SENSING DYNAMIC INTERACTION WITH THE ENVIRONMENT

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1 Introduction

Study of the dynamic interaction with the environment and loading of the human body is important in ergonomics, sports and rehabilitation.

This paper presents a method to estimate power transfer between the human body and the environment during short interactions and relatively arbitrary movements using a combination of inertial and force sensing.

2 Methods

Power transfer between two bodies is given by:

$$P = \vec{F} \cdot \vec{v} + \vec{M} \cdot \vec{\omega} \qquad (1)$$

Performed work follows by integrating power over time. Angular velocity $\vec{\omega}$ can be measured using rate gyroscopes, velocity $\vec{v}$ can be estimated from accelerometers after rotation to the inertial coordinate system, subtraction of gravitational acceleration, integration and applying adequate start and end conditions. Force $\vec{F}$ and moment $\vec{M}$ can be sensed by a 6 DOF force/moment sensor system [1] (Figure 1).

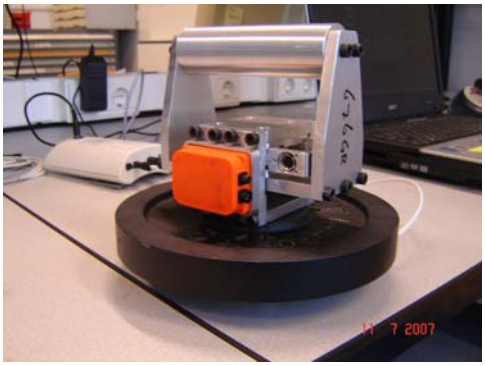

Figure 1. Experimental setup of a handle connected to a mass load, with 3D inertial and force/moment sensors.

3 Results

An example result is shown in figure 2. The mass is transferred from the ground to a 75 cm high table, accounting for a potential energy change of 69 J. The estimated performed work in this case is 70 J.

4 Discussion

The presented method also allows partial characterization of the dynamic characteristics of unknown loads.

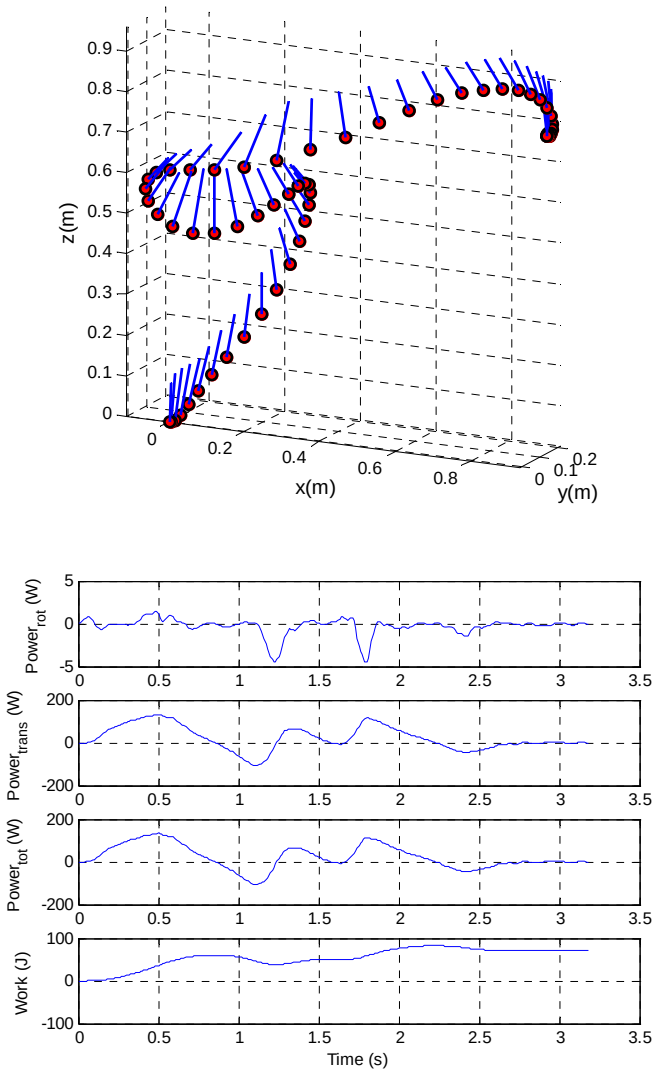

Figure 2. Example measurement showing the feasibility of the PowerSensor concept: Upper: reconstructed position and force directions; Lower: Estimated power transfer and work done.

Acknowledgement

This study was financially supported by the Dutch Ministry of Economic Affairs under the FreeMotion project. Patent application has been filed.

References

[1] H.M. Schepers, B.F.J.M. Koopman, P.H. Veltink, Ambulatory Assessment of Ankle and Foot Dynamics, IEEE Trans. Biomedical Engineering, vol. 54, 2007, pp. 895-902.