Prowl of Autonomous Mobile Robot with Network Camera

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Abstract: This research aims to develop the autonomous mobile robot that helps various kinds of people. The evasion of the obstacles is absolutely imperative so that the robot acts under human life environment. So we develop a robot that hangs around in doors dodging the obstacle with the help of the image taken by the camera set up on the robot.

Keywords: Network camera, Autonomous mobile robot, Image processing

I. INTRODUCTION

Recently Japan is facing the serious concerns of rapid aging and very low birthrate. The share of the elderly population in Japan exceeded 14% in 1994. After that, it has been increasing rapidly as shown in Fig.1. In the future, it is expected that elderly population will keep increasing until 2020 and it will stably change. However it is estimated the share of the elderly population will keep increasing constantly because total population will be decrease. If the share kept increasing, it is apprehended that the acute aging society that one person per three people is elderly people will coming.

Additionally Japan is beset with the problem that labor force will decrease. The proportion of the laboring population in Japan dropped down from 77.7% in 1996 to 73.3% in 2006 as shown in Fig. 2. This causes many problems such as the number of elderly person who should be given enough care increase or many companies cannot get enough hands.

Owing to these social trends, development of robots has been conducted by many companies. Already many robots such as "wakamaru" (Mitsubishi Heavy Industries, Ltd) or "TPR-ROBINA" (Toyota Motor Corporation) are coexistent in our society. As mentioned above, the coexistence with the robot is believed to be a must in Japan for the future.

So this research aims at developing the autonomous mobile robot that helps people in various environments. For example, robots are expected to appear which guide a guest to another's room or carry his bag. As the very first step of this study, we decide to develop a robot that hangs around in doors dodging the obstacle with the help of the image taken by the camera set up on the robot.

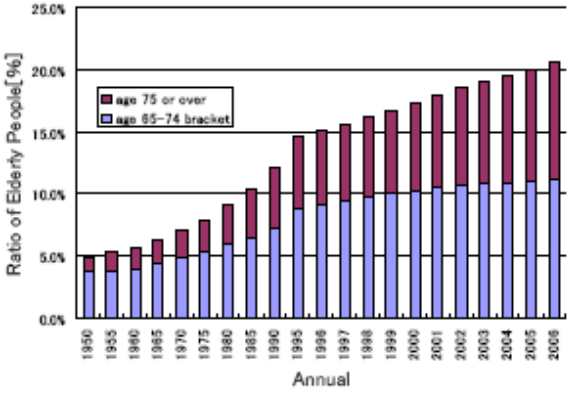
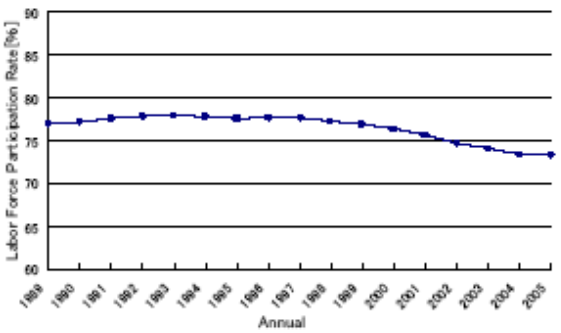


Fig. 1 Changes of elderly population ratio in Japan



II. SYSTEM ARCHITECTURE

1. System Overview

Our robot's composition is so simple and it is equipped with a network camera, a wireless LAN card and a motor driver. This composition makes it possible for a PC outside of the robot to be driven it by receiving and processing an image and transmitting motion commands. As a result, we succeeded in the miniaturization of the robot.

This system is made by using the Microsoft Visual Studio .NET.

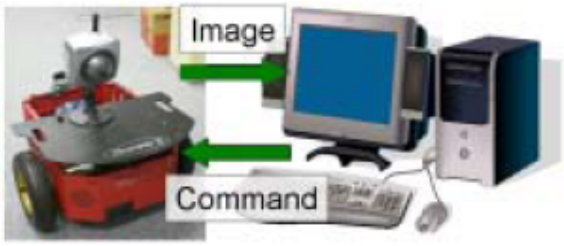


Fig.3. System Overview

2. Robot's Overview

As shown in Fig. 1, a network camera is installed forward on the robot. And a motor driver and a wireless LAN card are set up inside and in the rear of the robot, respectively.

