A Path Generation Algorithm of Autonomous Robot Vehicle By the Sensor Platform and Optimal Controller Based On the Kinematic Model

Tong-Jin Park*, and Chang-Soo Han**

* Department of Precision Mechanical Engineering, Hanyang University Sungdong-ku, Seoul, 407 Korea
(Tel : 82-2-2281-8423; Fax : 82-31-406-6242 ; E-mail: djpark@hymail.hanyang.ac.kr)
** Department of Mechanical Engineering, Hanyang University Sungdong-ku, Seoul, 407 Korea
(Tel : 81-31-400-5247; Fax : 81-31-406-6242 ; E-mail: cnrlab@hymail.hanyang.ac.kr)

Abstract

In this paper, path generation using the sensor platform is proposed. The sensor platform is composed two electric motors which make panning and tilting motions. An algorithm for a real path form and an obstacle length is realized using a scanning algorithm to rotating the sensors on the sensor platform. An ARV (Autonomous Robot Vehicle) is able to recognize the given path by adapting this algorithm. In order for the ARV to navigate the path flexibly, a kinematic model needed to be constructed. The kinematic model of the ARV was reformed around its body center through a relative velocity relationship to controllability, which derives from the nonholonomic characteristics. The optimal controller that is based on the kinematic model is operated purposefully to track a reference vehicle's path. The path generation algorithm is composed of two parts. One part is the generating path pattern, and the other is used to avoid an obstacle. The optimal controller is used for tracking the reference path which is generated by recognizing the path pattern. Results of simulation show that this algorithm for an ARV is sufficient for path generation by small number of sensors and for low cost controller.

Keywords : ARV (Autonomous Robot Vehicle), Sensor platform, Path generation, Kinematic modeling, Optimal Control, Scanning algorithm

1. Introduction

There are two conditions under which an ARV (Autonomous Robot Vehicle) recognizes a path and generates drive path instructions occur: first of all, whenever there is a demand for driving flexibility which then generates a proper path for obstacle avoidance; secondly, path recognition which then creates a path for reaching a goal point. Thus, a study of a path generation algorithm includes path planning, obstacle avoidance, self-localization, and self-organizing maps.

There have been a number of recent studies of recognition of objects while reducing the number of sensors recently. Matthies and Shafer(1987) studied precisely recognition using the stereo camera method. Miller and Wagner(1987) investigated about the path generation algorithm along with the input of an infra-red sensor using a rotating sensor platform.

In addition, research on appropriate control of the ARV actuators based on kinematic modeling has been conducted. Sarkar(1996) investigated the dynamic feedback control which based on a ARV kinematic model with two steerable wheels. As well, Roberts(1996) based his studies on the kinematic model of the four types of wheeled mobile robot with a steerable wheel. This kinematic model has the advantage that the ARV can be improved as the ARV actuator control is achieved thorough control of kinematic model. The algorithm for path generation can be developed with more ease.

The present study investigates the path generation algorithm. The path generation algorithm consists of the recognition of a path pattern by the ARV or an obstacle by rotating the sensor and an optimal controller for path tracking. The path generation algorithm, first of all, requires a sensor platform for the ARV. The type of ARV's driving is two-wheel drive (2WD), which is steered by difference angular velocity of both wheels.

The control goal of the ARV is that the ARV tracks the reference path which is inputted by signal of sensor platform. The optimal control method is used for minimizing error between the reference path and the navigating path presently. When the actual controller is applied to the constructed ARV, the reformed optimal controller to proper for the capacity of the actuators by various simulations. Through the actuator control based on the ARV kinematic model, a path tracking algorithm would be constructed easily.

2. System Modeling

2.1 Sensor platform

In the present study, a sensor platform is designed to enhance sensor inputs for more effective path recognition. The number of sensors for path generation may be reduced, so that sensor inputs are more effective with the ARV controller. Fig. 1 shows the sensor platform that is operated by two electric motors.

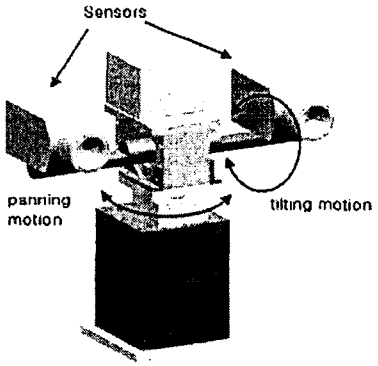

Fig.1 Sensor Platform Design

As the sensor inputs become larger, they require more accompanying filters or quantity of managing data. Consequently, a higher level of control is needed or these would be increased difficulty with driving at high speeds.

The sensor platform can be scanned by two electric motors with a transmission mechanism. To recognize the direction of right and left path, the sensor platform utilizes a panning motion. To direct up and down paths, tilting motion is simultaneously available. It is composed of two sensor-decks able to apply various sensors. In this study, ultrasonic sensor is