Intelligence Self-controlled Parking System

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These days, the research for an unmanned vehicle are highly being investigated. At this point of time, the self-controlled parking is as important as the self-controlled driving. The research for the self-controlled parking by ultrasonic sensors have already been studied. But according to parking situations there happen many problems. Furthermore, the dynamic characteristics of vehicle are changed in every parking and difficult for skilled drivers to park in unknown situations . In this paper, we try to solve these problems in parking by using Fuzzy controller. In the end, the unmanned parking was capacitated by the intelligence predicted-algorithm in any situations.

I. Introduction

As the industry develops, production lines in the factory have fully being automated. And many various robots have taken the place of a human in dangerous or hard work conditions. The development of various kinds of robots is needed and the research of mobile robots to take the place of a human is positively proceeded all over the world. FA has already been changed and impacted by AGV's practical uses. These days, the mobile robots which can work in general work condition efficiently are required with not depending on a particular situation and the ALV, unmanned mobile vehicle are highly being investigated. Development of unmanned car is being done as a part of this research. Automotive is getting important in modern life, More convenient and safer unmanned automotive development necessarily requisite. Therefore, we applied fuzzy controller to the unmanned vehicle parking in this treatise.

II. Vehicle modeling

Figure.1 is the model of vehicle to be used in this paper.

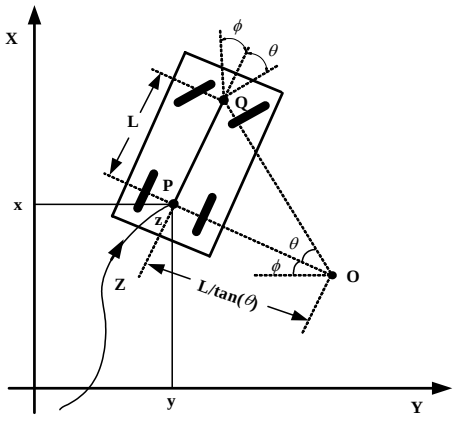

Fig. 1. Model of car

Equation (1)~(4) is the equation of dynamic characteristics modeling of vehicles in figure.1 .

$$\frac{d\phi}{dt} = v\frac{\tan(\theta)}{L} \quad (1)$$

$$\frac{dY}{dt} = v\sin(\phi) \quad (2)$$

$$\frac{dX}{dt} = -v\cos(\phi) \quad (3)$$

$$\frac{dZ}{dt} = v \quad (4)$$

With equation (3) and (4), if a variable t and v in equation (1) and (2) are deleted, we can obtain equation (5) and (6).

$$\frac{d\phi}{dX} = -\frac{\tan(\theta)}{L\cos(\phi)} \quad (5)$$

$$\frac{dY}{dX} = -\tan(\phi) \quad (6)$$

Through equation (5) and (6), we can know that speed variable v of vehicles is deleted. That is, the parking of vehicles is independent of speed in meaning of the vehicle speed by drivers passive action. In other words, equation (5) and (6) are the indication of reverse driving and if considering forward driving, we can define equation (7) and (8).

$$\frac{d\phi}{dX} = \frac{\tan(\theta)}{L\cos(\phi)} \quad (7)$$

$$\frac{dY}{dX} = \tan(\phi) \quad (8)$$

All the variables used in the equation are explained in table.1.

Table 1. Index of Parameters

Parameter	Description
x, y	position of vehicle
v	speed of vehicle
L	length of vehicle
ϕ	vehicle movement in x axis
θ	steering angle

III. Controller design

We decide car's situation, position to be reached and the direction based on Fuzzy control to control the car moving. To decide the position to be reached we calculate a suitable target by a computer considering car's dynamic characteristics. Fig.2 indicates a position function by each input(x, y, ϕ) and its output position function form.

