Experimental Investigation on Map-Environment Disparity to the Performance of Image-Retrieval-Based Localization

Junji Takahashi (✉ takahashi@mech.kagoshima-u.ac.jp)

Kagoshima University <https://orcid.org/0000-0003-3742-3536>

Kohei Shimmra

Kagoshima University

Yong Yu

Kagoshima University

Akihiro Shibata

Kagoshima University

Toshiaki Sakamoto

Kagoshima University

Research Article

Keywords: vision-based localization, simulation, quantification of disparity between map and environment

Posted Date: May 6th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-445870/v1>

License: This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

This paper deals with a problem of map-based localization. When a robot has a pre-constructed map of an environment and explores there with sensing, the localization problem boils down to the problem of finding the closest data pattern to the sensing data from the map. Although, the map quality as well as the sensing data quality greatly affects to the localization performance, however it has been rarely discussed up to this point. To study the influence of the map quality to the localization performance, we propose a simulational experiment using an architectural 3D CAD models. We prepared a precise 3D CAD model imitating a corridor of elementary school and generated a 3D wireframe map and virtual sensing images from the CAD model. The precise 3D CAD model is regarded as the ground-truth data through the whole experiments. Then, we prepared several levels of broken maps with randomly shifted joinery parts such as, doors and windows. For localization process, our previously developed image-retrieval based localization method is used. Totally 3,500 number of localization experiments are conducted with various broken map setting. We show the influence of map-environment disparity to the localization performance by comparing these experimental results and discuss the requirements of map quality.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Overview of the cloud-based positioning system (UMap) (taken by [8])

Figure 2

The workflow of image-retrieval-based localization method (modified from [8])

Figure 3

A scene of the developmental environment of grasshopper in Rhinoceros

Figure 4

A shot of the broken map generated by Rhinoceros with grasshopper (5-m-width-corridor)

Figure 5

The simulational experiment localization workflow (modified from [8])

Figure 6

A corridor with a width of 3 m (precise model) and examples of virtual sensing images

Figure 7

A corridor with a width of 5 m (precise model) and examples of virtual sensing images

Figure 8

Examples of experimental results. Upper row: overlaid image of query31 and k-th image in each map, Middle row: graphs of similarity and pose error versus DB index: k, Lower row: graph of similarity versus pose error on logscale, Upside-down triangle: the minimum of pose error, Circle: the maximum of similarity.

Figure 9

The pose error of each query that is localized using ± 0 -map (3-m-width-corridor). Upper side: pose error versus query No., Lower side: the frequency ratio and cumulative ratio according to the pose error in log scale.

Figure 10

The cumulative ratio accordint to the pose error. 3-m-width-corridor

Figure 11

The cumulative ratio accordint to the pose error. 5-m-width-corridor