The Fifteenth International Symposium on Artificial Life and Robotics 2010 (AROB 15th '10),
B-Con Plaza, Beppu,Oita, Japan, February 4-6, 2010

Study on the Route Extraction Based on the Image Processing

Jiwu Wang[1] Masanori Sugisaka[2]

Department of Mechanical Engineering, Beijing Jiaotong University, Beijing, China[1]
Department of Mechanical and Electrical Engineerin, Nippon Bunri University, Oita, Japan[2]
Email: jwwang@bjtu.edu.cn, ms@alife-robotics.co.jpT

Abstract: In the application of a mobile robot, we generally pay more attention on the navigation. In this paper, we study the visual based navigation for a mobile robot. We assume that we set the moving trace with some simple marks. Based on the image processing, the robot can extract the moving trace and realize self-location. At the same time, combing with some logic algorithms, the robot can reach the target point. Here, we try to find how to extract the visual signal from the simple continuous landmarks.

Keywords: Image processing, Navigation, Mobile robot**.**

I. INTRODUCTION

Navigation is the important part to develop a mobile robot. After we complete the development of the fundamental functions, such as the basic motor control etc. We will consider how to make the robot reach specified target. Till now, many solutions have been developed for the navigation. Considering the reliability and repeatability, we pay more attention on the visual navigation.

For the visual navigation, the robot uses the visual signal to control navigation. The robot captured the images with the CCD camera. By special image processing technique, the target signal is extracted. That means the target signal is important for the visual based navigation. But it is not easily to extract the target signal under any environments based on present image processing techniques. This is because the background is always changed when the robot is moving. Sometimes, some objects similar to the target will appear in the background. The robot will make mistakes if the algorithms are not robust enough. Moreover, the lighting conditions are changed as the robot moves. Most of important, some landmarks will be missed if the robot move at different speed. In view of those problems, there are many things to be studied before the robot can realize reliable visual based navigations.

In this paper, we pay more attention on the route extraction. We assume that we set the moving trace with some simple marks based on our requirements. The route works like the continuous landmarks. By the image processing, the moving trace will be extracted and the robot can realize self-location. Moreover, it will also know the moving target. We will introduce how to extract the guideline from the common guideline settings. And we will also introduce how to mark the cross points, the horizontal line and vertical line. After the robot obtain those information, combined with some logic algorithms, we hope the robot can realize self-location under some simple environments settings.

II. ROUTE PLANNING

For the navigation, it is necessary to perform route planning first. In real applications, generally we will meet following route planning.

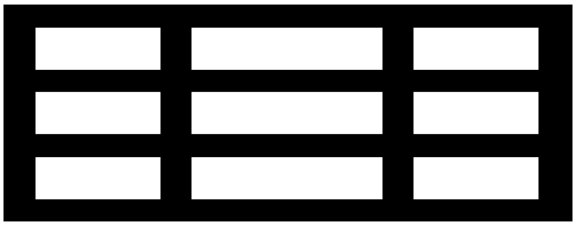

Figure 1 Route format sample 1

In format sample 1, we only set the route simply. It is also the common setting for general applications. In this case, the robot has to recognize the crossing point automatically.

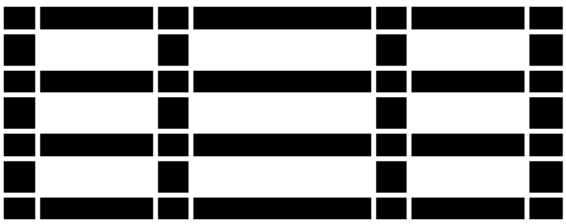

Figure 2 Route format sample 2

In format sample 2, the crossing points are intentionally separated from the vertical line and horizontal line.

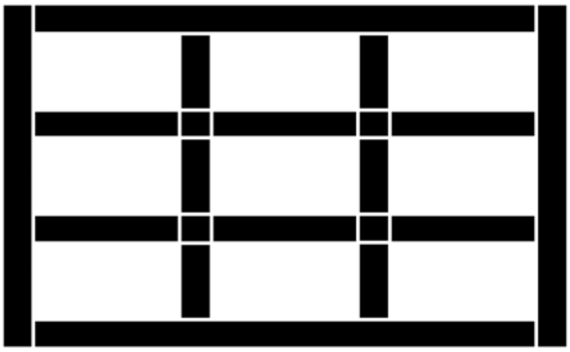

Figure 3 Route format sample 3

In the format 3, it is a little different from sample 2. Here only the internal crossing points are considered.

In the real applications, we will design various routes based on the requirements. But for the robot, it is necessary to separate the vertical line, the horizontal line and the crossing points. After the robot obtains those information, combining some sign landmarks, the robot will gradually realize the self location.

Considering the geometric information of the route, we can separate the vertical line, horizontal line and crossing points. The results are shown as followings.

