Dynamic Calibration of an Extended-Range Electromagnetic Flock of Birds Motion Tracking System

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INTRODUCTION

Electromagnetic (EM) motion tracking systems are a popular alternative to optical motion tracking systems. EM systems provide both position and orientation data from each sensor and can be used in environments with line-of-sight obstructions that would limit the use of camera-based systems. However, the presence of metal in the environment distorts the electromagnetic field and can cause significant errors [1,4]. Calibration procedures have been developed to improve accuracy by characterizing the distortion [2,3,4]. Previous efforts have used specialized fixtures with carefully controlled geometry to generate the reference data for calibration.

A new calibration technique is proposed that uses an optical motion tracking system as the source of reference data. The electromagnetic sensors are attached to a hand-held calibration wand that is also marked with optical targets. The wand is moved throughout the capture volume while data are gathered from both systems. Translation and rotation offsets are calculated for volume elements (voxels) of the capture space and subsequently applied to data from the electromagnetic system using an interpolating kernel.

METHODS

An Ascension Technology 'Flock of Birds' (FOB) electromagnetic tracking system with an extended range transmitter (ERT) was calibrated. Four sensors reporting both position and orientation were sampled at 50 Hz. Optical data were obtained using a Qualisys ProReflex MCU240 6-camera tracking system at 50 Hz. Five reflective markers, 25 mm in diameter, were placed on the wand, as shown in Figure 1. The configuration of the wand allowed the orientation of the FOB sensors to be calculated from the optical data.

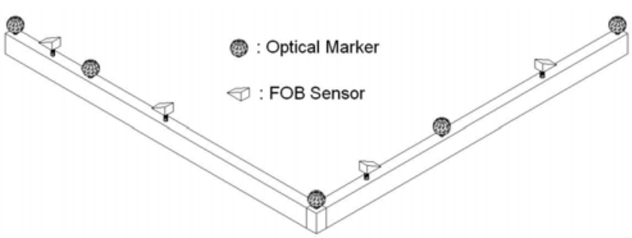

Figure 1. Calibration wand, showing optical markers and electromagnetic sensors.

The FOB system was calibrated throughout a 3.6 x 4.8 x 2.0 m volume adjacent to the FOB transmitter. Data were gathered simultaneously from the two systems as the wand was moved slowly through the capture volume. Data were collected for 3 to 5 minutes for the main calibration dataset. The optical data were examined to verify that the capture volume was adequately spanned. Holes in the calibration dataset were filled with shorter 1-2 minute trials.

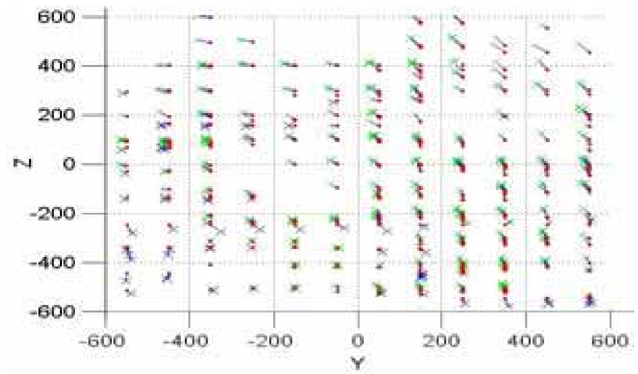

Figure 2: Positional offsets for all voxels in subset of the measurement volume.

Locally weighted linear regression was used to interpolate the scalar positional offsets for the FOB output position using a method similar to that reported by Day et al 2000 [2]. A Gaussian kernel centered at the FOB output position was used to determine weighting factors for the local regression. Orientation offsets were decomposed into Euler angles and handled in a similar fashion.

RESULTS AND DISCUSSION

Three-dimensional translational offsets are shown for a subset of the capture volume (Figure 1). Voxel size is $50mm^3$. Circular dots indicate the reported FOB position and the connected cross is the associated global position. In practice, voxel size can be varied depending on the observed local field distortion, or the data can be used directly in the local interpolating functions, rather than aggregated into voxels. The accuracy with which the EM data match the optical data can be controlled in part by adjusting the density of the data gathered. Visual and quantitative tools provide feedback during the calibration process of the accuracy of the fit, allowing additional data to be gathered where needed.

Most previous approaches to EM system calibration have used specially constructed fixtures to move the EM sensors throughout the capture volume. The method reported here is faster and can easily be used around obstacles or with a changing environment. One group has reported using an optical system to obtain reference data [4], but only to improve the accuracy of measurements from a fixed-position calibration grid. Although the current approach is only practical when an optical system is available, it provides a relatively fast and accurate way of ensuring that data gathered from the two systems can be accurately merged for analysis.

REFERENCES

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