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Modelling of Automatic Material Handling System using PLC

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ABSTRACT

The Programmable Logic Controller (PLC) is widely used in industries to control a mechanical movement for an efficient production. The paper presents modelling of PLC based system to automate material handling process in industries. In the proposed system the packages are sorted out with the help of scanners and stamp it if the package is correct and then stack it. The simulation studies of the modelled system for various sections such as filling, sorting, packaging, stamping and loading are also presented in the paper. It is found that the developed system may substitute the human labour involved and thus reduce the time consumption and human errors in handling of materials in industries. The stamping and sorting is done with the help of human labour in most of the industries.

Key words: PLC, SCADA, Material Handling, TIA Portal, Sensor.

1. INTRODUCTION

Automation is used in different control systems for operating machinery and other process with least human intervention. Before the advancement of Programmable logic controllers (PLC) many control tasks were solved with the use of contactors and relay controls or hard-wired control. Circuit diagrams needed to be designed and then electrical components had to be installed according to the specifications. Wiring of the electrical system would be done and if some errors were made then the whole system had to be reconnected correctly. With the advancement of VLSI programmable logic controllers (PLC) were developed. A PLC can be programmed with (a) Ladder logic (LAD) (b) Functional block diagram (FBD) (c) Statement list (STL). Material Handling includes the transportation of materials throughout the operation period inside an organization [4]. It mobilizes the materials from particular operation to the another, and also mobilizes materials picked from stores to the location where they are required. The sole purpose of materials handling is to provide better mobility, fewer journeys, efficient equipment, lesser damage, and providing exceptional packaging and handling where required[6].In the manufacturing industry for semiconductor, in a 12-inch fabrication plant machine to machine Automatic Material Handling System (AMHS) is used for transportation of wafers. A system for transporting wafers called Manual Material Handling System (MMHS) is used with high speed and efficiency [5]. Constant search for cost reduction and better performance is demanded by the highly competitive environment, linked to the globalization phenomena. Material Handling is a method of storing, packing, and including the movement of subsystems in various forms. Movements of all types like horizontal, vertical or combination of both along with material of all types semi fluid, discrete items or fluid items comes under material handling. Considered as a crucial activities of the time spent in the plant area by the materials around 20% of the utilized time is for the actual processing while the remaining time of about 80 % is spent in moving from particular place to another. The material handling system has a very critical role in most manufacturing systems since it has the responsibility for providing the correct material at the correct time and at the correct place. Automated guided vehicles (AGV's) are unmanned vehicles used to move unit loads, heavy or light, from particular location to another [1]. In Indian industrial environment various companies are trying to reduce the human labour involved in the manufacturing process by automating the manufacturing processes.

In the paper, the main controlling part of material handling system is PLC which can monitor and control all the mechanical system. The proposed system uses human machine interface (HMI) along with PLC and infrared sensors. A pneumatic air bar compressor is also used to sort and stamp. In the paper designed system displays the filling screen of an industry then a sorting screen, packaging screens, stamping, and truck loading. The sorting is based on height i.e. the containers of different heights are sorted for different boxes or packages.

2. PROPOSED METHODOLOGY

The flow chart used to design the system has been depicted in Figure1. PLC S7-300 through the use of Totally Integrated Portal (TIA portal) is used in the programming of proposed work. . The PLC S7-300 has been chosen because of the availability of simulation in this PLC which makes it easier to monitor various parameters involved in the work. Ladder logic takes in account the programming functions that are graphically displayed to resemble the symbols that are used in hard wired control diagrams. The designing of this project

is based on object sorting using height as criteria. The system is designed according to international standards [9]. The system is designed keeping in mind the need for automation, reliability, and time consumption. The whole process is shown in five screens which are filling screen, sorting screen, packaging screen, stamping screen and loading screen.

