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Plan of Approach

4 in a row – Robot Game

Name of client: ALTEN
Name of tutor: Michael van der Velden
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Version History			
Version	***Date***	***State***	***Comment***
1	10-02-2023	Draft	First draft set-up
2	13-02-2023	Draft	Put main bodies of text
3			
4			

Acronyms and Abbreviations	
Term	**Explanation**
PoA	Plan of approach
BSP	Board support package
OS	Operating system

Referenced documents				
ID	**Reference**	**Title**	**Date**	**Author**

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1. Background information:

My graduation internship for Fontys Hogeschool will be conducted in the company ALTEN, with my task being to realize an embedded software architecture on a STM32H7 processor, for their 4-in-a-row robot, which was previously developed by another graduation project.

ALTEN is an international Technology and IT consultancy and Engineering company. Originally ALTEN was created in 1988 in France and currently they span over 30 countries with over 54100 employees, having established themselves in all the major sectors: Aeronautics & Space, Defence & Naval, Security, Automotive, Rail, Energy, Life Sciences, Finance, Retail, Telecommunications and Services.

Within the Netherlands, their expertise falls within the following categories: ALTEN IT, Technical Software and Mechatronics. The 4-in-a-row project falls within the Mechatronics department. Where my technical supervisor, Michael van der Velden, is also working as a consultant for ASML. With other 20 years of experience in the electrical engineering industry he has enough technical knowledge to guide me successfully through the project. Additionally, we have an appointed business manager, Gijs Haans, who is responsible for our personal development within the company and progress as engineers.

ALTEN has in-house projects, which are often used to develop new skills of consultants or the ones of interns. The 4-in-a-row (Connect4, Four Up) robot was developed for demos at trade fairs and open days at universities. The robot game is meant to demonstrate the knowledge of the consultants of ALTEN, and it is therefore developed with industrial components.

The game is simple, there is a seven-by-six rack board, with slots at each spot for two coloured tokens. A red one and a yellow one. The first player to Connect 4 tokens in any direction wins. In our case, one player is a human, the other one is the robot. It is a completely autonomous process. After a token has been placed in the idle robot, the machine is able to calculate its next move based on a difficulty setting. In order to be able to execute everything, the 4-in-a-row robot is equipped with ‘X’ and ‘Z’ plane motors, a rotating vacuum gripper, and a routine to clear the board and reset the token.

2. Project results:

2.1 Goals of the project:

Implement the previously developed software architecture for the new STM32H755ZIT6U controller. Before this project and its last iteration, the system was running on a single Cortex-M4 core. Which wasn’t powerful enough to provide resources for the software and hardware expansions ALTEN wanted to introduce to it. Therefore, they decided to upgrade the system with a dual-core processor. With this new shift, a new architecture was developed and partially implemented, but only to demonstrate the functionality of the architecture.
My task will involve to further develop the needed modules to make the system reliable

and functional to the best of its capacity. Which will involve writing code for the needed modules and improve and adapt flowcharts, and other logic, to suit the tasks at hand. Further steps will include the further development of the BSP and the OS and finally, testing on the robot itself. Additionally, the game-logic part (the module where the next decision for the robot is made), as of right now, is developed on a Raspberry Pi. In this project ALTEN would like to make the STM32H the sole master of the system. Moreover, research on ethernet communication with the robot should be investigated.

2.2 Problem definition:

Implement the new dual-core architecture by developing the necessary modules to make the 4-in-a-row robot perform more reliably. Research ethernet communication.

2.3 Description of the project result:

1. Developed software modules
2. Tested modules on the robot
3. STM32H:Cortex-M7 is the only master in the system
4. Next-Move-Decision module implemented in the STM32H

2.4 Design model

The V-Model is a useful tool to manage and deliver projects. By using this model, the student can ensure that their project is completed in a systematic and efficient manner, and that the requirements set out at the beginning of the project are met.

