



**CALIFORNIA STATE SCIENCE FAIR  
2016 PROJECT SUMMARY**

<b>Name(s)</b> <b>Rajiv Movva</b>	<b>Project Number</b> <b>S1415</b>
<b>Project Title</b> <b>Halo: A Machine Learning Assisted System to Detect Concussions in Sports</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Every single fall, collision, or strike puts an athlete's brain at risk. This danger manifests as 4 million sports-related concussions occurring annually, of which an estimated half remain undiagnosed. Detecting concussions immediately is critical to avoiding future damage that often leads to permanent neurological disability. Thus, the goal of my system is a real-time concussion detection system that is accessible to athletes at all levels of play.</p> <p><b>Methods/Materials</b> A biomechanical model of the head was designed in ScanIP by concatenating MRI data (from the Alzheimer's Disease Neuroimaging Initiative) and meshing the 3D volume to a model containing ~250,000 elements. To quantify concussive tissue damage, ten NFL impacts were reconstructed by performing finite element analysis on the model in COMSOL Multiphysics. An artificial neural network was trained to classify accelerations as concussive using 358 impacts simulated in the finite element model. The system hardware layout was designed in DipTrace, and PCB production was outsourced.</p> <p><b>Results</b> The neural network was validated with 57 NFL impacts reconstructed in the finite element model after video analysis. 53 of 57 impacts were correctly identified (accuracy: 93%), with sensitivity 98%. The current revision of the system costs ~\$20.</p> <p><b>Conclusions/Discussion</b> Here, the neural network allowed for approximation of the complex computational processes modeled in the finite element solver. Thus, the cost of realtime concussion detection was reduced to an affordable amount while maintaining a high sensitivity. This system will aid in prompt identification of brain injury, significantly reducing athletic risks the world over.</p>	
<b>Summary Statement</b> Halo is an affordable system that can be worn by athletes to detect sports concussions in realtime.	
<b>Help Received</b> Dr. Nelson helped explain some concepts in physics and reviewed a draft of my technical paper. My brother gave me tips on poster design, and my parents provided support.	