Abstract

Clinicians and researchers in the orthotics and prosthetics community are interested in monitoring the interface loads in prosthetic sockets and at other interfaces. Most available pressure sensors have performance limitations, such as non-linearity, hysteresis and drift that prevent accurate long-term measurements. In particular, shear pressures are of interest and no commercially available shear sensors exist of the appropriate size and form factor for these applications. Finally, integration of the sensors into the socket interface is a challenge.

We have developed a three-axis optical pressure sensor that can be used for these applications. This poster will describe the sensor construction and detailed characterization. The sensor was calibrated and tested using a commercial 6-axis load cell. The sensor exhibited low drift and low to moderate hysteresis and coupling between the measurement axes. In aggregate, the average sensor errors were generally between 2-4% in the shear directions and between 3-7% in the normal direction.

We have also developed methods to integrate the sensors into an elastomeric liner with similar geometry and material properties to those many amputees wear. As many as 16 sensor sties have been integrated into a liner. These liners have been tested for comfort on amputees with good results. We have also developed electronics to convert the analog sensor data to digital and transmit to a computer or store on a USB thumb drive for untethered use.

This poster will describe the liner construction and will present data collected from a liner with eight sensors that was worn with a custom-fit, two-piece socket attached to an ankle/foot off-loading orthotic, which has similar properties to a prosthetic socket. The liner was worn while a subject walked overground for several minutes. Peak interface pressure generally ranged from 5-50 kPa and peak shear pressures ranged from 0.5-12 kPa.

These sensor liners have the potential to provide novel data to the O&P research community and may become a useful clinical tool to evaluate socket fit. The ability to monitor shear loads is particularly novel and interesting to the community. The system can be worn chronically and log data over several days without clinician intervention.

Biographical Sketch

Jason Wheeler is a Principal Member of the R&D staff in the Robotics and Cybernetics Group at Sandia National Laboratories. He received B.S. (BYU), M.S. (MIT) and Ph.D. (Stanford) degrees in Mechanical Engineering. His research focuses on prosthetics, musculoskeletal biomechanics and assistive and rehabilitative robotics. He is the holder of several patents and the author of several peer-reviewed papers in these areas.

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