402 - BME Design Excellence Award - jht_sensor_holder - Executive Summary (poster 4)

Johnson Health Tech is working to improve the fitness of people around the globe by bettering the equipment available to them. In order to accomplish this goal, Johnson Health Tech must be able to accurately test their equipment. These sensors are used to measure acceleration which can then be used to compute the center of mass and different ground reaction forces. Currently, they do not have a way to properly secure Delsys Trigno Sensors to the shoes and chest of the test subject.

Multiple commercial systems currently exist for strapping different motion sensors. Xybermind has a device used to evaluate displacement angles where the sensors are secured to the ankle region rather than the heel of the user. Having the sensors centered on the back of the user's heel is important, since this location of the sensor is most representative of the ground reaction force that is being experienced and it allows them to make generalizations about total body movement. Many different companies create chest straps to secure different types of sensors to the user's chest; Polar has multiple heart rate monitors that utilize a chest strap to be secured to the user and is in direct contact with their skin, but there are no holders for the motion sensors commonly used for testing.

The sensor holder that goes on the shoe is designed in two parts. The first part is an 18 gauge steel wire bent to secure in place on either side of the user's heel. The base of the wire goes under the heel pad of the shoe to help stabilize the device, and the sensor sits in a pouch attached to the wire frame. To decrease the amount of bouncing against the heel, a strap wraps around the sensor, under the arch of the shoe, and ties on top near the laces. The chest strap is an elastic band that is clipped together with a buckle and is adjustable to fit a variety of users. In the center of the strap there is a pouch to hold the sensor. To decrease the slippage, there is a silicone lining on the inside. The sensor secured by the holder allows data to be retrieved over a variety of surfaces and can be measured directly while performing an activity.

To test these devices, the design was compared to the current method of taping on the sensors. This current method takes time and the tape can bunch up presenting a danger to the user. There was no slippage or movement of the fabricated device in any way that would pose as a risk to the user. Out of the three design alternatives that were tested, the method described above performed the best. The accelerometer data was gathered over multiple trials and a band-pass filter was used to filter out the acceleration due to stepping, and the remaining signal was considered noise. With this data, the signal-to-noise ratio (SNR) was computed. The SNR should be approximately equal throughout each trial meaning that the amount of noise is proportional to the signal and can be reliably filtered out. The taped sensor had a standard deviation of 2.007, 4.390, and 5.206 in the X, Y, and Z directions respectively. The new sensor holder had standard deviations of 2.686, 0.8144, and 0.636. Although the SNR values themselves were not the focus, they were not completely disconsidered. On average the tape had a higher SNR value (18.245, 7.555, and 15.779) compared to the new sensor holder (20.012, 3.246, and 12.4739). However, this may be due to extra movement of the sensor exaggerating the signal and the acceleration of the steps.

This will facilitate more accurate testing of Johnson Health Tech's exercise equipment which will result in the development of innovative technology. Beyond this, the design allows for more accurate data from a wide variety of people due to its adjustability. EMG sensors are used in many biomechanics research labs with focuses on physical therapy, clinical settings and sports medicine. Due to the wide variety of applications of this design, it has the potential to impact many areas in biomedical research and the design of many different types of equipment.