Industrieel Ingenieur Informatica

Workplan Thesis

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Title: 3D state estimation and prediction for surface vessels using sensor fusion

Research group

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Existing situation and problem definition

More and more autonomous systems and vehicles are being used. These systems can be developed to take over the work of humans in certain situations. More specifically for military operations they can play an important role. They can be used in situations that are too dangerous for humans, but also for support and for logistics.
The Autonomous Surface Vessel or ASV is one of many autonomous systems being deployed. The ASV is an unmanned vessel that can have many functions. Depending on the functionality required, these vessels have specific hardware on board that must work together correctly. One of the main requirements is being able to determine the vessel's orientation live, and predict it using sensors. This data can then be used to, for example, land other unmanned vehicles such as drones on the ASV with minimal impact and effort.

Objective of the project

Using sensors such as stereo cameras and an Inertial Measurement Unit (IMU) on board the ASV, create a model that can determine and predict the condition of the vessel. To do this, deep learning and sensor fusion are used, applied to the data stream of the on-board sensors. The vessel's orientation is determined in six dimensions: pitch, yaw, roll, z, angle, angular velocity. The model is tested in a simulator via Unreal Engine and is then implemented on the on-board hardware. The ASV, in turn, communicates with a drone so that it can determine for itself when the best time to land is.

Planning and milestones

Date	Milestone

18/okt – 8/nov	Data and literature review:
	- Research the available data: what data is available from the IMU and stereo cameras and which is usable or needs to be cleaned up
	- Research the methods used to solve this problem and what data they use
	- How do existing solutions translate to my problem, what can I learn from them
	- Research and compare what methods are used for sensor fusion
	  ○ Time series algorithm
	  ○ Kalman Filter

	○ CNN neural network - Investigate the different methods of doing deep learning: ○ Data driven predictions: LSTM neural network ○ RNN neural network Thesis: - Introduction - Literature review describe Milestone: - Literature review around sensor fusion, deep learning and existing solutions read, analyzed and forwarded to supervisor
15/nov – 6/dec	Technology exploration: - What libraries are used, what frameworks - Learning programming languages: python, c++ - Learn to work with Unreal Engine and Blender - Developing examples in the SDK of the z-mini camera - Process and manipulate available data Analyze objectives: - Make up comprehensive objectives. - What is this research trying to accomplish? - How can this be achieved? - What architecture and methodology to use? Thesis: - Technology exploration and observations describe Milestone: - Advantages and disadvantages of exploratory technologies around deep learning and sensor fusion investigated and results forwarded to supervisor
13/dec	Preparation of interim presentation Analyze objectives: - Prepare comprehensive objectives. - What is this research trying to achieve? - How can this be achieved? - What architecture and methodology to use?
20/dec	Deadline: - Interim presentation
27/dec – 7/feb	Exams and lesson-free week
14/feb – 21/feb	Implementation: - Test out different deep learning and sensor fusion models and choose the best one based on the experimental results - Extensive comparison of the models and their results Thesis: - Describe choice and analysis deep learning neural network and sensor fusion model
28/feb - 14/maart	Implementation: - Further research into deep learning and sensor fusion models - Create simple model that can use the available data from the sensors

	Thesis: - Describe choice and analysis deep learning neural network and sensor fusion model
21/maart – 28/maart	Implementation: - Continue to create model, be able to display live position of ship in Unreal Engine Deadline: - Thesis submission (25 pages)
28/maart – 4/april	Implementation: - Deep learning model testing and training with the data streams of the ZED-mini and ground truth data - Deep learning model testing with the simulator in Unreal Engine - Optimize time parameters based on test results Thesis: - Describing and trying to explain discoveries - Describing parameter optimizations
11/april – 18/april	Implementation: - Further development of the model and testing in the Unreal Engine. - Possibly testing on the physical ASV Thesis: - Describe elaboration
25/april – 2/mei	Buffer week - Catching up - Continue writing thesis - Optimize model
9/mei - 16/mei	Implementation: - Debugging, optimization - Refactoring if needed - Further performance analysis if needed Thesis: - Description of obtained results - Documentation - Describe the complete model
23/mei	Thesis: - Proofreading - Formatting - Finishing Deadline: - Submit first draft of thesis (95%)
30/mei	Thesis: - Improve based on feedback first draft
6/jun	Thesis: - Proofread for language and grammatical errors - Process remaining comments feedback Deadline: - Thesis submission: electronic on plato

	- Submit thesis: paper version to assessment committee - Short abstract (html)
13/jun	Public defense - Preparing defense
20/jun	Public defense - Preparing defense
27/jun	Get logbook and email reporting in order Practice final presentation Deadline: - Upload logbook and email reporting on Plato - Presence: public defence