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Three-dimensional Reconstruction for Intelligent Tracking Systems

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In this work, a software tool has been created that allows the three-dimensional (3D) geometry of a scene to be reconstructed from multiple overlapping camera views. This software tool is targeted at an application where individual birds and bats within multi-camera views of large groups can be automatically tracked in 3D space and their trajectories reconstructed. In this scenario, a spatial calibration sequence is recorded at capture time, wherein a wand of known length is waved within the overlapping field of view of the cameras. The location of the two endpoints of this wand in each camera view across multiple frames is then used as input to the Direct Linear Transform (DLT) method to reconstruct the scene geometry.

The software tool produced provides the user the ability to view corresponding frames from multiple camera views simultaneously, and to select the location of the two endpoints of the calibration wand by clicking in each image. After locating a sufficient number of these points, the 3D scene geometry is computed using the DLT method. In order to validate the accuracy of the reconstructed scene, the user is provided with (1) the computed distances between the cameras, (2) the magnitude of the residual error from virtually projecting the calibration points onto the computed image planes, and (3) a graph showing the computed location of the calibration wand in space in each frame. The user may also validate the reconstruction by clicking a point in one view, and observing whether the epipolar lines drawn in the other views intersect the expected scene point. The parameters of the reconstructed scene can be saved to a file, and applied to other sequences recorded with the same camera placement.

This calibration tool has been used to compute the 3D scene geometry of sequences containing colonies of bats recorded using both visible-light, and thermal infrared cameras.