MOVE 4D: Accurate High-Speed 3D Body Models in Motion

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Figure 1: Sample frames of a 3D-in-motion sequence captured with MOVE4D

Abstract

This paper describes the features and outcomes of a novel 3D/4D scanner developed by IBV. MOVE4D modules can be set up for different spatial, resolution and frequency requirements to cover a wide range of biomechanical applications in apparel, sports and health. MOVE 4D software automatically processes of the captured point clouds to provide dense watertight 3D meshes in motion, which vertices can be traced along the motion frames.

Keywords: Anthropometry, temporal scanning, 4D, artificial intelligence, data-driven, body model, human motion, markerless, motion analysis, image processing, 3D body model, shape, pose, soft-tissue deformation

1 Introduction

Nowadays, 3D body scanners [1], [2] are used in many industrial and health applications [3]–[9]. Typically, a single body scan of a person minimally clothed in A-pose is obtained to get measurements or 3D surfaces that are used to develop a garment, a helmet, an orthotic device or a shoe. However, the use of most of these wearable products also involves human motion. To cope with this need, different technologies have been developed over past years to obtain 3D scans over time (so-called *temporal 3D scanners* or *4D scanners*).

The ability to process a 3D scan is essential to obtain accurate metrics and “clean” and complete 3D models that facilitate product design and virtual simulation. The automatic processing of markerless human 3D scans is not trivial, especially in non-standard poses. It becomes even more challenging in the case of processing a series of 3D scans of humans performing real-life or sports movements.

2 MOVE4D Features

We have developed a modular photogrammetry-based 3D/4D capture and analysis system. It consists of a set of synchronised 4D scanning modules and a processing software (Figure 2). The system can be configured to scan body parts or full bodies with texture. A typical full body configuration (Figure 3) can provide a spatial resolution of 1mm. Depending on its configuration (Table 1), it can capture up to 180 fps. The software has been conceived and optimized to automatically process the raw point clouds captured (it does not require intermediate 3D mesh reconstructions). The processing software relies on deep learning and a data-driven body model including shape, pose and soft-tissue deformation. The processing software is fully automatic for full bodies, and does not require any interactive landmarking or revision.

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Figure 2: Detail of MOVE4D module

Figure 3: MOVE4D at Human Analysis Lab (HAL)

Table 1: Summary of technical specifications

Optic unit resolution	1 mm (hires), 2 mm (midres)
Capture frequency	90-180 fps
Scanning time	1 ms
Footprint	5.5m x 5.5m (12 units configuration)
External synchro	Trigger and synchro input/output
Capture	Simultaneous 3D and texture
Lighting	Inbuilt lighting system

3 MOVE4D outcomes

For full bodies, as 3D outcome, it provides one noise- and artefact-free watertight dense mesh (99K tri faces) per frame (figure 1). The 3D meshes of one sequence can be provided with point-to-point correspondence (50K landmarks) and can also be rigged (23-joint skeleton). This type of outcome can be suitable to seamlessly interface 3D digital applications such as CAD, simulation, AR/VR, video-games, cinema, etc. In addition to 3D outcomes, the processing software can also automatically extract a set of body measurements at single 3D frames in standard poses. Other metrics such as non-standard measurements and joint angles can also be obtained and tracked along the motion sequence captured. These features can facilitate the use of 3D/4D body scans in biomechanical analyses in sports applications and health-related assessments. MOVE4D is ready to be easily synchronized with other laboratory equipment by means of synchro signal.

4 Further works

MOVE 4D modules and software have been firstly installed into the new Human Analysis Lab (HAL) at IBV facilities (Valencia, Spain). It is expected that HAL will be open for companies and researchers before the end of 2019 (Figure 3). The first study to take place in HAL is the Phase 2 of the Comparative Analysis of Measurement Methods of 3D Body Scanning entitled ‘Past, present and future of 3D body scanning’ (14^{th} to 18^{th} October 2019). This study is coordinated by IEEE Industry Connections – 3D Body Processing (IC-3DBP) working group (https://standards.ieee.org/industry-connections/3d/bodyprocessing.html). Data gathered in this study will be used to compare different body measuring technologies, namely traditional anthropometric methods, 3D scanners and smartphone apps available in the market.

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