Bachelor's Thesis

Project Description

Software Engineering 6th Semester 20th March 2020

Reduction of Physical Supervision / Herning Vand

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2. Background description

Since the dawn of civilization water supply and sanitation have been the logistical challenges to provide clean water and sanitation systems. Where water resources, infrastructure or sanitation systems were insufficient, diseases spread and people fell sick or died prematurely.

Major human settlements could initially develop near rivers or natural springs. Throughout history, people have devised systems to make getting water into their communities and disposing of wastewater more convenient.

The principle of sewage treatment throughout history was on the conveyance of raw sewage to a natural body of water, e.g. a river or ocean. Early human habitations were often built next to water sources (f.eks rivers) which would often serve as a crude form of natural sewage disposal. (The History of Clean Drinking Water | APEC Water, 2020)

Over the millennia, technology has dramatically increased the distances across which water can be relocated. Furthermore, treatment processes to purify drinking water and to treat wastewater have been improved.

Wastewater treatment is used to remove contaminants from wastewater or sewage and convert it into an effluent that can be returned to the water cycle with minimum impact on the environment, or directly reused. The latter is called water reclamation because treated wastewater can be used for other purposes. The treatment process takes place in a wastewater treatment plant (WWTP), often referred to as a Water Resource Recovery Facility (WRRF) or a Sewage Treatment Plant (STP). Pollutants in municipal wastewater (households and small industries) are removed or broken down. (How Wastewater Treatment Works | USEPA, 1998)

The whole population of Denmark has continuous access to an improved water supply and improved sanitation. According to the European Environment and Health Committee the Danish national microbial failure rate (measured against E. coli) among large water supply systems is generally zero. Very occasionally, large water supply plants have microbiological failures during a limited period. The national chemical failure rate (measured against nitrate ions or against other ions of local importance) among large water supply systems is near zero. The average availability of 20 companies participating in an analysis done by DANVA benchmarked 99.9933% ,which means that customers only had to be without water on average 35 minutes a year. (Water in Figures | DANVA, 2020)

Such water quality is achieved through continuous monitoring and treating of pumps, treatment facilities and pipes. The water cycle monitoring is usually performed physically, by sending an employee to check the quality of the device and take a

sample. The task is fairly simple but the simplicity is foreshadowed by the number of checkups that have to be executed.

Herning Vand is a utility company that operates 170 pumping stations for ground water and 14 WWTPs. The spanning network of their apparatus is of a substantial length and their supervision is done physically, by their employees.

3. Definition of purpose

Analyse all possible solutions to the problems of physical supervision, in order to develop an appropriate monitoring system.

4. Problem statement

Herning Vand operates 170 pumping stations and 14 wastewater treatment plants and this project will focus on reducing the frequency of sending crews to check on various apparatus. The project will put an emphasis on research, determining the types of measurements, number of devices, frequency of scans and system architecture.

5. Delimitation

1. We will not consider video recording devices such as video cameras.
2. We will not consider the general public as potential users.
3. We will not consider the marketability of the system.

6. Choice of models and methods

What is the partial problem?	Why study this problem?	Which level of outcome is expected?	Which methods, models and theories are used?	Who in the group is responsible?
How will the collected data about the pumping stations be stored?	To make sure that the datasets remain organized and stable despite the amount of data collected.	As conditional data is collected from the various pumping stations it will be organized and stored for on-demand retrieval.	Data Persistence/Data Design API	Mihail
When should the client be notified that a physical check is recommended?	To ensure that physical crews are only sent when something is wrong.	Station data is monitored within a threshold and a notice is sent when that threshold is exceeded.	Design Patterns Separation of concerns	Amahdya Dominika
How can the reliability of the system be ensured?	To keep the system functional despite dirty conditions.	Within reason, will collect data on a continual basis.	Embedded/Hardware Deployment Design Patterns	Whole Group
What type of sensors should be integrated?	To find the most accurate measurement.	Once the contents under analysis are known, a thorough research of available sensors will be done.	Embedded/Hardware Deployment	Dominika
How would the system interface with the user?	To design the most effective user experience.	A thorough and simple to operate user interface.	Cross-media	Amahdya

