Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(3):218-224

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Research of adaptive control algorithm research based on rough set and implementation

Zhu Weiliang[1*], Zhou Guanchen[1], and Zhao Yingna[2]

[1]Qinggong College, Hebei United University, Tangshan, Hebei Province, China*
[2]Hebei United University, Tangshan, Hebei Province, China

ABSTRACT

This paper studies the robust adaptive control algorithm based on rough set, compared with other correction method does not make the system performance degradation. In the circumstance of no interference, the adaptive law can guarantee the asymptotic stability of the tracking error and the signal. Simulation results of traffic rules advanced verify the robustness and effectiveness of the proposed control strategy.

Keywords: Adaptive Control Algorithm, Robust, Neural network control

---

INTRODUCTION

1. Background

Because the object adaptive control is that the uncertainty of the system, so this control should be the first to run in the process control system, by continuously measured system input, state, or output parameters, gradually understand and grasp the object, then according to the information obtained, according to the design method, make the control decision to update the controller structure, parameters and control effect, so that the control effect reached the optimal or sub optimal in some sense, or reach a desired goal, according to the design idea of control system is adaptive control system.

For study the influence on the traffic flow and safety issues after the models mentioned above are introduced in the intelligence system. We improve the cellular automaton model. And we analyze the traffic flow and minimum safe distance while the traffic rules are controlled by intelligence system instead of humans. Finally we take the multilane overtaking and imaginary tail vehicle model to analyze the traffic safety under the control of intelligence system [1].

The situation of freeway is in the ideal state, namely the freeway shall be not affected by weather or geology. While driving, the factor of weather and geology in actual traffic condition are very complex, and hard to be solved. Drivers drive vehicles complying with the traffic rules generally, and drivers who break the rules such as drunken drivers will be excluded. Vehicles are changing lanes in a constant accelerated speed, and other vehicles are moving in a constant speed. As vehicles change lanes in a higher speed, the transverse velocity will not affect the longitudinal velocity, since while vehicles change lanes especially in a higher speed, the Longitudinal Angle caused by lane-change is small.

2. Rough set Theory

Rough set cannot confirm individuals vest in border areas, and the boundary area is defined as the upper approximation set and lower approximation set difference set. Because it has certain mathematical formula description, complete by data decision, so as to avoid the influence of subjective factors. In data pretreatment process, the rough set theory can be applied to feature more accurate extraction. Data preparation process, using rough set theory, data reduction properties of data set for dimension reduction operation. In data mining stage, the rough set theory is used for classification rule discovery. In the interpretation and evaluation process, the rough set theory can be used for the result of statistical evaluation. The basic method of rough set has been in decision-making, forecasting, uncertainty reasoning, the network planning, and the ensemble.

A relational database can be viewed as an information system, the column to property and the line to object. Suppose $P \subset A,\ x_i, x_j \in U,$ definition two binary relation $IND(P)$ called equivalence relation[2]:

$$IND(P) = \{(x_i, x_j) \in U \times U \mid \forall p \in P, p(x_i) = p(x_j)\}$$

If and only if $P(x_i) = P(x_j)$ for all $p \in P$, then x_i, x_j is equivalence relation about the property set P .

Suppose $X \subset U$ is a subset of the individual domain in the information system $S = \{U, A, V, f\}$, then the lower approximation and upper approximation set and the boundary region of X are as follows:

$$\underline{P}X = \{Y \in U / P : Y \subseteq X\}$$
$$\overline{P}X = \{Y \in U / P : Y \cap X \neq \varnothing\}$$
$$Bnd_P(X) = \overline{P}X - \underline{P}X$$

Which $\underline{P}X$ is elements in $X \subset U$ and must be classified collection, that is the maximum of definable sets in X . Which $\overline{P}X$ is elements in U and must be classified collection, that is the minimum of definable sets in X . $BndP(X)$ is the set of elements which can not be classified in $X \subset U$.

Suppose $S = \{U, A, V, f\}$ is a information system and $X \subset U$, $P \subseteq A$, then the accuracy of approximation of X in S is as follows [3]:

$$\mu_P(X) = \frac{\underline{\mu}_P(X)}{\overline{\mu}_P(X)} = \frac{card(\underline{P}X)}{card(\overline{P}X)}$$

Note: $card(X)$ is the number of elements in set X .