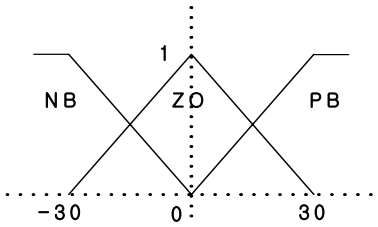

Fig. 2(a). Membership function of Input x, y

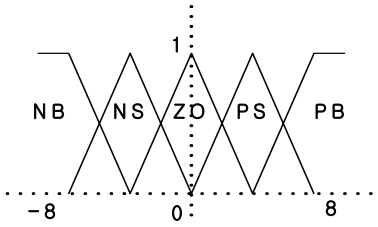

Fig. 2(b). Membership function of Input ψ

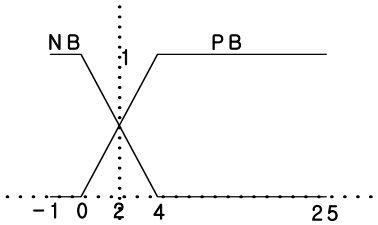

Fig. 2(c). Membership function of Input θ

Reasoning method to be used in fuzzy controller is Mamdani's Max-Min. And de-fuzzification used Center-of-Gravity Method. The rule table of fuzzy controller is represented by table.2 and table.3 in this treatise.

Table 2. Rule table (case of φ is NB)

x / y	NB	ZO	PB
NB	ZO	ZO	ZO
ZO	ZO	ZO	ZO
PB	ZO	ZO	ZO

Table 3. Rule table (case of φ is PB)

x / y	NB	ZO	PB
NB	NB	NS	PS
ZO	NB	NS	PS
PB	NB	NS	PB

IV. Simulation

The precondition in self-controlled parking of unmanned vehicle in this paper is following.

· The vehicle speed is constant 5m/s and the vehicle longitudinal length is 4m.

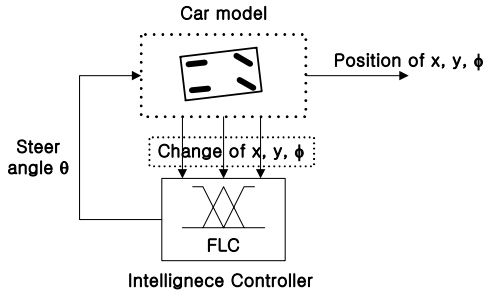

Fig. 3. Block diagram

Figure.3 is the block diagram of unmanned parking vehicle system by fuzzy controller to be designed in this paper. We want to find an appropriate condition, such as the present state of moving car, the position of (x, y) axis and car moving angle by using fuzzy controller based on dynamic characteristics which are presented in part II. Figure 2 is the whole block diagram for simulation. The simulation procedure in this treatise is as following.

Step 1. Set the first position of vehicles.

Step 2. Calculate a wanted data(x, y)and vehicle movement through controller.

Step 3. Define a present vehicle position(x, y) and movement based on dynamic characteristics equations following the vehicle moving direction.

Step 4. Repeat step 2 and stop the simulation when the vehicle enters into a parking area, the final position.

