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Development of control logic in simulation system for material handling system based on cyber physical system (CPS) architecture

Mohamad Shariff Osman, Azrul Azwan Abdul Rahman*, Mohd Hisham Nordin, Muhamad Arfauz A Rahman, Effendi Mohamad, Shariman Abdullah

Advanced Manufacturing Centre (AMC), Fakulti Kejuruteraan Pembuatan, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

*Corresponding e-mail: azrulazwan@utem.edu.my

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ABSTRACT – The purpose of this manuscript is to present a project that develop control logics for a material handling system. The requirement of advanced skill converting simulation control to physical system control especially on current reconfigurable manufacturing system is the issue. Controlling the material handling system operation directly by using simulation software is possible with OPC. The structure of the control logic is from the virtual control logic that created in simulation software. The architecture of cyber-physical system enables the development of the control logics.

1. INTRODUCTION

Control systems can be created in virtual and on real system. Real control system can be tested through simulation and virtual control system only can be verified by using simulation. The control system used at real system usually is Programmable Logic Controller (PLC) control logic. This PLC control logic then can be tested with simulation through the concept of Hardware in the Loop (HiL). On the other hand, the control logic is different on simulation. On previous study, there are multiple development of PLC control logics that have been verified through simulation [1-2].

The aim of this manuscript is to describe the procedure on creating the control logics in virtual system that can be used on physical system. Developing and modifying control logics become faster and easier by using the proposed architecture. Figure 1 shows the architecture of the system.

The control logics is developed in simulation software, then OPC (Open Protocol Platform) exchange the data between PLC and simulation software. The control logics in virtual simulation used at physical system. This method minimise the translation or conversion between simulation and real system control logic. In addition, different PLC vendors has different program method. The approach of using control logic from simulation system shortening the translation from control logic in simulation to PLC ladder diagram.

The approach also supporting the current reconfigurable manufacturing system [3]. Configuring multiple controller with different languages takes longer preparation. In real situation, converting from simulation to real system also required an expertise to develop the system that will need additional cost. The approach can simplify the control logic for the system.

In relation of cyber physical system, the architecture presented is based on propose architecture of Cyber-Physical System (CPS). CPS the current technologies that interconnect physical entities with virtual entities enable by internet communication [4]. CPS is able to record input information through sensors. The system create in virtual system then evaluates then affect or react to the output. CPS that connected through network improve the reliabilities of the system [5].

Material handling system is the suitable platform to show the capability of the approach. Material handling system require multiple machine interact with each other. Section 2 will show the real system structure and the development will show one of the control logics at the material handling system at section 3.

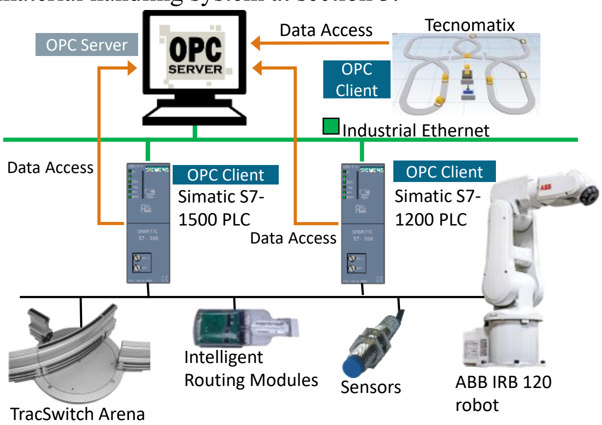

Figure 1 Cyber Physical system architecture.

2. METHODOLOGY

This study is using the Montrac automation system as the material handling system. The system consists of entities such as shuttle, Intelligent Routing Modules (IRM), pick and place robot, TracSwitch arena, sensor and others. Figure 2 show the diagram of material handling system that showing the placement of IRM sensors, stations and direction of shuttle movement.

The shuttle is intelligent transport carrier. Each shuttle has sensor to avoid collision between obstacles or others shuttle. There are 6 shuttles that separated into 3 paths. 2 shuttle with group ID = 255 will travel through station 1 only, 2 more shuttle with ID = 1 will travel through station 2 only and another 2 shuttle with ID = 2 will travel through station 1 and station 3.

IRM is a programmable control element that arranged on the monorail system to communicate with the shuttles via infrared interface. Robot used in the material handling system is programmed to pick and place item at station 2 and 3. When shuttle at its station, PLC will send or received signal from robot controller. TracSwitch Arena is uses to convey shuttle from one lane to another lane at 45° angle. The control elements can be configured using command through serial communication to PLC system.