Suppose S is a information system and $P \subseteq A$. Let $\psi = \{x_1, x_2, ..., x_n\}$ is a classification of U and $X_i \subseteq U$, then the $P-$ lower approximations and the $P-$ upper approximations of ψ can expressed as follows：

$$\underline{P}\Psi = \{\underline{P}X_1, \underline{P}X_2, \ldots, \underline{P}X_n\} \qquad \overline{P}\Psi = \{\overline{P}X_1, \overline{P}X_2, \ldots, \overline{P}X_n\}$$

3. **Model of rules advanced**

We think that the right and left line of traffic rules are symmetric in theory. Therefore, they are identical in terms of traffic. But the two rules have a great impact on the driver. we assume that, based on "the instinct of a man - in a car accident before turn to the left" theory , other factors are unchanged under two lanes to research the minimum safe distance problem under two kinds of rules [4].

3.1 **Model design**

When there is an emergency, the reaction process of the driver in high speed under the rules is shown in the figure below, as Fig. 1, Fig. 2 shows as follows:

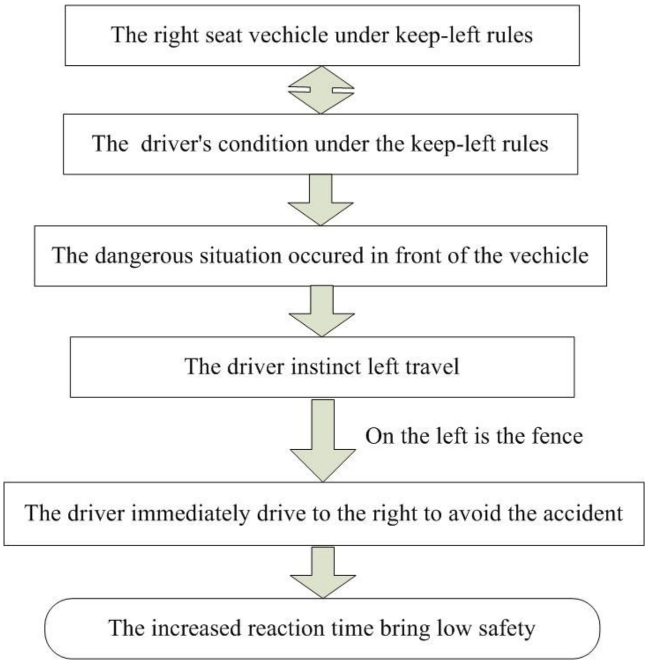

Fig. 1 Diagram of the relationship between time of t t5s and time of t t20s

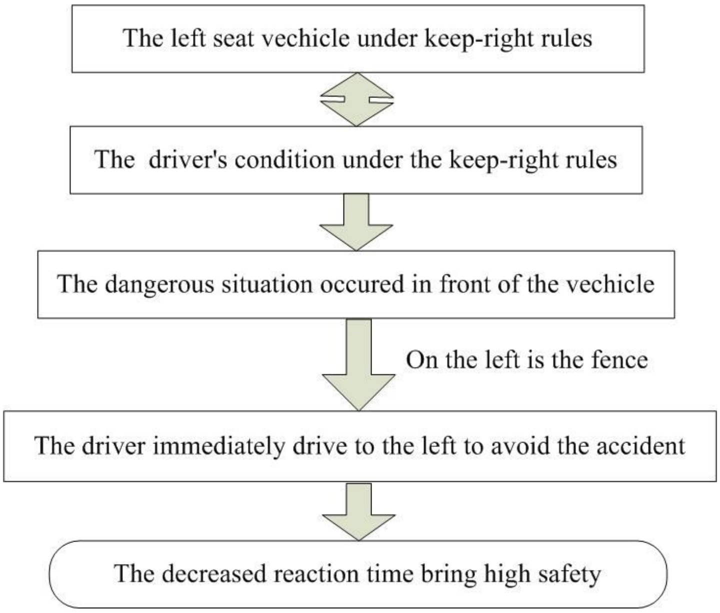

Fig. 2 Diagram of the relationship between time of t t5s and time of t t20s

Assuming the extra time to avoid danger of left vehicles than the right is t_c . At this point, the extra safe distance of left line of vehicles is s . When the left line speed of the vehicle is $v_0 \le v_{\max}$, and moving at a constant speed：

