

Design of Warehouse Control System for Real Time Management

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Abstract: Warehouse Control System (WCS) aims to manage a broad range of facilities in the warehouse. WCS is different from warehouse management system (WMS). It manages and controls facilities (e.g. equipment) in the warehouse while WMS manages orders in the warehouse. A WCS controls a number of equipment simultaneously while an equipment control system (ECS) controls individual machine. We analysed key functions and limitations of existing WCS and suggest a new architecture for WCS for managing real time event.

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1. INTRODUCTION

Warehouse Control System (WCS) provides an integrated interface to a broad range of material handling equipment. It is able to collect equipment information and control equipment in real time. The state-of-the art WCS is expected to have versatility, integrity, information-visibility with variety of function for supporting warehouse control and material flow.

In this paper, we analysed key functions and limitations of existing WCS and suggest a new architecture for WCS which provide plug and play equipment interface and also provide the result of communication test between pilot system and material handling equipment using new architecture.

2. SURVEY ON WAREHOUSE CONTROL SYSTEMS

Conventionally, warehouse is operated by manual operation such as forklift, conveyor and cart, etc. However, due to time critical orders and low profit caused by manual operation, automated facilities such as Automatic Guided Vehicle (AGV), Automated Storage and Retrieval System (AS/RS) are widely getting more attention by big players such as Amazon.

The control of automatic facilities require control software such as Warehouse Control System (WCS), Material Flow Controller (MFC), Equipment Management System (EMS) or Equipment Control System (ECS). Even though, the objectives of WMS and WCS are quite different, many software providers use those terms in the mixed ways. WMS focused on the management of an order and generally interfaced with ERP system whereas WCS is more focused

on the controlling of machines and deals with dynamic data with shorter timing (close to real time). It is rather focused on the monitoring of machine status and controlling machines. From the functional point of view, WCS consist of the following functions: interfacing equipment; collecting equipment data; executing and control material flow; and monitoring & controlling equipment. In this paper, we define that WCS is a system that controls all equipment/facilities in the warehouse.

WCS is currently under development by a few vendors. In this paper we have compared WCS of five companies such as Dematic (2014), Daifuku (2014), SSI-Schaefer (2014), Bastian Solution (2014) and QC software (2014). Fig 1 shows the comparison of solutions provided by five companies.

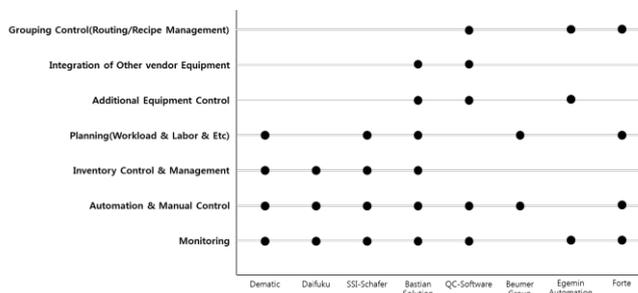


Fig. 1. Comparisons of Warehouse Control System (Adapted from Son et al., 2014)

From the review of eight companies, we found that most companies typically do not provide generic interface for third parties. Also most of companies do not provide flexible user interface (UI) and functionality for lifecycle management of equipment. It is considered that warehouse control system should provide such capabilities with generic capabilities.

3. WCS AND EQUIPMENT CONTROL SYSTEM (ECS)

3.1 System Architecture

Fig 2 shows the concept of this system. Human Machine Interface (HMI) is also called as Human Machine Interface for Equipment Control System (HMI-ECS). It is a system installed in the individual equipment and user can control individual equipment using HMI. As in the figure, key function of HMI (or HMI-ECS) is control and monitoring. A WCS can control many HMI-ECS and it provides monitoring of equipment in the warehouse and controls actions if required. A WCS can provide a good grip of equipment in the warehouse to the manager.

