Master's Thesis Engineering Technology

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Automated Resupply Management in Existing Production Line with a Cobot and an Automated Guided Vehicle

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ⓘ Context: Industry 4.0

The industry is rapidly evolving, and we are in the middle of the transition to "Industry 4.0". In this new industrial revolution, almost every technical component is connected to create a smart factory. In the T2-campus in Genk is a scaled model of a smart factory called the Smart Innovative Factory (SIF-400) developed by SMC International Training. It contains all kind features of a smart factory and is especially made for training and demonstrating purposes. The SIF-400 contains 13 different modules (SIF-401 - 413) and an automated guided vehicle (AGV, SIF-414). As shown in figure 1, these modules are lined up next to each other to form one production line.

Figure 1: SIF-400 and Automated Guided Vehicle [1]

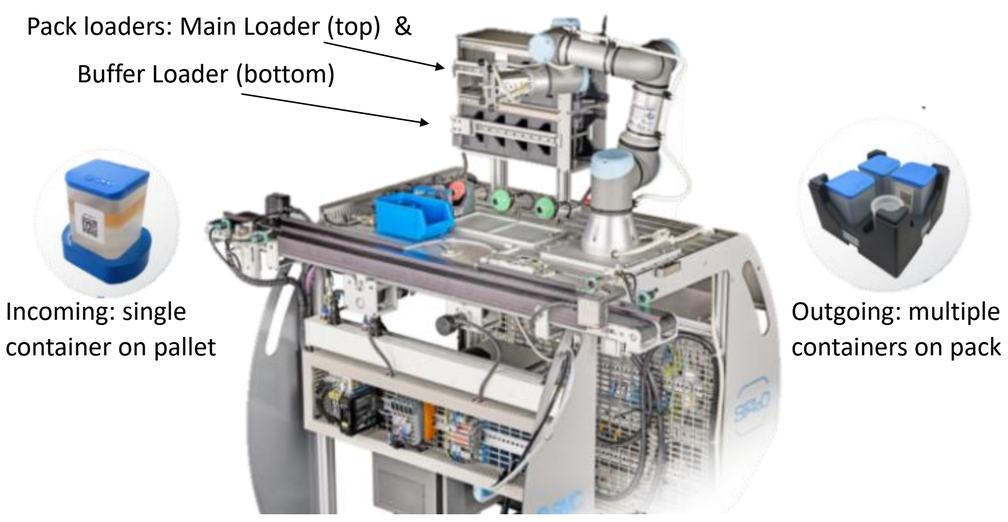

Figure 2: SIF-408 [1]

Objective: Enhance automation

The goal of this project is to enhance the autonomy of the eighth module (figure 2) by automating the refilling of its stock. The main purpose of this module is stacking incoming containers onto packs and then move these packs to the next module with its on-board collaborative robot (cobot).

Two fellow students developed a program which ensures that the AGV arrives near the SIF-408 with a new pile of packs. This thesis focusses on the creation of a program that can take these packs and place them back into the loaders of the module. There are three important aspects that form the basis of this thesis:

- the communication (SIF-408 - AGV, PLC - cobot and Original program – new program);
- the physical limitations (range of cobot and localization of the packs);
- the best way to implement new technologies into an existing production line.

Materials and Method

There are two important new hardware components for this project. First, there is the add-on for the AGV (figure 3) to present the pile of packs firmly and within the range of the cobot. Secondly, a 2D camera (figure 4) is added in order to determine the exact location of the packs relative to the base of the cobot (figure 5).

To accomplish the goal, two new programs were created in the PLC. An important aspect was to separate these two new programs from the standard workflow of the module as much as possible. In the diagram on the right, there is an overview of the programs in the PLC. Although these programs are completely separated while they are being executed, they still start from the same idle state. In future work, it is possible to create a distinct hierarchy with priorities for the different programs in this idle state.

