MEASURING UPPER LIMB PROSTHETIC DEVICE USAGE FOR MANIPULATIVE AND NON-MANIPULATIVE TASKS

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INTRODUCTION

Despite the high rejection rate of upper limb prostheses (Biddiss & Chau, 2007), few studies have attempted to distinguish between upper limb prosthetic wear time and usage during manipulative tasks. Therefore, in this preliminary study, a wearable sensor was used to collect acceleration data in order to differentiate between a non-manipulative task and a manipulative task. The ability to monitor the task-related usage of an upper limb prosthesis will provide a better representation of its usage and may lead to improved prosthetic design and training practices (Bouwsema et al, 2010).

METHOD

Subjects: One healthy female subject 23 years old.

Apparatus: A wearable Opal sensor (APDM Inc., Portland, OR), the size of a wristwatch, was placed on the subject's right wrist. The Opal sensor includes a triaxial accelerometer, a triaxial gyroscope and a triaxial magnetometer, but only the accelerometer component was used in this study. One major benefit of the Opal sensor is that it can collect data for an entire day on one charge and store up to 28 days worth of data. Therefore, it can be used outside of a laboratory setting and during a person's normal activities of daily living.

Procedures: The subject was asked to walk at a comfortable speed for 20 seconds. The subject was also asked to sit in a chair with their arm resting on a table while holding a glass, and to drink from the glass every 10 seconds, for a total of 50 seconds. Both tasks were repeated 5 times.

Data Analysis: The data from the Opal sensors was exported into MATLAB (MathWorks, Natick, MA). A program was used to filter the raw data with a moving weighted average digital filter, plot the acceleration in the x-direction (which corresponds to anterior-posterior for walking and up and down for drinking) and count the number of actions (tasks) above a threshold acceleration of 6 m/s^2.

RESULTS

An example of the results from one trial is shown in Figures 1 and 2. During walking (Figure 1), all acceleration values were below the threshold and the program did not detect any manipulative tasks. During the drinking task, the program detected five manipulative tasks as shown by the number of peaks above the threshold in Figure 2. These results accurately corresponded to the actual tasks performed by the subject.

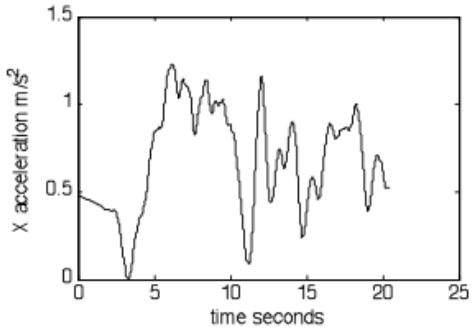

Figure 1 x-acceleration during walking

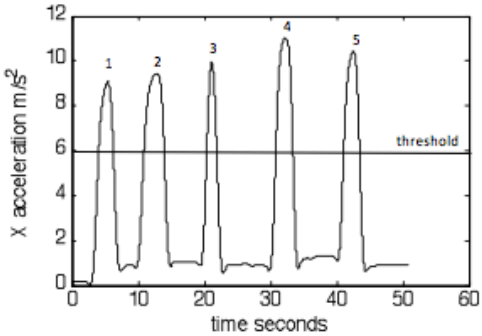

Figure 2: x-acceleration while drinking from a glass

DISCUSSION

The accelerations during walking were all significantly below the threshold and did not yield any false positive readings. Each of the manipulative tasks was well above the threshold and correctly identified by the MATLAB program. Future work will involve more subjects, additional manipulative tasks, prosthetic users and monitoring outside of a laboratory setting.

CONCLUSION

The preliminary results provided a clear differentiation between the manipulative and non-manipulative tasks, demonstrating the effectiveness of a wearable Opal sensor in monitoring the usage of an upper limb prosthesis for manipulative tasks.

REFERENCES

Biddiss & Chau, Prosthet. Orthot. Int.. 31, 236-257, 2007.
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