

Biomedical ultrasonics, 2013

Course project

Date of the instructions: 13.10.2023

The course project aims at facilitating learning of physical phenomena relevant to biomedical ultrasonics. The student is expected to be able to build connections between the different phenomena even if there is a main phenomena under observation. The course project consists of (i) Literature search, (ii) Lab work and analysis and (iii) Inventing a new biomedical solution exploiting the physics studied.

Create a report that includes the following sections. Every student will make their own reports. The experiments can be done together as a team.

1. Literature search, max 2 pages (20p)

Select 10 experimental articles related to the main physical phenomenon of your experiment, all articles relevant to biomedical ultrasound. If your topic did not mention a physical phenomenon, you may instead want to select 10 articles related to the (i) method or (ii) device of your topic or (iii) if these are not applicable (applies only to the needle), devices that are physically close as possible to the device of your topic.

Write a 2 pages summary of those articles, which includes a table (max. filling one of the pages) summarizing the following: the dimensions of the device and the field, frequency, a quantity describing the power (Intensities, be specific which intensity you refer to; Electrical input power; What are the dimensions of the acoustic field; Pressure; Langevin Radiation Pressure; Pulse parameters; Other relevant parameters such as displacement etc.; Main physical ultrasound-tissue -interaction mechanism reported on those papers). If the papers did not disclose parameters, estimate these values. In case you estimated yourself, describe in a separate appendix how you did it and add a footnote about this to the table.

Summarize the essentials of these articles in writing and build connections between the physical phenomena.

It is in the best interests of the student to find unique articles, also articles not presented during the lectures or in course materials.

Add one schematic presenting the essential part of the typical devices of your literature.

Add the cited articles to a reference list that you add in section 5. Reference list not counted into the max 2 pages.

2. Lab work & analysis, max. 3 pages in the report, (55 p)

During a separate 2h session, plan a laboratory experiment that you conduct with your team members. Demonstrate the essential physics in quantitative way. Use similar parameters in describing the physics than you presented under section 1.

Categorize this section with following sub-sections addressing the contents below:

2.1 Aim (5 p)

Define the main aim of the experiment, e.g. what do you aim to show? The main mechanism you aim to show needs to directly relate to the topic of your project.

2.2 Methods (10 p)

Describe the methods of your experiments in a way that the experiments could be repeated by an independent operator. Describe your analysis. Any codes used need to be added to an appendix.

2.3 Results (20 p)

Report results as e.g. image series, graphs, bar charts, maps etc. of one main mechanism of study. Results need to be reported in SI units, not arbitrary units or non-SI units.

2.4 Discussion & conclusion (20 p)

Discuss the results in respect to the physics you have studied on the topic. Regardless on what your main mechanism of study, you should discuss and consider the possibility of the radiation force, acoustic streaming, cavitation, atomization, shear forces, heating, i.e. why or why not the other phenomena were or should have been / should not have been present.

3. Invent a new biomedical method, max 2 pages (25 p)

Propose a new method and/or device for biomedical use using key aspects you identified in section 1 or 2. The device needs to address a clinical need. Make an illustration of the device and explain how it works. Explain the physics associated. Consider that more than one of the following mechanisms are expected to be present at the same time: radiation force, acoustic streaming, cavitation, atomization, shear forces, heating. How can you select parameters in a way that you emphasize the most preferred physical ultrasound- tissue/matter -interaction? The device can use be for e.g. imaging or therapy/surgery or cell work.

Materials to be delivered:

1. Presentation

- a. Every student will deliver a presentation on their own topic.
- b. Slides will be sent at the day of the presentation into a hand-in box by the beginning of the session.

2. Report

- a. Provide the report (max. 7 pages + optional appendix) according to the instructions above into the hand-in box.

Using ChatGPT is not forbidden, but how it was used needs to be disclosed clearly. Chat GPT cannot be used to generate or used to help to text for your report or to generate text that is manually modified based on. If Chat GPT is used and not disclosed, this would be handled as plagiarism. Based on the description of Chat GPT usage, the teacher evaluates the added benefit, and takes that into consideration in evaluation.

More detailed evaluation criteria will be provided separately.