2021 International Symposium on Advanced Technology (ISAT-19)

Extended Abstract

Development of infants suits for motion measurement

Yu Amagasaki[1, a *], Shigeo Yamashita[2], Shinichiro Morichi[3], Hisashi Kawashima[3], Gaku Yamanaka[3], Satoru Kizawa[4] and Ayuko Saito[1,b]

[1]Department of Mechanical Science and Engineering, School of Advanced Engineering, Kogakuin University, Tokyo, Japan

[2]nac Image Technology Inc., Tokyo, Japan

[3]Department of Pediatrics and Adolescent Medicine, Tokyo Medical University

[4]Department of Mechanical Engineering and Robotics, National Institute of Technology (KOSEN), Akita College, Akita, Japan

[a]s518003@ns.kogakuin.ac.jp, [b]saito@cc.kogakuin.ac.jp

Abstract

Measuring postures and movements of infants and discovering a pattern for their typical characteristics are useful for early screening of infants at developmental risk. Although the optical 3D motion analysis device has the advantage of high accuracy compared with other motion measurement methods such as inertial sensors, reflective markers give the burden on infants. In this research, we developed a measurement suit for an infant using 2D reflective stickers that could be used to measure the motion by an optical 3D motion analysis device. Since the 2D reflective stickers would not make the subject feel uncomfortable during wearing the measurement suit, it could reduce the burden on infants. We measured the movement of a healthy infant using 2D reflective stickers and conventional reflective markers. The results for the knee and hip joint angles obtained using the stickers and markers were almost the same, and the same tendency was shown for the ankle joint angles.

Keywords

Infant, Motion analysis, Reflective marker, Reflective sticker, Suit

1. Introduction

Measuring postures and movements of infants and discovering a pattern for their typical characteristics is useful for early screening of infants at developmental risk. An optical 3D motion analysis device is widely used in human motion measurement [1][2]. The device, however, requires 30 to 40 reflective markers to be attached to the body when using the conventional motion analysis model. Therefore, an optical 3D motion analysis using the conventional motion analysis model requires a long time and is not suitable for measuring the movement of infants. Nevertheless, the optical 3D motion analysis device has the advantage of high accuracy compared with other motion measurement methods such as inertial sensors. The optical 3D motion analysis using quite very few reflective markers can be expected to be applied to the measurement of infants because reducing the number of reflective markers to be attached to the body contribute to reducing the burden on the subject. In this research, we developed a measurement suit for infants using 2D reflective stickers that could be used to measure the motion by an optical 3D motion analysis device. Since the 2D reflective stickers would not make the subject feel uncomfortable during wearing the measurement suit, it could reduce the burden on infants. We measured the movement of a healthy infant using 2D reflective stickers and conventional reflective markers. Finally, we evaluated the measurement accuracy of the suit developed by using 2D reflective stickers.

2. Motion measurement suit for infants

Fig.1 shows the motion measurement suit for infants proposed in this study. Hook and loop fasteners were attached to the surface of the suit, which enabled to attach and detach reflective stickers to fit the joint positions.

3 Experiments

3.1 Subject and measuring device

A 2-year-old healthy boy participated in the experiment. Following an explanation of the purpose and requirements of the study, the

Fig.1 Motion measurement suit for infants

(a) Reflective sticker *(b) Reflective marker*

Fig.2 Reflective sticker and reflective marker

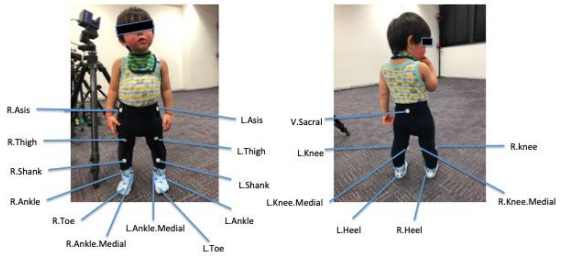


Fig.3 Marker positions

participant's parent gave her written informed consent to the participation of her child in the study. Study approval was obtained from the Research Ethics Board, Kogakuin University. During the experiment, kinematic data were collected using an optical three-dimensional motion analysis device (MAC3D, MOTION ANALYSIS Co. Ltd.).

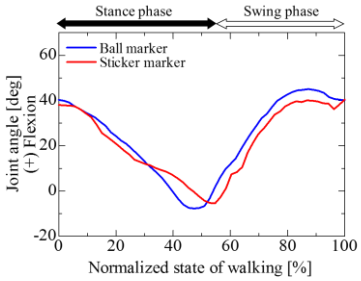
3.2 Conditions

Fig.2 shows a reflective sticker and a reflective marker. The sticker and marker positions were decided referring to the Helen Hayes marker set (Fig.3)[3]. After starting the measurement, the infant started walking at his own timing.

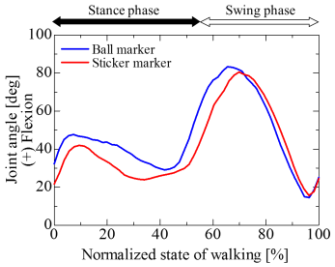
The sampling frequency of the optical three-dimensional motion analyzer was 100 Hz.

3.3 Results

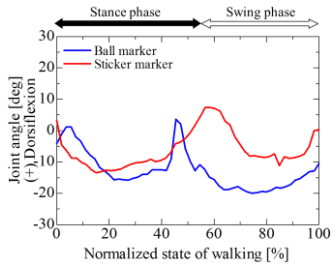
Fig. 4 shows the results of the lower limb joint angles. The horizontal axis shows the normalized time with one gait cycle including one stance phase and one swing phase as 100%. The vertical axes are the joint angles, in which the positive values are the hip and knee joints' flexion, and the ankle joint's dorsiflexion. The blue solid



(a) Hip joint angles



(b) Knee joint angles



(c) Ankle joint angles

Fig.4 Results of the lower limb joint angles

curves represent the results obtained using the conventional reflective markers, and the red solid curves represent the results obtained using the reflective stickers. The results for the knee and hip joint angles obtained using the stickers and markers were almost the same, and the same tendency was shown for the ankle joint angles.

REFERENCES

[1] Stief F., et al., Reliability and accuracy in three-dimensional gait analysis: A comparison of two lower body protocols, Journal of Applied Biomechanics, 29-1, pp.105-111, 2013.

[2] Nazareth A., et al., Effect of Tibia Marker Placement on Kinematics in Pathological Gait, Journal of applied biomechanics, 32-6, pp.603-607, 2016.

[3] Thomas, D. C. et al., A six degrees-of-freedom marker set for gait analysis: Repeatability and comparison with a modified Helen Hayes set, Gait & Posture, 30(2), pp.173-180, 2009.