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The Status Info Processing and Keeping System for Production Equipment

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***Abstract*—**With the globalized production and logistics environment, the need for reducing the product development interval and lead time, having a faster response to orders, conforming to quality standards, fair tracking, and boosting information exchanging activities with customers and partners, and coping with changes in the management environment, manufacturers are in dire need of an information management system in their manufacturing environments. There are lots of information systems that have been designed to manage the condition or operation of equipment in the field but existing systems have a decentralized architecture, which is not unified. Also, these systems cannot effectively handle the status data extraction process upon encountering a problem related to protocols or changes in the equipment or the setting. In this regard, this paper will introduce a system for processing and saving the status info of production equipment, which uses standard representation formats, to enable flexible responses to and support for variables in the field equipment. This system can be used for a variety of manufacturing and equipment settings and is capable of interacting with higher-tier systems such as MES.

***Keywords*—**DAS, Equipment Status, Regular Expression

I. Introduction

TODAY, where the manufacturing process is unified in a global network, it is essential to put all information starting from the development of products into an effective management system. With the globalized production and logistics environment, the need for reducing the product development interval and lead time, having a faster response to orders, conforming to quality standards, fair tracking, and boosting information exchanging activities with customers and partners, and coping with changes in the management environment, manufacturers are in dire need of an information management system in their manufacturing environments. NGM (Next Generation Manufacturing), a report that was issued in 2006 by IMS (Intelligent Manufacturing System), also emphasized the importance of building an information system for three categories including: Product Design, Definition & Data Interchange, ERP (Enterprise Resource Planning,) and Manufacturing Planning & Execution [1].MES (Manufacturing Execution System), one type of info management system, supports all kinds of activities carried out on the production line (i.e., scheduling, work instructions, QA, or work performance). It produces, processes, and maintains the data such as work performance, equipment load/status, operation, and malfunctions, on the basis of information it receives from the field, (i.e., the equipment and operators), in real time. The info systems that are used a lot for the management of the operation and status of field equipment includes SCADA (Supervisory Control And Data Acquisition), HMI (Human Machine Interface), and DAS (Data Acquisition System)[2]-[3].

These traditional systems, which are designed to run or maintain each individual piece of equipment or special-purpose system, are difficult to incorporate into higher-level systems, and have limitations in extracting particular status info upon a change or error in the communication protocol, equipment, or the status. Therefore, manufacturers need an equipment status info processing system that is interoperable with MES, a higher-tier info system, in order to ensure the efficiency of MES and the integrity of status data that has been collected for production equipment. From this perspective, this paper will introduce a system for processing and saving the status info of production equipment, which uses standard representation formats, to enable flexible responses to and support for variables in field equipment.

II. Status Info Processing and Keeping System

A. Equipment status info

Today, it is an industrial trend to automate production equipment but many small and medium enterprises cannot afford the cost of automation and are still relying on common info systems that are not equipped with control instruments. The status info about various types of equipment in the field is critical for the effective management of equipment operation, which may include the data on sequence such as PLC, machine tools, relay, and limit switches. For a CNC shelf, such information can be collected through contacts of I/O cards (CB105, CB106, CB107) and for general-purpose machines or hydraulic compressors, through the control panel. Table 3.13 is a summary of equipment data that has been quoted from the Equipment Manual ("CUTEX-160"). In addition to these things, there can be many types of status data, and this data must be properly collected and processed, so that it can be used as meaningful information.

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TABLE I
CUTEX-16'S I/O CARDS

contacts of I/O cards	contact info.
X30	Bed lubrication overload
X31	Coolant motor 1 overload
X33	Chip conveyor overload
X80	Hydraulic motor overload
X84	Emergency stop
X87	Door close
Y24A	Chuck open sol
Y25A	Chuck close sol
Y32A	Tail stock adv. Sol
Y33A	Tail stock ret. Sol
X51	Bed lubrication oil pressure
X56	Turret clamp pos. S/W
Y47	Bed lubrication motor
Y60	Flick lamp(RED)
Y61	Flick lamp(GREEN)
Y62	Flick lamp(YELLOW)

B. System design

The status info processing and keeping system is designed to collect the data from the production line and equipment interfaces and store them in the database system. Fig. 1. is a system layout that was designed for this system. The system consists of a Data Communication Module, which is responsible for communication with equipment interfaces. The Data Parser Module is for processing status data, and the Data Archive Module is for saving status data. The status info database is divided again into standard representation formatting, status info mapping, and keeping sub-database systems. It has been designed to maintain the processed data.

