Engineering a Novel Wearable Biosensing Mechanism through the Implementation of Microelectromechanical Systems and Machine Learning to Realize Anomalies Hinting towards Future Cardiac Episodes

Choudhary, Prerit (School: College Park High School)

Cardiovascular disease is the worldwide leading cause of death, yet there is a salient lack of cheap and proactive solution towards this problem on a global scale. To address this issue, a cheap ($42.37), long-term, wearable device was fabricated that continuously monitored the electrical impulses of the heart and the vibrations within the chest valves to produce an ECG (Electrocardiogram) and SCG (Seismocardiogram). A dual-layer Printed Circuit Board was created in regards to its versatility with combining numerous electrical components, and to communicate wirelessly through Bluetooth. In addition to the sensor itself, a multifaceted system was implemented that added a multiphase machine learning algorithm and a mobile application for the user. The first phase utilized a Gray-Level Co-Occurrence Matrix to extract the crucial features from the ECG and SCG images. The second phase employed a Support Vector Machine as the primary method for abnormality determination and yielded a 93.7% accuracy in binary determination while also predicting potentially fatal cardiac episodes approximately 23 minutes before they occurred. The final phase of the algorithm involved a Deep Convolutional Neural Network to classify the abnormality into a more specific cardiac issue and was done with 98.3% accuracy. The final component, the mobile application, effectively warned users and medical teams ahead of time of any abnormalities, and allowed the user to directly access their ECG and SCG data. The system was deemed successful as the combination of all the components could potentially save 53% of the lives lost to cardiac disease.

Awards Won:
Second Award of $1,500
King Abdulaziz &amp
his Companions Foundation for Giftedness and Creativity: $21000 Scholarship for Machine Learning in Real-World Chemistry or Environmental Applications