FACTORY AUTOMATION SYSTEM FOR LEARNING: AUTOMATE MATERIAL HANDLING SYSTEM

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ABSTRACT Automation is widely used in manufacturing process nowadays. Fixed automation is generally used due to low unit cost but high production rate. However, it costs very high in order to modify its functions when the production process change is required. Eventually, flexible automation is invented for the multi-purpose manufacturing process in effort to reduce the cost and make the multi-functional automation.

Materials transportation automation is a flexible automation because of the diversity of forms or shapes of any object to be picked up, held and transported to the destination within the different period of assigned time precisely, this study is required data control and getting the systems linked which showing as learning kit in flexible automation for materials transportation system. The automation contains the automatic picking and holding system which sort the materials out and record the specifications in computer system for ease to manage and check. The next system is delivering system that will deliver the materials to the next production line. The system send the request to the assembly station for the required materials to assemble, picking and holding system will provide the materials per the request and pack then deliver by the automated guided vehicles (AGV) and it will return back to the beginning. The process will run as iterations repeatedly. The whole system is connected to each other via the network which all data are stored in the database containing materials specifications, materials requests from the assembly station as well as the status of all the systems working at a time for gathering and analyzing to the manufacturing system. The study shows the transportation of materials and automated manufacturing process for the learner.

1. INTRODUCTION

Current industrial manufacturing in small, medium until big industries respectively has a system to collect parts for assembly which the process for parts delivery to each station for assembly requires the good dispensation to transfer parts to each station quickly and precisely. Currently, automations and many technologies are applied to this process i.e. Barcode, RFID, VISION etc. for more accuracy and ease for data verification.

RFID Technology is a system that developed from Barcode which is the identification system using magnetic media recording and reading via radio wave technique. Present technology is advance quickly due to electronics ship and sensor pricing reduction, higher data transfer performance in lower cost. These are causing many companies started using RFID to manage regarding equipment and parts in the company and including tracking the goods that require transportation. Work areas those populary use RFID are warehouse, distribution center, logistic, inventory system etc. RFID working system contains with 3 parts: RFID Tag, RFID Reader and Antenna. RFID does not have only the capable to collect data but also to identify the location as called ‘Real-time Location System’ (RTLS)

Automotive industries in Germany use RFID to collect data under the Electronic Product Code (EPC) Tag Data Standard and use in checkup containers those are portable between producer and supplier in supply chain by tag RFID (passive EPC) and installing Real-time Location System (RTLS) around the area in factory for accuracy and fast working in order to collect real-time data of stock inventory in assembly station while this technology can identify the location of the object by RFID tag.

There are many studies in the decade passed that using RFID such as Intelligent Warehouse Management System with RFID Technology by Khon Khaen University. This technology has been applied to warehouse system to

become more automatic or intelligent. Every ralated system including input, output, collection, security of the warehouse and cost saving, the most important thing for expense of product storage in warehouse, organization reliability and trustful from the clients. This study well encourages the above mentioned topics

Refer to robot which is currently high cost and does not make the profit in term of the investment. However, there are some studies regarding the low-cost robot such as Dimitrios Bargiotas Technology Educational by Institute of Chalkida, Greece made a study to build 'Scalar Robot', the low-cost robot for picking and moving object in-out of warehouse.

For object delivery, there are many studies regarding AGV in present depend on guidance and navigation system such as laser, line tracking, vision and so on.

This study would build the automatic object delivery system for educational media in an effort to educate the learners to become more understanding and knowledgable in automated equipment in manufacturing process includgin controller and programming as well as the flexible automation which RFID technology is applied to manage parts or equipments data and locations in warehouse in the system when parts or materials are brought into warehouse by human with a request via computer program of the system is sent out by any station; the cartesian robot will pickup parts from the station's request with the verification system using RFID and contain to the automated guided vehicles (AGV) to deliver the objects to the target station per the request. In each round of delivery cycle to the destinations, the target stations must not be more than 4 stations in a delivered turn. During the process, computer system is recording all data for check and analysis.

