A Piezoelectric Smart Textile Sock for Gait Analysis – A Feasibility Study

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Gait analysis focusing on mobility parameters such as cadence, stance and swing time, and joint angles of hip, knee and ankle, has become a common tool in sports and rehabilitation medicine. Traditionally, gait analysis has been confined to the laboratory as it makes use of the combined inputs from e.g. treadmill, force plates, accelerometers and (3D) video systems. Recent developments in materials science have produced textile based sensors that can be integrated in regular clothing which opens up for ambulatory monitoring outside the lab on a 24-7 basis. *The aim of this study* was to investigate the feasibility of extracting gait information from signals recorded by a smartphone from a newly developed piezoelectric textile sensor integrated in the heel and toe of a smart textile sock.

Signals from the heel and toe of an instrumented sock were recorded from five subjects. A protocol for treadmill walking and running at pre-defined and self-chosen speeds was followed using the three foot-strike types; heel-, mid- and toe-strike, resulting in a database with well-defined walking/running sequences. A software system for gait analysis based on the piezoelectric textile sensor signals was developed, focusing on the timing of heel and toe contact to the ground and foot-strike type identification. A neural network based classification of each step as a heel-, mid-, or toe-strike, was implemented.

Apart from presenting basic gait parameters (cadence, stance and swing time) the developed software system identified foot strike patterns with an accuracy of up to 98%. This demonstrates the feasibility to use the piezoelectric textile sensor for direct measurement of gait related parameters. Further development of the sensor is needed to overcome the signal fade off within 5–20 minutes, which currently limits the smart textile sock's general applicability.