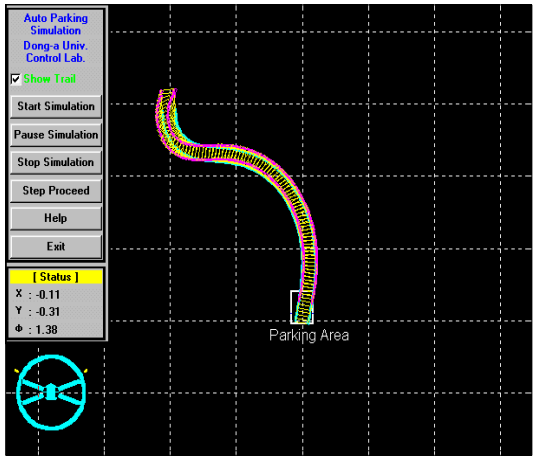

Fig. 4(a). in case that the beginning position is x=-20.12, y=28.05, φ =1.66

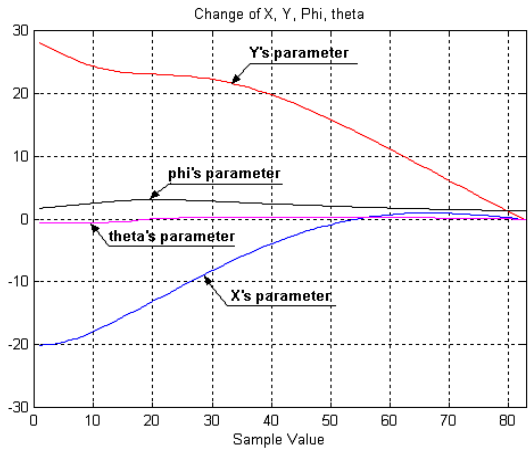

Fig. 4(b). x, y, φ change during vehicle parking

Figure.4(a) is the simulation result when the vehicle is located into the left side, top position in the parking area. The last position where the parking is ended is (x = 0, y = 0).

Although the vehicle parking has ever tilted slightly during the simulation, the

vehicle eventually enter into correct parking area.

Also, figure 4 (b) displays the x, y, ϕ, θ change. Figure 5 is the result in case that the beginning position is x=15.95, y=23.91, φ =−4.76, figure 6, 7 is the result in case that the beginning position is x=−15.75, y=10.66, φ =−4.10 and x=14.04, y=15.09, φ =−4.06.

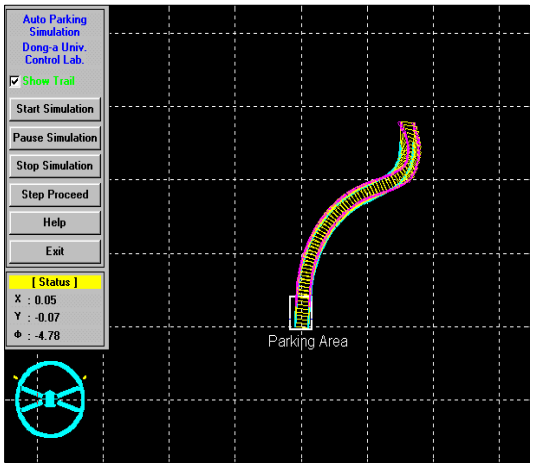

Fig. 5(a). the result in case that the beginning position is x=15.95, y=23.91, φ =−4.76

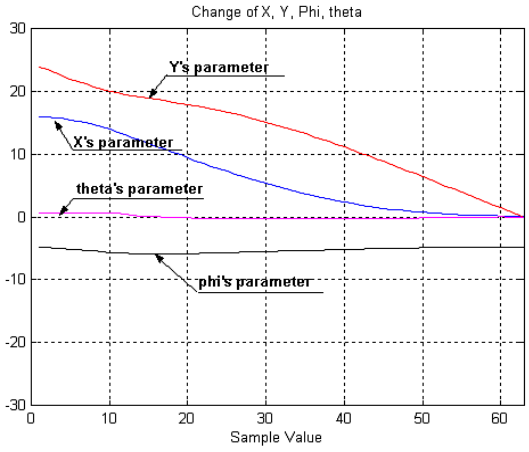

Fig. 5(b). x, y, φ change during vehicle parking

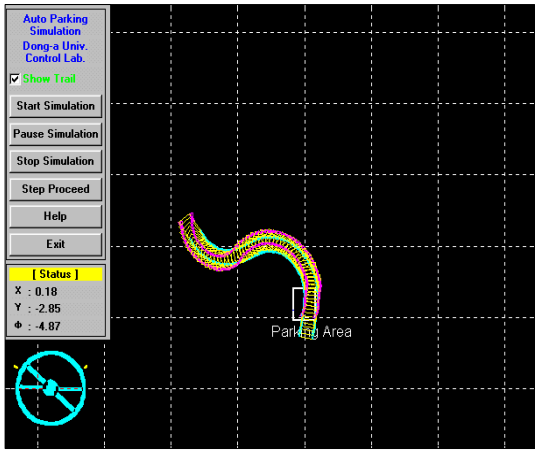

Fig. 6(a). the result in case that the beginning position is x=−15.75, y=10.66, φ =−4.10