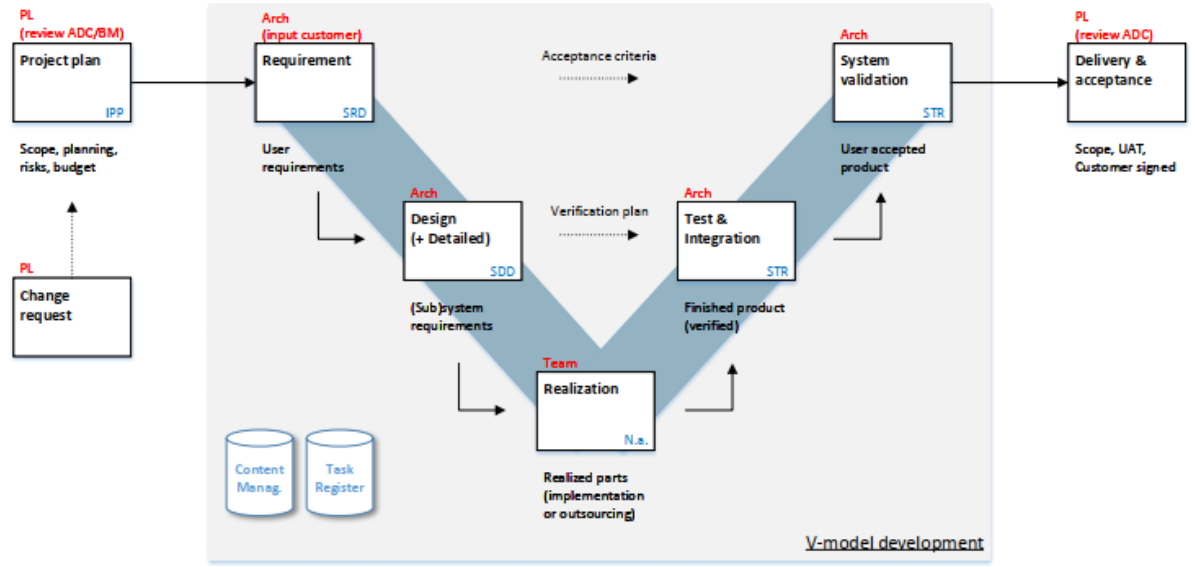


Figure 1: The V-model

3. Project activities:

1. Programming on the STM32H controller
2. Transferring code from RaspberryPi to STM32H
3. Designing flowcharts for software modules

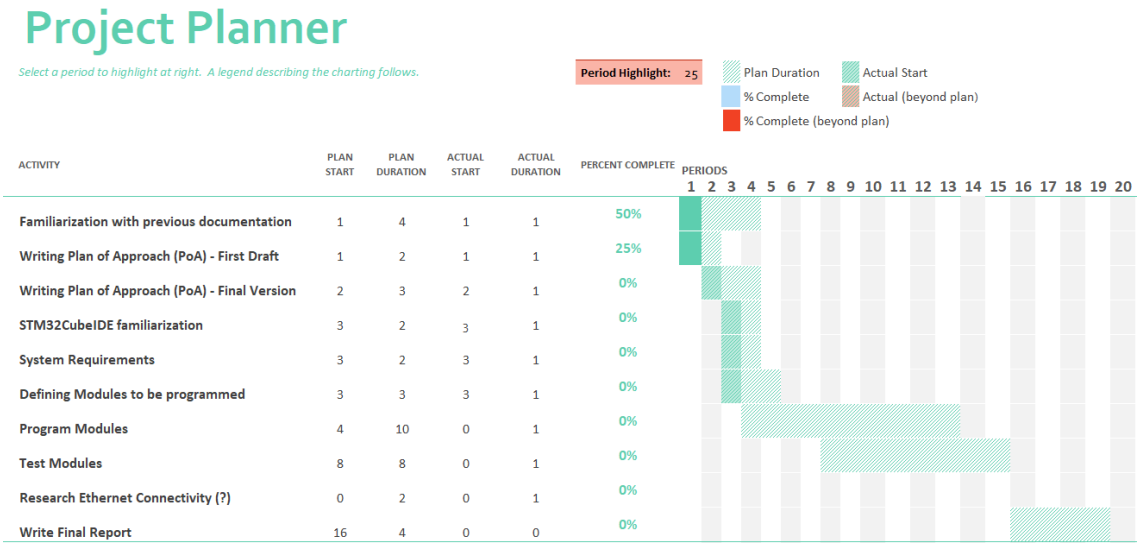
4. Project limits:

The main limiting factors in this assignment would be my knowledge on the different subjects needed to realize this project (Give examples if needed)and depending on how big the scope of the assignment is made, time.

5. Intermediate milestones:

1. System Requirements Document
2. Implementation of modules
3. Test Plan

6. Planning:



7. Risks:

Risk description	Likelihood	Impact	Risk	Mitigation
Context: Hardware failure Event: Component malfunction	2	3		
Context: Software bugs Event: Software modules not working as expected	2	4		
Context: Integration issues Event: Unresponsive while testing new software modules	4	2		
Context: Time constrain Event: Failure to complete tasks due to poor time management and/or unexpected events	2	2		
Context: Unclear scope of project Event: Unclear user requirements	1	3		
Context: Wrong logic in state machines Event:	1	1		
Context: Event:				

Table 1: Risk list

Likelihood	Consequences of impact			
	1	2	3	4
4	4	8	12	16
3	3	6	9	12
2	2	4	6	8
1	1	2	3	4

Table 2: Qualitative risk analysis matrix