Calibration of Electromagnetic Tracking Systems

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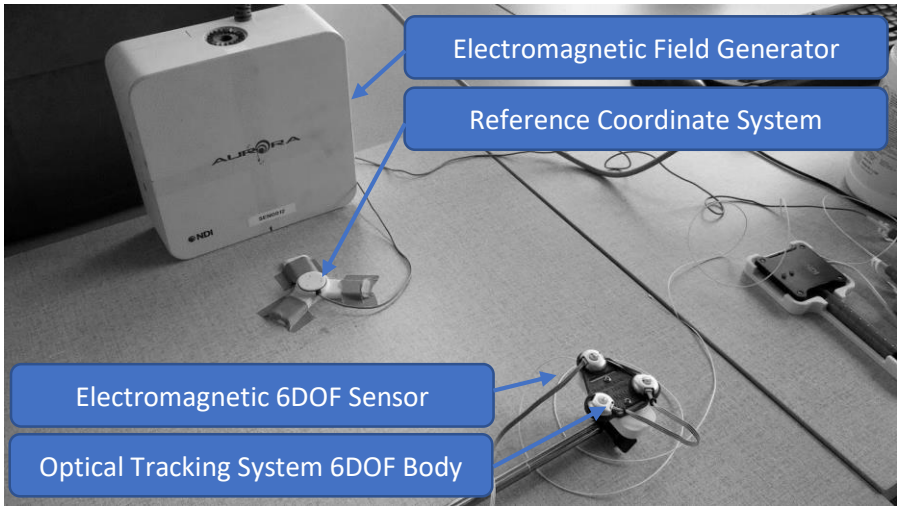

Figure 1 - Apparatus for Measuring Ground Truth Position and Orientation of EMTS Sensors using OTS

Electromagnetic tracking systems(EMTS) are able to provide tracking of motion in a six degree of freedom space with a high level of precision. The system functions by generating a magnetic dipole and measuring the field intensity and gradient at a given point to produce a 6 degree of freedom(DOF) transformation for that pose. The field is easily distorted by ferromagnetic objects, causing the system to provide inaccurate results. This provides a challenge for application of EMTS to a medical setting, where the clinical environment is present with many field distorting objects. It is possible to calibrate the system against the ground truth pose of the sensor. Ground truth poses are typically provided by a second system, such as an optical tracking system(OTS), which localizes infrared diode markers by capturing images in multiple views and measuring the marker position in each 2DOF plane. These 2DOF locations in each view are combined to find the 3DOF location of a marker, and with multiple markers it is possible to produce the 6DOF ground truth pose of an object. Assuming calibration is effective, EMTS is well suited for use in a medical environment because unlike OTS it does not require line of sight to markers, and sensor sizes are significantly smaller than OTS markers.

We performed an extensive literature review to develop an understanding of the current state of calibration techniques, and whether EMTS is a fit for future application to our lab's projects. Based on this review, we concluded that it is possible to calibrate the system to our desired level of accuracy and moved forward with developing our own calibration technique. We developed a program for simultaneous capture between the Aurora EMTS and Optotrak OTS, and performed experimentation to validate the synchronicity of the systems, as well as field distortion induced by our ground truth system. Following this, we implemented a proof of concept calibration algorithm utilizing nearest-neighbor spatial interpolation, and fourth-order polynomial fits to reduce error in position and orientation.