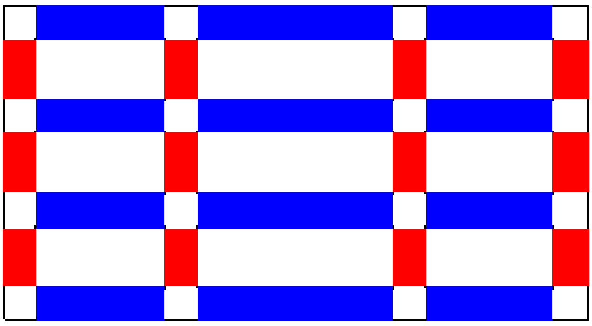

Figure 4 The result of the sample 1

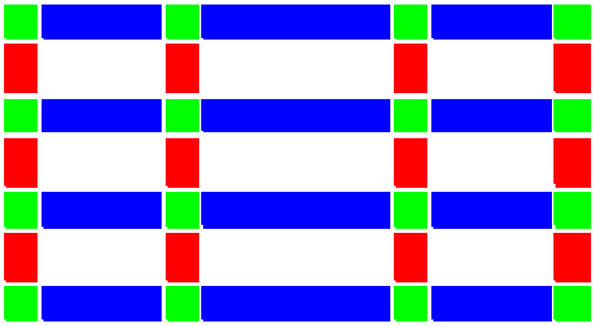

Figure 5 The result of the sample 2

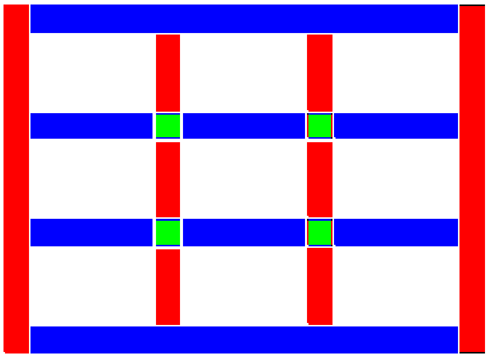

Figure 6 The result of the sample 3

In this process, we mark the vertical line, horizontal line and crossing point of different formats with different color.

III. EXPERIMENTS

The structure of our mobile robot is shown in figure 7.

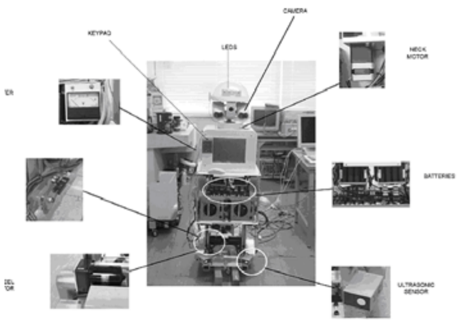

Figure 7 The structure illustration of the mobile robot

In the navigation development of our mobile robot, we only use the visual signal to control the robot to reach the specified target. The navigation route is set with the continuous landmarks.

Till now artificial landmarks of red/yellow circle, triangle, cross and guideline were developed. Under normal lighting conditions, these landmarks can be recognized accurately. But under poor lighting or strong reflection conditions, because there were not enough pixels that can be extracted from the image taken by the CCD video camera, sometimes these landmarks can be detected but not be recognized. Figure 8 is the illustration of the red landmarks of triangle and cross that were recognized in recognition experiments.

In real cases, it is normal that the characters of the sign landmarks can not be all extracted because various reasons, such as lighting, hiding, the interval of the camera to take the picture etc. It is necessary to use compound sensors or compound image processing techniques for some important sign landmarks.

