Industrial Automation, Spring 2025

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Course Project
Industrial Automation (Spring 2025)

Context

This semester's project focuses on the design, implementation, and supervision of an automated chocolate powder factory. The factory aims to produce high-quality chocolate powder through a sequence of precisely controlled processes, from raw material handling to packaging. As part of the project, students will work in groups of four to analyze the plant's requirements, select appropriate sensors and actuators, design the Programmable Logic Controller (PLC) logic, and develop a supervisory control and data acquisition (SCADA) system.

Figure 1 - Illustration of a chocolate factory plant generated by ChatGPT

Plant Description

The chocolate powder factory includes the following main stages:

1. Raw Material Handling:
    - Ingredients such as cocoa powder, sugar, and milk powder are stored in three different silos equipped with level sensors to monitor inventory.
    - A common pneumatic conveyor transports the materials to the mixing station.
2. Mixing Station:
    - A large mixing tank equipped with a motorized stirrer combines the raw materials.
    - Temperature sensors monitor the heat generated during mixing, and a heating element ensures the mixture remains homogeneous.
3. Drying and Milling:
    - The mixture is dried using a rotary dryer with temperature and humidity sensors.
    - The dried mixture passes through a milling machine to achieve the desired powder consistency.
4. Packaging:
    - The finished chocolate powder is transferred to an automated packaging line.
    - Load cells ensure accurate weight measurement, and actuators control the filling and sealing process.
5. Safety:
    - Safety systems include emergency stop buttons throughout the plant, gas detectors and fire detection mechanisms.

The goal of the project is to provide the monitoring and control infrastructure to operate such a plant by defining the automation architecture from the sensors/actuators up to the SCADA system.

Tasks

Considering the plant presented in the previous section, you will have to perform the following tasks:

1. Functional Analysis

Identify, for the whole plant, the following points:

- List of input signals (sensors) with their types and ranges
- List of output signals (actuators) with their types and ranges
- List of alarms to be displayed to the plant operators
- List of interlocks and their logic

Along with the signal identification, you will have to provide the P&ID of the plant you considered.

2. Automation Architecture

Define the automation architecture of the plant based on the functional analysis defined previously. You will have, at least, to specify the following:

- PLCs or industrial controllers (type, number, etc.), including their I/O modules
- Fieldbuses between PLCs (for interlocks) and between I/O modules and PLCs if needed
- Network protocols between PLCs and SCADA

All choices will have to be motivated and as precise as possible with reference and links to the different manufacturers catalog.

3. Supervision

3.1. SCADA

- Make a list of requirements for the SCADA which will be used to monitor the plant (e.g. number or I/O, communication protocols, functionalities, cost, etc.)
- Perform a market survey of at least three different products and motivate the choice of the selected SCADA

3.2. Synoptic views

- Identify the different synoptic views required to supervise the whole plant. The number of views and the logical relation between the views should follow the principles presented during the class. Create a mockup/wireframe of the different synoptic views (e.g., using PowerPoint, hand drawing, etc.). Make sure that you are respecting the best practices described during the SCADA class given.

4. Qualitative Dependability Analysis

Perform a qualitative dependability evaluation (FMEA and/or FTA, motivate your choice) of the whole plant. You will first have to clearly identify the different components considered for the analysis before performing the analysis itself.

Project Organization

The project shall be executed by an interdisciplinary team (4 persons) as defined in Moodle. Given the amount of work to be done to complete the project, the team will have to organize itself to split the work among the different members.

During the semester, time will be dedicated during the classes for the team to work on the project and interact directly with the instructors to refine the requirements and make the necessary assumptions. The initial requirements written in this document are not enough to complete the project: all teams are expected to interact with the lecturers to complete the project. The lack of detailed requirements is intended and reflect the necessary interactions with the clients during a real-life project of this nature.

Outside classes, the expected workload for each team member is around 20 hours.

Milestones

Until 11.03.2025:

Register for a project group on the Moodle website

Until 18.03.2025:

Group contracts are sent to both instructors by email

15.04.2025:

Hand in intermediate report including draft of task 1, 2 and 3.

20.05.2025:

Hand in final report

27.05.2025:

Project Presentation