SkiTracker: Robust Outdoor PTZ-Tracking

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1 Motivation

As social media networks become more and more important in our daily life, people tend to share their experiences online, accentuated with pictures and videos. Numerous companies follow that trend and use it as possibility to intensify the linking to their costumers. Especially tourism industry is always endeavor to find innovations. Computer Vision is a perfect tool to support such developments, as holiday pictures and videos have always been part of this experience and the excepted fault tolerance is high compared to, e.g., surveillance applications. In this work we sketch a successful Computer Vision application for pan-tilt-zoom tracking of skiers over multiple cameras, running daily under harsh conditions during winter season. The system produces automatic skier movies for tourists, which are simple available via download, for sharing with friends or to watch and discuss via a terminal in the next ski lodge. To deliver such a product, we have to solve unconstrained visual tracking, which is a fundamental and challenging task. Many extrinsic influences such as changing and/or similar background, multiple objects variations in illumination as well as moving camera viewpoint complicate the task. Robust visual tracking therefore depends on discriminative appearance models and robust and efficient updates during tracking. A variety of tracking algorithms have been proposed to overcome these difficulties. Furthermore, our application controls several pan-tilt-zoom (PTZ) cameras and therefore real-time capabilities of the tracking algorithm are essential. This work is based on an efficient approximation of a covariance-based feature representation for tracking in a particle filter framework [3]. Additional Computer Vision algorithms control object detection, tracker re-initialization and weather depended visibility checks for recommender systems when to switch off the system, as can be seen in Figure 1. For the reminder of the paper we will line out the overall system with a focus on the tracking part.

2 System

A direct way to incorporate several feature cues for compact region based representation has been proposed by Porikli et al. [4]. Their proposed covariance descriptor captures spatial and statistical as well as correlation relation between

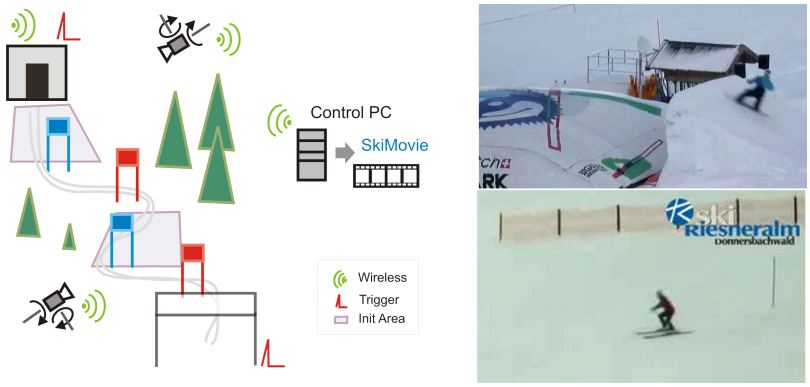

Fig. 1. Left: System overview with a typical two camera setup. Right: Example snap shots for post-processed freestyle and skiing videos.

features, while the dimensionality of the descriptor keeps small. The required statistical moments can be computed efficiently on Cartesian space using an extension of an Integral Image structure. Since covariance matrices do not lie on a Euclidean space, non-linear mappings to Riemannian manifolds or Lie algebra [4] are used to obtain vector spaces in which the metrics for machine learning techniques are defined. In [4] the *Foerstner* metric [2] is applied to approximate covariance similarity measurements on the Riemannian manifold. In [3] we derive an efficient and discriminative feature representation that provides a distance computation directly on Euclidean space. The idea of this approximated representation perfectly fits to the application of tracking, where the method of the similarity measurements significantly controls efficiency and real-time capability of the resulting approach. In combination with a particle filter this leads to an efficient and robust tracker. Adopting the uncertainty evaluation of a particle set by [1], motion model, number of particles and recommendations for switching to an offline learned motion trajectories can be derived. Trackers are initialized automatically in predefined init areas, assuming no camera motion and only one characteristic object, and the trigger signal coming from the start or another camera. Various videos are available under SkiMovie: http://www.skiline.cc.

References

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