Describing Inaccuracies in Wearable Heart Rate Monitors: An Optics Simulation

Team 8

The overarching goal of our project was to investigate novel approaches to universally improving the accuracy of wearable heart rate measurement devices via modeling and data analysis techniques. After a thorough review of the literature, we chose to investigate five possible sources of error in such measurements, including fat content, hair follicle density, dermal thickness, skin tone, and the presence of sweat. The current literature has indicated that these sources encompass the leading causes of inaccurate heart rate measurements in these devices; however, only minimal in-depth research exists on any one of these. The purpose of our model is to correct for this downfall, leading to improvement in heart rate detection and, thus, minimizing the current minority barrier seen due to these physical attributes. Our design plan consisted of using the softwares SolidWorks and TracePro to create a tissue and capillary blood flow model, respectively. 40 skin models with varying optical properties were generated and tested through this model. Python was then used as a means of data processing and quantifying error, as it could directly take input from SolidWorks and TracePro in order to assess the accuracy of our model. It was found that 1) dermal fat, superficial sweat, and melanin all decrease the flux of photons and reduce ray intensity as rays arrive at photodetectors, 2) hair follicles decrease the total flux to photodetectors by misdirecting rays, and 3) dermal thickness has no effect on readings. Due to the nature of this project and the resources currently accessible, our budget was solely dependent on the cost of licensure for the TracePro software. Our next step is to deploy our model into the fields of optics and sensors by consulting large corporations that mass produce inaccurate devices.