

Incremental Extendible Tracking for Augmented Reality

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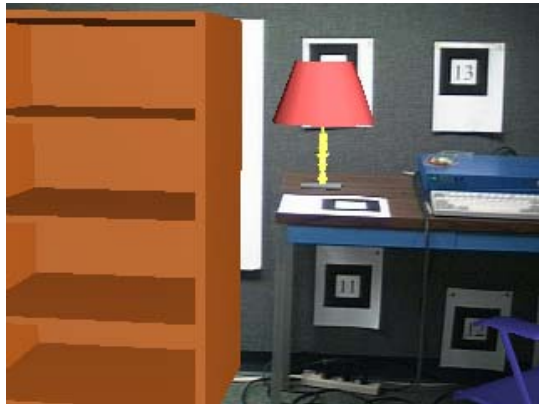
An augmented reality system blends virtual objects with the real environment in the view of the user. The virtual objects should appear at the correct locations to the user. To achieve this illusion, the user's viewpoint (or camera pose) needs to be determined accurately. Though many existing vision-based tracking techniques can achieve the accuracy suitable to an augmented reality system, they can only work in the prepared environment where the system operator can put and calibrate artificial landmarks. Their dependence on prepared environment limits their tracking range and usefulness, especially in large-scale and outdoor environments. Our goal is to develop an extendible tracking method that can reduce the dependence of tracking system on prepared environments.

In our system, the dependence on prepared environments is reduced by extending tracking from a prepared area to a neighboring unprepared region. Our system makes use of both pre-calibrated artificial landmarks and a-priori unknown natural features. Pre-calibrated landmarks are used to initialize the tracking process, and extendible tracking is achieved by auto-calibrating unknown features in the environment.

We use Extended Kalman Filter to estimate camera pose and auto-calibrate unknown point features in the environment. The Kalman Filter is a recursive predictive update technique used to determine the state of a dynamic system. It composed of two parts: prediction and measurement update. Prediction uses prior camera pose estimates and a dynamic model to predict the current camera pose. Measurement update uses observable image measurements of 3D features to correct the prediction. Measurement update is incremental in that it processes one feature at a time. Since one feature only provides partial information, camera pose and unknown features are estimated by incrementally integrating incomplete information from measurements. An unknown feature is initialized by triangulation method when it is observed in two views. In the following tracking process, the estimate for the unknown feature is augmented on camera state and is refined together with camera state in the measurement update.



(a) A virtual bookcase and a lamp with all pre-calibrated landmarks observable (Pre-calibrated landmarks are behind the bookcase).



(b) As the camera moves, a virtual bookcase, lamp, and chair become visible while some of pre-calibrated landmarks remain in view.

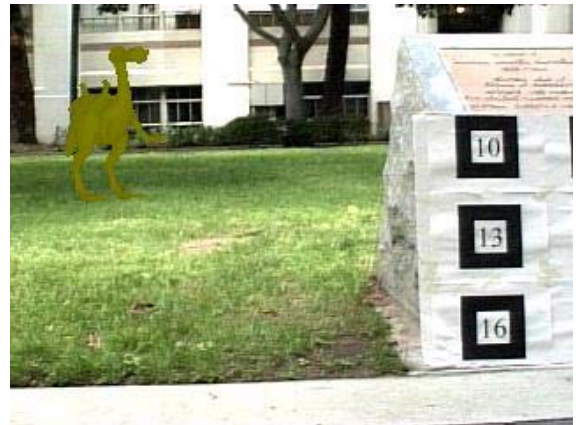


(c) The virtual chair and lamp from another viewpoint where none of pre-calibrated landmarks are observed. Camera pose is computed only from autocalibrated features.

Figure 1 – Extendible tracking for the indoor experiment



(a) Camera pose was estimated from pre-calibrated landmarks on the board.



(b) Camera pose was estimated from the pre-calibrated landmarks and auto-calibrated line features.



(c) Camera pose was estimated from auto-calibrated line features. None of the pre-calibrated landmarks were observable.

Figure 2 – Extendible tracking for the outdoor experiment