Knee joint angle measurement using accelerometry based system

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1. Introduction

Today human gait analysis systems are mainly laboratory optics based systems. Sometimes these devices could restrict patients’ natural movements because of their construction and/or weight. Therefore [1, 2, 5] measurement results may be completed by some errors. Secondly, there are no fully-compact systems commercially available, which could provide measurement of selected gait parameters having abilities to be easily connected as feedback to today’s systems.

In this paper authors present competitive measurement methods which allow data collection of selected kinematics parameters of human gait. To do this authors used low-cost, widely available MEMS 3-axis acceleration sensors. Presented methods of knee joint angle measurement was based on gravitation acceleration sensitivity of the accelerometer. A set of 3 electronic devices based on 3-axis MEMS accelerometers has been used [2]. Collected data from those accelerometers were further used for calculations of each sensor orientation.

2. Methods

Calculations were based on acceleration in 3-axis orientation. One of three used methods is described below:

\[ \text{,} \]

\[ \text{,} \]

\[ \text{,} \]

(1)

(2)

(3)

where:

, , - calculated angles,

- measured acceleration for single axis.

Sensors were placed on coronal plane of lower limb like it shows Figure 1a. For calculated angles see Figure 1b.

Fig. 1 a) Sensor placement; b) measured angles
3. Results

All the proposed methods required low computational procedures and gave results that were comparable to optical systems [3, 4, 5, 6]. To compare results given from our system, data was collected simultaneously by BTS optic system. Measurement results are presented in Figure 2.

4. Discussion

Obtained results show that systems based on accelerometers have potential to be widely used in gait analysis. Results for single sensor give already very promising results. Presented system provides measuring, counting and analysis, when surveying is proceeded. This is exceptional when compared to optical systems. Low computational procedures is the biggest advantage of this system. Secondly, this system is cheaper than today's popular optical systems. These systems may take advantages in many other disciplines such as applications in robotic, for example robot stabilization using orientation measurements.

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References