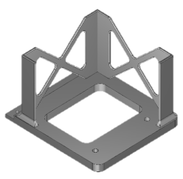

Figure 3: AGV add-on

Figure 4: SICK inspector

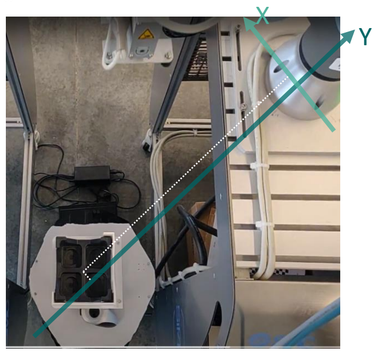

Figure 5: X and Y coordinate detection of pack by camera

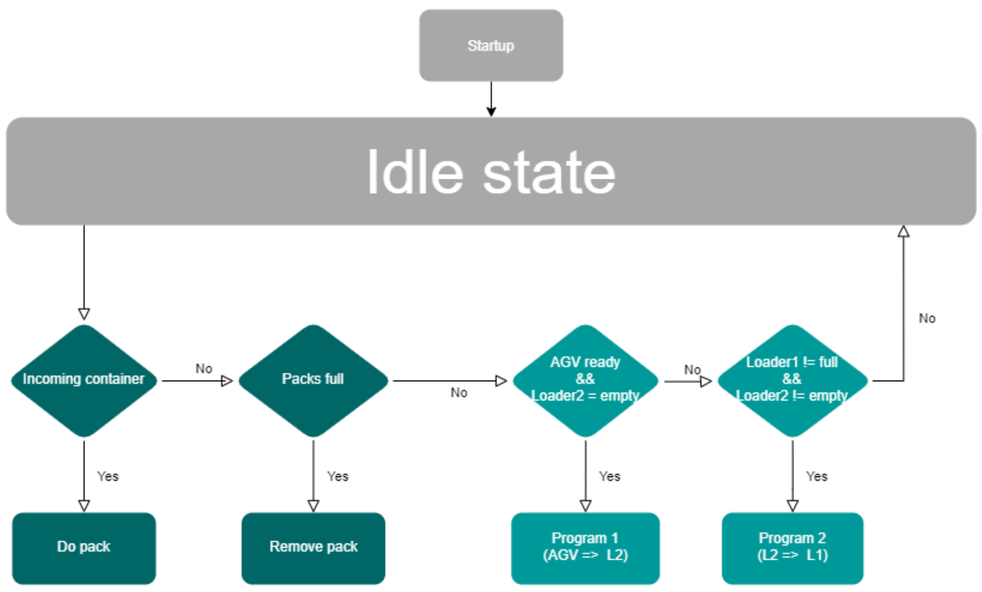

Figure 6: schematic overview of PLC program flow. Dark boxes resemble the original program. Light boxes are newly added programs

Figure 7: Program 1

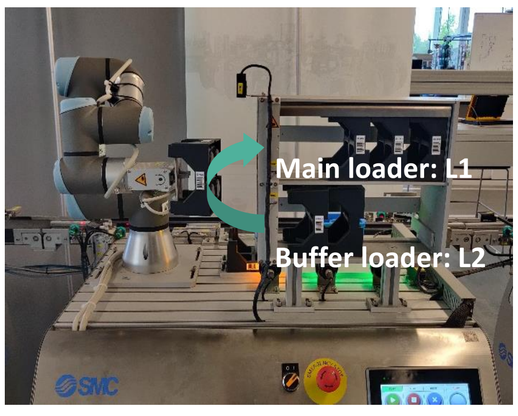

Figure 8: Program 2

Results and Conclusion

The two newly added programs make this module completely autonomous. The first program (figure 7) moves packs from the vehicle into the buffer loader of the SIF-408. And the second program (figure 8) takes care of the stock management between the buffer loader and the main loader. The use of two separate loaders to store the packs enable us to separate the newly added programs from the main functionalities even more.

This thesis successfully showcases the possibility to add new technologies and automation to an already existing production line. Besides that, it can become the base for new improvements and additional automations for the SIF-4o0. Finally, by extending these solutions to real scale production lines, this project can reduce the downtime of the integrated cobot and increasing its productivity to the benefit of the operator

Supervisors / Co-supervisors / Advisors

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[1] SMC International Training, "SIF-400 - Photo Gallery," SMC International Training, 2021. [Online]. Available: https://www.smctraining.com/en/webpage/indexpage/1210. [Accessed 21 05 2021].

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