Anatomically Scalable Transfemoral Knee Design

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Abstract

The knee and ankle joints are a vital part of human locomotion. They are responsible for articulation, load bearing, and the general dynamic control of overall stable gait. Therefore, amputation that causes a loss of either joint is detrimental to a person's gait. Improving the design of prostheses can greatly increase the quality of life for people with amputations by increasing their potential mobility. With the advent of 3D printing technology on the rise, it is becoming possible to customize a prosthesis to a specific individual's size and gait pattern. It is possible to tailor make a prosthesis that is anatomically similar to the person while making the design inexpensive and passive

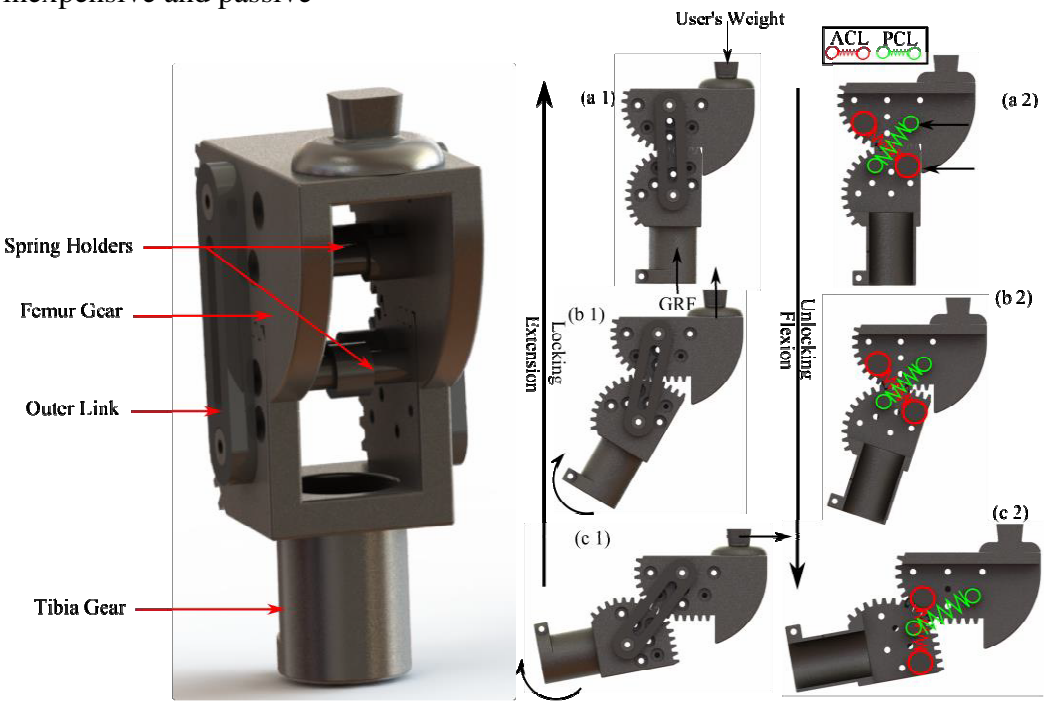

Figure 1: The Labelled Knee Design and Working of the Biomimetic Knee Mechanism

Figure 1 shows our passive knee locking mechanism design that incorporates a 4 bar mechanism that is similar to the kinematics of the Anterior Cruciate Ligament (ACL) and Posterior Cruciate Ligament (PCL). The flexible 4 bar mechanism guides the motion of the

knee and aids in the return of the knee from full flexion to extension. The flexible 4 bar mechanism also connects the femoral spur gear to the tibia spur gear. The gears are based on a circular radius and are connected using a parallel link to keep the femur and tibia from moving away from each other when the knee is in motion. This prosthetic knee design, shown in Figure 1, is based on the anatomical dimensions of a human knee which allows the design to be scaled from a large adult male to a small pediatric knee.

The knee mechanism was tested on a single subject fitted with a prosthetic simulator, shown in Figure 2. The trial was performed on a split belt treadmill with a Vicon motion capture system. The knee's motion was recorded using three reflective markers placed on the prosthesis to obtain the knee angles of the biomimetic knee, shown in Figure 2. The results showed that the biomimetic knee design's kinematics are closer to the standard Winter knee angles compared with the Ossur Total Knee.

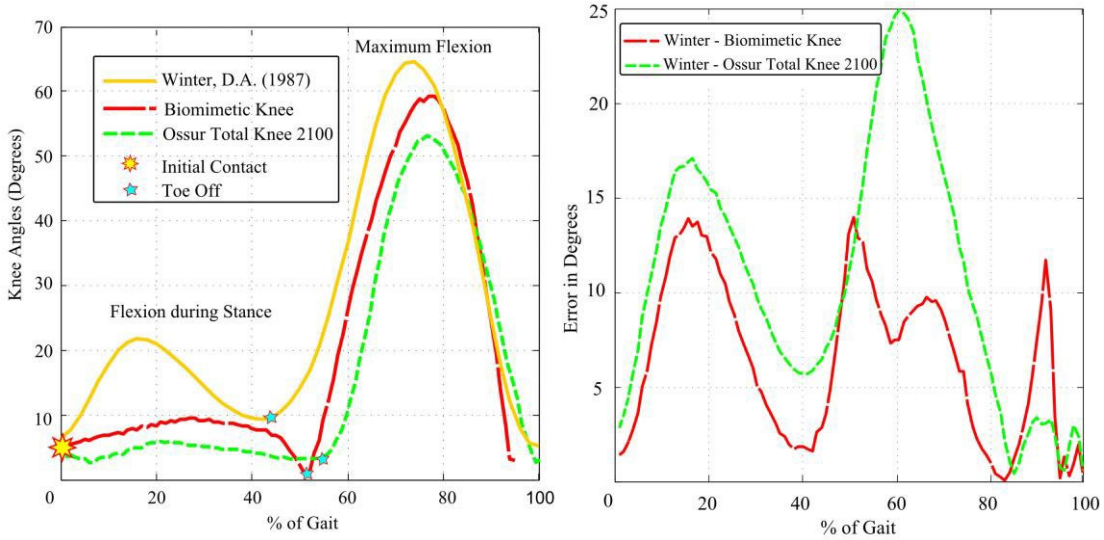

Figure 2: Biomimetic knee compared to an Ossur Total Knee and standard Winter knee angles

Biographies

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