Marker-Based Motion Capture using Consumer Cameras

Motion capture systems that deliver high-quality data are expensive and specialized on their application. State-of-the-art systems use markers to generate motion models of the measured object. CSEM SA has developed tags that enable low-cost localization with six degrees of freedom. In this project, the functionality of a system using these tags was evaluated and compared with a professional motion-capture system.

Introduction

The Bern University of Applied Sciences Movement Laboratory in the Health Division performs a variety of studies that require capturing human movement. The laboratory currently uses a state of the art passive-marker multi-camera system (Vicon Motion Systems Ltd) to capture three-dimensional human movement. This system delivers high accuracy and data rate but is relatively expensive.

Squat knee-angle measurement with Vicon Motion Systems markers (1) and CSEM 6D tags (2)

Goal

In this project, an affordable alternative for a marker-based motion capture system using industrial cameras and 6D tags as markers shall be designed. The system shall be validated with a moving robot arm and its performance compared to the Vicon system in a test phase with humans in the Movement Laboratory.

Methods

An industrial camera (acA1300-200um, Basler AG) was used to capture images. CSEM's software library was used to find and locate the 6D tags in the images. The resulting data includes the tag id, position,
rotation and form-factor. The tags were mounted first on a robot for calibration of the system and for characterization of the accuracy and repeatability. In a later stage, tests were performed in the Movement Laboratory using the tags and the Vicon System simultaneously. The data generated by both systems were evaluated and compared with MATLAB (The MathWorks Inc.).

Results

A clear advantage of the 6D tags is that no motion model is required. One tag is enough to track one body segment, while the Vicon system requires several markers. This reduces substantially the amount of time to prepare a person for measurements. The system can perform movement tracking as long as the tags are in camera view and with enough accuracy for many applications at a fraction of the cost of the Vicon System. Additional cameras could be added to enable more motion freedom and enlarge the measurement volume. The system with the 6D tags can still be further optimized in efficiency and stability.

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