Senior Design 491 - May1629
Project Plan

Development of "Triple Halo Coil" for Deep Transcranial Magnetic Stimulation

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Introduction

Transcranial magnetic stimulation (TMS) utilizes the properties of magnetic fields for noninvasive procedures that stimulate specific regions of the brain. TMS is currently used to treat depression, but the potential uses of TMS treatment reach much further, including Parkinson's disease, post tramatic stress disorder and other deep brain neurological disorders. Current coil designs cannot produce magnetic fields that can effectively and acuratley stimulate regions deep within the brain.

In order to use TMS to treat deep brain neurological disordes, a new TMS coil must be developed. Previously, the Halo Coil was developed to increase the depth of TMS coils. This design must be further improved upon to produce even greater depth and accuracy of the magnetic fields. This brings us to our development. We must design, simulate, and fabricate the new Triple Halo Coil.

Solution

Proposed Solution

During our design we must consider the geometry, orientation, and current direction of each coil. The orientation and current direction will determine the direction of the magnetic fields. In addition, these variables in combination with the geometry of the will determine how each magnetic field interacts with the others. Knowing this, we can utilize contructive and destructive magnetic fields. We can shape and orient the coils so that constructive fields will increase depth, while destrcutive fields will increase focallity.

Assesment of Proposed solution

We must also consider the drawbacks of these solutions. Increasing depth without high focallity is potentially dangerous and could cause more harm to the brain. In contrast, increasing focallity with destructive magnetic fields is likely to lower values of depth.

Validation and Acceptance Test

The first step for testing is calulation. We must have a good idea of the succesfullnes of the design before taking the time to simulate it. After reasonable calculations, we will simulate the magnetic fields in Sim4Life and the thermal and structural integrity of the coil in COMSOL.

Interface/system description

(by Aashwatth Agarwal)

Content

1. Designing of Triple Halo Coil
2. Fabrication and measurement using Comsol and SimCAD/Sim4life
3. Testing using Finite element analysis by using anatomically realistic head models

Technical approach

- Precise measurement
- Capable of deeply stimulating the brain
- Management of efficiency reagrding coil decay rate
- Prevention of overheating of coil
- Ensure complete safety to the patients

Process details

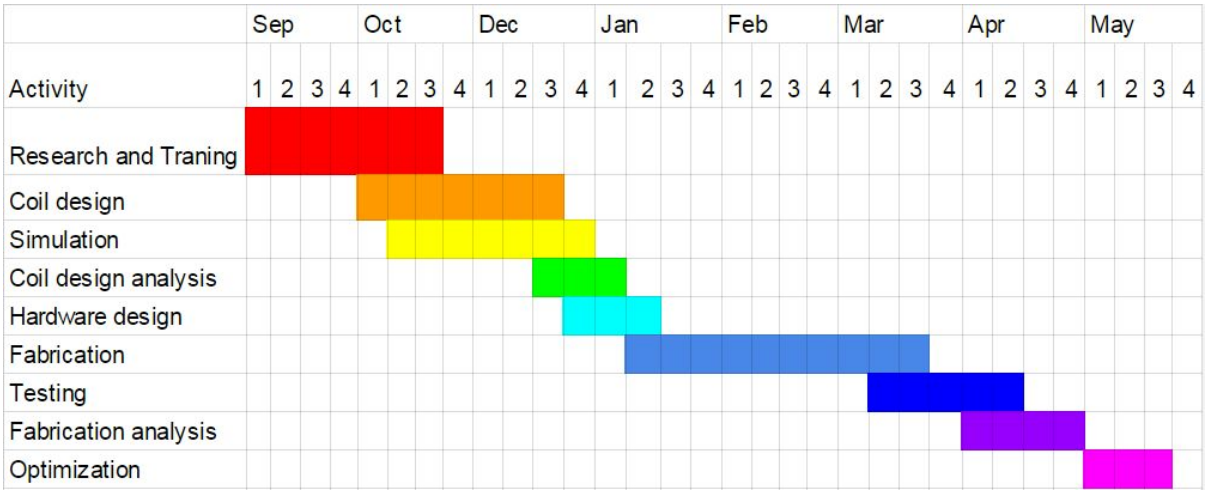
1. Simulation of the Triple Halo Coil using Sim4life and Comsol
2. Fabricating our designed coil
3. Testing of the coil using finite element analysis
4. Optimization of the coil

Test plan

- Use of finite element analysis to test our fabricated coil, through anatomically realistic head models.

Work Breakdown structure

Project schedule



Risks / Feasibility Assessment

Risk Item	Effect	likelihood(0-10)	Severity(0-10)
Physical Dangers	being injury	1	7
PC demange	can not do simulation for a while	1	6
Lack of Experience	need to get training	6	4

Cost Considerations

Product	Price Per item	Quantity	Total
Hardware/softw are	free	1	free
Document	$2	10	$20
Coils	$5	10	$50
Energy storage capacitor	$10	2	$20
Thristor	$5	2	$10

Market/Literature survey:

Rachana Kaul, Bridget N. Hogan, Ravi L. Hadimani, Lawrence J. Crowther, and David C. Jiles. “New Coil Designs for Deep Brain Transcranial Magnetic Stimulationusing Halo Coil Configurations”

L. J. Crowther, P. Marketos, P. I. Williams, Y. Melikhov, D. C. Jiles, and J. H. Starzewski. “Transcranial magnetic stimulation: Improved coil design for deep brain investigation” Journal of Applied Physics, 2011

L. J. Crowther, I. C. Nlebedim, and D. C. Jiles, "Developments in deep brain stimulation using time dependent magnetic fields," Journal of Applied Physics, 2012.

P. I. Williams, P. Marketos, L. J. Crowther, and D. C. Jiles, “New Designs for Deep Brain Transcranial Magnetic Stimulation,” IEEE Transactions on Magnetics, 2012.

Zhi-De Deng, Sarah H. Lisanby, Angel V. Peterchev, “Electric field depth–focality tradeoff in transcranial magnetic stimulation: Simulation comparison of 50 coil designs, Brain Stimulation”, 2013.

Conclusion