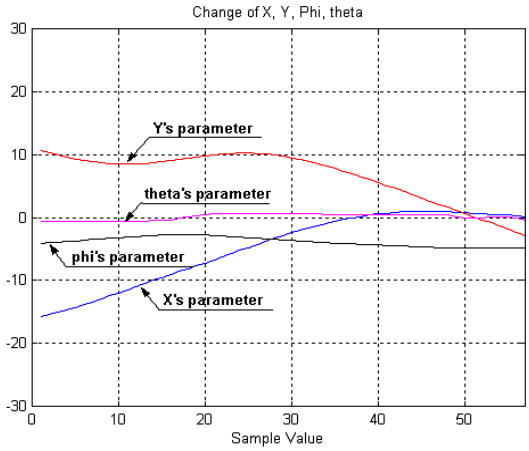

Fig. 6(b). x, y, φ change during vehicle parking

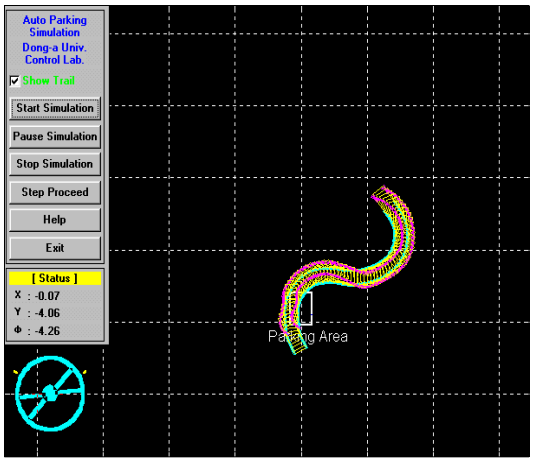

Fig. 7(a). the result in case that the beginning position is x=14.04, y=15.09, φ =−4.06

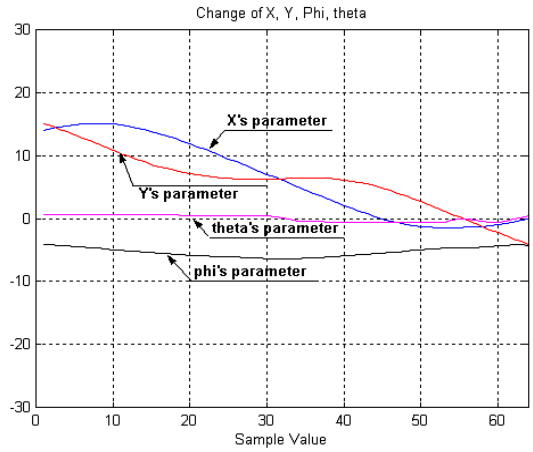

Fig. 7(b). x, y, φ change during vehicle parking

In figure 6 and 7 that the vehicle is positioned near the parking area, the vehicle is a little wrongly parked. This is a problem of the rule of fuzzy controller or membership function in this paper.

V. Conclusion

This treatise proposed unmanned parking control system and tried a simulation. As a result of the simulation, we could certify that vehicles are parked into the correct parking area. The nearer to the parking area the controlled vehicle is situated, the farer from the parking area the vehicle goes. Also, We can know that the steering angle of vehicles gets tilted a lot. Also, the fast parking is impossible because the vehicle speed is constant. Therefore, the next research will be to solve these problems. Also, we will create a new concept of algorithm and apply them to practical vehicles.

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