A Stairway Detection Algorithm for UGV Stair Climbing Using Local Hough Transforms

Jugkit Sringamphong and Werapon Chiracharit

Department of Electronic and Telecommunication Engineering, Faculty of Engineering
King Monkut's University of Technology Thonburi, Bangkok, Thailand

52403402@st.kmutt.ac.th

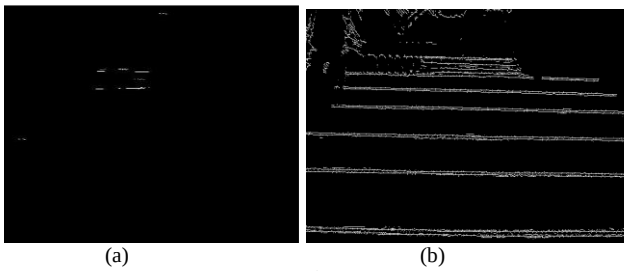
Abstract— **This paper proposes a stairway detection algorithm for autonomous stair climbing. The proposed algorithm is implemented on the unmanned ground vehicles (UGV) that is usually used in surveillance robot. Two important parameters, the position of vehicle on a stair and the angle between UGV heading and horizontal stair edges, are determined. The purpose of the algorithm is to extract the stair edges in indoor on low-light condition. All possible noisy edges are firstly detected. Local Hough transform is proposed in order to speed up the calculation and estimation of true horizontal stair edge. The transformation processes in Hough space are reduced. The experimental results show that the proposed method can detect stairway in poor light conditions 81% in accuracy.**

***Keywords*— Hough transform, stair climbing, UGV**

I. INTRODUCTION

The mobile robot technology has much developed to solve many important problems in rescue or surveillance robots. Tele-operated robot is widely used because of a limitation of a hardware design in autonomous surveillance robot. The obstacle detection system for autonomous robot is important for obstacle avoidance and/or climbing. The images captured from on-board camera are used to be processed for robot vision. The challenge of UGV is an ability to detect and climb the stairway autonomously. In the previous UGV vision for stairway detection, Gutmann *et al.* [1] used stereo vision to find depth of stair for guiding the human robot to climb up and down the stairway. Lu *et al.* [2] and Turchetto *et al.* [3] introduced image processing-based methods by using stereo vision for object segmentation and line matching for reconstruction of 3D environment to detect stairways and to locate curbs. Anastasios *et al.* [4] proposed methods to extract monocular stair edge using edge detection. Cong *et al.* [5] proposed apply Gabor filter to eliminate the influence of the illuminate and keep stair edges. However, poor indoor lighting image is a limitation of using Gabor filter. The experiment results of Gabor filter show blurred images which cannot be applied to poor lighting images. Fig. 2 show results of edges from Gabor filter compared with pure edges in poor lighting image (Fig 1). Exactly, robot can be increasing lighting source, it cause of a lot of power consumption.

Fig. 1 Original image captured in low-light condition.



(a) (b)

Fig. 2 Detected stair edges (a) Gabor filtered edges (b) horizontal edges.

In order to guide the UGV for autonomous stairway climbing, it needs to determine two important parameters. The first parameter is a position of UGV on the stair, and the second is an angle between the stair's horizontal direction and the UGV heading direction. The ability to avoid the UGV colliding to the wall depends on the position on stair, and UGV direction is guided by the angle of UGV movement to the right direction. Fig. 3 shows UGV movement to right direction by using wireless control.

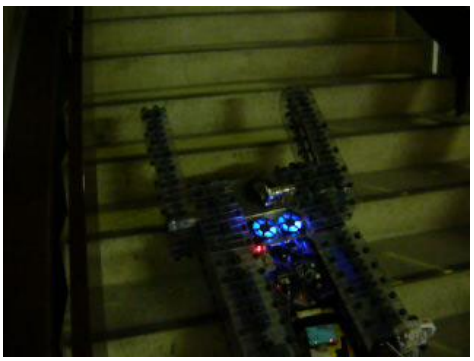


Fig. 3 UGV: wireless control stair climbing robot.