Camera-based Accuracy Improvement of Indoor Localization - Extended Assignement

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1 Introduction

Within past years Global Navigation Satellite System (GNSS) developed into highly reliable tool for navigating people. Nowadays even the buildings can be so spacious and sophisticated that we need to navigate around them. As [2] mentions, GNSS is not adequate for indoor positioning because of the degradation of satellite signals indoors which are the prerequisites for GNSS. Furthermore, indoor localization requires much higher accuracy since two different rooms may be separated only by few meters. This leads to a need of new techniques for indoor localization.

The following image summarizes common approaches for different types of localization in relation to the level of accuracy and area of interest.

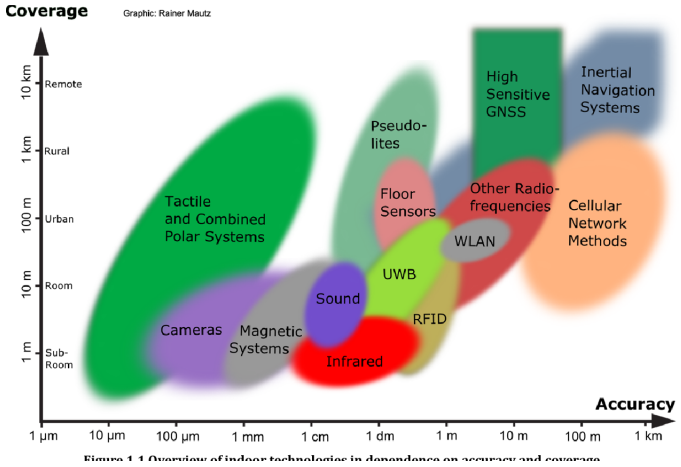

Figure 1: Indoor Positioning Technologies. [1]

2 Objectives

Our work aims to improve the accuracy of indoor localization with the use of camera images. The objectives are as follows.

1. Explore methods using images from camera to improve the indoor localization accuracy.
2. Propose computer vision methods for indoor environments and explore machine learning approaches for user localization.
3. Evaluate proposed methods with focus on accuracy and applicability.

3 Solution proposal

After the first survey of the successful use of camera images, we propose several possible directions of our thesis.

a) **Door detection.** Door would be a reliable object for detection since it stays at the same position all the time of building existence at usual. The door edges are clearly recognizable, so we suppose edge detection would be a first step before further image processing.

(a) Camera view (b) Canny edge detector applied

Figure 2: Door detection.

b) **Movement pace.** If we could determine the movement pace, we would be more precise in differentiating between two similar objects (windows, door, etc.) one can observe at a given time. This can be done by the use of

visual odometry, which compares the position of the same point of scene on two consecutive camera images. Regarding to the difference in these positions, the distance and direction of user's movement can be identified.

(a) Camera view (b) KLT pyramid applied

Figure 3: Movement pace determination.

c) **Power of large dataset.** Part of our assignment is to explore the contribution of machine learning in indoor localization. Having a large data set of representative images is fundamental, therefore we would look for available sources of datasets and extend them by our own images taken in the school building.

In every case the goal is also to observe whether machine learning methods can improve the solution of stated problem. To resolve that we need need to reveal a suitable digree of image preprocessing before the use of machine learning methods. For example we can detect edges as first and later on train a neural network on the preproceessed images.

4 Literature

Our first research will be based on the following resources.

1. MENDOZA-SILVA, G. M. et al. A Meta-Review of Indoor Positioning Systems. In Sensors. ISSN 1424-8220, 2019, vol. 19, no. 20, p. 4507.

2. WALCH, F. et al. Image-based localization using lstms for structured feature correlation. In Proceedings of the IEEE International Conference

on Computer Vision. Venice, Italy: Computer Society, 2017. ISBN 978-1-5386-1032-9, p. 627-637.

3. SZELISKI, R. Computer Vision: Algorithms and Applications. London: Springer, 2011, p. 812. ISBN 978-1-84882-934-3.

4. ALOM, M. Z. et al. A State-of-the-Art Survey on Deep Learning Theory and Architectures. In Electronics. ISSN 2079-9292, 2019, vol. 8, no. 3, p. 292.

5 Methods

The programming language used for implementation is probably going to be Python with the use of its libraries such as Keras for machine learning and OpenCV for image operations.

References

[1] MAUTZ, R. Indoor Positioning Technologies. Habilitation Thesis.

[2] MENDOZA-SILVA, G. M. E. A. A Meta-Review of Indoor Positioning Systems. *In Sensors. ISSN 1424 8220 19*, 20 (2019), 4507.