RAMS

Reliability, Availability,
Maintainability, and Safety

Thesis Title

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PROJECT

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Preface

Some preface.

Trondheim, 2012-12-16

(Your signature)

Ola Nordmann

Acknowledgment

I would like to thank the following persons for their great help...

O.N.

(Your initials)

Summary and Conclusions

...

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Chapter 1

Introduction

Introduction to the problem, some background about the Survey Explorer project..

1.1 Background

Where do we stand? What has been done before?

Problem Formulation

Literature Survey

What Remains to be Done?

...

1.2 Objectives

The main objectives of this project are

1. Investigate existing solutions for HIL testing of autonomous boat
2. Describe implementation of sensors and data processing on Odin and/or Jolner for situational awareness above the surface.

3. Discuss complexity and solutions related to simulation of raw sensor data from Radar, Lidar and camera versus simulation of pre-processed data.

4. Specify interface between simulator and autonomous navigation system.

5. Specify system for logging and visualization of simulation in real-time and for post simulation analysis.

6. Necessary protyping in C++ and MATLAB to verify assumptions.

7. Investigate which other agents (ships, small boats etc.) that can be interesting to implement as a part of the simulation environment.

8. Discuss methods for using the model as a part of an automized test environment related to ROS, MROS, scripting, repetition and regression testing.

1.3 Limitations

1.4 Approach

1.5 Structure of the Report

The rest of the report is organized as follows. Chapter 2 gives an introduction to ...

Chapter 2

Existing Solutions

2.1 CyberSea Simulator

The CyberSea Simulator developed by Marine Cybernetics is a simulator for HIL testing of Dynamic Positioning (DP) systems.

Key points from [Johansen et al. (2005)]:

- Capabilities for data logging and real-time presentation of results
- Emphasis on vessel dynamics and accurate simulation of vessel motion at low speed (< 3kts, wave, wind and current loads (of course, because of DP) in six degrees of freedom "using a nonlinear rigid-body model of the vessel".
- Several options for interface between HIL Simulator and Computer Control System ("Analog, digital, serial/NMEA protocol", normal network protocol or "dedicated test I/O built into the DP computer system").
- Generation of realistic signals from all the common sensors and position reference systems (such as "Gyro-compasses, VRUs, wind sensors, thruster feedback [...], power feedback from thrusters, switchboard and generator sets") used in modern DP technology "contaminated with typical noise levels".
- Advanced generation of GNSS signals with possibility of simulating a broad specter of common failure modes.

2.2 MSS (Fossen)

2.3 MCSim (Marine Cybernetics)

2.4 Gazebo (ROS)

Chapter 3

Implementation and Simulation of Sensors

3.1 Sensors Implemented on Odin

A brief description of the sensors on Odin used for situational awareness above the surface. How is the data processed?

3.1.1 Radar

...

3.1.2 Lidar

...

3.2 Generating Virtual Sensor Data

How to generate realistic sensor data during simulation. Discuss complexity and benefits regarding generating raw data versus preprocessed information.

3.2.1 Generating Data from Virtual Environment

Using maps of sea and coast line, information of other simulated agents and 3D models of installations in sea (for example harbors) to decide what the sensors "see".

3.2.2 Raw vs Preprocessed Sensor Data

Complexity and benefits regarding generating raw data versus preprocessed information.

Chapter 4

Simulator - HIL interface

4.1 Physical Interface

4.2 Software Interface

4.2.1 Necessary Exchange of Information

4.2.2 Message Protocol

Chapter 5

Logging and Visualization of Simulation

5.1 Logging

5.2 Visualization

5.3 C++ example?

Chapter 6

Use of Model in Autonomous Testing Environment (ROS)

Chapter 7

Other Agents and their Behavior as Part of Simulated Environment

7.1 Possible Agents

7.1.1 Ships

7.1.2 Small Boats

7.2 Pros and Cons of Agents Behavior

7.2.1 Reactivity?

7.2.2 Predictability

7.2.3 Possibility of Repeating Scenario

Chapter 8

Summary and Recommendations for Further Work

8.1 Summary and Conclusions

8.2 Discussion

8.3 Recommendations for Further Work

Appendix A

Acronyms

FTA Fault tree analysis

MTTF Mean time to failure

RAMS Reliability, availability, maintainability, and safety

Appendix B

Additional Information

This is an example of an Appendix. You can write an Appendix in the same way as a chapter, with sections, subsections, and so on.

B.1 Introduction

B.1.1 More Details

Bibliography

Johansen, T. A., Fossen, T. I., and Vik, B. (2005). Hardware-in-the-loop testing of dp systems. Technical report, Marine Cybernetics, Norwegian University of Science and Technology, Trondheim, Norway.