Abstract

The study of biomechanical function provides beneficial insight into human motion, injury, rehabilitation and surgical techniques. Flinders University have a six degree of freedom Hexapod robot which performs in-vitro biomechanical testing. The Hexapod can only mimic flexion and extension of approximately 50° which means that specimens such as elbows and knee are unable to reach full range of motion. The purpose of this thesis was to increase the range of motion to test as many joints as possible. A cradle device was designed to insert into the inner space of the Hexapod while simulating flexion and extension. Crucial requirements included successfully synchronising movement between the cradle and Hexapod assembly while closely imitating physiological joint motion and load.

A major design requirement was to increase the range of motion of the cradle while avoiding collision between the cradle device and moving encoders. These encoders make up the inner space of the Hexapod. Due to the tight space, a computational model and physical prototype was created to ensure accuracy. There was a strong association between these measurements. The cradle was designed to create 140º flexion while avoiding any collisions between the cradle and Hexapod.

Static and dynamic requirements determined the stiffness and motor specifications of the cradle device. These requirements were based around joint specimen failure loads and motion found in the literature. Finite Element Analysis was performed to analyse the stiffness of the cradle at certain flexions. Reiterations of the design were made according to these results. Stiffnesses were in the range of 3701 – 17334.3 N/mm which complies with biological specimen and hexapod stiffnesses. However, undesirable displacements were found at 3.07 mm. Next, motor and gearbox selections were analysed based on the dynamic simulation requirements. A superior actuator with a unique strain wave gear was identified as a suitable actuator to integrate into the cradle system. This motor consisted of 58 Nm continuous torque with a compact actuator length of 93 mm, this satisfies walking loads and motion however it will not be capable of withstanding failure loads and motion.

A suitable plan included manufacturing the cradle with a lock system to validate the structure followed by integrating the SHA series actuator into the system at a later point in time. Future work will include further structural analysis, manufacturing, generating funds and integrating this actuator into the complex hexapod control system.