

Note on research methods that I currently use or might use in the future

Olof Troeng

June 20, 2016

Introduction to my research

My research is focused on control of the accelerating electric fields in the 155 accelerator cavities of the European Spallation Source (ESS). The primary objective of my work is to ensure that the 155 control loops will work satisfactorily once the facility starts operation.

In previous accelerator projects the cavity field control problem has typically not received attention by people with a background in automatic control. Although a relatively easy problem, it has some features that would benefit from a thorough control theoretic treatment. This is a secondary objective of my research.

Research methods that I use

Much of the my daily work is strictly speaking not research, but rather engineering *work* – modeling of the cavity system, predicting the performance using numerical models and writing reports documenting the work done. To gain confidence that the controller will work in the accelerator I evaluate it experimentally in test setups with the controller running on hardware identical to what will be used in the final implementation.

It would be relatively easy to design a simple controller with close to the best achievable performance, if the subsystem components would be given. However subsystems have not yet been designed and a lot of my work is to discuss with engineers working on the radio-frequency system to ensure that the subsystem requirements guarantee that sufficient control performance can be achieved.

Introductory texts and models used for cavity are typically not clear or complete. So some in my work I attempt to synthesize and rewrite a clear, coherent and complete introduction of the modeling and control of radio-frequency systems for cavity field control. This will hopefully improve the quality of future work in the field.

Some questions and issues that come up in the course of my practical work, could be considered engineering *research*. For example I have investigated a more compact and convenient way of representing the system dynamics. This was shown to be equivalent to a larger, less convenient representation which has been used in previous research literature. This I would consider as analytic, qualitative research along the line of most control theoretic research.

Non-standard, potentially beneficial research method

Qualitative interviews is a research method which I would consider quite uncommon in my field of research, however I believe that it could be a method useful for me to meet the objectives of my PhD work.

The context that I envision that they could be useful, is sitting down with engineers and researchers at existing accelerator facilities and try to understand and summarize the challenges and solutions that they have come across during their work with their specific accelerator type.

A study summarizing the outcome from such interviews would enable a taxonomy of different classes of cavity field control problems. This would make it easier to understand the contexts of the many articles and PhD theses that consider problems specific for a certain accelerator types.