$$s(0) = v_0 t_c \tag{1}$$

When the left line speed of the vehicle is $v_0 \le v_{\max}$,and acceleration a_M forward in advance:

$$s(1) = v_0 t_c + \frac{1}{2} a_M t_c^2 (14) \tag{2}$$

When the left line speed of the vehicle is $V_0 = V_{max}$:

$$s(2) = v_{mas} t_c \ (15) \qquad (3)$$

3.2**Solution of Artificial violation of the rules**

Artificial violation of the rules is not considered.

(1) When converting rules from artificial control to intelligent control, following problems can be ignored:

A car is running at low speed on the highway, leading to each car from behind to choose overtaking. In case of overtaking, the extra time consumption led to the decrease of the amount of communication for traffic flow, reducing the amount of communication channels. The whole system is less efficient.

In order to consider security issues, a traffic road tends to limit the highest speed(In the perspective of a safe distance). But, when no car is on the high road(for example, highest speed in the morning will block the traffic),the largest limit speed will be changed according to the number of cars.

If you need to pass, tell the car in front through the signal, then you can get a better protection in the initial stage of the safe.

It refers to the vehicle didn't accelerate, or not to the maximum acceleration. Because only in people' s control , initial acceleration is not the best value(Such as: acceleration is 5 m/s the soonest, and because of concerns about security, you cause your acceleration is only 2 m/s
). If so in the whole road, it will cause a decline in the amount of communication of the whole system [5].

(2) The influence of rule by the intelligent control of traffic flow

Lack of influence of artificial factors, such as psychology, when converting rules from artificial control to intelligent control, human concern can be ignored in decision-making system , such as fear of a traffic accident. Intelligent control has the following improvements:

When speeding up is allowed, speed, and acceleration can be the best;

Speed will not be decreased for no apparent reason, in addition to the necessary parking, out of the car

If overtaking, the time is the best, such as: lane changing considering time to 0;

So the cellular automata is improved, and corresponding relationship with the time of different vehicle density are as follows:

Density D veh/km	time （second）	Density D veh/km	time （second）
23.25	26.04166667	80	56.52380952
31.5	29.76190476	85.75	60.8025641
39.125	32.73333333	91.5	69.44444444
45.5	34.83188406	93.5	74.45757576
56.25	39.41666667	108.625	78.43333333
63.25	42.95964912	112.5	89.59259259
69	46.91960784	118.875	98.56666667
74.75	52.75555556	134	118.197619
76.75	55.55555556	139.125	131.6888889

Through the comparison between human judgment and intelligent system control is as follow figure.

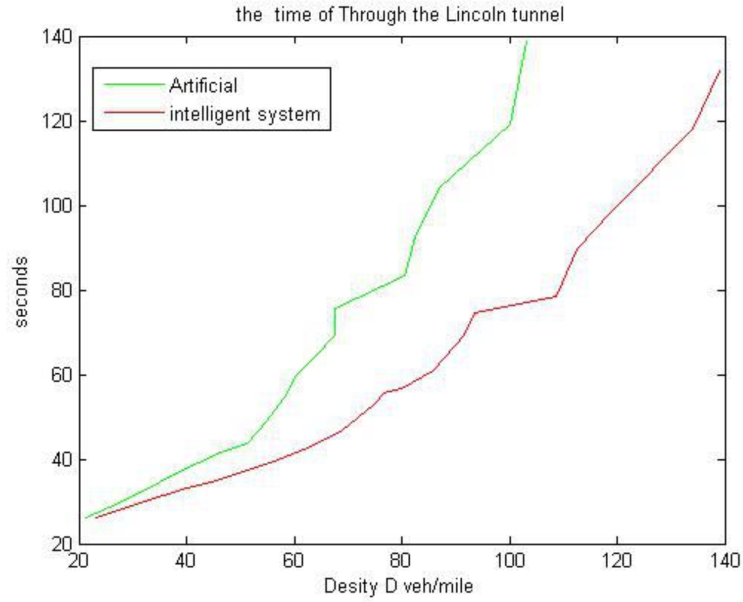

Fig. 3 This relationship between Density and t

From Fig. 3, we can get the conclusion: after resorting the intelligence system, the intelligence system takes less time in the same vehicle density, which means the traffic flow of the intelligence system is larger than that of the manual traffic.