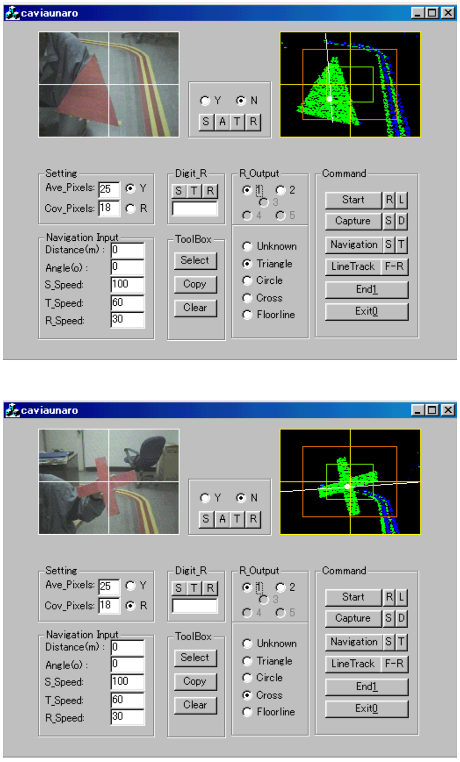

Figure 8 The recognition illustration of some landmarks

In order to find the guideline in any intervals when the robot is moving, the moving speed should be controlled based on the curvature of the guideline. Because of the camera frame rate (NTSC 30fps) and time constants of the motors (20-30ms, experimentally determined from non-load step response), the cycle time for our control loop was impossible to be extended. The robot will miss some landmarks or the guideline if the robot moves at high speed when there is the curvature change of the guideline or the locations of the landmarks does not correspond the intervals effectively. In the practical applications, such cases can not be avoided. In order to make the response in real time, the speed of the robot was controlled based on the curvature of the guideline. The robot can move at high speed when it moves along the straight guideline. Otherwise, it will move at low speed. Figure 9 is the illustration of self-location for the robot when it is moving. One is the case of straight guideline, and another is the robot will move along the curve line. The position and direction of the robot relative to the guideline were calculated in the real time.

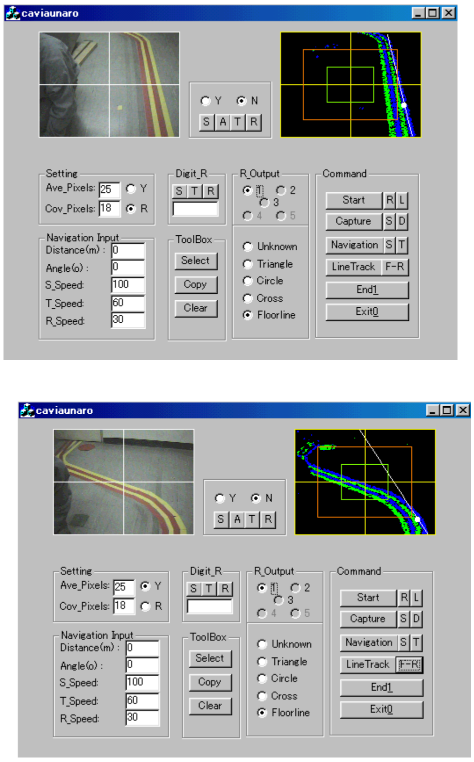

Figure 9 The illustration of the self-location in the visual servo control

IV. CONCLUSION

In this paper, we try to study how to control the mobile robot with the visual signal. It is possible to extract the general map setting based on the image processing technique. By the image processing, the robot can realize the self location. Moreover, the robot will also separate the vertical line, the horizontal line and the crossing points. Finally, we test the navigation of our mobile robot with the visual signal.

REFERENCES

[1] M.Sugisaka, Wang Xin and J. Lee, "Artificial brain f or a mobile vehicle", Applied mathematics and computa tion, Vol. 111, 2000.

[2] Jiwu Wang, M.Sugisaka, "Study on a color based target detection technique", Proc. of the seventh Int. Symp. On artificial life and robotics (AROB 7th'02), Beppu, Oita, Japan. 16-18 January, 2002.

[3] Cathy-Ann Radix, Andrey Loukianov, Masanori Sugisaka, "Evaluating motion on the alife robot prototype", Proceedings of the 32nd ISR (International Symposium on Robotics), 19-21 April 2001.

[4] Ulrich Nehmzow, Carl Owen, "Robot navigation in the real world: experiments with Manchester's Fortytwo in unmodified, large environments", Robotics and autonomous systems, Vol. 33, 2000.

[5] F.El-Khaly, M.A.Sid-Ahmed, "Machine recognition of optically captured machine printed Arabic text", Pattern recognition, vol. 23, No. 11, 1990.
[6] Alireza Khotanzad, Yaw Hua Hong, "Rotation invariant image recognition using feature selected via a systematic method", Pattern recognition, Vol. 23, No. 10, 1990.
[7] S.O.Belkasim, M.Shridhar and M.Ahmadi, "Pattern recognition with moment invariants: a comparative study and new results", Pattern recognition, Vol. 24, No. 12, 1991.
[8] Jiwu Wang, M.Sugisaka, "Improve digit recognition capability of backpropagation neural networks by Enhancing image preprocessing technique", Proceedings of International Conference on Control, Automation and Systems, Cheju University, Jeju, Korea, October 17-21, 2001.
[9] Jiwu Wang, M.Sugisaka, "Study on calibration of stereo cameras for a mobile robot prototype", Proc. of the seventh Int. Symp. On artificial life and robotics (AROB 7th'02), Beppu, Oita, Japan. 16-18 January, 2002.
[10] Seth Hutchinson, Gregory D.Hager, Peter I.Corke, "A tutorial on visual servo control", IEEE Transactions on Robotics and Automation, Vol. 12, No. 5, October 1996.
[11] Peter I.Corke, Malcolm C.Good, "Dynamic effects un visual closed-loop systems", IEEE Transactions on Robotics and Automation, Vol. 12, No. 5, October 1996.