Passenger Condition Based Route-Planning for Cognitive Vehicle System

Hironori Hiraishi, Ashikaga Institute of Technology, Ashikaga, Japan

ABSTRACT

This article proposes a route-planning method for an environment in which self-driving vehicles are widely used. Such vehicles generate a new route to avoid traffic congestion when it occurs. Through the self-developed traffic simulator, the author was able to clarify that it is not always best to generate an avoidance route, and the decision to drive along the current route without generating an avoidance route becomes important in certain cases. Thus, the author proposes a method in which a vehicle judges whether to generate an avoidance route based on the passenger’s condition. To detect the passenger’s condition, the author uses a sitting-pressure sensor and succeeded in recognizing passenger fatigue. The author can therefore make certain judgments: The vehicle will go along the current route if the passenger seems to be relaxed and in a comfortable atmosphere, the vehicle will arrive earlier by avoiding traffic congestion if the passenger seems to be tired or irritated, or the vehicle will stop for a break period if the passenger seems to be significantly tired.

KEYWORDS

1. INTRODUCTION

Various carmakers and IT companies have recently developed various levels of automation for self-driving vehicles (On-Road Automated Driving [ORAD] committee, 2014). A self-driving vehicle requires the development of various technological levels (Bacha et al., 2008; Leonard et al., 2008), for example, a sensor level for detecting the environment and pedestrians (Dolla’r, Wojek, Schiele & Perona, 2012), a communication level to obtain information on the traffic and other vehicles (Hiraishi, Ohwada & Mizoguchi, 1999), a motion level to make decisions based on the information obtained from the sensor and communication levels (Aguiar & Hespanha et al, 2007; Dolgov, Thrun, Montemerlo & Diebel, 2010), a route-planning level to generate a route to a destination (Nilsson, 1980), and finally, a cognitive level to clarify the relationship between humans and vehicles (Sega, Iwasaki, Hiraishi, & Mizoguchi, 2011; Harada, Iwasaki, Mori, Yoshizawa & Mizoguchi, 2014; Harada, Mori, Yoshizawa, & Iwasaki, 2015; Yoshizama, Nishiyama, Iwasaki & Mizoguchi, 2017). Thus, a wide range of technologies related to not only the level of movement but also the levels of safety and comfort are indispensable to realizing a self-driving vehicle. Among such technologies,
in this paper, we focus on a route-planning technology, and discuss how to realize the avoidance of traffic congestion for an environment in which self-driving vehicles are widely used.

It is well known that traffic congestion on highways is caused by the unintentional slowdown of drivers on curves and uphill roads. In general, because self-driving vehicles can be controlled to maintain a constant speed, it has been stated that the spread of self-driving vehicles will lead to a reduction in traffic congestion. However, vehicles often have to stop at corners and signals on urban roads. Thus, unlike on a highway, the effectiveness of self-driving may not be as great as expected. Furthermore, if we consider a situation in which self-driving vehicles will be mass-produced and widely distributed, a large number of vehicles driving on similar routes generated through similar route-planning methods may cause new types of traffic congestion. Therefore, a policy to resolve the congestion problem is necessary if vehicles are to coexist under an exceeded road capacity.

Some approaches to the problems of traffic congestion have been suggested, including, an analysis and improvement of the road itself through traffic engineering (Amudapuram & Kalaga, 2012), and traffic management through signal control in the ITS (Intelligent Transport System) (Rahane & Saharkar, 2014). We approached the problem of traffic congestion using a route-finding method. When traffic congestion occurs along a route, our vehicles generate a new route to avoid the congestion. We executed some experiments on the relationship between the total efficiency and diffusion rate of self-driving vehicles using our own self-developed traffic simulator. We placed a large number of vehicles within a certain range, and made all the vehicles move toward the same destination simultaneously. In addition, we changed the rate of vehicles executing the avoidance of traffic congestion to verify the effectiveness of the proposed avoidance method. We can regard this as the diffusion rate of self-driving vehicles. As a result, we were able to clarify the phenomenon in which a total efficiency peak occurs, and in which the efficiency decreases as more vehicles generate an avoidance route. Therefore, it is not always best to generate an avoidance route, and the decision to drive along the current route without generating an avoidance route becomes important in certain cases.

Therefore, we propose a method in which the vehicle judges whether to generate an avoidance route based on the passenger’s condition. To detect the condition of the passenger, we use a sitting-pressure sensor, which can detect the movement of the passenger’s center of gravity. This sensor allows us to succeed in recognizing passenger fatigue (Zuojin, Jun, Liukui, Ying & Jinliang, 2017). Therefore, we can make certain judgments: The vehicle will continue along its current route if the passenger seems to be relaxed and in a comfortable atmosphere, the vehicle will arrive earlier by avoiding traffic congestion if the passenger seems to be tired and irritated, or the vehicle will stop for a break period if the passenger seems to be significantly tired.

Thus, this paper proposes a route-planning method for an environment in which self-driving vehicles are widely used. Vehicles plan their route based on the passenger’s condition, which is recognized by a sitting-pressure sensor. The remainder of this paper is organized as follows: Section 2 provides some results of our traffic simulation, and based on the results, we propose a cognition method for the passenger’s condition in Section 3. Finally, we provide some concluding remarks in Section 4.

2. TRAFFIC SIMULATION

We conducted experiments using our own traffic simulator to clarify phenomena that will occur when many vehicles move along similar routes, and to verify whether our dynamic route-planning will work properly.

Figure 1 shows an output of our traffic simulator, which we can use to create many vehicles and simulate traffic congestion. Vehicles are represented as triangles, and we can visually check where traffic congestion occurs. Each vehicle moves forward one step along the planned route for every loop of the simulator. In our simulation, we set one loop as 1 s, and 15 m as the one-step distance,
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