Optical Localization of Very Distant Targets in Multi Camera System

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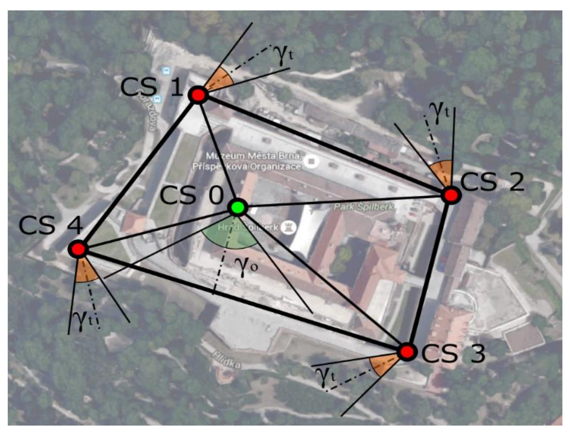
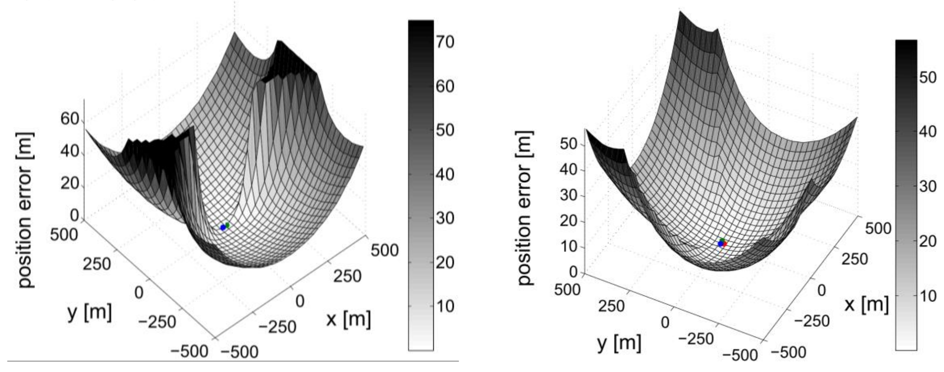
System Overview

This poster presents a semi-autonomous passive multi-camera system for tracking and localizing the distant objects, which is based merely on ordinary RGB cameras. The main building block is a camera station, a standalone unit consisting of a surveying tripod, a camera, a Pan Tilt unit and hardware components for estimating geographical coordinates. The system is designed to work with an arbitrary number of stations which should be positioned so as to form approximately regular polygon with long enough bases.

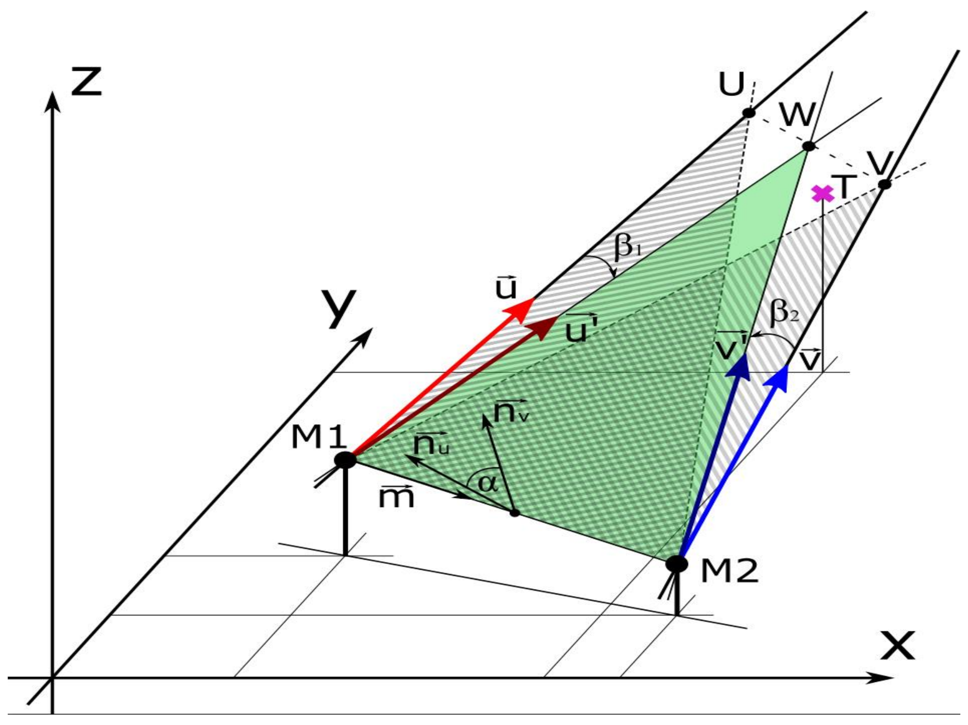


Stereoscopic systems are affected by a phenomenon of diminishing accuracy of depth measurement (known from the domain of stereoscopic systems) with increasing distance of the target. However, the OLS does not conform to the canonical stereo setup as all cameras can rotate freely. Furthermore multiple cameras can be utilized which alleviates the geometrical limitations of the two-camera setup. In the multi-camera setup the subset of two cameras yielding the lowest geometrical error can be chosen or weighted estimates of all cameras can be utilized.



Target Localization

The autonomous tracking uses the implementation of the visual tracker combining the background subtraction, motion model and object model in the particle filter framework. This approach can even cope with the moving cameras and thus is suitable for the OLS. The target is represented as a rectangular template (consisting of gray-scale intensity values) The Bootstrap particle filter is used to generate and evaluate candidate positions of the target.



In OLS, the intrinsics were estimated for each camera during calibration and extrinsics are known at each time due to the sensory data streamed from the manipulators. The estimation of the 3D position of the target uses back-projection to find the 3D direction vectors (aiming on the target). Due to the random error the vectors do not intersect, thus they are projected to a common plane and the intersection is computed. If more then three camera units are used, 3D location can be estimated as the weighted centroid of the estimates computed by each pair of the camera units forming a unique base.

Experiments

The system was tested in the real-world environment in the basic two-camera setup. The camera stations were precisely positioned using the differential GPS sensor (achieving accuracy of ca 0.01 m) so that the base would be exactly 30 m long. The local heading was estimated by aiming the units on each other. The system was tested against both static and dynamic targets, and in both cases only horizontal position was considered.

As for the static targets, nine landmarks with a priori known UTM coordinates (obtained from the cadastral map) and one target carrying an ordinary mobile GPS sensor were chosen. The system was tested against one dynamic terrestrial target equipped with a mobile GPS sensor (a walking person) as well. The target was tracked for 120 s and the estimated positions were captured and compared to the ground truth path; on average the system achieved the precision of 6.25 m.