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Biomechanical Validation of Upper-body and Lower-body Joint Movements of Kinect Motion Capture Data for Rehabilitation Treatments

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***Abstract*—New and powerful hardware like Kinect introduces the possibility of changing biomechanics paradigm, usually based on expensive and complex equipment. Kinect is a markerless and cheap technology recently introduced from videogame industry. In this work we conduct a comparison study of the precision in the computation of joint angles between Kinect and an optical motion capture professional system. We obtain a range of disparity that guaranties enough precision for most of the clinical rehabilitation treatments prescribed nowadays for patients. This way, an easy and cheap validation of these treatments can be obtained automatically, ensuring a better quality control process for the patient's rehabilitation.**

***Keywords*-motion capture; markerless motion capture; depth camera**

I. Introduction

Motion capture techniques are used over a very broad field of applications, ranging from digital animation for entertainment to biomechanics analysis for clinical and sport applications. Although there are other technologies, like inertial [1] or electromagnetic sensors [2], at present, using optical systems with reflective markers is the most common technique [3] [4]. Despite their popularity, marker based methods have several limitations: usually a controlled environment is required to acquire high-quality data and the time required for marker placement can be excessive [5][6]. Several recent review articles have summarized the common shortfalls of skin based marker techniques [7] [8] [9]. Markerless motion capture [10] [11] offers an attractive solution to the problems associated with marker based methods, but the general problem of estimating the free motion of the human body is under-constrained without the spatial and temporal correspondence that tracked markers guarantee.

From the powerful game industry new devices like Kinect [12] have appeared, allowing to interact with game consoles in real time. Moreover, this new hardware is considerably cheaper than the usual complex multi-camera systems. Kinect can be thought as a 3D markerless motion capture system because it gives you a simplified skeleton in real time. No especial dress or other equipment is required. The skeleton is made of 15 joints and due to its simplification it cannot be used (by now) for very accurate studies. Because of that, we aim to use it when such accuracy it is not needed, like clinical rehabilitation where the correctness of a motion can be validated without been extremely precise. For these kind of applications, in this paper we consider the validation of the Kinect data in terms of joint angles when motion of the main limbs is involved. We compare these data with a professional motion capture equipment and we compute the error along the complete capture.

For the biomechanics community and clinical therapy in general, it is needed a validation of the precision of this new devices and to understand the possible appropriate applications for these cheap and portable technology. As it is shown in section 4, the obtained accuracy for the measurements of the angle joints are enough for most of the prescribed exercises in rehabilitation treatments. As a consequence of our study, we have implemented Rehabtimals. Rehabtimals is a rehabilitation framework that covers all phases in physical rehabilitation cycle allowing patients recover from their injuries by playing with a serious game at their homes.

The rest of the paper is organized as follows: in section 2 we relate some previous work, section 3 describes the equipment used in our study, section 4 describes the motion capture performance and in section 5 we present the results.

II. Related work

A. Motion Capture and Rehabilitation

The interest of some videogames researchers towards use videogames in physiotherapy, occupational therapy, and psychotherapy increased last years. Many physical therapies are based on repetition to achieve a range of motion or control over a specific muscle group. That process is done without any external encouragement [13] and causes patients losing motivation during the therapy and the rehabilitation becomes slower and frustrating. By developing a serious game as a rehabilitation tool, we achieve the motivation associated to games. Low cost technologies like webcams

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