AMBULATORY ESTIMATION OF RELATIVE FOOT POSITIONS USING ULTRASOUND

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ABSTRACT

The recording of human movement is used for biomedical applications like physical therapy and sports training. Over the last few years inertial sensors have been proven to be a useful ambulatory alternative to traditional optical systems. An example of a successful application is the instrumented shoe, which contains two 6D force/moment sensors beneath the heel and the forefoot and two inertial sensors rigidly attached to the force/moment sensors [1]. These shoes can be used for ambulatory assessment of walking kinetics and kinematics. The relative position of the feet is currently not measured directly but estimated from double integration of feet accelerations. However, this method immediately leads to large position errors (drift) when the estimated inertial accelerations are inaccurate.

In this study we investigated the ambulatory estimation of the relative positions of the feet using ultrasound transducers. On one shoe we mounted a 400PT120 Air Ultrasonic Ceramic Transducer (13 mm diameter, 10 mm height, 85º beam angle) sending a 40 kHz pulse to a similar transducer on the other shoe. Using the time of flight, the distance is estimated. Under static conditions a mean error of 5.7 ±0.8 mm was obtained over a range of 5 till 75 cm [2].

From this pilot study we concluded that the distance between the feet can be estimated ambulatory using small and low-cost ultrasound transducers. Future research includes the use of multiple transducers on each foot for a distance measure during different daily-life activities. Also the relative positions of the feet will be investigated by fusing the distance estimates with inertial sensor data.

REFERENCES

[1] H.M. Schepers, "Ambulatory assessment of human body kinematics and kinetics", PhD thesis, University of Twente, 2009.

[2] Arno A.G. Geessink, Bart Verstoep, Frank J. van der Hoek, Michiel van der Coelen, "*Happy Feet"*, Electrical Engineering B2 Project, 2012.