Table 1 - Choices of models and methods

7. Time schedule

The workload of the project is divided into two semesters: 6th (Spring 2020) and 7th (Autumn 2020). During the 6th semester each student has 5 ECTS for BPR1 and during 7th semester 15 ECTS for BPR2, which gives a total amount of 1650h of work on this project.
During the Spring semester 412,5h of work is required. This time will be split into different phases using the waterfall model. The following table shows approximation of the time schedule for semester 6.

Week	12	13	14	16	15	17	18	19	20	21	22	23
Analysis					X							
Design					X							
Implementation					X							
Test					X							
Documentation					X							

Table 2 - Time schedule 6th semester

The main focus during the first half of the project will be on a proper analysis and documentation starting from week 12 until week 20. During the last weeks of the semester (20-23) first draft of the design will be completed.
The remaining 1237,5h of work will be completed in Autumn 2020. This time will be also split using the waterfall model, and it will complete the model that was started in Spring. The following table shows approximation of the time schedule for semester 7 (this table is estimated based on our knowledge since no plan for the semester in Autumn 2020 is done yet).

Week	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Analysis																	
Design																	
Implementation																	
Test																	
Documentation																	

Table 3 - Time schedule 7th semester

Starting in week 36 until week 41 the design that was started in Spring will be continued. Once the end of design and beginning of implementation comes some documentation will be written. Implementation will approximately last from week 41 until week 49. At the end of the project most of the documentation will be written (weeks 47-52) and the last four weeks will be testing (49-52).

8. Risk assessment

Risk	Description	Likelihood Scale 1-5 5 = high risk	Severity Scale 1-5 5 = high risk	Risk mitigation e.g. Preventive & Responsive actions	Identifiers	Responsible
Risk not meeting the client's requirements	Poor schedule, bad communication with the client, lack of knowledge	3	5	Preventive: Continuous communication with the client, respect the schedule Responsive: Contact the client, respect the agreement	Not meeting the deadlines	Amahdya
Technical issues	Software crashes, hardware failures, damaged sensors	2	5	Preventive: Use GitHub for backup, being careful with the hardware Responsive: Restore data from GitHub, order new hardware	Corrupt data, unexpected hardware behaviour	Dominika
Injuries or illness	COVID-19, bicycle or skateboard accidents, seasonal viruses, mental health	4	3	Preventive: Respect the COVID-19 preventive guidelines Responsive: Work from home	Not feeling well	Mihail
Insufficient knowledge	Lack of knowledge in hardware development	3	4	Preventive: Attend classes, reading extra materials Responsive: Ask supervisor or the company for help	Not being able to find solutions to problems	Dominika
Group conflicts	Fights and disagreements between members	2	4	Preventive: Stay open minded Responsive: Try to compromise	Not moving forward with work	Mihail

Table 4 - Risk assessment

9. Sources

(The History of Clean Drinking Water | APEC Water, 2020)
Apec Water, 2013. The History of Clean Drinking Water.[online] Available at: <https://www.freedrinkingwater.com/resource-history-of-clean-drinking-water.htm>

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United States Environmental Protection Agency, 1998. How Wastewater Treatment Works...The Basics.[online] Available at: <https://www3.epa.gov/npdes/pubs/bastre.pdf>

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● Appendixes

- Effluent is an outflowing of water or gas to a natural body of water, from a structure such as a wastewater treatment plant, sewer pipe, or industrial outfall

- Escherichia coli, also known as E. coli, is a Gram-negative, facultative anaerobic, rod-shaped, coliform bacteria of the genus Escherichia that is commonly found in the lower intestine of warm-blooded organisms.