3.3**the impact of rule controlled by intelligence system on safety**

Presume there is a tail for each vehicle, the shape of which is similar to the right part of the clamped beam round curve. For the first car, the width is[6].

$$t_{ik} = \begin{cases} 0 & when\ s_k - s_i > k \\ b_k[3(1-\dfrac{s_k - s_i}{L_k})^2 - 2(1-\dfrac{s_k - s_i}{L_k})^3]\ when & s_k - s_i \le k \end{cases}$$

In the formula, t_{ik} is the tail width of the cars in front of the car i , L_k is the length of tail for each vehicle, s_i represents the car position, i represents different cars, i and k represent the same meaning.

$$L_i = \frac{\sum_{k=2}^{i} t_{ik}}{b_{Road} - b_{Time} - b_i}$$

In the formula, b_{Road} is the actual road width, $b_{Time} > 0$ is a margin value, b_i is the car i 's presumed width, t_{ik} is the tail width of the cars in front of the car i .At this time, the expression of real simulation speed is

$$v_i = v_i^{(0)} - (v_i^{(0)} - \bar{v}_i)\left\{1 - [3(1-\frac{t-\tau_0}{T_R})^2 - 2(1-\frac{t-\tau_0}{T_R})^3]\right\}(16)$$

1) take the length of the time step as a fixed value ΔT , command T=0;

2) define array $L(j)$, $1 \le j \le n$ to place the presumed tail length of various cars, the presumed tail length of different cars will be confirmed by camera;

3) define array $Tuo(j)$, $1 \le j \le n$ to twice place various cars, the initial value is 0;

4) the initial position, the initial speed and the largest speed of each car are taken by the camera.

5）the car number of each car in the car group mentioned above in sequence are 1,2， ...,n，define array Lead(n)，including n factors，Lead（j）represents the car in front of the car which is closely to the car whose car number is j; if there is no car In front，then Lead（j）=0，at the beginning，there is
6）

$$\mathrm{Lead}(j) = j + 1, 1 \le j \le n-1, \mathrm{Lead}(n) = 0$$

Define liner array Follow including n factors，Follow(j) represents the car number of the car which is behind the car which is close to the car with the car number j.: $1 \le j \le n-1$

6)renew time，i.e. command $T := T + \Delta T$；
7)renew the position of each car，i.e. command $s_{j:} = s_j + v_j \Delta T, 1 \le j \le n$
8)presume the car number of car in the place i is p, the car number of car in the place $i+1$ is q，i.e. command Lead-new(p):=q
9)to any car with the car number j， if $\mathrm{Lead\_new}(j) \ne \mathrm{Lead}(j)$, then command $\mathrm{Tuo}(j) := T$, and command $v_0(j) := v(j) :, 1 \le j \le n$
10)renew array Lead i.e. command Lead（j）: =Lead_new(j)，$1 \le j \le n$
11)from the car in the first place in the car team，conduct the calculation in succession，to any $j(1 \le j \le n)$，calculate the common speed Virtual（j）. if Lead（j）=0，then command Virtual（j）: =Vmax（j）; otherwise，all the cars in front of car j can be deduced on by one according to the array Lead., it can be calculated through accumulation.

The subscript k can be any car number in front of the car j；Then calculate:

$$c_j = \frac{\sum t_k}{b_{Road} - b_{T\max} - b_j}$$

Then the budget speed of the car j can be calculated

$$\bar{v}_j = v^{(\max)}{}_j (1 - c_j) + c_j v_{\mathrm{Lead}(j)}$$

With the formula（26）The car's actual emulate speed can be calculated.

12）if T $<$named time，then resort to（26）to repeat the steps above; Otherwise exit the routine.

For the initial speed of the overtaking vehicle and those k vehicles in front need to grasped by camera, the initial position, the largest speed are substituted according to the set rule (more cars overtaking and the presumes tail model), a graph about speed with the change of time t.

