THE DEVELOPMENT OF A LOW COST MOTION ANALYSIS SYSTEM: CEKAK VISUAL 3D V1.0

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ABSTRACT: To date, there is lack of biomechanical characterisation on defensive technique (martial arts) due to the unavailability of appropriate motion tracking system that can be used to characterise the technique in quasi-training environment. Therefore, this paper presents the development of a novel low cost motion analysis system, Cekak Visual 3D v1.0 which is capable to track dual martial art practitioner's skeleton motion in a single frame view using integration of Matlab GUIs and Microsoft Kinect. The accuracy and precision of the coordinate data recorded by the system was tested to ensure the quality of the system. The systems perform the tracking motion with a single Kinect which is a combination of various sensors (RGB and depth sensor) thus makes it capable in providing three dimensional coordinate data. The analysis reveals that Visual Cekak 3D v1.0 resulted lower percentage error with high internal consistency (Cronbach Alpha, $\alpha = 0.904$). The proposed marker-less system is capable to track and store dual skeleton data in a single session tracking. This capability makes the systems suitable in providing quasi-training and natural setting environment for any martial arts biomechanics investigation. Therefore, we believe that the system provide new concept development for basic research in martial arts biomechanics.

Keywords: Cekak Visual 3D, Low Cost, Martial Arts, Motion Analysis System, Seni Silat Cekak Malaysia

1. INTRODUCTION

Motion capture is a process where a movement can be recorded digitally and most commonly used in Martial Arts Biomechanics [1]–[3]. Analysis on trends of publications each year reveals that motion capture technology as a research tools is currently attracting more attention from the martial arts biomechanics community [4]. Shinagawa and Nakajima (1997) for instance, have used this method to analyse human stability by capturing body movement by using a few camera video [5]. The system is then used to analyse Shorinji Kempo, a technique in Chinese Martial Art in order to verify the three dimensional analysis system. The motion capture activities is also observed in Wong and Fok (2007) work on stance position effectiveness study in providing striking force in aspects of Tai Chi Chuan (side kick, roundhouse kick, rising kick, straight punch) with the aid of the smart motion capture system. Recently, Motion Capture (MoCap) Systems like the Vicon (U.K) and Eva Real Time (U.S.A) is available to serve the need in biomechanics study and was observed has been used to characterize pushing and kicking technique [6], [7]. The capability to rapidly track (multiple points) small and high speed movement in three dimensional space [8], [9] maybe the reason on why Motion Capture technology are more popular compared to others available research tools.

Despite its popularity, motion capture technique possesses several limitations. Existing motion capture system requires multiple expensive high performance cameras structured and calibrated within a controlled environment system (dedicated room, tracking suit and lighting capacity) [6], [9], [11], [12]. Due to that, this technology must undergo complicated set up for the advanced hardware that makes the process complex resulting difficulties for the system to be used in quasi-training environment such as sport field and training studio [13]. The cameras restrictions also create another drawback which is the markers placement. The marker attached will probably affect the subject's movement and its placement is time consuming [14].

Factors mentioned encourage the exploration towards low cost and portable solution [10], [15]. There are several potential devices that can replace the role of expensive high performances cameras such as web cam, depth cameras and RGB sensor [16]–[18]. Recently, the availability of Kinect[TM] sensor released by Microsoft Corporation in 2010 offers a great potential to be used as an alternative low-cost motion tracking tool. This cost effective, light and portable devices [14] is capable to substitute the role of digital high speed camera with the ability to provide an array of three dimensional coordinate data. Thus, this features contributed in a large number of applications such as 3D measurements, angle measurements, gait tracking, postural control observation, motion assessment, rehabilitations, ergonomics, coaching, metrological evaluation as well as the martial arts biomechanics