What is the best triangulation approach for a structured light system?

Abstract

It has become customary to calibrate a camera-projector pair in a structured light (SL) system as a stereo-vision setup. The 3D reconstruction is carried out by triangulation from the detected point at the camera sensor and its correspondence at the projector DMD. There are several algebraic formulations to obtain the coordinates of the 3D point, especially in the presence of noise. However, it is not clear what is the best triangulation approach. In this study, we aimed to determine the most suitable triangulation method for SL systems in terms of accuracy and execution time. We assess different strategies in which both coordinates in the projector are known (point-point correspondence) and the case in which only the one coordinate in the DMD is known (pointline correspondence). We also introduce the idea of estimating the second projector coordinate with epipolar constraints. We carried out simulations and experiments to evaluate the differences between the triangulation methods, considering the phase-depth sensitivity of the system. Our results show that under suboptimal phasedepth sensitivity conditions, the triangulation method does influence the overall accuracy. Therefore, the system should be arranged for optimal phase-depth sensitivity so that any triangulation method ensures the same accuracy.