

Problem Statement and Goals

Optimal EM Placement

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Table 1: Revision History

Date	Developer(s)	Change
Date1	Name(s)	Description of changes

1 Problem Statement

1.1 Problem

Microrobots are being explored in minimally invasive surgeries due to their ability to navigate millimeter spaces. The magnetic actuation systems used to control these microrobots suffer from bulkiness and can obstruct a surgeon's view. Electromagnetic actuators can also pose a safety risk due to the heat they emit as a result of the current they receive.

1.2 Proposed Solution

We propose a design that places the actuation system under the operating table while only taking up limited space. We introduce optimization methods to solve the electromagnet (EM) arrangement problem leading to an E-optimal design (**TODO:** add appendix reference).

1.3 Inputs and Outputs

1.3.1 Inputs

The program will receive the volume of the under-the-table workspace and properties of the EMs (# of turns, area, current). In addition, the user will input their desired number of EMs in the system and the sample size (a larger size leads to a more optimal solution).

1.3.2 Outputs

The program will output the optimal positions of the EM actuators.

1.4 Stakeholders

1.4.1 General Stakeholders

Surgeons and medical professionals that might operate an actuation system, engineers involved in the physical development of such systems, and researchers working on biomedical engineering systems and/or applications of optimization algorithms.

1.4.2 Specialized Stakeholders

Some specific stakeholders include Dr. Onaizah (HeART Lab), and Dr. Giamou (ARCO Lab).

1.5 Environment

1.5.1 Software

A working Python environment is required. The software is compatible with Windows, MacOS, and Linux.

1.5.2 Hardware

More computing power will allow for more accurate results, but any personal computer should work.

2 Goals

3 Stretch Goals

4 Challenge Level and Extras

[State your expected challenge level (advanced, general or basic). The challenge can come through the required domain knowledge, the implementation or something else. Usually the greater the novelty of a project the greater its challenge level. You should include your rationale for the selected level. Approval of the level will be part of the discussion with the instructor for approving the project. The challenge level, with the approval (or request) of the instructor, can be modified over the course of the term. —SS]

[Teams may wish to include extras as either potential bonus grades, or to make up for a less advanced challenge level. Potential extras include usability testing, code walkthroughs, user documentation, formal proof, GenderMag personas, Design Thinking, etc. Normally the maximum number of extras will be

two. Approval of the extras will be part of the discussion with the instructor for approving the project. The extras, with the approval (or request) of the instructor, can be modified over the course of the term. —SS]

Appendix — Reflection

[Not required for CAS 741 —SS]

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
2. What pain points did you experience during this deliverable, and how did you resolve them?
3. How did you and your team adjust the scope of your goals to ensure they are suitable for a Capstone project (not overly ambitious but also of appropriate complexity for a senior design project)?