

Reflections on what research methods I currently use and which ones I might consider using in the future for my work

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Abstract

I am currently performing research about how sensor data can be fused in new ways on naval platforms, in order to make the platforms more efficient and autonomous. This report describes which research methods that are currently used and which that could potentially be used in the future to complement the current methods.

1 Introduction

Military naval submarines contain complex heterogeneous system-of-systems gathering a large amount of different type of sensor data. The sensor systems are mainly used for detecting nearby ships. A typical submarine contains sensors for:

- detecting acoustic sounds from propellers and engines,
- recording visual and IR video by use of optronics or periscope,
- detecting communication and radar emission in different frequencies, and
- detecting ships by use of radar.

All these data from the sensors are fused in different ways by a system that is named the *Combat Management System* (CMS). The main objective for the CMS is to give the operator a good situational awareness, so that the operator knows which and where the surrounding ships are, and which of these that can be considered as a threat to the own or other vessels. The research topic is to investigate how all this collected data can be fused with already present classification databases and other data collections. The objective is to fuse and present data in new ways for the operators, in order to enhance the capability of the own ship, or alternatively to reduce the crew size by replacing operators with smart algorithms.

1.1 Current Research Methods

The current plan for the research is to start to do a *Literature Survey* in the field of data fusion in order to learn what the state-of-the art is in the field. The literature survey will also include the surrounding fields, in order to understand how the data fusion algorithms interacts with these fields. Relevant articles will be found by searches in various article databases, and good references as books and new articles will be checked. The survey will give me a broad theoretical knowledge base which will complement my experiences from working in the field practically.

The plan is to find a few specific research topics to examine further, e.g. what type of data fusion algorithm that can be used in order to solve a specific operator need. Hopefully this algorithm can first be implemented and *Evaluated* through some sort of *Simulation*, and then finally *Evaluated* in a real scenario onboard a ship. During a test like this, it is important to let real submarine operators evaluate the performance and usability, so that a correct analysis of the solution can be made. This type of research methodology can be typically characterized as *Engineering Research*.

1.2 Proposed Research Methods

Another research methodology that could be interesting to apply would be a *CaseStudy*, where the current behavior and work flow is studied. This would typically be done onboard a submarine while the submarine is in some sort of exercise and launching training torpedoes against other ships. A situation like this would be a great opportunity to study:

- which operators who are exchanging information to whom,
- what information the operators need in which situation,
- what type of work the operators perform, and which of this work that instead could be performed by a computer if the function would be implemented, and
- what amount of time that is consumed for different actions.

The result from a case study like this can either confirm ideas that is already taken care of in the research, or give new insights of what can be improved. Typically, this case study would be complemented with a written/oral *Survey*, where the operators would be interviewed about complementing questions to the case study. The survey would also give them an opportunity to reflect on which improvements they would like to see in the systems in the future.

1.3 Conclusion

This paper has given an introduction to the field of how sensor data can be fused in new ways on naval platforms. The planned research methodologies

have been presented, and two new research methodologies have been proposed, namely *Case Study* and *Survey*. An overview of how these two new methodologies could be used has been given.