2016

Ground Reaction Force Measurement with a Piezoelectric Insole

Mohamad Khattab
Cleveland State University

Ground Reaction Force Measurement with a Piezoelectric Insole

Washkewicz College of Engineering

Student Researcher: Mohamad Khattab

Faculty Advisor: Hanz Richter

Abstract

The objectives of this research project are to design and build an instrumented shoe to measure the vertical ground reaction force (GRF) associated with a person walking or running. Sensor outputs are calibrated to actual GRF with an artificial neural network.

Currently, GRF measurements require special equipment such as force plates or scientific treadmills. A force plate measures GRF over a limited area. A shoe insole fitted with sensors was identified as a good solution that allows free-range walking over arbitrary surfaces.

Piezoelectric film sensors were chosen due to their low cost, flexibility and for being self-powered. Eight sensors were bonded to a conventional insole and wires attached. A data acquisition interface was prepared using a dSPACE MicroLabBox system, which contained digital filters for noise removal.

Training and validation data were collected using a force-sensing treadmill available at the Parker-Hannifin Human Motion and Control Lab at CSU. A 3-layer feedforward network was successfully trained to approximate the training data. A separate data set was used to validate the trained network. A normalized root mean square error associated with training was 1.01, while the error in validation was 2.78.