This research aimed to investigate whether the optimization for electrode placement and current passed through those electrodes to generate an electric field on the brain could be made robust and whether this provided any benefits. This is relevant in designing electrode placement schema for stimulation experimentation and medical treatments since a robust placement scheme may minimize the neurons outside the targeted region for stimulation that are activated, in turn reducing potential side-effects.

The identified sources of uncertainty in the original model were the radii of the different sections of the head and the conductivities of each section. This study focused on uncertainty in the conductivities of each section of the head model since the radii can be determined accurately via MRI scans. This study built off work that developed a model and optimization scheme to place electrodes on the scalp and pass current through those electrodes to generate a desired electric field in some 'focus' regions in the brain while minimizing the field in other 'cancel' regions in the brain.

The investigated robust approach iteratively maximized the error on the electrode setup chosen by varying the conductivity parameters within some tolerance and then found a new electrode placement for these new parameters. At each step, particle swarm optimization was used to find new values for conductivities and the original convex optimization technique was used to find the new electrode setup. The findings of the study revealed that there are benefits of robust optimization in a worst-case scenario. The electrode setup designed by the robust optimization had 12.5% less electric field in the 'cancel' region than the original electrode setup in the worst-case scenario. There was, however, no benefit of using robust optimization in the average case and the findings suggest that the particular robust optimization used in this study may be worse in the average case.

The results from this study show that given uncertainty in physical parameters in the head model, such as conductivities and depths of the layers of the head, there is a benefit to using the investigated robust optimization method in the worst case scenario but not in the average case. This may help researchers design safer electrode stimulation studies. Further research is required to validate these findings, compare other robust formulations, and determine the effects of other types of uncertainties on the robust optimization results' performance.