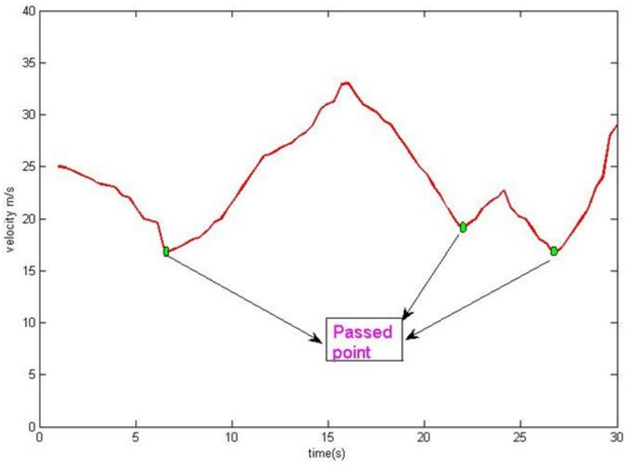

Fig. 4 The relationship between v and t

From Fig. 4, we know that whenever the speed of the car decrease means the car has encounters the tail of the front car. It means the car overtake another slow car when the speed of the car recovers[6] Presume each car as a particle, the largest speed on this curve and the area below the curve of the smallest curve can be taken as the safe distance. The calculation of this area can be done by computers. While in the real life, cars cannot be taken as particle, so in order to get the actual safe distance, it is necessary to subtract the length of the overtaken car shot by the camera. With the same manner, the safe distance to overtake other car can be calculated.

4. Summery

From the perspective of human nature, we conducted our research and got the result that it takes longer safety distance when driving left than right. So we conclude that it is safer when driving left. Though we conducted the quantity analyses about the advantages and disadvantages of driving left and right respectively, we need take many other factors into consideration when choosing which side to drive in the real world. For example, drivers in England and its former colonies have already formed the habit of driving left, and, in addition, driving left has the advantage of protecting people's heart. Therefore, driving left also has its rationality. Of course, driving right also has its benefits. For example, driving right is suitable for right-hand drivers, who count for a majority among people. Furthermore, the biggest benefit of driving right is that most countries around the world adopt it. However, we cannot cover all the differences between left driving and right driving through the analyzing the features of them.

When the intelligent control of vehicles, we found that it greatly improves the traffic flow and the safety coefficient. In twentieth century 90, the New York municipal government planned to build a new tunnel to the sate if New Jersey. But after the traffic modeling and rational analysis, the government decided to use the intelligent traffic control and management system. This decision made the traffic flow increase by 20%. Hence the government cancelled this plan at last. So we get the conclusion that the intelligent transportation system is able to produce significant economic benefits [7]. Therefore human beings should increase the development and application of intelligent system as far as possible to solve a series of problems. For example, we use the intelligent system to improve the situation of traffic and save the economic cost.

This paper proposes an adaptive neural network algorithm has strong compatibility, some noise data, not including related function and reduce the input dimension, a fast learning process, uncertainty processing and force enhancement explanation. This paper introduces the research of robust adaptive control algorithm. First introduces the improved adaptive robust control. The adaptive law can guarantee the system asymptotically stable and robust. Then, discrete time nonlinear system by the uncertainty of output correction factor, for neural network prediction, this paper proposes a robust adaptive neural network control algorithm, simulation results verify the robustness and effectiveness of the proposed control strategy.

REFERENCES

[1] Z. Pawlak, *Communications of ACM*,**1995**,38(11):89-95.

[2]L.T. Polkowski, *Intelligent Decision support*, **1992**,11(17):305-311.

[3] A. A. Mohammed, R. Minhas, Q. M. J. Wu, M. A. Sid-Ahmed. *Pattern Recognition*, **2011**, 44(10-11): 2588-2597

[4] X. Zhang, H.L. Wang. *Acts Physical Silica*, **2011**, 60(11):567-570

[5] S.Y.S. Leung, Y. Tang, W.K. Wong. *Expert Systems with Applications*, **2012**,39(1): 395-405.

[6] H.Y. Chen, J.J. Leou. *Journal of Visual Communication and Image Representation*, **2012**, 23(1): 343-358.

[7] C. Robert, L.F. Wang, M. Alam. *Expert Systems with Applications*, **2012**, 39(1): 555-563.