Kalman Filter based Algorithms for Estimating Depth

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The Kalman filter is used in various areas, such as motion tracking, acoustic tracking and estimating the depth. It stems from maximizing the a posteriori probability of previous measurements. With this features, we can estimate depth from image sequences using known camera motion.
To make Kalman filtering, we should assume that the system has a linear property and the noisy in this system is white and Gaussian noise. It seems that Kalman filters make the real environment with simple equations, yet it actually gives a good performance to practical systems. Kalman has two important model. The first one is system model, which make a new status with transition matrix and priori status and the second is measurement model, which make a measurement with measurement matrix and status. With these models, we can implement the prediction phase and the update phase with Kalman gain and make a two-phase estimate cycle mode. Actually, Kalman filter can maximize the a posteriori probability without keeping a long history of the previous measurements. Thus we can iteratively update our model of a system's status and keep only that model for the next iteration. With this reason, Kalman filter could simplify the computational process and is applicable to real-time systems.

Pixel-based algorithm estimates the depth and depth uncertainty at each pixel and refines these estimates with Kalman filter algorithm. Since the paper supposes that a 3D model with camera motion has an idealized focal length (focal length =1), we can compute the inversed depth (1/Z). With this inversed depth, when we compute the depth with sequence images, lateral motion is more attractive because it causes less error than forward motion. Actually, since lateral motion gives more an angle between two images, it is axiomatic that the relative error is smaller than forward motion. Moreover, horizontal image sequences has a lot of noise in image processing, it could find the vertical small image from the scene.

To sum up, estimating the depth with pixel based Kalman filter is initiative. And it gives a good performance with well segmented area. (White region is closer object in the picture). Now, the further research about the behavior of the correlation based flow and stereo fusion remains.