

Modeling and calibrating triangulation Lidars for indoor applications

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Abstract. We present an improved statistical model of the measurement process of triangulation Light Detection and Rangings (Lidars) that takes into account bias and variance effects coming from two different sources of uncertainty: *i*) mechanical imperfections on the geometry and properties of their pinhole lens CCD camera systems, and *ii*) in accuracies in the measurement of the angular displacement of the sensor due to non ideal measurements from the internal encoder of the sensor. This model extends thus the one presented in [2] by adding this second source of errors.

Besides proposing the statistical model, this chapter considers: *i*) specialized and dedicated model calibration algorithms that exploit Maximum Likelihood (ML) / Akaike Information Criterion (AIC) concepts and that use training datasets collected in a controlled setup, and *ii*) tailored statistical strategies that use the calibration results to statistically process the raw sensor measurements in non controlled but structured environments where there is a high chance for the sensor to be detecting objects with flat surfaces (e.g., walls). These newly proposed algorithms are thus specially designed and optimized for inferring precisely the angular orientation of the Lidar sensor with respect to the detected object, a feature that is beneficial especially for indoor navigation purposes.

Keywords: Maximum Likelihood, Least Squares, statistical inference, distance mapping sensors, Lidar, nonlinear system, AIC

1 Introduction

Lidars are ubiquitously used for mapping purposes. Different types of Lidar technologies, such as Time of Flight (ToF) and triangulation, have different statistical performances: for example, ToF Lidars have generically lower bias and measurement noise variances than triangulation ones. At the same time,