Synchronization and Calibration of a Camera Network for 3D Event Reconstruction from Live Video

Sudipta N. Sinha Marc Pollefeys
Dept of Computer Science
UNC-Chapel Hill
{ssinha, marc}@cs.unc.edu

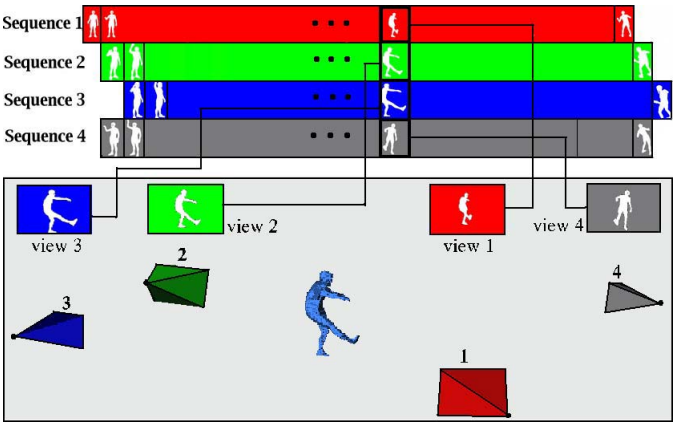
DESCRIPTION

We present an approach for automatic reconstruction of a dynamic event using multiple video cameras recording from different viewpoints. Those cameras do not need to be calibrated or even synchronized. Our approach recovers all the necessary information by analyzing the motion of the silhouettes in the multiple video streams. The first step consists of computing the calibration and synchronization for pairs of cameras. We compute the temporal offset and epipolar geometry using an efficient RANSAC-based algorithm to search for the epipoles as well as for robustness. In the next stage the calibration and synchronization for the complete camera network is recovered and then refined through maximum likelihood estimation. Finally, a visual hull algorithm is used to the recover the dynamic shape of the observed object. For unsynchronized video streams silhouettes are interpolated to deal with subframe temporal offsets. We demonstrate the validity of our approach by obtaining the calibration, synchronization and 3D reconstruction of a moving person from a set of 4 minute videos recorded from 4 widely separated video cameras.

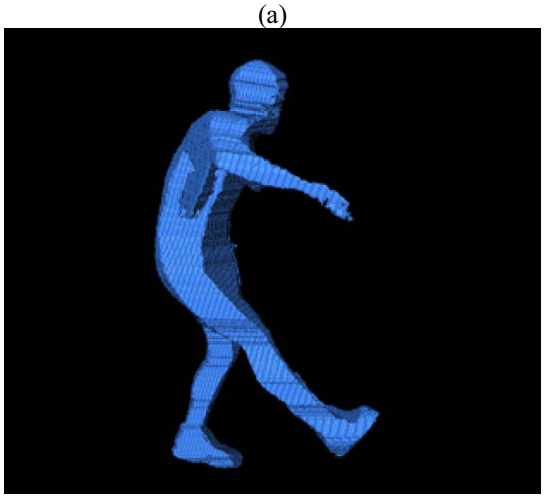
The proposed method is robust and accurate and allows calibration of camera networks without the need for acquiring specific calibration data. This can be very useful for applications where sending in technical personnel with calibration targets for calibration or re-calibration is either infeasible or impractical. To record events in large environments we are exploring the possibility to extend this work to networks of active pan-tilt-zoom cameras. In this case one has to solve significant additional challenges, e.g. background segmentation becomes harder, the observed events need to be actively tracked and calibration needs to be maintained. However, such a system would offer a far greater flexibility than existing systems with fixed cameras.

REFERENCES

[1] S. Sinha, M. Pollefeys. Synchronization and Calibration of Camera Networks from Silhouettes, International Conference on Pattern Recognition 2004.
[2] S. Sinha, M. Pollefeys, L. McMillan. Camera Network Calibration from Dynamic Silhouettes, Proc. of IEEE Conf. on Computer Vision and Pattern Recognition, 2004.
[3] S. Sinha, M. Pollefeys. Visual-Hull Reconstruction from Uncalibrated and Unsynchronized Video Streams, Second International Symposium on 3D Data Processing, Visualization and Transmission, 2004.



(a)



(b)

Fig. 1
(A) A NETWORK OF 4 CAMERAS OBSERVES A MOVING PERSON. THE SILHOUETTES OF THE MOVING PERSON FROM RECORDED VIDEO SEQUENCES ARE USED TO DETERMINE THE SYNCHRONIZATION AND CALIBRATION OF THE COMPLETE CAMERA NETWORK. (B) A VISUAL HULL RECONSTRUCTION OF THE MOVING PERSON FROM A SET OF SYNCHRONIZED FRAMES IS SHOWN. THIS IS BUILT USING THE COMPUTED CALIBRATION AND INTERPOLATED SILHOUETTES COMPUTED USING THE SUB-FRAME SYNCHRONIZATION RECOVERED BY OUR METHOD.