2. EXPERIMENT

Overall system consist of sub systems in figure 1. The computer program have 4 portions: the central working (main server) parts or materials data in warehouse (web application) picking and moving object in-out of store automated system and AGV controller system. All the systems are connected and communicated via network system.

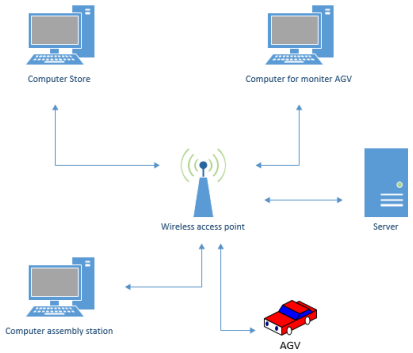

Figure 1. Show overall system.

2.1 The induction of parts to the warehouse system

Parts or materials induction to the warehouse system would be executed by human. Parts or materials those would be brought into the system must be pasted on pallet with RFID tag. The actor must be able to monitor the number of parts or materials those are still in warehouse to analyze the selection of parts and materials into warehouse. When parts and materials are inducted to warehouse, the system records data of that parts and the placing location of the parts. RTLS technology is used for verifying the placing location of the parts, figure 2 shows the monitoring of RTLS technology.

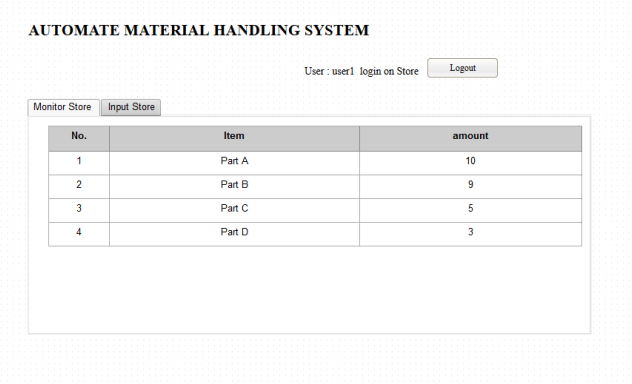

Figure 2. Show page from web application for warehouse system.

2.2 The request from assembly station

User at the assembly station can request parts or materials from web application by specifying the required number of parts or materials in warehouse. Anyhow, user at each station can monitor the inventory of parts and materials in warehouse and AGV availability status as shown in figure 3

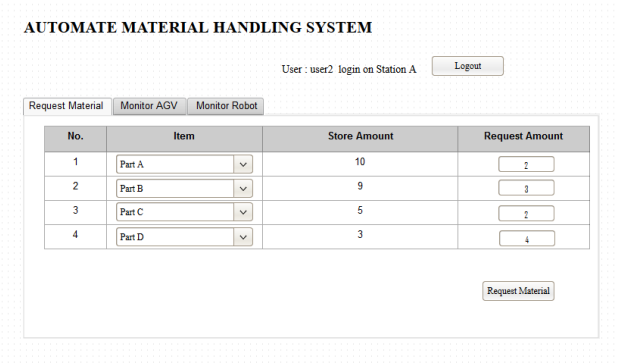

Figure 3. Show page from web application for assembly station.

2.3 Cartesian robot

If AGV is available and in ready state and the robot has been commanded from the server to deliver parts or materials to the outside from warehouse, cartesian robot will pickup the reqested parts or materials and contain parts and materials into the boxes portion by each station those are placed and ready to deliver on the AGV. When

the robot completed the task, it will send data to the server and AGV ahead while the robot is working, it can be monitored via web application. Shown in figure 4

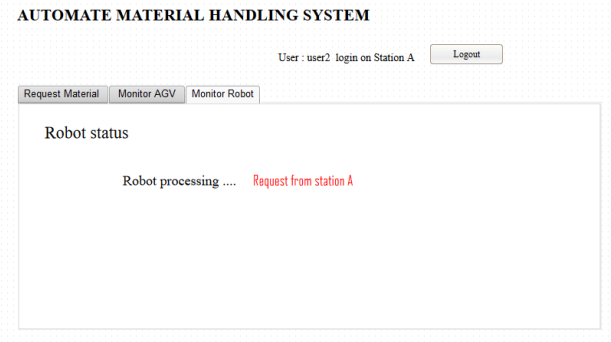

Figure 4. Show page from web application for monitoring Cartesian robot.

