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Gait analysis using augmented reality markers

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ABSTRACT

The protocol provides guidelines, preparation and execution instructions to perform and process a gait analysis trial by a novel motion capture method using virtually calibrated anatomical points tracked by augmented reality (AR) markers.

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Protocol status: Working
We use this protocol and it's working

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PROTOCOL integer ID:
12665

Keywords: gait analysis, augmented reality

GUIDELINES

Marker preparation

Use wide elastic bands to fix markers on the body segments in order to minimize soft tissue artefact.

Adjust the measurement setup so that all markers are continuously visible by the camera. During anatomical calibration, the marker on the calibration wand and the marker of the calibrated body segment needs to be visible by the camera.

Camera

The accuracy of AR marker pose estimation depends mainly on the quality of camera calibration, which eliminates optical distortions and sets the resolution of input images and marker size on the image in pixels. For the AR marker detection algorithm, a high shutter speed is important to avoid unrecognizable blurry images at faster motions. From the viewpoint of gait analysis, the highest possible frame rate (fps) is required for high temporal resolution. It is also essential for the camera to have a fixed zoom and fixed focal length because camera calibration is valid for fixed values of these parameters.

MATERIALS

MATERIALS

✂ GoPro Hero 5 Black action camera **Contributed by users**

✂ AprilTag AR marker detection software **Contributed by users**

✂ Custom software to perform homogeneous coordinate transformation to calculate the coordinates of the calibrated anatomical points relative to the AR markers **Contributed by users**

✂ AprilTag markers rigidly attached to a rigid bent plate (e.g. commercial shin protectors) that are fixed on the body segments using wide elastic bands **Contributed by users**

✂ OpenSim biomechanical analysis software **Contributed by users**

BEFORE START INSTRUCTIONS

The camera used needs to be calibrated using e.g. OpenCV

(https://docs.opencv.org/2.4.13.4/doc/tutorials/calib3d/camera_calibration/camera_calibration.html)

Kinect v2 (color video recording)	Full HD (1920 x 1080 pixel)	30	cannot be set	1034.68	$k_1: 0.0312$ $k_2: 0.0450$ $k_3: 0.0049$
GoPro Hero 4 Silver	Full HD (1920 x 1080 pixel), narrow mode	60	cannot be set	1641.94	$k_1: 0.2971$ $k_2: 0.1752$ $k_3: 0.0755$
GoPro Hero 5 Black	2.7k (2716 x 1524), linearmode	50	1/200	1483.71	$k_1: 0.0$ $k_2: 0.0$ $k_3: 0.0$

GoPro Hero 5 Black	4k (3840x2160), wide mode	25	1 / 100	1775.89	k_1 : -0.2534 k_2 : -0.00894 k_3 : -0.0167
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*Modes in GoPro cameras refer to the field of view option of the device; Kinect v2 has only a fixed wide field of view

** p_1 and p_2 distortion parameters are equal to 0 in each setup. For details see OpenCV camera calibration manual.

- 1 Attach the AR markers on the corresponding body segments (for gait analysis: pelvis, thighs and legs)

- 2 Start recording and perform anatomical calibration on the subject using the pointer after palpating the calibrated anatomical points.

- 3 Record the gait trial.
- 4 Upload the video takes to a computer.
- 5 The calibration and gait trial video files are processed offline by the image processing software where the frames of pointing to anatomical landmarks are selected manually.
- 6 After this manual post processing a file is available with the calculated marker trajectories during the trial in a standard .trc file format.
- 7 A third party open-source biomechanical analyzing software (OpenSim) can be used to calculate gait parameters.