

Georg-Simon-Ohm-University of Applied Sciences Nuremberg

Report of the application project at the Faculty of AMP

# Simulation of a medical therapy method with finite elements

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# 1. Introduction

Lets talk about:

- Medical Treatment of Tumor
- Radio frequency ablation
- This project in General
- Motivation

## 2. Computer-aided simulation of radio frequency ablation with finite elements

Introduction

### 2.1. Theory of finite elements

- Elliptical problems
- Using cylindirc domain
- Rewrite the equations to zylindric coordinates

### 2.2. This part is about the concrete PDEs itself

Laplace in kartesian coordinates:

$$\nabla^2 := \Delta := \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} \quad (1)$$

Laplace in cylindric coordinates:

$$\Delta := \frac{\partial^2}{\partial r^2} + \frac{1}{r} \frac{\partial}{\partial r} + \frac{1}{r^2} \frac{\partial^2 f}{\partial \varphi^2} + \frac{\partial^2 f}{\partial z^2} \quad (2)$$

Laplace in polar coordinates:

$$\Delta := \frac{\partial^2}{\partial r^2} + \frac{1}{r} \frac{\partial}{\partial r} + \frac{1}{r^2} \frac{\partial^2}{\partial \varphi^2} \quad (3)$$

## 2.3. PDE for Electric potential

Three parts are interesting: - Inner domain

- Fixed Potential of electrodes
- Inner domain
- Outer boundary -> Robin

Constant material parameters:

### 2.3.1. Inner Domain

The PDE :

$$-\nabla \cdot (\sigma(x, y, z, t) \nabla \phi(x, y, z, t)) = 0 \quad (4)$$

- Elliptical boundary problem
- Assuming constant material parameters: Equation becomes Laplace's equation,  $\phi$  becomes time independent

$$\sigma \Delta \phi(x, y, z) = 0 \quad (5)$$

- Using cylindrical domain, we can use cylindrical coordinates

### 2.3.2. Electrodes

### 2.3.3. Outer boundary

The inner domain:

(6)

### 3. Summary and Outlook

This is the conclusion part

## 4. Style Test

### 4.1. foo

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

### 4.2. bar

#### 4.2.1. git

#### 4.2.2. bash

### 4.3. waldo

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This is the second paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

And after the second paragraph follows the third paragraph. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

After this fourth paragraph, we start a new paragraph sequence. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

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## References

- [1] Tim Kröger et. al. *Numerical Simulation of Radio Frequency Ablation with State Dependent Material Parameters in Three Space Dimensions*. Springer, 2006.
- [2] Michael McLaughlin. *C++ Succinctly*. Syncfusion Inc., 2012.
- [3] Physicists like to think that all you have to do is say 'These are the conditions now what happens next?'. *Richard Feynman*. The Character of Physical Law, 1965.
- [4] Not only is the Universe stranger than we think it is stranger than we can think. *Werner Heisenberg*. Across the Frontiers, 1972.



## A. Source code Visual C++

Listing 1: For loop to print numbers from 1 to 10

```
1 // Print numbers from 1 to 10
2 #include <stdio.h>
3 int main() {
4     int i;
5     for (i = 1; i < 11; i++)
6     {
7         printf("%d_", i);
8     }
9     return 0;
10 }
```

---

## B. Source code MatLab

TODO