Development of a Smart Cervical Vertebrae Brace for Neck Pain Prevention and Rehabilitation

Fan, Muning (School: College Park High School)

To combat the main source of headaches, neck tension, a smart cervical neck brace was devised using Raspberry Ri and Arduino System. Patent and literature research demonstrated no such technologies exist. Next, a neck brace was designed in Spaceclaim and then 3D printed. The neck brace is equipped with 2 stepper motors, each applying a force in the vertical or horizontal directions. It was originally hypothesized that as the angle of the neck increases, the tension would increase. Then, a FEA (Finite Element Analysis) model was built to simulate the neck and head. The neck was loaded by self-weight at varying angles. The head was based on rigid structures while the neck was modeled as elastic materials. To simulate real world conditions, a 3D printed head and neck system was utilized. The neck brace was then inserted on the model. Rubber bands were used to simulate the neck muscles. The neck tilted at respective angles and the tension of the rubber bands was measured. Measurement data in the neck tension were acquired using a load cell and an analog to digital converter with Wheatstone bridge and amplifier. Program Processing installed on the Raspberry Pi was used to plot and visualize the data. Results from FEA and the model testing supported that as the angle of the neck increases, neck tension increases as well. Ongoing research aims to incorporate machine learning for the best optimal decision regarding the neck brace, such as the amount of force or when to activate.