Some novel statistical problems related to UAV controls

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Recently, relatively small and even micro unmanned aerial vehicles (UAV) came into play and the navigation based on computation of the camera path and the distance to obstacles with the aid of the opto-electronic cameras (OEC) became highly demanded. There are some urgent specific features related to the navigation with the aid of OEC. First, the information registered by camera is not convenient for navigation at all and designed mainly to be appropriate for human vision. Second, in various applications of the UAVs there are some specific constraints restricting the usage of actively irradiating systems such as radars and even GPS. In the literature there are two types of statistical problems related to this class of applications, they are: filtering on the basis of bearing-only observations and the usage of the optical flow (OF). There are various approaches to the motion estimation with the aid of the bearing-only observations, namely: linearized Kalman filters (KF), particle filters, unscented KF and many others. However, they provide almost the same level of accuracy especially in navigation issues based on bearing-only observations [1], as well as the most simple pseudomeasurements filter known long ago. While all above mentioned filters produce unknown bias, one can suggest the bias-free version of peseudomeasurement filter which gives also the unbiased estimation of the quadratic filtering error [2]. Such filter plays a key role in the UAV navigation on the basis of natural landmarks because it permits to reduce the number of incorrect correspondences (outliers) between template image and in-flight observable images of the underlying terrain surface [3]. OF is another vision feature related to the absolute linear and angular velocities of the UAV. The sequence of frames registered by on-board OEC consists of series of shifted features, such that the values of shifts are directly related to the linear and angular velocities of the camera, and therefore of the UAV itself. The extraction of the UAV motion from the field of shifts in the registered images is another statistical problem [4]. Since the OF is the linear function of linear and angular velocities of the UAV it can provide an additional means of the navigation parameters. In this talk we discuss both of these approaches and give examples of their implementation.

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References

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