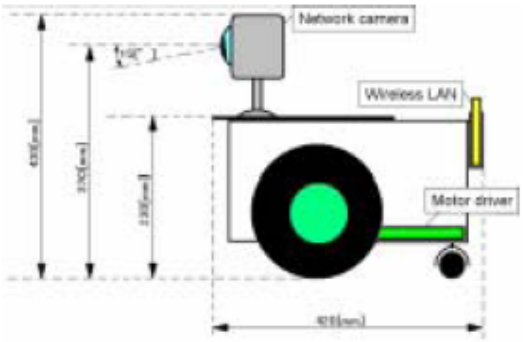


Fig. 4 Robot Overview

III. Algorithm for Prowl

The robot recognizes the floor in front of itself to roam indoors. In this algorithm, a robot regards everything except for a floor as obstacles and drives while avoiding them.

1. Floor-Extraction Algorithm

Floor-Extraction is conducted according to the following steps.

Step 1:The image is captured. (Fig. 6 (a))

Step 2:The lower area of the image is extracted. (Fig. 6 (b))

Step 3:Floor surface is extracted based on the floor color information acquired from five yellow points as shown in Fig.6 (c). (Fig. 6(d))

Step 4:A robot keeps the color of a floor updating because a light may give effect to the color.

Note here that the algorithm assumes that no obstacle is in front of the robot immediately before it starts driving and there is no pattern on a floor.

Red area in Fig.6 (d) is regarded as a non-target of image processing because it is far from a robot. Blue area is recognized as the floor while green area is recognized as that including obstacles.

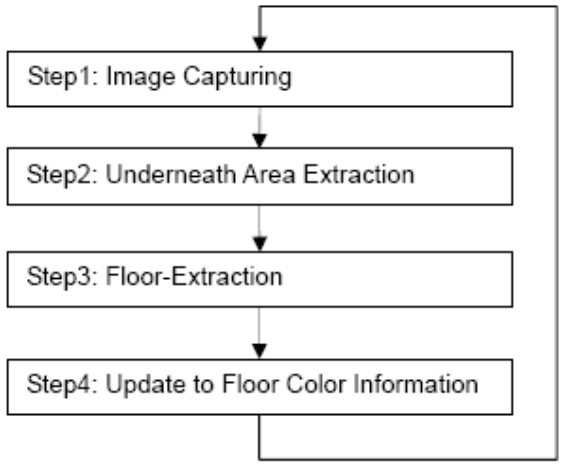
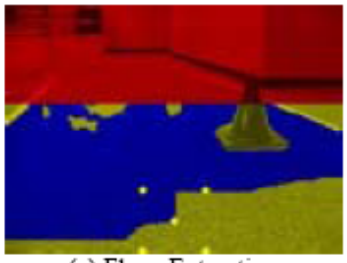


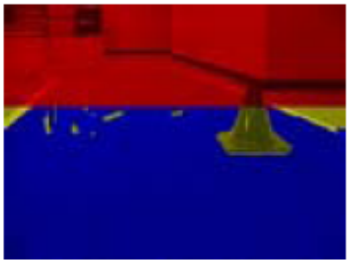
Fig.5. Floor-Extraction Flow

(a) Image Captured.

(b) Underneath Area Extraction



(c) Floor-Extraction



(d) Resultant image

Fig.6. Appearance of Floor-Extraction

2. Choice of Motion Command

The robot is controlled by five kinds of operation. They are "direct advance", "curve to the left", "curve to the right", "counter-clockwise turning" and "clockwise turning". When a robot confirms an image of the extracted floor, it selects and drives the appropriate operation from them.

