Detection of Hamstring Force to Reduce Player Injuries with GHD Machine

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Background

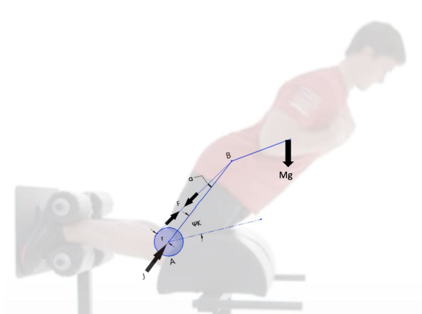
The most common injury in football is a hamstring strain. In an effort to reduce the occurrence of these injuries, players often perform glute-hamstring exercises to strengthen the muscle. These exercises also play a role in determining when a recovering athlete is ready to go back onto the field. Our work focused on providing both players and coaches a way to view the force exerted by the hamstrings during one glute ham raise. While existing products for force collection are used, such as the Nordbord, this device can only be used for the Nordic Curl exercise, which is a high strain movement that can be difficult for both athletes returning from injury and athletes of a higher mass. On the other hand, the Glute-Ham Developer machine allows for more user modification of the exercise. For this reason, our work aims to integrate force collecting capabilities into the adaptable GHD.

Approach

The team decided to split into three sub-teams to approach the project: sensors, biomechanics, and UI/UX.

Sensors

The team researched different types of sensors for the data collection process and created various test setups to simulate the movement of the player. For muscle force measurement, load cells were the most conducive to this application. This was the sensor type selected. The data was then converted into a format that could be analyzed by our biomechanical model.



Biomechanical model of internal knee force

Biomechanics

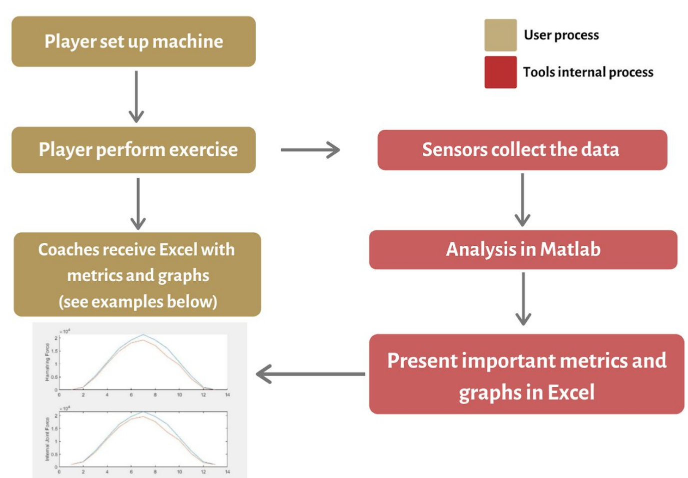
A static mechanical analysis was conducted to quantify the forces on the hamstring and the knee joint of the athlete. The athlete was modelled as a collection of hinged beams with the hip angle fixed and the mass above the knees concentrated at one point. Users input athlete geometry such as tibia, femur, and torso length, in addition to mass. Using these inputs as well as time varying force data from the sensors, a MATLAB code predicted the angle of the knee and subsequently output the force exerted by each hamstring over time.

UI/UX

The team compiled the force data to present the players and trainers with the most relevant information, namely the maximum force exerted by each hamstring, the imbalance of force between the hamstrings, and a graph of the force exerted over time. We also created a wireframe to outline the flow of a potential app that could be used by both players and coaches when implementing this technology in the training regimen.

Conclusions and Discussion

Our vision is that the load cells could be integrated into existing GHD machines, causing minimal disruption to the current workout process. The data would then be collected from the load cell during exercise, run through our biomechanical analysis to determine hamstring force, and uploaded to an iPad app modelled after the wireframing that has been done. Coaches and players could track progress of the hamstring strength and imbalance over time, giving them a more complete view of the athlete's health, and reducing the occurrence of hamstring injuries overall.



Process flow of the final tool