BIOMECHANICAL MEASURES FROM USING SMART BODY-WEAR SENSORS FOR GAIT ANALYSIS

Abstract

There has been remarkable growth in the use of smartphone applications as a means of describing human movement. Accelerometer sensors in smartphones can be used to detect human movements and define gait characteristics. Photogrammetry approaches are used to study human gait for a variety of purposes such as medical, forensic and sport performance. This is a shift from insole sensors which were widely used to study human movements in recent decades. Importantly, each of the mentioned techniques can provide sets of data leading to a better understanding of human gait. For example, data extracted from insole sensors can be related to force and pressure, accelerometers mainly provide spatial-temporal parameter data, and photogrammetry data can better describe joint location (kinematics) during walking. However, there is a lack of research literature assessing the accuracy of such smartphone use. Thus, the main aim of this work was to provide evidence for the applicability of smartphones as an effective tool for collecting biomechanical data and assessing human gait during walking. The current research work aimed to fill this gap in the literature by using a set of objectives comparing smartphones with other techniques.

The first objective was to identify existing accelerometer measurement data obtained from smartphone devices and evaluate this data by comparing captured data with camera image-based photogrammetric data. The data were collected during walking trials. Smartphones were attached to the subject's knee joints, and cameras were placed around a 5m-walkway at specific positions. Ten subjects (with no prior injury, disability or illness) were recruited and asked to perform a two steps walking

trial, with five repetitions. The results indicated that the linear location values for the whole stance phase are relatively similar and closer to that of a camera's 3D location in the x y planes (Z direction) (R= 0.935) which supports the hypothesis of our research that the smartphone can be utilised as tool for gait characteristics measurements. The remaining research objectives were to develop a new methodology for smartphone sensor device analysis of spatiotemporal gait parameters, and to compare the spatiotemporal data between the smartphones and F-Scan insole sensors during walking. Data were collected from both the triaxial accelerometer embedded in the Samsung S9 cameras and insole sensors. Two smartphones, one attached to each lower limb, were used in this experiment. Thirty subjects were asked to walk along a 10-m walkway at a laboratory setting at the Exercise and Sport Science Centre at the University of Southern Queensland (USQ). Data for the four parameters of step time, stride time, cadence and walking speed were collected during walking. The results pointed out close data readings from both devices. For example, the step time findings were (0.68±0.02 insole) and (0.69±0.03), and the stride time findings were (1.21±0.05 insole) and (1.21±0.05). From the results of the four parameters, it was noticed that there is a high agreement between the smartphone and insole sensor when measuring gait parameters.

Furthermore, these results demonstrated that the smartphone sensor can efficiently measure the spatiotemporal gait parameters of healthy adult participants. Thus, smartphone sensors can provide reliable data without the need for expensive devices. Finally, the proposed study will help experts work more efficiently and objectively, and at less expense when evaluating gait.