University of
South-Eastern Norway

Faculty of Technology, Natural Sciences and Maritime Sciences

Industrial IT and Automation master programme

Course IIA1319
Software Engineering: Object-Oriented Analysis, Design, and Programming

Software analysis of a control system

Version 0.6 (A)

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Chapter 1

Software analysis of a control system

1.1 Introduction

The motivation for this assignment is making an analysis of the software for a control system. The control system will control a set of valves, motors, and/or pumps in order to monitor and control a process. The devices and specification for your control system will be according to the ControlProcess application that can be downloaded together with this document.

The goal of the assignment is to practice the usage of the FURPS+ for collecting the requirements, convert the requirements into a use case diagram and a domain model, select an important use case for making the fully dressed use case document and the system sequence diagram (SSD), and the use of the unified process (UP) for the analysis steps.

This assignment must be written as a technical report, delivered as a PDF file, within the deadline (due date), and must be approved to pass the course. At least 70% of the tasks must have been fulfilled to get this assignment approved. Report writing and the report structure is part of the approval of this assignment, including using references. The versions of this document are:

Version	Description	Date
0.1	First version of the document (HiT)	NOS / 2006
0.2	Add more details for the buffer tank	NOS / 2008
0.3	Updated the text for approved / not approved	NOS / 2012
0.4	Minor updates of text and institution (HSN)	NOS / 2017
0.5	Minor updates of text and institution (USN)	NOS / 2020
0.6	Include IIA1319 ref. and focus on buffer tank, not vessel	NOS / 2021

1.2 Specifications

Your company has two separate plants, plant section #1 and plant section #2, and two separate control systems for these plant sections. An extension of the plants have been performed and a connection between the plant sections is wanted. However the production in plant section #1 is time variant and the same with the usage in plant section #2, so a buffer tank is needed. The buffer tank has been installed as a buffer between these two plant sections, allowing the liquid produced in plant section #1 to be buffered before used in plant section #2. Several pumps both for input and output are needed. No sensors are needed, and therefor not installed. Extra device can NOT be installed in the buffer tank system. The structure of the system is shown in 1.1.

The new control system consists of the buffer tank, a set of pumps, and may be a PV[1] (an ON/OFF security) valve. The input pumps are located at the top of the tank and the output pumps are located at the bottom of the tank. Duplicated pumps are connected in parallel, the capacity given is for each pump. The reason for several pumps are that the liquid is taken or used at different locations in the plant sections. The PV valve is placed on top of the buffer tank, if present, for security reasons. The PV valve will control the gauge pressure of a closed buffer tank. The size of the buffer tank and the maximum capacity of the pumps are given according to the ControlProcess application. The capacity

[1] PV valve: Pressure Vacuum valve

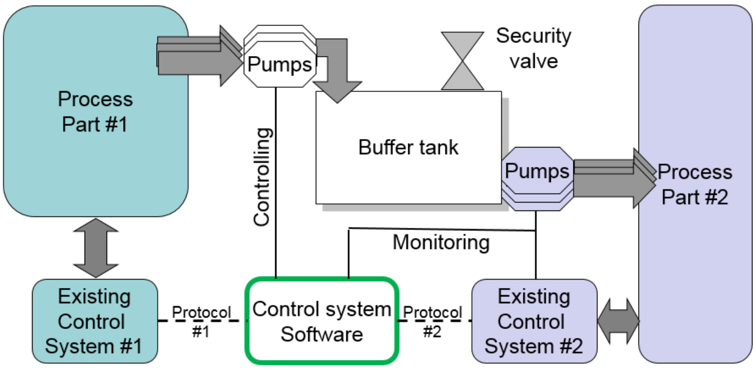


Figure 1.1: An overview of the plant sections with the existing systems and the new buffer system. The white boxes are the devices and modules for the new buffer section.

of the pumps can be controlled or monitored by your control system, see Figure 1.1, and the current capacity is proportional with the control signal to the pump. This control system should be as cheap and simple as possible, no advanced controller algorithm is needed. The input to your control system is a set point for the wanted liquid volume percent in the buffer tank. Your control system may have communication with the existing controller systems using different protocols. The usage of the protocols are given in the ControlProcess application. If you have communication with the control system #2 the monitoring signals from the output pumps are not needed as this is part of the protocol. Note that your control system application can NOT control the output pumps, only monitor these pumps as they are controlled by the existing control system for plant #2. Any alarms should also be sent on the protocols, if present. If no protocols, the alarms should only be given as indication in your control system, as the alarms are not an important part of the buffer system. The control system should indicate the current contents in the buffer tank according the specification, and any alarm outputs for low and/or high limits.

1.3 Task Descriptions

The tasks in this project is to follow the UP with focus on the analyses step of the elaboration phase and the analyses step of the first construction phase.

