Calibration of Laser Bundles for Optical Indoor Positioning Systems

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According to the survey paper of Mautz and Tilch (2011), optical indoor positioning systems can be categorized into seven classes depending on the type of reference information used – a) 3D building models, b) images, c) coded targets, d) projected targets, e) no reference and f) reference from other sensors. The camera pose of an optical positioning system is determined in the same coordinate system where the reference information is given.

Systems that rely on a projected reference field for camera positioning such as in Habbecke and Kobbelt (2008), Tilch and Mautz (2012), Köhler et al. (2007) or Popescu et al. (2006), require precise determination of the directions and offsets of the laser beams with respect to the projector coordinate system. This knowledge is necessary to create a geometric relationship between a mobile camera and a static projector.

The provision of such geometric relationship requires a one-time calibration of the projector beams. The proposed calibration method is based on the reconstruction of the laser bundle. Thereby, the projector has a static set-up in front of a planar surface where the laser beams are projected on. The surface is then subsequently shifted. At each location, the three-dimensional coordinates of the laser spots are determined by another positioning system. With a traditional theodolite measurement system or photogrammetric measurements, all 3D coordinates of the laser spots can be obtained. As a result of deploying multiple surfaces, each laser beam is represented by a set of 3D spot coordinates which can be used for the reconstruction of the laser beam by applying a principle component analysis or alternatively by a least squares fit. As a result, each laser beam can be described by an initial point and a direction vector in the projector coordinate system.

Additionally, if laser distance meters are used for scale introduction, their scales and distance offsets can also be calibrated by carrying out distance measurements to each plane and comparing these distances with the coordinate distances from the reference positioning system. Finally, the desired parameters scale and distance offset can be derived.

With the proposed approach, directions can be calibrated with an accuracy of about 0.01°.

References

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