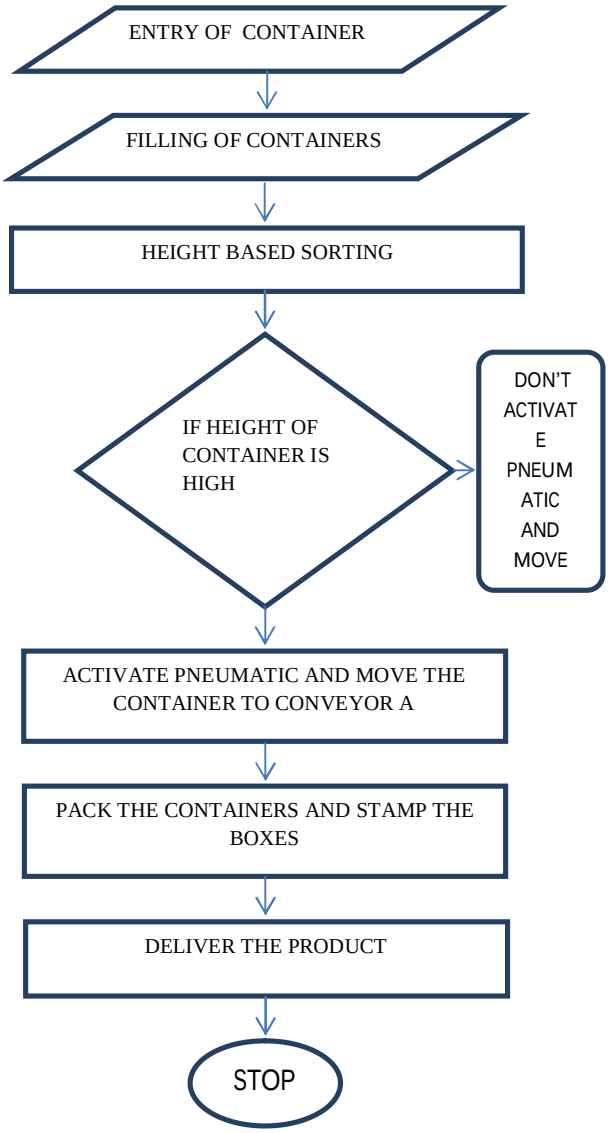

Figure 1: Flowchart of Automatic Material Handling System

The programming for the designing of system has done on the PLC S7-300 through the use of Totally Integrated Portal (TIA portal). The PLC S7-300 has been chosen because it makes easier to monitor various parameters involved in the system.

The SCADA system has been used to control and monitor the performance of the designed system and WinCC software is used for this purpose of visualization.

The program uses PLC tags, counters, and other features provided by TIA portal. The counter function used in the program helps in segregating the containers with height as criteria as shown in figure2.