1.3.1 Assignment Introduction (3%)

Download and run the ControlProcess application, input your name, student number and the year, and click the *Get Assignment Information* button. This application will give you a set of parameters that you will use as basis for the analyze of the software for the control system. See Appendix A.1 for more information about the ControlProcess application. Include a screen dump of the **ControlProcess** application in the introduction section of your report.

1.3.2 Requirements (20%)

Make a list of the requirements for your control system. These requirements should be testable.

1.3.3 Use case (10%)

Make a use case diagram of your control system. The use case diagram is only a graphical presentation of your requirements.

1.3.4 Domain model (10%)

Make a domain model of your control system. Use the specification for making the domain model.

1.3.5 Use case Analyses (20%)

Select the most important use case in your control system. Give a short explanation why this is the most important use case in your system.

Make a fully dressed use case document (FDUCD) of the most important use case in your control system. Try to make the *Main Success Scenario* and *Extension* sections as detailed as possible, and should contain enough details to understand the events and actions between the system and any actors.

1.3.6 System Sequence Diagram (10%)

Make a SSD of the use case from the fully dressed use case document. The SSD must be a graphical presentation of the *Main Success Scenario* and *Extension* sections from the FDUCD.

1.4 Development Process (20%)

This section should contain four sub sections:

- Describe in your own words how you will use the UP to develop this control system.
- Relate the performed tasks to the elaboration or construction phases.
- Estimate the development time for this project.
- Indicate which document(s) that can be used for testing the application.

1.5 Summary (2%)

Make a short conclusion of the results including the software knowledge of your control system. Do you have enough information to start designing and implementing the software?

1.6 Reference list (5%)

A technical report must include some references. Include a couple of references using a proper style and format.

Appendix A

Appendix

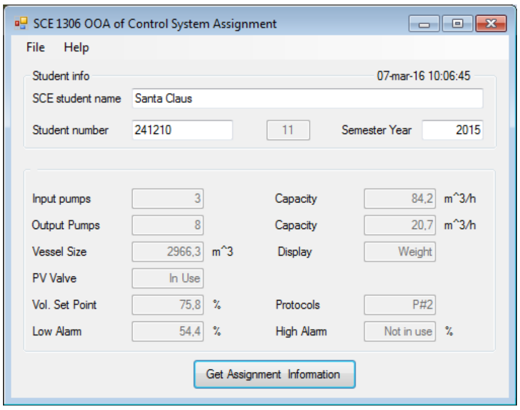
The appendix contains some additional information about the ControlProcess application and the usage of UML diagrams.

A.1 ControlProcess application

A screen dump of the ControlProcess application with an example of the information for your exercise is shown in Figure A.1. The information will be different each you are running the application, so please take a screen dump of the application the first your are running the application. A screen dump can be made by using the key combinations <ALT> and <PrintScreen> to copy the image to the clipboard, and use the *paste* option to get the image into your application.

A.2 UML diagrams

UML diagrams can be made in any applications or by hand, but remember that these diagrams are part of the documentation and should be clear and easy to understand. Any information about the UML diagrams can be found in text books like (Martin 1993), (Larman 2002), (Pender 2003) or (Larman 2005), or in the lecture notes like (Skeie n.d.*a*) or (Skeie n.d.*b*).


SCE 1306 OOA of Control System Assignment
File
Help
Get Assignment Information

Student info 07-mar-16 10:06:45

SCE student name Santa Claus

Student number 241210 11 Semester Year 2015

Input pumps 3 Capacity 84,2 m^3/h

Output Pumps 8 Capacity 20,7 m^3/h

Vessel Size 2966,3 m^3 Display Weight

PV Valve In Use

Vol. Set Point 75,8 % Protocols P#2

Low Alarm 54,4 % High Alarm Not in use %

Figure A.1: A screen dump of the ControlSystem application with a set of assignment information.

Bibliography

Larman, C. (2002), *Applying UML and Patterns, An Introduction to Object-Oriented Analysis and Design and the Unified Process*, 2. edn, Prentice Hall, USA.

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Martin, J. (1993), *Principles of Object-Oriented Analysis and Design*, Prentice Hall. ISBN 978-0137208715.

Pender, T. (2003), *UML Bible*, Wiley Publishing, Inc., USA.

Skeie, N.-O. (n.d.*a*), 'IIA1317: Object-oriented analysis, design, and programming', Lecture notes for the master course IIA1317 at the University College of Southeast Norway (USN) (and SCE1306 at the Telemark University College (TUC)). The Unified Process (UP) as the software process, the Unified Modeling Language(UML) for Object Oriented Analysis and Design, and the C-Sharp programming language for implementation.

Skeie, N.-O. (n.d.*b*), 'IIA1319: Software engineering', Lecture notes for the master course IIA1319 at the University of South-Eastern Norway (USN) (same as for previous IIA1317 and SCE1306 courses). The course uses the Unified Process (UP) as the software process, the Unified Modeling Language(UML) for Object Oriented Analysis and Design, and the C-Sharp programming language for implementation.