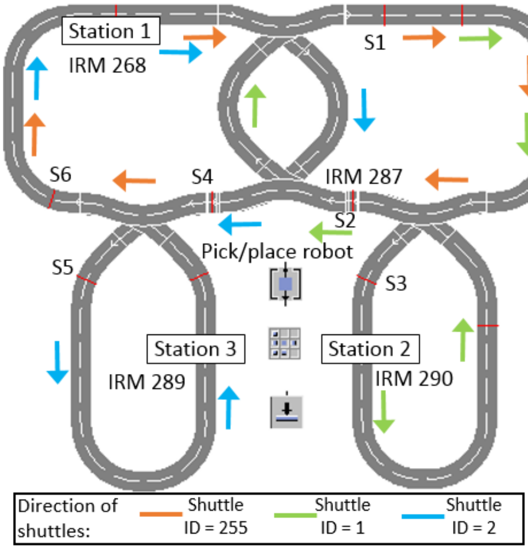

Figure 2 Material handling system visual representation.

3. RESULT AND DISCUSSION

There are two TracSwitch that can be controlled from PLC. The paths of shuttles can be controlled through IRM. IRM 287 and IRM 268 is programmed to control the path at the middle of the system.

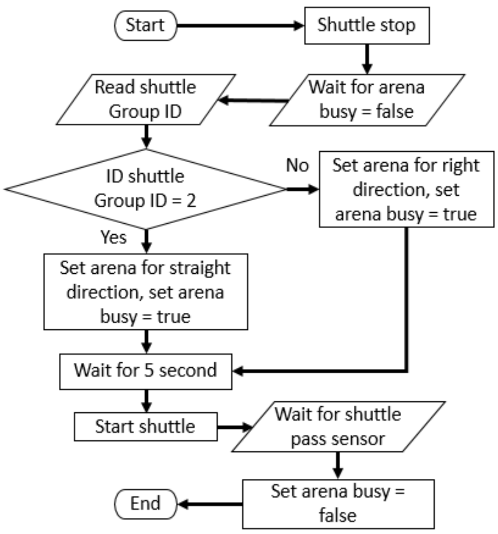

Figure 3 Structure of control logic at station 1

The structure of control logic based on figure 3 will start when IRM received signal from the shuttle. IRM 268 controlled the shuttle at station 1. Every shuttle that travel at station 1 will stop to wait for the instruction from IRM. The shuttle will stop and wait from variable for arena busy to be false. Arena busy variable will represent that there is another shuttle is undergoing control logic at the middle of the system. Arena busy is Boolean variable. IRM will read the shuttle's group ID to provide the correct path for the shuttle. Only shuttle's group ID = 2 will travel on different path. The other will travel on the straight path. On the same time, variable arena busy will be set to true. Then the control logic will wait for 5 second for the TracSwitch Arena to changes its direction of path. After TracSwitch Arena is switch its direction, the shuttle will start to move from station 1. For shuttle's group ID = 2 will wait for sensor S4 to reset variable arena busy = false. The other group ID will wait for sensor S1 to reset variable arena busy. After the variable reset, the control logic will be ended so another control logic can proceed its program. The control logic will prevent collision of shuttle at the middle of the system.

The control structure also used in simulation of the material handling system. Both real and simulation control logic using the same language shows that there will be no translation of control logic from simulation to PLC ladder diagram. In addition, the architecture also supports interface and real time data collection and presentation.

4. CONCLUSION

The control logic created in simulation software will prevent shuttle collision and control the path of shuttles. The approach also could reduce tuning of control logic and error during execution of physical manufacturing system. High level of configuration from the application of the approach is suitable for reconfigurable manufacturing. Moreover, the architecture is the based for cyber physical system mechanism for future references.

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REFERENCES

[1] C. M. Park, S. Park, & G. N. Wang. (2009). Control logic verification for an automotive body assembly line using simulation. *International Journal of Production Research 47(24),* 6835-6853.

[2] Stephan, S., Ulrich, D. & Jürgen, H. (2012), Approach to a Simulation-Based Verification Environment for Material Handling Systems, *Proceedings of 2012 IEEE 17th International Conference on Emerging Technologies & Factory Automation (ETFA 2012).*

[3] Azrul Azwan, A. R., & Günther, S. (2013). Integrated control system simulation for supporting changes of routing strategy in an automated material flow system. *Procedia CIRP 7,* 407-412.

[4] L. Monostori, B. Kadar, T. Bauernhansl, S. Kondoh, S. Kumara, G. Reinhart, O. Sauer, G. Schuh, W. Sihn, and K. Ueda. (2016). Cyber-physical systems in manufacturing. *CIRP Annals - Manufacturing Technology 65(2)*, 621-641.

[5] Yang, L. (2017). Cyber Physical System (CPS)-Based Industry 4.0: A Survey. *Journal of Industrial Integration and Management 2(3),* 1-57.