

MOTION CAPTURE SYSTEM VALIDATION WITH SURVEYING TECHNIQUES

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1. Introduction

Studies with motion capture measurements should always consider system errors when evaluating their results, but it's rarely done. Validation studies evaluate the accuracy of motion capture systems in the form of measuring the detected deviations of coordinate distances of rigidly fixed markers in various places of the measuring volume [1]–[4], or by measuring small relative translations [5]. The present study aims to analyze the absolute volume accuracy of a 18 camera OptiTrack Flex13 motion capture system using a geodetic reference points.

2. Methods

2.1 Setup

The independent control network used for the quality control of the OptiTrack system has been created as a 0.5m raster grid with the total dimension of 4m x 2.5m. The grid points of the control network was set out using a Leica TS15i 1" Total station. The local coordinate system was aligned approximately with the orientation of the grid. We considered important to check the marked control points with independent measurements. The coordinates of the two independent observations were compared, and the mean three dimensional coordinate residual between the two measurements was 0.758 (0.315) mm with maximum residual of 1.672 mm. The final coordinates of the control points were calculated as the mean value of the two coordinate solutions. Thus it can be stated that the accuracy of the coordinates of the control network is 1mm in the worst case scenario.

2.2 Measurement protocol

Retro reflective markers (diameter: 8mm) are used for all motion capture measurements. These markers were placed on the geodetic reference points onto their bore on the bottom with the

possible largest precision to measure the reference positions by the OptiTrack system (Fig. 1). However, this process includes human inaccuracy on the placement of the markers. Therefore to give a statistical basis for the marker placement the whole process was repeated by four people, 10 repetition each. The average coordinate of the 40 repetition of each calibrated reference point will approach the true position of the reference points. Measurements were recorded in the Motive software (NaturalPoint, OR, USA) for 30 seconds, at 120 Hz.



Fig. 1. IR marker placed on the geodetic reference point.

2.3 Determination of absolute accuracy

The comparison requires the matching of the geodetic and the OptiTrack coordinate system. OptiTrack coordinate system can be assigned with three markers designating the origin, a point on X axis and a point on X-Z plane. Three of the geodetic reference points were used for this purpose to define a simple transformation between the two coordinate systems. Two dimensional deviations between the coordinates of the geodetic reference points and the average coordinates of the repeatedly placed markers measured by the OptiTrack system were analyzed. Mean, standard

deviation and RMS of the 2D deviations and correlation between the observed error and the distance from the origin was calculated to characterize the error of the system.

3. Results

Results on the comparison of reference coordinates and measured average coordinates of the markers showed significantly larger deviations than the reliability of the reference coordinates. The errors are characterized by RMS deviation: 1.735 mm, average deviation: 1.576 (SD: 0.733 mm) and maximum deviation of 3.072 mm. Deviations of the marker coordinates from the reference coordinates showed strong correlation to their distance from the reference frame origin (correlation: 0.81). This high positive correlation suggested that there must be a scaling factor behind the observed errors as seemingly the virtual space is a bit larger than the real space.

The observed average error vectors of each measured points are indicated on Fig. 2. Error vectors are displayed in hundredfold magnification for sufficient visibility.

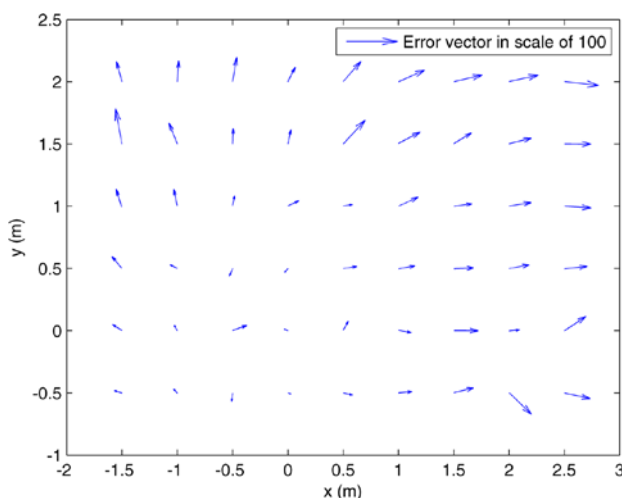


Fig. 2. 2D deviation vectors of the detected average marker coordinates and the geodetic references. Vector magnitudes are scaled with 100% for visibility.

4. Remarks

- The study analyzed the absolute accuracy of a 18 camera OptiTrack Flex 13 motion capture system using geodetic reference points, which method is capable to detect inaccuracies of the system that are undetectable using conventional camera system validation methods.

- A distance dependent distortion in the measurement volume was detected that is owed to scaling errors that can be compensated after detection.
- Similar validations should be performed on every camera system that is used for precise robotic or human motion analysis.

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