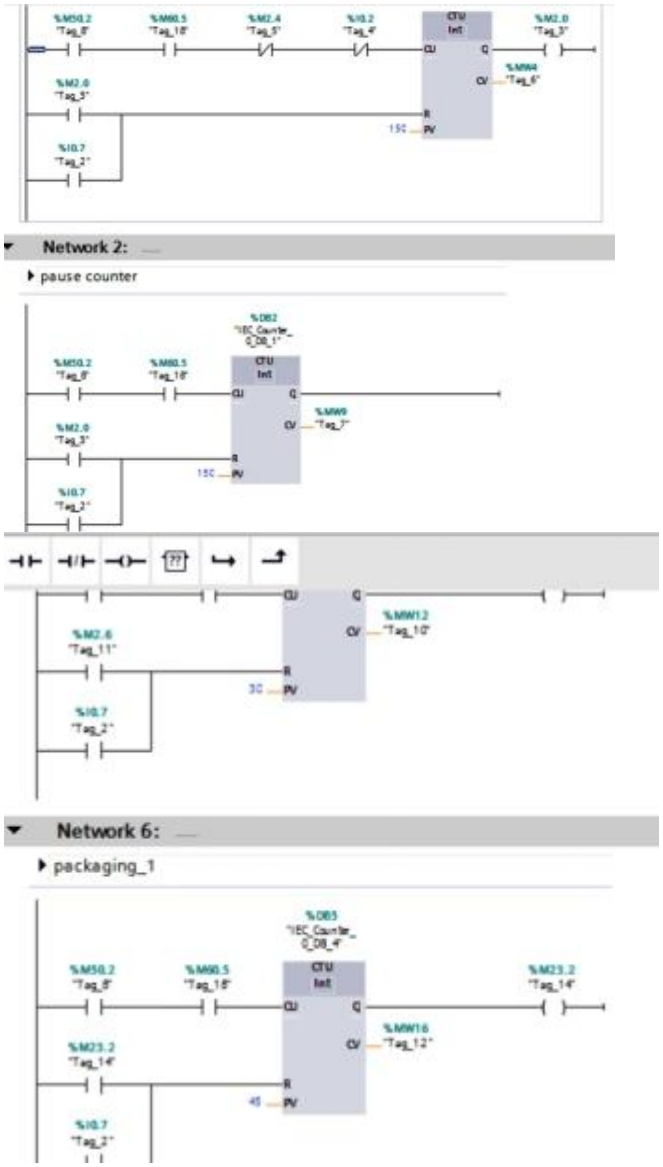

Figure 2: Programming

3. SIMULATION STUDIES

The filling screen presented in Figure 3 shows a container coming on a conveyor and then getting filled. The filling process is shown using two tanks and a mixer. The mixer mixes the components of the tanks and when a container arrives just below the mixer the mixer fills it up to a certain level. Then the containers are further send to the next level of

handling i.e. sorting where the containers are sorted using height as criteria.

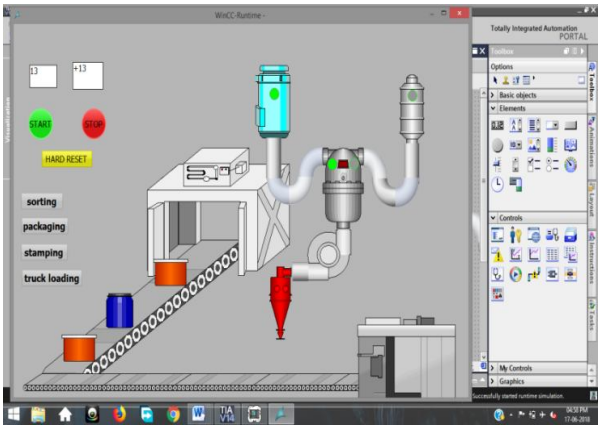

Figure 3: Filling screen

In sorting stage as shown in Figure 4 the containers are sorted based on height as criteria. The sorting stage has two conveyors i.e. A and B, a sensor and a pneumatic arm. The conveyor A is for container of more height and conveyor B is for container of smaller height. The containers after coming from filling stage are scanned by scanners and then according to the height sorted i.e. if a container of bigger height is detected by the sensor then the pneumatic arm is activated which pushes the container to conveyor A while a container of smaller height is sent to conveyor B. The conveyors, pneumatics and sensor segregate the containers.

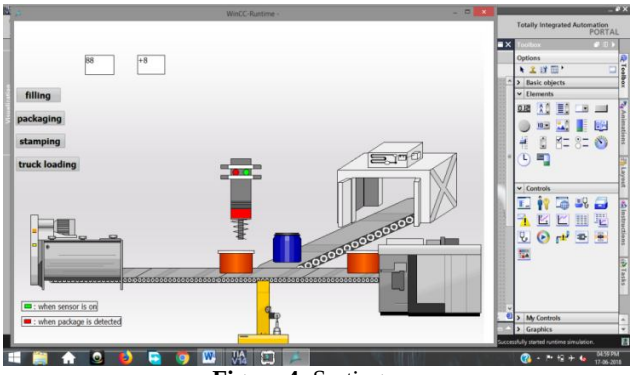

Figure 4: Sorting screen

Then containers are moved to packaging section as shown in fig4 where the containers are packaged into boxes with the help of electric cranes as shown in Figure 5. The cranes pick up the boxes from conveyors and place it at the belts. The boxes are then sent to sealing section as presented in Figure 6 where the boxes are sealed and sent to stamping section. The sealing is simply shown using boxes of different shapes.

