



US DEPARTMENT OF DEFENSE

BLAST INJURY RESEARCH PROGRAM COORDINATING OFFICE

Orthotics and Prosthetics

Sensing and Actuation Systems for Monitoring and Adjusting the Comfort and Fitting of Prosthetic Socket

After amputation, fluctuations in limb volume throughout the day can affect the fit between the residual limb and a prosthetic socket. This can cause discomfort, skin irritation, and ulcers, and may lead to rejection of the prosthesis. To aid in maintenance of a proper fit, researchers at the University of Texas (Arlington, TX) designed a microstrip patch antenna sensor to simultaneously measure shear and pressure stresses at the limb-prosthesis interface (Huang, *et al.*, 2017). The sensors were implanted in textile material (e.g., denim) and embedded in prosthetic silicone liners, together called a “smart liner.” A compact, portable sensor interrogation unit was developed to enable real-time data collection from the embedded sensors.

In addition, dynamic actuator inserts designed to monitor and modulate pressure at the limb-prosthesis interface were further developed (initial work described in Carrigan *et al.*, 2016). The actuator inserts were integrated into an ankle-foot orthosis device worn by a healthy volunteer to test pressure mapping and modulation capabilities during walking. Upon positive results, both the custom-made liner and the dynamic actuators were integrated to a transtibial prosthesis and tested for feasibility and usability by an individual with transtibial amputation. Data analysis is ongoing, but if successful, the smart liner will enable monitoring of socket fit during daily activities and can be used to guide the adjustment of the dynamic actuator, leading to more comfortable prosthetic sockets.

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REFERENCES:

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- Huang, H. Y., Farahanipad, F., & Singh, A. K. (2017). A Stacked Dual-Frequency Microstrip Patch Antenna for Simultaneous Shear and Pressure Displacement Sensing. *IEEE Sensors Journal*, 17(24), 8314-8323. doi:10.1109/Jsen.2017.2765893