2.4 Automated Guided Vehicles (AGV)

If AGV is available and in ready state and the robot has been commanded from the server to deliver parts or materials to assembly stations. AGV will move to each station with line tracking technique. AGV would analyze its route in case of one delivered turn must be less than 4 stations then calculate the shortest route. While AGV is working, user at each station can monitor the status of the AGV as shown in figure 5. When the target station receive parts or materials, the system will record delivery data that the requested parts or materials have been sent to the station and to be analyses delivery data ahead.

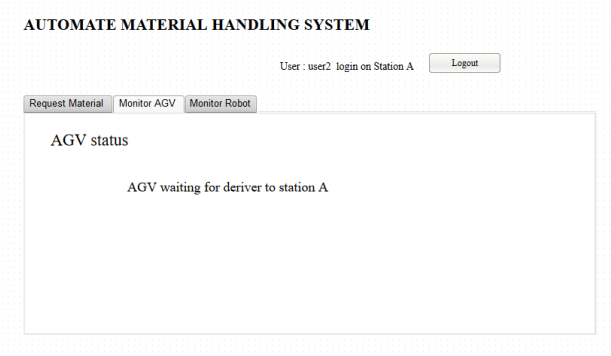

Figure 5. Show page from web application for monitoring AGV.

Web application is programmed with php programming language which optimize in terms of data accessibility and ease for data management and analysis. Data input and recording is managed by MySQL database system. The database consist of details of data in the overall system showing in ER diagram in figure 6. All the tools for web application in this study are under open source license. Cartesian robot and AGV are controlled by Microcontroller. Cartesian robot is assembled by the consolidation of 2 linear robots and integrate for the dislocation ability in both x and y axis.

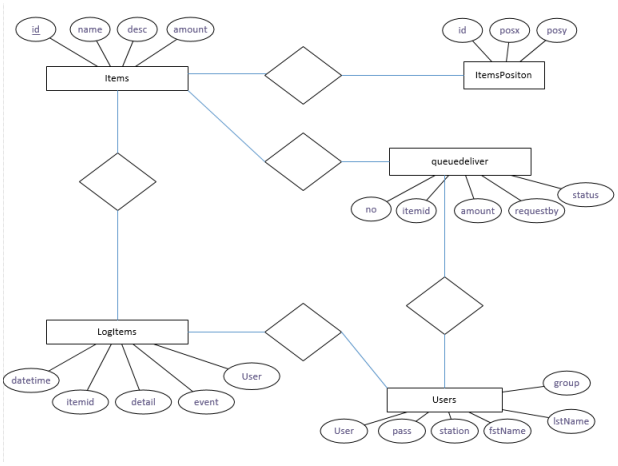

Figure 6. Show ER Model for MySQL Database.

From overall working system, the system will record the data in term of the process for data analysis and report. All the reports consist of parts or materials input summary, requests from assembly stations summary and AGV working summary. The example of report execution is shown in figure 7.

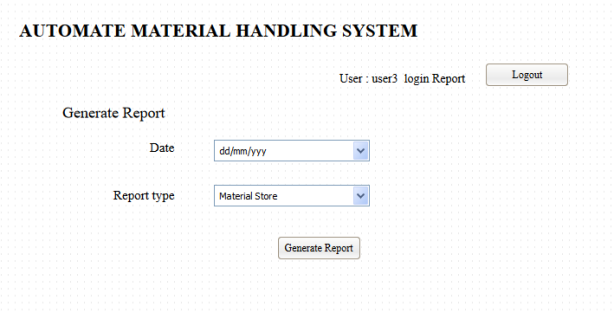

Figure 7. Show page from web application for report generate.