Interfaces to the equipment are divided as Direct, GPIB (General Purpose Interface Bus), and PLC (Programmable Logic Controller)-based types. All of which are designed to send the status info to data packets. Fig. 1. shows a simulated example where the data is sent from equipment A, B, and C. STX and ETX universal across all data packets indicate the beginning and end of each piece of data sent, respectively. The rest of the data is all unique data in non-standard formats.

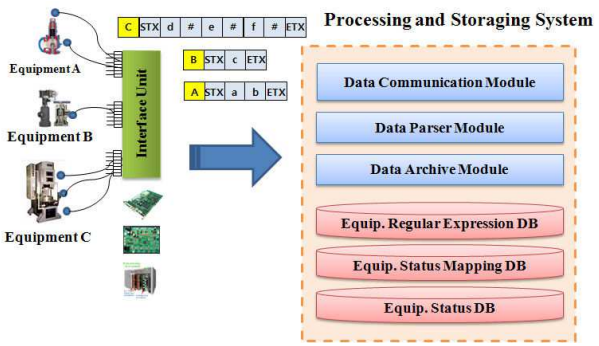

Fig. 1 System Architecture

C. Regular expressions used for the representation of status data

These regular expressions are a formal language that is used to express the group of characters in a specific rule or pattern [4]. The system proposed in this paper uses IEEE POSIX (Portable Operating System Interface), and Table 1 shows a regular extended representation formula, which is a standard provided by POSIX.

TABLE II
POSIX EXTENDED REGULAR EXPRESSION

POSIX	ASCII	Description
[:alnum:]	[A-Za-z0-9]	Alphanumeric characters
[:alpha:]	[A-Za-z]	Alphabetic characters
[:blank:]	[ ]	Space and tab
[:cntrl:]	[\x00-\x1F\x7F]	Control characters
[:digit:]	[0-9]	Digits
[:punct:]	[][!"#$%&'()*+,./:;<=>?@\^_`{|}~-]	Punctuation characters
[:space:]	[ ]	Whitespace characters
[:xdigit:]	[A-Fa-f0-9]	Hexadecimal digits

The data packets sent from equipment interfaces and that are defined for each facility are compared with regular representation formats. It is separated on the basis of data positions that have been assigned to the data unit of the representation format and saved into the status info database. In Fig. 2. which is a system that has been designed to extract and process the status data sent from the equipment, the status data sent from the equipment defines a regular representation format in the first place. This regular data representation format has the definition of the pattern of status info, (i.e., type of data) as shown Fig. 2. STX and ETX indicate the beginning and end of data packets and are represented as [:cntrl] and the status data of, d, e, and f, incoming in 2 bytes, as [:alpha] and [:alpha]. ‘’, is a delimiter of each status data and is represented as [:punct].