It judges the possibility of going straight by examining whether the free area recognized as the floor is included in yellow and green rectangles shown in Fig.7. Otherwise, the free areas included in green rectangles are checked out, and if the occupied area including obstacles is small, it is judged that the robot can take a curve. In the case, the direction where obstacles can be evaded effectively is judged on the comparison of the areas included in the right and left yellow rectangles. Finally, it is judged on the areas included in green rectangles whether a right or left curve can efficiently evade the obstacle.

These results are stored in the memory of 4bit as shown in Fig. 8. The operation corresponding to the lowest bit among bits whose value is 1, in the case shown in the figure LEFT, is selected as the most plausible motion.

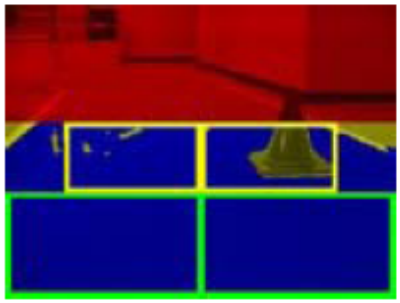


Fig. 7 Rectangle to Choice the Action

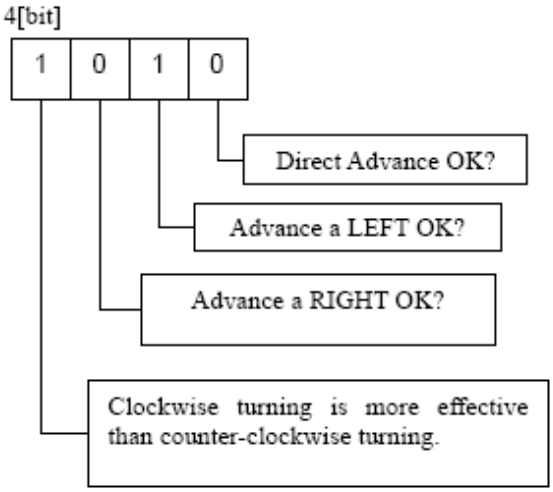


Fig. 8 Storage of Operable Action

3. Algorithm to give a weight to an obstacle

The operation selected by a robot may continuously change when the difference between the amount of a right side floor and that of a left side floor is little. So the algorithm puts a weight on an obstacle so that the operation is stably selected. For example when a clockwise turning is selected, the weight of obstacles in the left rectangle is increased.

IV. EXPERIMENTAL METHODOLOGY

We had a robot move in the environment shown in Figure 9. The gray region in Fig. 9 is a course in which a red triangle is an initial position of the robot, and it a blue rectangle is an obstacle.

V. RESULT

The robot successfully confirms the floor region and wanders dodging an obstacle in front to of it by selecting suitable operation as shown in Fig.10. Additionally, it successfully goes along the boundary of the course by recognizing it as well as the obstacle.

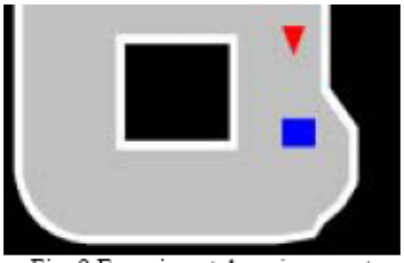


Fig. 9 Experimental environment

VI. CONCLUSION

This research aims to develop the autonomous mobile robot that helps someone. As the very first step of this study, we aim that the robot hangs around in doors dodging the obstacle with the help of the image taken by the camera set up on the robot. And, it was confirmed that they are possible in the environment that there is no design in the floor.

VII. FEATURE WORK

The robot will be made to execute operation with a purpose in the future. We target that the robot is given the destination, and drives there while avoiding the obstacle. To that end, presumption of the self-position and the route search are needed.

ACKNOWLEDGEMENT

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[1] Goto Hiroki, "Usage of Shared Memory for Multimodal Data Processing in an Outdoor Mobile Robot "

(a) Time = 0.0[sec]

(b) Time = 4.0[sec]

(c) Time = 5.5[sec]

(d) Time = 8.0[sec]

(e) Time = 12.0[sec]

(e) Time = 15.5[sec]

(f) Time = 18.5[sec]

Fig.10. Locus of Robot