Making Sense of Orthopedic Technologies

Sensors have become an integral part of medical devices across most industry sectors. Providing vital information to the healthcare provider or patient, they can significantly enhance the quality of a treatment solution. This article reviews several types of sensors that are being used in conjunction with orthopedic implants to enhance their effectiveness.

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In past decades, sensor technology has made significant advancements in developing miniaturized products with long MTBF (mean time between failure), endurance, durability, and overload protection. These advancements have been very instrumental in supporting medical technology. Additionally, the advancement and miniaturization of electronics and wireless capabilities at affordable costs have also paved the way for smarter and more capable sensors regarding functionality and feedback.

Examples of several different types of sensors that may be used in orthopedic applications.

In particular, orthopedic sensors have been used in various applications including research and study, surgery, and implants. These sensors can also be used to aid during a healing or correction process. Following are several examples that explain the use of sensors in orthopedic applications.

Lower and Upper Prosthetic Limbs

Sensors have been very instrumental in the advancement of prosthetic devices to closely mimic human limbs. Through a sophisticated micro processor controller, sensors provide feedback to drive servo/stepper motors or hydraulic and pneumatic mechanisms. As one example, in the lower prosthetic limbs, the micro processor utilizes the data from load cells, and accelerometers to control the resistance in mini hydraulic or pneumatic units within the knee to control the swing of the

prosthesis and provide further stability. The microprocessor can then recognize when the person is losing balance or stumbling, and will automatically adjust and guide the knee providing more stability and in turn preventing a fall. Through the use of software and continuous data collection, further adjustments are provided for safer and more natural actions while walking. This advanced system allows users to continue on other life activities and forget about their foot.

In upper prosthetic limbs, sensors are utilized in the most advanced myoelectrically controlled prosthetic hand. While the sense of touch in our fingers is something often taken for granted in daily tasks, a microprocessor can be used to create that feedback for someone. Through the feedback from small strain gauged force sensors or load cells placed in the finger tips, the microprocessor can provide sense to the hand to detect if an object being held is slipping to automatically adjust the grip. Even though interfacing the advanced prosthetic hand nerve signals is complex and challenging, it is still aiding in faster and more natural responses for tasks that involve many movements.

Hip and Knee Simulators

Manufacturers of artificial joints and robotic limbs have followed in the footsteps of quality control applications by using multiple pancake-type load cells to test durability. The load cells are used in hip and knee simulator machines to create friction and wear tests of multiple joints for endurance testing and determining mean time between failures. These types of tests are a means to developing better, stronger, and more-flexible devices for lifelong usage. [

Illustration of a sensor in a unique application to restore proper balance and posture.

Corrective Orthopedics

Load cells can be used in corrective orthopedics in the unique application to correct posture. A very-low-profile flat-plate or load-button load cell is placed into shoe heels with a connection to the headset of an MP3 player. The unit plays music when the user is walking with proper balance and posture. If the person falls into an irregular foot pattern and throws off the body’s balance, the music stops. This effect trains the person to adjust his/her walking pattern correctly.

Neuromuscular and Skeletal Disorders

A uniquely customized three-channel load cell integrated with specially developed

software can be used in aiding the early detection or severity of neuromuscular and skeletal disorders such as carpel tunnel.

Implantable Simulator of Knee
This circular disk sensor shaped like a miniature UFO measures patelloformal force on a patella implant.

Implantable Simulator of Knee and Tibia
In order to control and measure the loads between the tibia and the femur, a special sensor is designed to interface with a trial knee implant resulting in precise positioning of the implant and greater knee stability.

Patella Ligament Sensor
This sensor is used to measure the tension of the patella ligament with any knee implant.

Tendon and Ligament Transducer
This is a customized "S" shaped sensor designed specifically to measure tensional forces of tendons and ligaments during surgical procedures.

These are just a few of the applications for load cells/sensors in the medical and orthopedics industry. As shown, sensor usage is becoming much more commonplace due to the advancement of sensor technology and the development of digital and wireless sensors which optimize the feedback and data collection process. A sensor solution provider can offer additional information about standard products such as digital hand grippers, pinch sensors, and other standard or customized sensors that could be used in a study/application.

ONLINE

For additional information on the technologies and products discussed in this article, visit Futek Advanced Sensor Technology Inc. at www.futek.com [1].

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