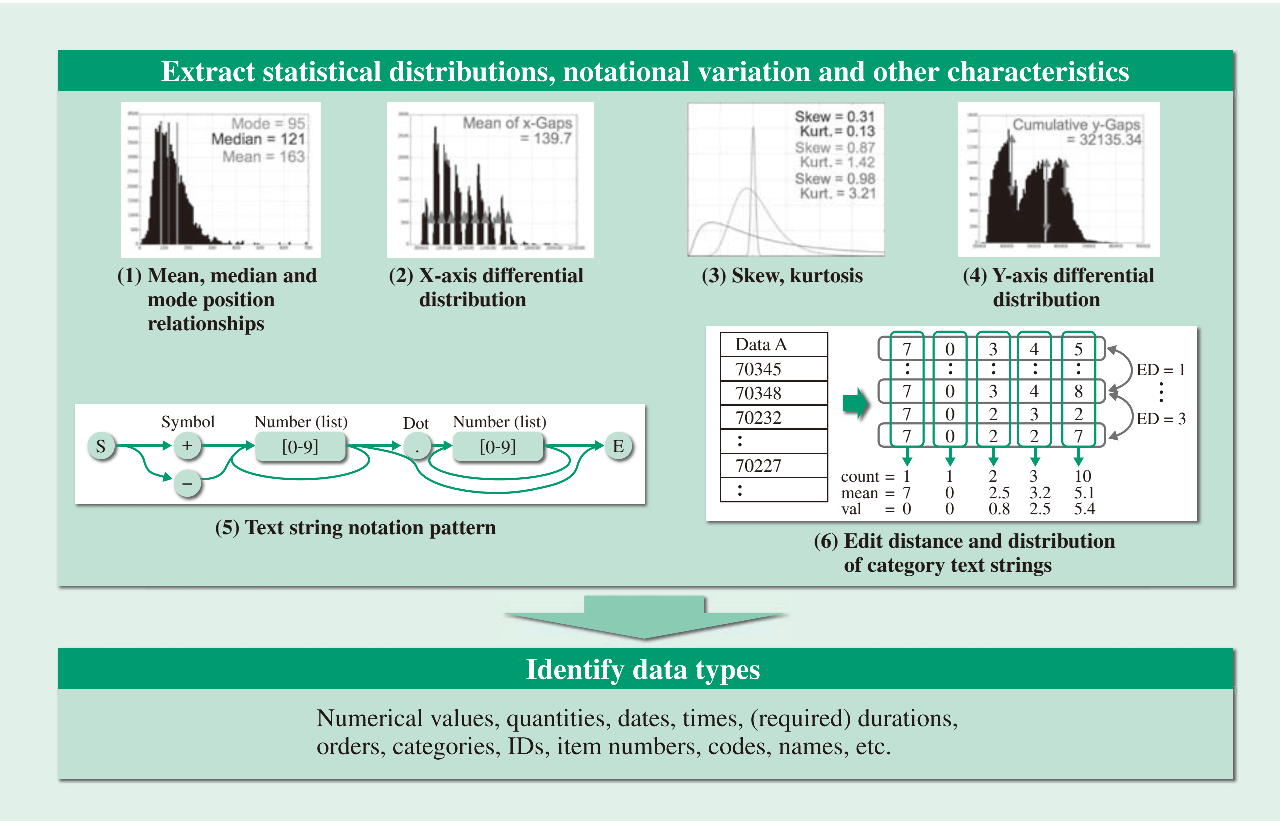

Fig. 3—Example of Automatic Identification of Data Types by H.
H combines statistical distributions of data and notational knowledge to automatically identify data types.

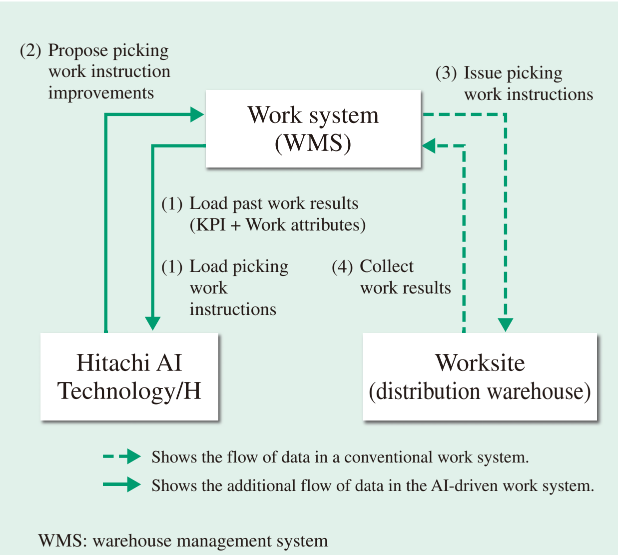

Fig. 4—Configuration of AI-driven Work System Used in Test.
The data flow of the conventional system is shown by (3) → (4). The AI-driven work system adds the new data flow shown by (1) → (2).

