MARKERLESS VS MARKER-BASED KINEMATICS A CONCURRENT VALIDITY STUDY

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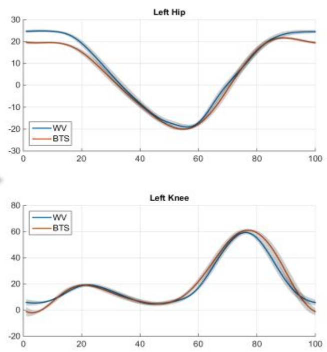
INTRODUCTION

In this study, the hip and knee sagittal angles provided by the Walker View (WV) medical treadmill (Tecnobody srl, Bergamo, Italia) have been compared to those provided by a traditional motion capture system (BTS Smart-DX, BTS, Milan, Italy). This was used as a gold standard. The WV is equipped with a markerless motion capture system.

Hip and knee sagittal angles provided by the Walker View (WV) medical treadmill (Tecnobody srl, Bergamo, Italia) have been compared to those provided by a traditional motion capture system (BTS Smart-DX, BTS, Milan, Italy) used as a gold standard. We computed the coefficient of determination R^2 and the root mean square error over the cycle (RMSE).



Comparison between the mean hip and knee sagittal angles provided by the two systems during treadmill walking at 1 km/h, in one subject.

R^2walking>0.95

R^2running>0.83

RMSE@Hip = 1 – 6 °

RMSE@Knee = 4 – 12 ° , increasing with speed

Main results of the comparison are summarized above. The WV system appears suitable to be used in rehabilitative settings, where walking speed is typically low.

METHODS

The WV device was placed in the middle of the calibrated volume of the BTS system.

Reflective markers were placed on subjects according to the Helen-Hayes protocol. These were used with the BTS system only, so as to compute the position of the body segments within the calibrated volume. The WV devices used its emboldebbed markerless (video-based) motion capture system, to obtain the position of the body segments.

Three healthy subjects were enrolled in the study. A static calibration and three repetitions on treadmill when walking (1, 3, 5 Km/h) and running (8 e 12 Km/h) were acquired for each subject using both devices simultaneously and independently. Three repetition of each trial were performed (3 trials at 5 speeds per 3 subjects). For each trial, 10 consecutive strides (6-15 from the start) were analyzed.

Data from ten consecutive strides were resampled over the gait cycle, averaged and compared using the method proposed in [1]. In this work, we focused on hip and knee sagittal angles.

We computed the coefficient of determination R^2 and the root mean square error over the cycle (RMSE) expressed both in degrees and as a percentage of the joint range or motion during the walking/running trials.

RESULTS

- For both angles and for all subjects, R^2 was greater than 0.95 in all walking trials and greater than 0.83 in the running trials.
- Average RMSE among subjects was comprised between 1 ° and 6 ° at the hip and between 4 ° and 12 ° at the knee, increasing with speed.
- At the knee, RMSE in swing was affected by speed, namely by the amount of knee flexion peak during the swing phase.
- On average, RMSE expressed as a percentage of the dynamic joint range was equal to 5.8 ± 1.5% during walking and to 7.8 ± 1.5% during running.

CONCLUSION

The error in hip and knee sagittal angle estimation of the WV system is similar to that found for between-labs assessment of the same subject [2]. It is also similar to that found for systems based on wearable units (IMUs), which are validated for the use in routine rehabilitation of the lower limb in orthopedic patients [3]. The WV system appears therefore suitable to be used in a rehabilitative setting.

REFERENCES

[1] Iosa et al, *Biomed Res Int.* 2014. [2] Benedetti et al. Gait Posture, 2013. [3] Leardini et al, J NeuroEng Rehab 2014.