Optical Localization of Very Distant Targets in Multi Camera System

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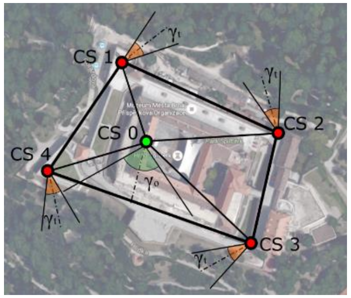
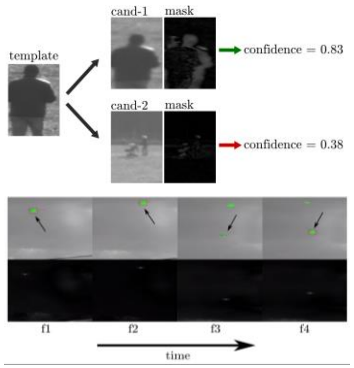
System Overview and Application



This poster presents a semi-autonomous multi-camera system for **tracking and localizing** the **distant objects**, which is based merely on ordinary RGB cameras. As opposed to the ubiquitous radar based solutions, this system is passive (the target is unaware that it is being tracked) and highly portable which allows fast deployment in various scenarios such as perimeter monitoring or **early threat detection** in defense systems or air **traffic control** in public space.

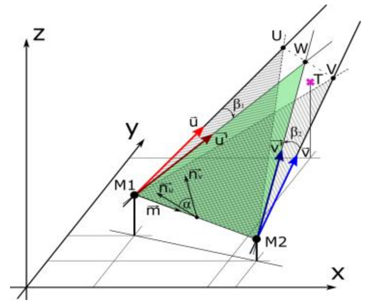
Visual Tracking



The tracking is based on two state-of-the-art approaches. TLD tracker leverages **detection and tracking** and it is robust against appearance change. The BGFG tracker combines the BG subtraction, motion model and object model in the **bootstrap particle filter framework**. Each measurement is assigned a confidence, localization subsystem can thus combine the measurements in the weighted manner.

$$confidence = \frac{\sum_{(x,y)\in I} e^{min(M_t^{(x,y)},M_c^{(x,y)})}(1-|I_t^{(x,y)}-I_c^{(x,y)}|)^2}{\sum_{(x,y)\in I} e^{min(M_t^{(x,y)},M_c^{(x,y)})}}$$

Target Localization

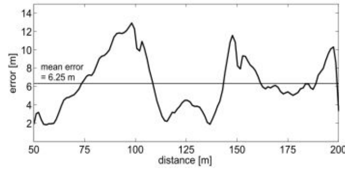


The estimation of the target location is based on multi-view triangulation working with noisy measurements. The **back-projection** is used to find the direction vectors. Target location is estimated as the weighted centroid of the estimates computed by each pair of the camera and with respect to the local **geometry constraints** and **tracker confidence**.

$$\gamma_i = |\vec{b_i}(\vec{T'} - \vec{bc_i})|$$

$$w_i = \frac{e^{\kappa\gamma_i}}{\sum_{j=1}^{N} e^{\kappa\gamma_j}}$$

Experiments and Results



A basic setup consisting of two camera units was tested in the real-world environment against static targets and a moving terrestrial target, and the precision of the location estimation was compared to the theoretical model. In case of static landmarks located in the distance up to 500 m the localization **error ranged from 4.4 – 23.9 m**. The dynamic terrestrial target was equipped with a mobile GPS sensor, it was tracked for 120 s and the estimated positions were compared to the ground truth. On average the system achieved the **precision of 6.25 m**.

Acknowledgements

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