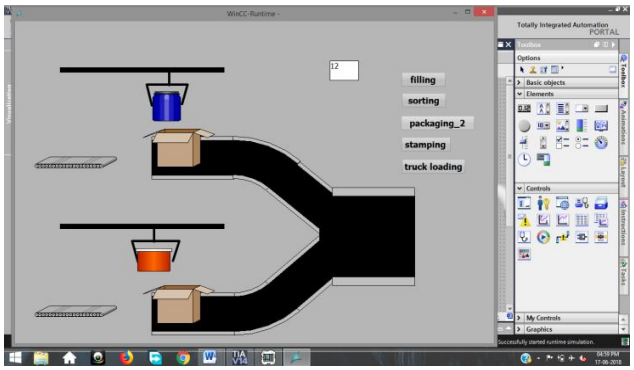

Figure 5: Packaging section

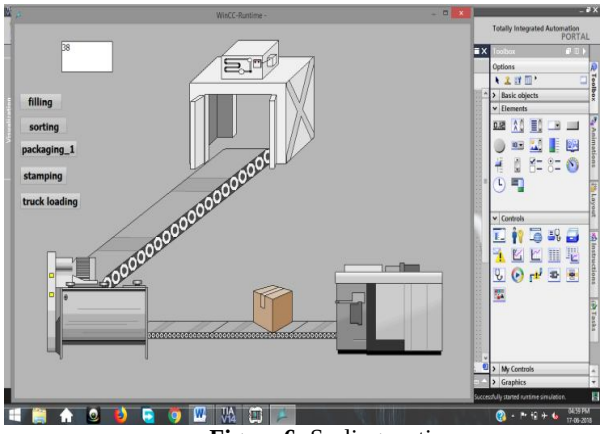

Figure 6: Sealing section

Then after packaging the boxes are stamped in stamping section as shown in Figure 7. The packages are stamped for the logo and other important details here and then sent further to delivery section. The stamping screen shows the stamp pad getting activated when a box arrives below the stamp machine. During stamping the stamp machine indicates a green signal to show the stamping.

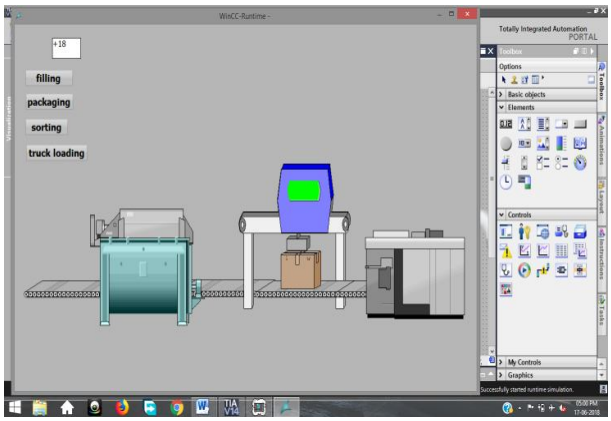

Figure 7: Stamping section

The loading of the packages onto the trucks is shown in in Figure 8. After the process of packaging the boxes are lifted from the conveyors using electric cranes and then kept on the trucks for transportation. The loading is shown by different sizes i.e. the box size decreases in which the loading is done

in trucks using electric cranes. The cranes pick up the boxes and place it in trucks.

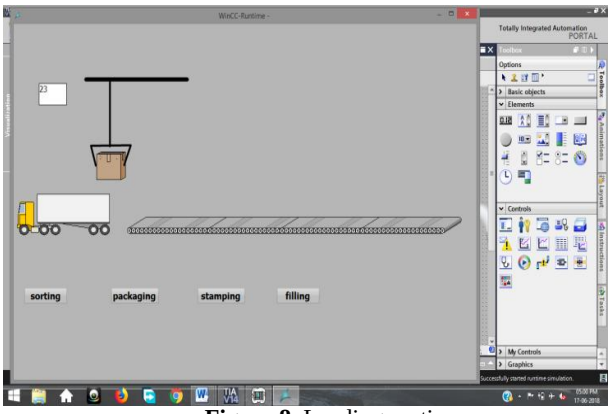

Figure 8: Loading section

4. CONCLUSION

The modelling of a automatic material handling system using PLC has been done in the paper. The fundamental reason for PLC in automation is utilized to control the entire system. Moreover in the program developed on PLC, troubleshooting of program and making changes to become very easy due to simplicity of the program. It can be concluded that any changes may be made to the program in between the process and then these can be downloaded into load memory of CPU without any inconvenience It can also be concluded that manual material handling may be replaced by automation with minimal or no human effort. The simulated material handling system can be used in small scale industries if made in a scaled-up manner by adding more graphics.

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