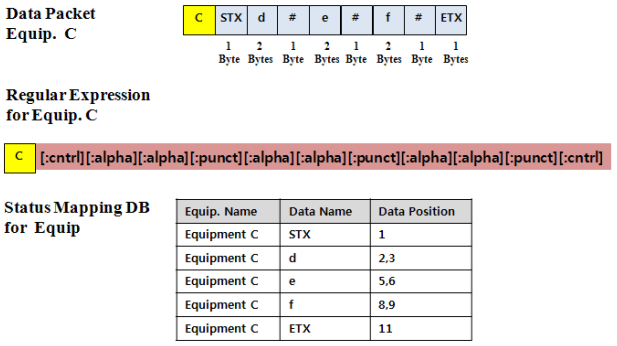

Fig. 2 Regular Expression for Equipment

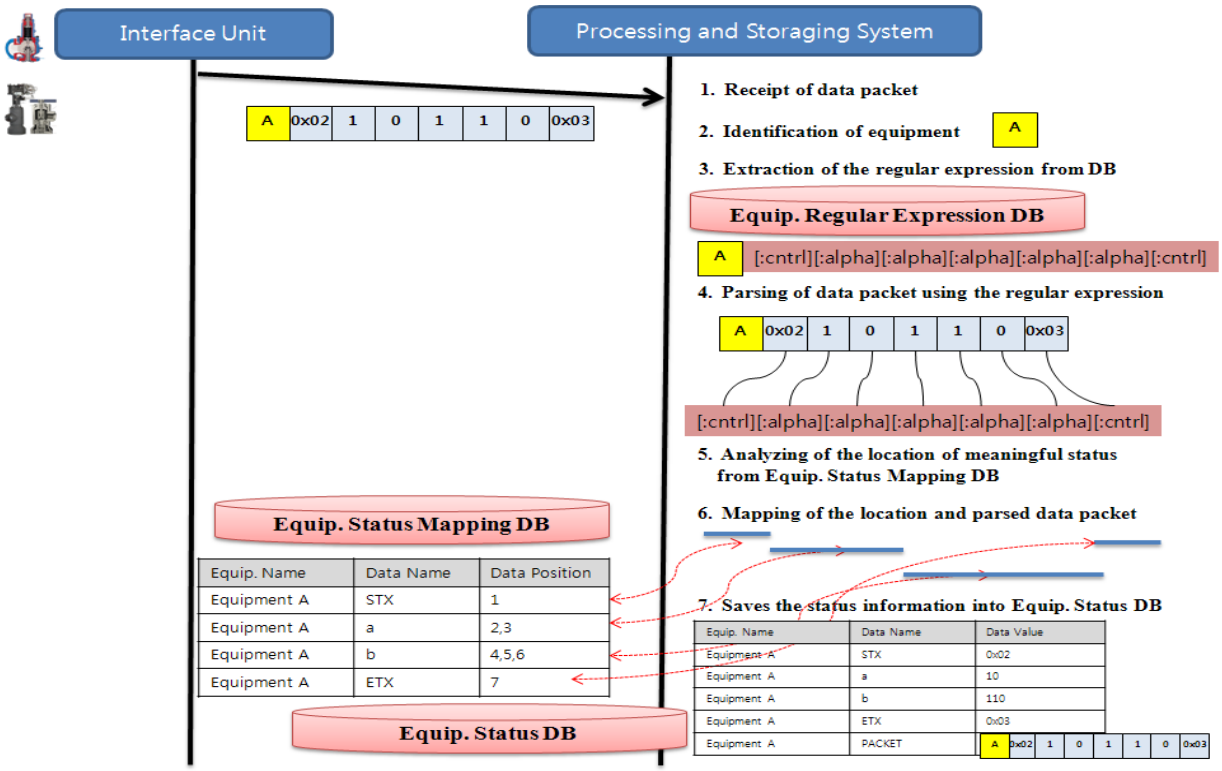

Fig. 3 system Operation Procedure

When the data analysis using the defined regular representation formats ends, the position of status info and the analyzed data will be mapped in a way where the status data mapping DB uses the position of analyzed data packets to map the name of variables of each status data with the definition of each data position.

D. Status data processing and keeping procedure

Fig. 3. shows a status data processing procedure. First of all, the point when the Data Communication Module receives data packets sent by the equipment interface is recorded as a system sight acquisition time. The Data Parser Module recognizes the source, (i.e., the equipment from which the data was sent). It extracts a regular representation format for the equipment from the pertinent DB, and analyzes the data packet by using this formula. The analyzed data packets are mapped with the position info and each variable of this info, which are then identified by the status data mapping DB. The Data Archive Module stores the extracted status info and data acquisition time for each machinery system into the status data keeping DB, along with the original copy of data packets for reinterpretation upon a later change or error in protocols. After a certain period of time, the status info will be transferred to the backup database system from the status info DB.

III. A Structure Interlocked into a Production Information System

The status data processing and keeping system introduced in this paper was applied to the process of collecting the equipment status data and sending them to MES.