3. ANALYSIS

The working of overall system, the system will record in every single step of working or execution in the process to the database. The system would stop when the failure happen or any excursion. The data must be checked to verify the failure, make the system continue working immediately. Moreover, the system is not limited the working area and be able to expand the working area as much as need by expanding network system to optimize the connectivity of the delivery system and inventory in warehouse or store to be connected. Besides, data from the system can be brought for statistical analysis in manufacturing system and cause the development in term of production capability, cost saving, inventory and warehouse management and manufacturing control to be proceeding correctly and accountably as shown in figure 8.

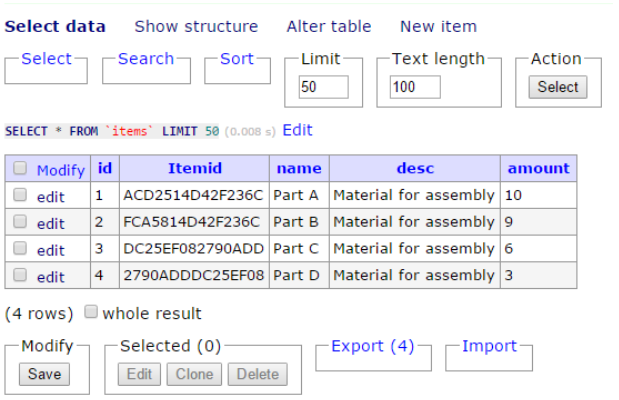

Figure 8. Show data save on database.

According to the working of the system, some possible failures can happen in AGV portion in case of AGV is not at ready state or during delivery parts or materials to each station and receive the additional request to deliver parts or materials. While AGV is working, the system cannot proceed the per the request immediately. The requestor must be waiting for the AGV to complete the current request it is working; AGV finish the current route or delivery turn ends. Then AGV can proceed for the next request. This possible failure can be solved by adding more AGV to the system. For warehouse system, the possible failure is location and direction for placing parts or materials to shelves. First input is done by human that cause the failure as mentioned. Therefore, pallet and shelves for placing parts or materials should have to develop and improve for human induced failure reduction.

CONCLUSION

In this study, learner can more understand in the working system of automatic system for parts and materials delivery in warehouse and also gain knowledge of automatic equipment working in manufacturing process as well as researching and programming for control the equipments in the system. Be more expertize in flexible automation and eventually, this study can be applied to the real industry for the optimization of manufacturing capability together with warehouse system analysis and management.

REFERENCES

Bargiotas D, Ktena A, Manasis C, Ladoukakis O, 16th International Conference on Systems, Signal and Image Processing, 2009.IWSSIP 2009. Pgs : 1-4

Vasili MR, Tang SH, Ismail N, et al. (2008) Class-based storage assignments for miniload AS/RS with open-rack structure. International Journal of Engineering & Technology (IJET) 5(2): 118–128.

Li Shengfang, Hou Xingzhe, 16th International Conference on Power System Technology 2006, 22-26 Oct 2006

M.Z.A Rashid, H.N.M Shah, H.I Jaafar, M.S.M Aras and S.K.S Nordin. International Journal of u-and e-Service, Science and Technology Vol.7, No.4 (2014), pp.19-30.

M.M. Rashid, Banna Kasemi, Mahmudur Rahman. 2011 4th International Conference on Mechatronics (ICOM), 17-19 May 2011.

Ashna Joy, B.Padmanabhan, A.Abinaya. International Journal of Engineering Trends and Technology (IJETT)-Mar 2014- Volume 9 Number 9.

Mr. Sagar R. Wankhade, Prof. V.A.Kane. International Journal of Research in Aeronautical and Mechanical Engineering. Vol.2 Issue.4, April 2014. Pgs: 99-110.

Pharadorn R, Somjit A, The 9th Thai Value Chain Management and Logistics Conference (Thai VCML 2015) ,19 – 21 Nov 2009

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