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# A Reference System for Indoor Localization Testbeds

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## ABSTRACT

We present a precise and inexpensive reference system to evaluate the performance of indoor localization systems and algorithms. Such a reference system must be able to continuously track the precise position of the moving node inside a building without significantly influencing the localization system under evaluation. Our approach allows a general statistical evaluation of localization algorithms under reproducible conditions without the need for extra infrastructure. The system consists of three components: a robot, the Robot Operating System (ROS) and a middleware for data aggregation.

We use ROS on a TurtleBot robot with two Microsoft Kinects mounted on its top. For optimal visual localization, the Adaptive Monte-Carlo Localization algorithm is used. This algorithm uses a map which can be built by the system itself using the GMapping library during the training stage. For even higher precision, a precise floor plan can be used. No infrastructural preparation is required. The driven path is logged and can be repeated multiple times with the timing of the original run. Our middleware combines the position data of the robot and the localization data of the system under evaluation, making clock synchronization between the two systems dispensable.

The accuracy of the system is sufficient for the evaluation of the most common localization systems. Test results show a maximum position error of ten centimeters. Due to the Kinect's limited range of 8 meters the precision will suffer if there are no walls or other obstacles inside the view of the Kinect. This is not an issue in the layout of most common buildings.

We propose our reference system as a very precise and easy to use reference system for indoor localization systems. It can be used in almost every building without any demands for a preinstalled infrastructure or on the localization techniques to be evaluated. The usage of ROS makes the system very flexible and many different robots can be used.

**KEYWORDS**: Indoor Localization, Reference System, Robot Operating System