

Project Rawseeds

Mapping Error (ME) *recommended performance measure*

"Mapping_Error" - page 1 of 3



NOTE: WHAT FOLLOWS IS BASED ON THE CONCEPTS DEFINED BY THE DOCUMENT "GENERAL CONCEPTS AND DEFINITIONS FOR BPs", WHICH IS PART OF THE INFORMATION ASSOCIATED TO ALL BENCHMARK PROBLEM INSTANCES. PLEASE REFER TO THAT DOCUMENT FOR CLARIFICATION.

Introduction

The Mapping Error is a recommended measure, i.e., its computation is encouraged but is not necessary for a Benchmark Solution to be considered valid. ME is applicable whenever an algorithm for the construction of maps of an environment is employed.

The aim of ME is the evaluation of the errors on map reconstruction obtained by the algorithm under test (henceforth called **AUT**). A set of corners is extracted from the *mappingGT* describing the explored location. Then, corresponding corners are identified in the reconstructed map. Finally, a comparison is performed between the relative positions of the corners in the *mappingGT*, and those of the corners in the reconstructed map. ME is an aggregated description of the results of such comparison.

Preparatory operations

A set of corners suitable for the evaluation of ME must be extracted from the reconstructed map. This set must be a subset of, or coincide with, the list of corners provided along with the *mappingGT*. The choice is done by the author of the Benchmark Solution that the Mapping Error measure will be applied to, and the reasons for it have to be stated (please see section "Additional information to be provided"). *If another BS including a suitable corner list is already available, the use of the same list should be preferred over the creation of a new list:* in this way, the significance of ME as a tool for the comparison of algorithms is enhanced.

If the reconstructed map does not use corners as its geometric primitives, some processing will be necessary to extract corner positions from the kind of representation of the environment used by the map. This is the case, for instance, of algorithms working with grid-based representations or sparse image patches. Some guidelines for the extraction of corners from different types of maps are provided in the document "General concepts and definitions for BPs". Please note that it is not necessary to determine the pose of the map generated by the AUT w.r.t. the *mappingGT*, i.e., alignment of the reconstructed map to the *mappingGT* is not required, as ME is based on relative displacements.

It must be noted that there are classes of algorithms (e.g., monocular SLAM) that are unable to determine the absolute scale of the reconstructed map of the environment. This information is necessary for the computation of ME: in

Project Rawseeds

Mapping Error (ME) *recommended performance measure*

"Mapping_Error" - page 2 of 3



such cases it can be extracted from the mappingGT data.

Computation

ME is computed by following these steps:

1. Select a set of corners $\{ \mathbf{x}^{\text{GT}_i} \}$ among those described in the list provided along with the mappingGT. The corners of this set (which possibly can include the entire list), and the corresponding corners $\{ \mathbf{x}_i \}$ of the reconstructed map, will be used to compute ME. The criteria used to perform such selection are arbitrary, provided that they are documented (please see section "Additional information to be provided"). In the following we will use the term "associated corners" to indicate an element of $\{ \mathbf{x}^{\text{GT}_i} \}$ and an element of $\{ \mathbf{x}_i \}$ which represent the same physical feature of the environment.
2. Compute the set $\{ D^{\text{GT}_k} = \| \mathbf{x}^{\text{GT}_i} - \mathbf{x}^{\text{GT}_j} \| \}$ of the geometric distances between all possible pairs of corners of $\{ \mathbf{x}^{\text{GT}_i} \}$, and the set $\{ D_k = \| \mathbf{x}_i - \mathbf{x}_j \| \}$ of corresponding distances between corners of $\{ \mathbf{x}_i \}$, where \mathbf{x}_i and \mathbf{x}_j are the corners of the reconstructed map associated, respectively, to \mathbf{x}^{GT_i} and \mathbf{x}^{GT_j} .
3. For each element of $\{ D^{\text{GT}_k} \}$, compute the normalized difference $N_k = (D^{\text{GT}_k} - D_k) / D^{\text{GT}_k}$.
4. Compute the following numerical values:
 - \bar{N}_k , mean value of the normalized differences $\{ N_k \}$;
 - σ_{N_k} , standard deviation of the normalized differences $\{ N_k \}$;
 - $a_{N_k, 3\sigma}$ and $b_{N_k, 3\sigma}$, extremes of the 3σ confidence interval of the normalized differences $\{ N_k \}$;
3. $\text{ME} = [\bar{N}_r \quad \sigma_{N_k} \quad a_{N_k, 3\sigma} \quad b_{N_k, 3\sigma}]^T$.

Additional information to be provided

Whenever a Benchmark Solution includes the Mapping Error, it is also required to include the following information:

- A short description of the rationale behind the choice of the corners used to compute ME, and of the process employed to actually select the corners from the list included in the BP¹. If the selection process was automated, the algorithm used to perform it must be described in detail.
- A full description of the procedure used to extract, from the map

¹ If the authors of the BS used the same corner list of a previous BS (which is encouraged whenever such a list is available), only a reference to the former BS is required, possibly accompanied by a note.

Project Rawseeds

Mapping Error (ME) *recommended performance measure*

"Mapping_Error" - page 3 of 3



reconstructed by the AUT, the positions of the corners to be compared with those from the mappingGT.

The term "full description" refers to a description that is sufficiently complete to let any interested (and technically competent) reader replicate the described process. If such process includes human intervention, the way in which this intervention is performed have to be described in detail, so that they can be assessed - and replicated as closely as possible - by the reader.

- A text file including the positions (on the horizontal plane) of all the corners extracted from the reconstructed map to be used for the computation of ME. Such file must include the position of one of such corners for each line; the prescribed format is the so-called *comma-separated values* (csv), i.e., the data of each line must be in the form $\langle id_j, x_j, y_j \rangle$. id_j is an integer number used to identify the specific corner, and must be equal to that of the mappingGT corner that it corresponds to, as specified in the corner list associated with the mappingGT. The positions of the reconstructed corners specified by the file should be expressed in the reference system of the reconstructed map.