An effective method for robot positioning based on panoramic reflectance images

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***Abstract*-This paper proposes a 2-step global positioning method utilizing panoramic reflectance images collected from laser ranger finder (LRF) with Bag-of-features (BOF) and ICP.**

I. INTRODUCTION

3D positioning for a mobile robot using vision in complex environment is a challengeable problem, it is not only because of variant illuminating condition, but also similar scenes and uneven roadway. Base on the existing Cooperative Positioning System (CPS), we propose two-step strategy for 3D localization in 3D map with less calculation.

We use LRF to get panoramic reflectance images by scanning 360 degree and BOF to get characteristic of each reflectance image. Reflectance images are resistant to change of lighting condition, so we also can locate the position of mobile robot in the night. CPS can get 3D map of complex outdoor environment with uneven ground which means we can locate a robot in 3D space, not only in 2D map.

II. TWO-STEP STRATEGY

A. CPS

CPS is a highly precise positioning technique of multiple mobile robots. The CPS-V which is a fifth machine model of CPS has one parent robot and two child robots (Fig 1). Beside range data, the 2D LRF mounted on the parent robot can acquire 2-dimensional reflectance data. Two examples of panoramic reflectance images are also shown in Fig 1.

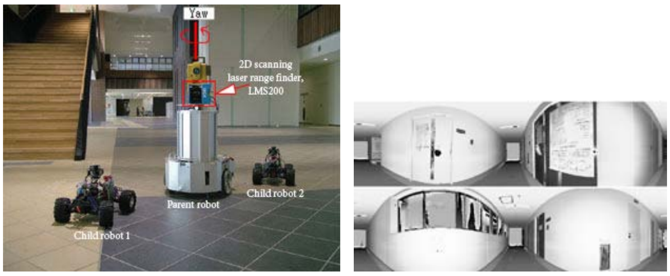

Fig.1 CPS-V and reflectance images

B. Two-step strategy

In fact, since CPS-V can collect local 3D model for each position, localization can also be done by finding match between 3D local and global maps[1] using Iterative Closed Point(ICP) algorithm. But implementing 3D data matching is time-consuming. So we propose a two-step strategy to avoid this problem:

(1) Initial localization by BOF using 2D reflectance images;

<1> Learning process: Create database using Bag-of-features.

CPS goes through objective environment and collects data in many locations. By using SIFT or SURF to extract descriptors and k-means clustering, the vocabulary for BOF is created, after using BOF, each reflectance image is represented by a histogram of frequency of features, finally a database representing the characteristic of environment is created.

<2> Execution process: Find similar images in database with current image.

When a new robot (called guest robot) is visiting the same environment, search the best M matches in the database for current reflectance images. Right match between reflectance images means the position of guest robot is found.

(2) Precise localization by ICP algorithm using 3D depth images (3D map);

From above M matches, ICP is used to eliminate wrong matches between reflectance images which remain large errors after ICP.

III. EXPERIMENTS

An preliminary experiment was done in a building in Ito campus of Kyushu University to verify this solution. The entire path is about 240 meters long.

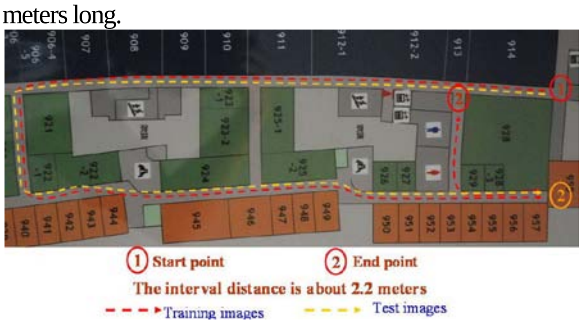

Fig. 2 The map of 9th floor

The result of reflectance images matching is listed in Table 1. 75 training images and 37 test images, M is set to 5.

TABLE 1 1

# of images	# of correctness	Accuracy
37	28	75.7%

From the result of (1) step, ICP is applied to evaluated the localization error, the average error is 248.1864mm.

IV. CONCLUSION

This paper proposes and demonstrates an effective two-step strategy for locating a mobile robot.

REFERENCES

[1] R. Kurazume, Y. Noda, Y. Tobata et al, “Laser-based Geometric Modeling using Cooperative Multiple Mobile Robots,” Proceedings of the 2009 IEEE international conference on Robotics and Automation, p.375-380, May 12-17, 2009, Kobe, Japan