Wireless Force Sensing Technology Improves Biomedical Device Design and Function

Advancements in wireless force sensing technologies have improved the design of biomedical devices for patient utilization.

By Jeannine Croteau, Marketing and Mark Lowe, Product Manager

The medical device industry is constantly evolving due to the progressive nature of technology. Design engineers and consumers are looking for sleeker, smaller medical devices that do not inhibit their every day activity. Patients and doctors want to be able to collect data and information from these untethered devices while in the comfort of their own natural environment. The adoption of wireless technology by biomedical engineers has made this progression towards wire-free technology possible. This wireless trend has sparked a movement towards more innovative, cost effective technologies for the medical market. The development of smaller, more powerful medical devices matched with wireless capabilities is significantly changing the medical industry as we know it.

Wireless devices allow real time data as well as constant monitoring. These devices have the ability to monitor the physiological metrics, bodily functions, and physical movements of a patient. In comparison to a clinical research setting, a wireless medical device allows greater freedom to the patient. One of the greatest advantages of wireless technology is at anytime the data can be in the hands of the patient. These devices allow patients and doctors to stay constantly informed and use the given data as they please. This feature of constant monitoring is important in fields such as geriatrics, where older patients must be kept under close watch at all times. Wireless medical devices pertaining to the elderly are often ideal for tracking progress and preventing additional physical complications.

The wide range of medical device capabilities is helping to transform and enhance the industry of biomedical engineering. The wireless transfer of medical information is a process often involving sensors, a wireless hub device, and a monitoring system. Small wireless sensors, either implanted or worn by a subject, transmit data to a hub device, which is then decoded by a real time monitoring system. This process allows information to be shared by caregivers and allows patients to track their own metrics through a device as convenient as their mobile phone or laptop. The ideal medical device is one the patient does not even recognize is there. A small, weightless and wireless device is not cumbersome and is easily integrated into the lifestyle of the patient using it.

The components designed into medical products are key to the effectiveness and durability of the device. In today’s market, there is a high demand for smaller, more affordable parts that are compliant to engineers’ design goals. Thin, flexible sensors that are easily incorporated into product designs are essential to the development and progressive nature of wireless devices. The size, cost, and accuracy of these sensors allow design engineers to incorporate these parts into a variety of product designs, including medical devices. Wireless medical devices can be worn both internally and externally. One current trend is that of designing sensors as thin as Band-Aids that are worn by a patient to measure and track key metrics, such as heartbeat and temperature. Sensors also aid doctors in tracking measurements beyond physiological metrics, for example, the movement of a certain subject. The adaptability of these sensors allows engineers to achieve innovative designs and mass-produce unique medical force sensing tools.

Piezoresistive force sensors mainly used for OEM projects, produced by the FlexiForce division of Tekscan, is one example. The thin design of these force sensors provide engineers with a simple yet effective tool for product design. The FlexiForce sensors come in various standard single-point forms mainly used for test and measurement as well as research and development. The force sensors are ultra-thin (0.008 in.) and have superior linearity and accuracy (+3%). The sensors are also made custom to meet the needs of design engineers and unique OEM projects. Sensor technology has continued to improve immensely over the years. Force sensors can now endure various environments and external factors, including high temperatures and a wide range of forces. The flexible and innovative nature of sensing technology is evolving to meet the technical and creative needs of the engineering industry.

These simple to use force sensors have been designed into various medical devices and applications. One example of a device is a shoe insole used to measure and analyze the force distribution of a patient’s foot. The sensors within the shoe insole cause no interference with the subject's everyday routine while simultaneously collecting data. This data can be used by doctors to evaluate a patient's progression of mobility and if the subject is deviating from his or her normal balance. These "smart" shoe insoles are ideal for patients undergoing physical therapy, those with balance issues, and the elderly. Another benefit of this monitoring system includes notifying family members in the event of a fall. The many uses of these insoles help take on preventative measures in averting further medical problems and concerns.

Thin, flexible sensors are also ideal for surgical applications. The amount of pressure applied to a subject or certain body part being operated on is crucial to the success of a surgery. Force sensors are integrated into the designs of medical devices used to evaluate surgeries and the effectiveness of specific medical tools. For example, FlexiForce sensors are designed into a device that is inserted in the knee joint during surgery. The sensor provides information to the surgeon on how to balance the knee joint so that the forces are equal on both sides of the knee. The device can also provide doctors with a total force measurement so they can adjust the joint for low friction and proper articulation. These sensors have also been used to digitally measure and record muscle activity during a MRI. The sensors allow an easy way to determine the amount of force being sent through a bone joint of a patient during a MRI as they press on the device. Design engineers found these sensors to be ideal for use within an MRI due to their wide resistance range, high linearity, and low power consumption.

A complete force measurement system combining force sensors, data acquisition software and electronics is also available. One example of these systems is a wireless in-shoe pressure mapping system that collects pressure and force measurement data. The system consists of a wireless unit, which is attached to the subject's waist. The pressure and force data is then directly transferred from the ultra-thin in-shoe sensors to a computer in real time. The advantage of this system is to collect data without altering the subject’s natural movement. The subject can travel up to 100 meters away while the sensors along with the system capture every event that occurs within the shoe. The sensors are placed underneath the plantar surface allowing the system to observe the interaction between the subject’s foot and the footwear. The system specifically quantifies timing and center of force trajectory allowing doctors to further analyze foot function and gait.

The applications for sensors used in biomedical devices are endless, from sensors designed to improve knee joint replacements to sensors implanted within the body to monitor blood pressure. Sensors along with their given systems are the ideal tools in unobtrusively collecting data while monitoring and keeping the patient and caregivers informed of their current medical state. The simplicity and ease of integration of the sensors provide biomedical engineers with low cost, yet efficient solutions in designing medical devices. A thin, flexible, non-intrusive sensor allows significant design freedom to an engineer. Whether the sensors are measuring a patient’s vital signs or the volume of medicine in their infusion pump, these medical device components are ideal for technological advancements in the medical engineering industry.

www.tekscan.com [1]

December 11, 2012

Links:
[1] http://www.tekscan.com