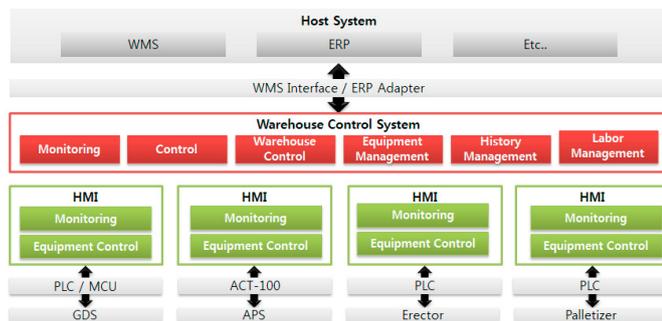


Fig 2. Concept of WCS and HMI-ECS

Fig 3 shows control framework of ECS for real time handling of machine event. ECS consists of control framework and Sensor/PLC interface module. Sensor & PLC interface module defines sensor and PLC Interface. ECS Control framework consists of event handler, driver handler, message map handler, and data logger.

Common UI module (Engine) manages the characteristics of each type of equipment. The UI generates event according to user operation, and transmits related data to event handler of control framework.

WCS/HMI-ECS contains firmware data to improve generality of WCS. Using firmware data, the users can connect equipment regardless of the brand of equipment manufactured. The system also supports dynamic plug and play (PnP), connection and the management of equipment. Dynamic PnP is a unique function to identify different types of equipment when it is hook up to the WCS/HMI-ECS system without system re-booting. Such capability is possible because of its pre-built in PLC and protocol information in the system. To make this, WCS/HMI-ECS is structured for duplication using imaginary fault tolerance tool. Dynamic

PnP starts when WCS/HMI-ECS is updated. When updating is completed, it is switched then the updated one replace existing one (After this process, the existing WCS/HMI-ECS could be updated).

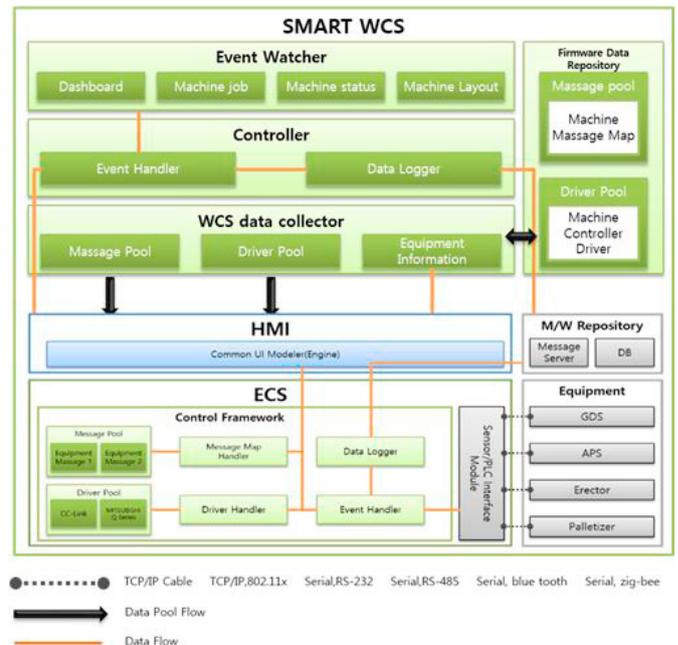


Fig 3. Smart WCS/HMI-ECS (Son et al. 2014)

WCS data collector registers equipment data to embody dynamic PnP of WCS/HMI. Driver Pool and Message Pool receive and store the Vender Drive data and the Message Map data of specific equipment which is managed by WCS and also transmit and manage Driver and Message Map of equipment to HMI. Kyusakov et al (2013) researched a new approach for making operation systems using SOA based wireless sensor and actuator nodes with Web Service Description Language. SOA is using WSDL form to send and to receive data. In our research the message map of message pool is applied instead of WSDL. Message map describes the information on the memory address of the PLC Program. And the system uses the message map for communicate to equipment. Equipment information is equipment data available for user to input and to adjust. It can be used to construct various application including machine monitoring screen. Controller works based on WCS data collector and includes Event handler and Data Logger. Event handler transmits an order from event data collected from HMI and provides the information to users. Data Logger transforms all event data collected from Event Handler into Log data and it is stored in the database. Event watcher provides integrated information to users. It provides equipment information such as Machine Job, Machine Status, machine Layout graphically to users.

3.2 System Function

Table 1 compares major functions of HMI-ECS and WCS. WCS transmits work orders from Host system to the equipment assigned for some order. WCS supports integrated

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