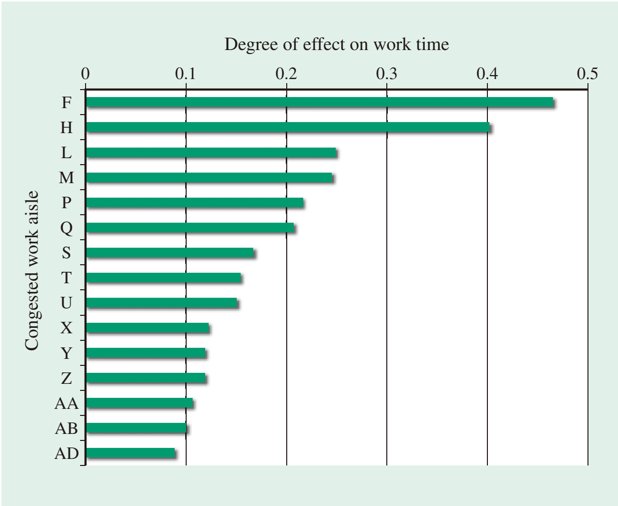

Fig. 5—Congestion and Its Effect on Work Time for Individual Work Aisles.
This histogram shows that the congestion of specific work aisles has a large effect on work time. (The work aisle names are sorted in order from greatest to least effect on work time.)

Analysis Results

The mathematical model results [the results of Step (1) in the previous section] generated by H are described below. The picking work times were set as the KPI, and the work attributes of picking work (what work was done, how much was done, and by whom, when and where) were set as the work behaviors.

Worker congestion at specific times and locations (aisles) in the warehouse was obtained as a behavioral characteristic that had a large effect on picking work time. Fig. 5 is a graph showing the degree to which each aisle's work time was affected. As it shows, the higher the value for an aisle, the more the work time tended to increase when that aisle was crowded.

Using the mathematical models, H created the day's work instructions in a way designed to reduce worker congestion at particular times and locations [Step (2) in the previous section].

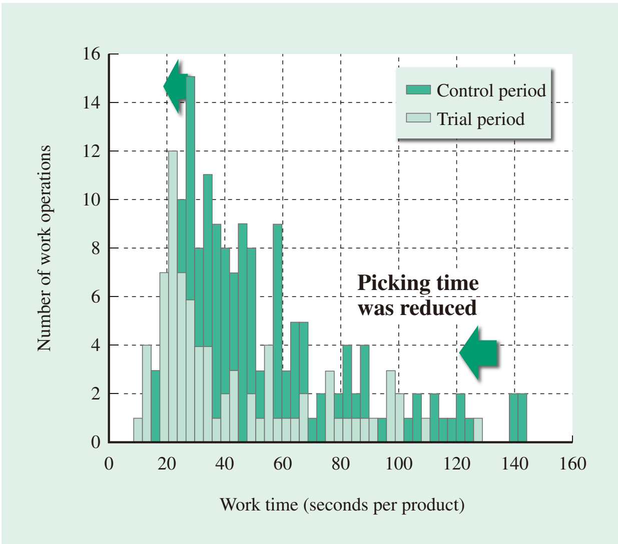

Fig. 6—Histogram of Work Operations by Picking Work Time.
An overall reduction in work time was demonstrated for the trial period relative to the control period.

Demonstration Test Results

Hitachi conducted a trial of the AI-driven work system over a period of about two months in an actual distribution warehouse, and compared the work efficiency to the work efficiency during a control period. The trial was not explained to the site workers, and they worked as usual according to the picking work instructions.

Fig. 6 is a histogram of the picking work times. The horizontal axis shows the work time, and the vertical axis shows the number of work operations. The histogram bars representing work operations done during the trial period are shifted to the left relative to the bars for the operations done during the control period, indicating an overall reduction in work time. Work time was reduced an average of 8%.

CONCLUSIONS

This article has described an AI-driven work system that uses big data from work performance information to issue appropriate work instructions with an understanding of the worksite improvements and environmental changes. A demonstration test of picking work improvement was conducted in a distribution warehouse, and a work reduction of 8% was obtained as the result. In the future, Hitachi will work on further generalization of this technology, and on expanding its application into other fields such as manufacturing and distribution.

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