Middle ware is generally defined as a tool designed to provide interoperability between heterogeneous platforms in a decentralized environment, positioned between the OS and applications. To interlock the production info system, we extended the interoperability concept of a common middle ware to a production information management solution, as Show in Fig. 4. And we considered the production line and the equipment in the field, the OS layer, MES, and application layer and implemented the system introduced here as middle ware. Interfaces were deployed to the CNC shelf (Cutext 160, FANUC 0i-TC Hwacheon Machine Tool Co., Ltd.) and the extraction of equipment status data is implemented by the signals at the output contacts of CNC that are sent to the input contacts of PLC. Input digital signals are sent to the MES server through the PLC function Block. The I/O data of PMC are generated in a voltage range of 0-24V, which indicates the status info of the shelf. The primary production field data collected by equipment interfaces are sent to the Data Communication Module of the status data processing and keeping system. These data are then interpreted/analyzed by Data Parser Module based on various equipment operation info protocols and general-purpose technologies before being processed into secondary information. To this end, the Data Communication Module has packet fields, which enables to store the equipment data packets into the DB system. This allows extracting the original copy of data packets as a meaningful data set by parsing them, even if the structure of data included in packets or a certain delimiter is changed later.

The data obtained for the equipment becomes key information sent to the manager and MES. The power supply status, operation of lamps, and Bed lubricant status can be monitored in real time through the MES' production info compiling function.

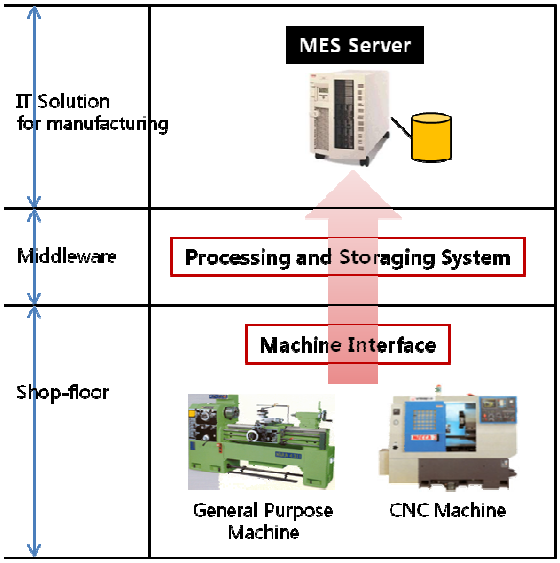

Fig. 4 Production info system interlocked architecture

IV. Conclusion

The study has introduced a system that has been designed to process equipment status info for flexible responses to changes in the equipment and the communication protocol. This system may improve the equipment data processing capacity and will upgrade the flexibility. In addition, it will contribute to the effort to minimize the work load of maintaining industrial information management software programs through higher interoperability with the system on higher layers as an industrial info processing medium that can be used in a wide range of industrial applications. In the future, the system will hopefully be interlocked to other equipment and production info management solutions will then be able to offer more flexible and powerful interoperability.

References

[1] IMS, "NGM(Next Generation Manufacturing) report", 2006
[2] Kwark, W. Y., Kim, W. S. and Park, G. D., "Design and Implementation of Equipment Monitoring System for Data Integration," Journal of the Korea Society of Computer and Information, 2009, Vol. 14, No. 9, pp. 115-126.
[3] Lee, S. W. and Lee, H. K., "Data acquisition system of compound semiconductor fabrication," Journal of Mechanical Science and Technology, 2007, Vol. 21, No. 12, pp. 2149~2158.
[4] http://en.wikipedia.org/wiki/Regular_expression.
[5] Panetto, H., Baina, S. and Morel, G., "Mapping the IEC 62264 models onto the Zachman framework for analyzing products information traceability: a case study," Journal of Intelligent Manufacturing, 2007, Vol. 18, No. 6, pp. 679-698.
[6] MESA International, IBM Corp. and Capgemini, 2008, "SOA in Manufacturing Guidebook," MESA White paper, No. 27, pp.1~69.
[7] Ju H., 2006, "An Overview of MES Solution Trends and a Strategy for Successful MES Deployment," SAMSUNG SDS Consulting Review, No. 2, pp.69~79.