Case Study

"The ANSYS Electromagnetics Bundle provided through the ANSYS Startup Program was essential to the successful design and development of our CerebroPatch™ product. Our analysis using ANSYS products was instrumental in determining the design parameters quickly and efficiently while making the system robust despite the variance seen in biological applications. We were also able to anticipate the complex interactions between the CerebroPatch and other medical devices that are used concurrently. The Startup Program was a perfect solution that allowed us to proceed on our limited startup budget and time."

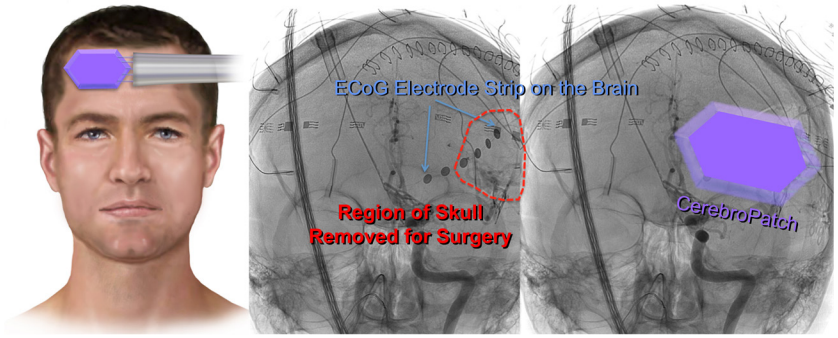
Samuel J. Hund
Senior Engineer
CerebroScope®
Pittsburgh, PA, U.S.A.

ANSYS **Case Study**

ANSYS Electronics Desktop in the Design of the CerebroPatch™

Introduction

CerebroScope® was founded with the goal of saving brain cells. We are developing a modified EEG system, called the CerebroPatch, with the goal of detecting, from the scalp, an electrical signal in the brain that occurs after severe acute brain injury, such as stroke, subarachnoid and intracerebral hemorrhage, and severe traumatic brain injury. This electrical signal — known as "cortical spreading depolarization (CSD)"— increases energy consumption near the damage site, which can result in the death of compromised brain tissue.



Conceptual placement of the CerebroPatch™ (left). X-Ray image of a patient showing (middle) an invasive brain surface electrode strip and the region where the skull was removed (red dashed line) to remove an aneurysm and the placement of the CerebroPatch™ on the scalp over the site of the injury (right).

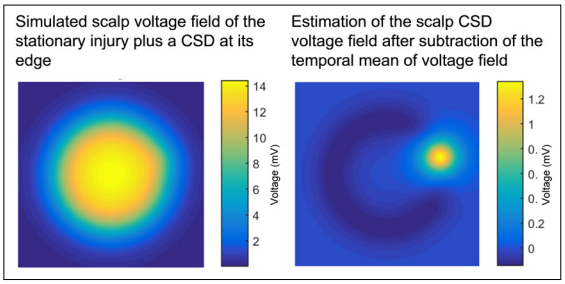
X-ray image supplied courtesy of Andrew P. Carlson, MD

Figures supplied courtesy of CerebroScope

Challenges

The behavior of the electrical signal is well-defined on the surface of the brain, but little data has been collected on the signal at the scalp. Obtaining this data would be financially prohibitive.

Material and geometric parameters for biological tissues can vary greatly — up to three orders of magnitude — depending on where on the scalp the measurement is taken. These parameters also vary from patient to patient. Our design challenge is to develop a prototype device for detecting these brain signals from the scalp as efficiently as possible.



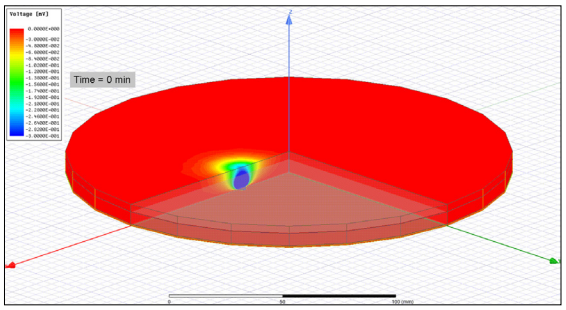
In the left panel, the stationary voltage field representing a residual voltage caused by the injury to the brain is combined with the voltage field of a CSD, obtained using ANSYS simulation. The CSD signal is just barely visible as a very slight bump at "2:30 o'clock". In the right panel, the CSD voltage field becomes fully visible after subtraction of the temporal mean of the complete voltage field.

Technology Used

ANSYS® Electronics Desktop™

Engineering Solution

The ANSYS Electronics Desktop allowed us to mimic the complex, time-dependent electrical signal that occurs in the brain, and to simulate how it propagates through the layers from the brain surface to the scalp. The parametric capabilities allowed us to study a wide variety of material parameters and geometric thicknesses. Coupled with Python scripting, we easily generated output files and coupled them with real full-band EEG data to create artificial test cases. ANSYS' multiprocessor capabilities allowed us to run simulations quickly and effectively.



The simulated voltage field at the scalp generated by a CSD traveling along the surface of the brain was modeled using a "disk" representation of the layers between the brain surface and the scalp. The voltage field becomes much expanded on the surface.

Benefits

Using ANSYS Electronics Desktop allowed us to obtain the spatiotemporal dynamics of the CSD's voltage potential on the scalp. We quickly developed a robust, optimized device with signal processing software (granted U.S. Patent Application No. 14/948,9950) for clinical testing in less than a year, increasing our likelihood of success over the competition. ANSYS reduced our design time by 75 percent compared to experimental methods, so we could start human studies trials sooner.

CerebroScope's mission is to design, build and validate non-invasive devices for monitoring brain-damaging electrical signals called cortical spreading depolarizations. CerebroScope's two-year Phase I NIH SBIR grant award has enabled the design and development of a proof-of-concept prototype system. Our team of three has expertise in the science of CSDs, numerical analysis and design.

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