Development of a lower-back muscle activity sensor system for educational support for care workers

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ABSTRACT

In training institutions for care workers, incorrect operation often causes a pain in the lower-back to trainees. The instructors have difficulty in judging whether the trainees perform an operation correctly without monitoring muscle activity in the lower-back. Accordingly, the purposes of the present study were (a) to produce a sensor to measure muscle activity in the lower-back and (b) to develop the education support system which shows the instructors a simultaneous display of muscle and physical activities in the lower-back and video of the operations. The experimental sensors consist of six channel electromyogram (EMG) sensors, three-axis acceleration, angular velocity and geomagnetic sensors. The software for data acquisition which records data from individual sensors synchronously was developed using LabVIEW 2015. Using this all-in-one experimental sensor system, five subjects had their lower-back muscle activity measured while lifting a dumbbell. The data acquired was compared to the data from the same experiment monitored by existing, commercially available non-integrated systems. Consequently, the experimental system could record the data smoothly from the sensors on the lower-back as expected. The integrated EMG values of the erector spinae muscles obtained by the experimental system and the commercially available EMG system had a strong positive correlation. Hereafter, our work will be to validate the experimental system by comparing the other data sources to existing sensor systems.

Keywords: lower-back muscle activity, electromyogram, care worker, educational support

1. Introduction

In training institutions for care workers, the basic method to master practical skills like a transfer operation is generally to utilize textbooks or videos as a reference for model operations. The instructors might be inclined to teach the skills based on their own experiences. Ono et al. (2010) indicated that incorrect operation often causes a pain in the lower-back to trainees. The instructors have difficulty in judging whether the trainees perform an operation correctly without monitoring muscle activity in the lower-back. Though there is an existing system for monitoring muscle activity, it is very complicated and therefore has not been introduced in the institutions.

Thus, the purposes of the present study were (a) to produce a sensor to measure muscle activity in the lower-back and (b) to develop the education support system which shows the instructors a simultaneous display of muscle and physical activities in the lower-back and video of the operations.

2. Method

Our group measured muscle activity in the lower-back while lifting a weight using an experimental muscle activity sensor system and then compared the data acquired from using the existing system. The Ethics Committee of Industrial Research Institute of Shizuoka Prefecture approved the experimental protocol (No.116-5). Informed consent was obtained from each participant before the experiment.
The experimental system consists of a battery, a microcomputer for control, a Bluetooth module for transmitting data acquired to PC and six channel electromyogram (EMG) sensors. Moreover, three-axis acceleration, angular velocity and geomagnetic sensors were built into the single circuit board (Figure 1). The software for data acquisition which records data from individual sensors synchronously was developed using LabVIEW 2015 (Figure 2).

Shown in Figure 3, five subjects participated in the experiment to lift a dumbbell up to the chest three times with both hands in 24 conditions with three types of weights (0, 4 and 8 kg), two positions of the dumbbell (near and far), angles of the back (45° and 90°) and speeds of motion (50 and 60 bpm show by métronome).

EMG data and integrated EMG values in the erector spinae muscles were obtained at 500 Hz and recorded using both the experimental system and the existing system (MQ8, Kisseicom) simultaneously; furthermore, the acceleration, angular velocity and geomagnetic angle of the trunk were measured synchronously.

3. Results

The integrated EMG values of the erector spinae muscle obtained on each subject showed a strong positive correlation between the two systems (Table 1).

<table>
<thead>
<tr>
<th>Subject</th>
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<tbody>
<tr>
<td>1</td>
<td>0.946***</td>
</tr>
<tr>
<td>2</td>
<td>0.788***</td>
</tr>
<tr>
<td>3</td>
<td>0.945***</td>
</tr>
<tr>
<td>4</td>
<td>0.960***</td>
</tr>
<tr>
<td>5</td>
<td>0.938***</td>
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</tbody>
</table>

\( n = 72 \) for each subject. *** \( p < 0.001 \)

4. Conclusion

The experimental system in this study could record the data smoothly from the sensors on the lower-back as expected. The integrated EMG values of the erector spinae muscles obtained by both systems had a strong positive correlation. Hereafter, our future work will be to validate the experimental system by comparing the other data sources to existing sensor systems.

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References