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DCT shift system based on fuzzy logic research

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ABSTRACT:- It is proposed that the problems exist in the traditional system of shift in this paper. Then, we conclude that a variety of factors influence the driver decision ,through particular analysis of the shiftprocess during making the decision[1]. At the same time, this paper extracts he main characteristics of DCT gear decision-making system which reflects driving intention in all kinds of driving mode. According to these characteristics, this paper adopts the fuzzy logic method to establish the new recognition of driving intention recognition system that contains road condition, and this method is accordance with the driver's decision-making process characteristics, using the fuzzy logic theory, which use more comprehensiveinformation than before, thus the result is more accurate and reliable.

Keywords:- *fuzzy logic,decision-making system,DCT,driving intentions*

I. INTRODUCTION

In recent years,the traditional shift schedule has beenmaturely applied in the automatic transmission,but traditional shift schedule only regards speed and throttle opening as the geardecision control parameters,at the same time it is just according to the car traveling in the straight road to determine the best performance or the best fuel economy . Literature [2] has carried on the exploration and analysis of double clutch automatic transmissionbasic shift schedule,but the article does not consider environmental conditions and the pilot driving intention, which is only based on automobile driving state shift schedulewhile in normal driving environment with good performance, howeverthis method may cause problems in some specific driving environment[3], such as vehicle frequently shiftproblems in the cycle of bumpy road , etc. This seriously affect the ride comfort, the span of service life and the vehicle dynamic performance.[4, 6] conducted technology based on fuzzy logic and expert knowledge on traditional automatic transmission of block a decision research, but the establishment of the fuzzy shift rules and membership functions of correction is more complicated, at the same time, the problem of block decision systemwith real time control system also need to be resolved.

The process of DCT shiftuse the method of pre-joint synchronizer. If the process has cycle shift or frequent shift phenomenon, it will inevitably lead to the synchronizer and clutch frequentlyunnecessary actions, and affect the ride comfort and the span of service life of clutch and synchronizer [7]. DCT shift system, therefore, must be carried out on the driving intention recognition, and should as far as possible eliminate frequent shift problem. In order to solve the defects of the traditional shift schedule, fuzzy logic block decision systemis proposed according to the driver's decision-making process,whichrecognize driver’s driving intention.

II. DRIVER'S DECISION-MAKING PROCESS

In order to better analyze the driver's driving behavior, we need to knowthe driver’s wholeprocess from the first reaction to the final operation. Driver's decisions are driver's subjective behavior, at the same time also largely decided by the objective factors of the surrounding traffic environment[8]. During the process of vehicle running, the driver make a series of pilot control decisionsbased on factors (vehicle speed, vehicle positionin front of the car window) such as acceleration, deceleration and uniform. In this reaction to the manipulation of the driver stimulated by external factors , the driver within the limited awareness of road traffic

informationanalyze these information to determine operating command, according to the driver's own experience[9] , and finally drive vehicle rightly.

According to the driver's decision-making process, we draw a driver's decision-making framework, as shown in figure 1.

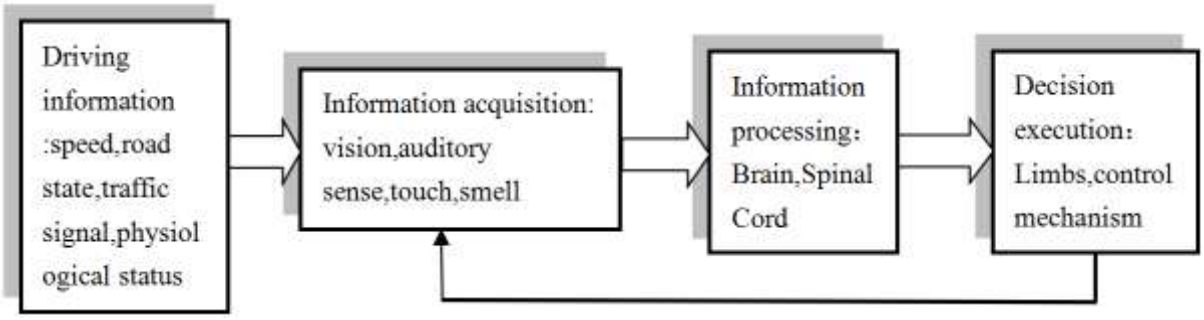

Figure1The driver’s decision-making process

(1) driving information

According to the driver's visual characteristics, transportation information that influence driver’s decision mainly includes speed ,acceleration of the vehicle, location, the frontvehicle speed, travel destination and travel time requirements, etc. These objective traffic factors has a decisive roleon the driver's driving behavior .

(2) information acquisition

This part is to point to the driver through the body sense organs affect driver's decision-making of traffic information collection, through the cerebral cortex processing, thus achieve the cognitive process. In the process of the cognition of information is the most important thing is to determine the scope of the driver's perception of information, if the information is outside the scope of the driver's perception, the driver will ignore this information, free.

(3) information processing

Driver's handling of information refers to the driver in accordance with its own driving experience who will classify the information such as the speed, acceleration, position. The category of the information means which driving decision the driver should be taken. Experience ,among them, should be the template as the basis of information classification, which often have subjectivity and fuzziness,so that causes the boundaries not clearbetween the different driving decisions.so the experience template is the key factor in driving decisions-making, and the key research pointof driving behavior study nowadays.

(4)decision execution

The driver of drive the vehicle in accordance with the decision. The driver's response mainlyrely on the driver's driving ability and vehicle performance, and the more driving ability is skilled, the less driver make mistake, and the driver's decision response will decide brake response and the safe distance between drivers and vehiclesin the emergency.

III. THE ESTABLISHMENT OF THE SHIFT SYSTEM

DCT shift control system must comprehensively consider three aspects, the condition of vehicle driving environment, road and the driver's operation intention. DCT make gear decisionaccording to the different characteristics of more comprehensive situation , so that make itselfmeet shifting control requirements in complex environment conditions[10]. Gear decision system should be able to meet the demand of different driving intention with shift control,and effectively solve frequently and unexpected shifting problems on the specific pavement[11],so as to realize the optimization of vehicle driving performance, fuel economy and

comfort. DCT shift control system principle is draw up in figure 2.

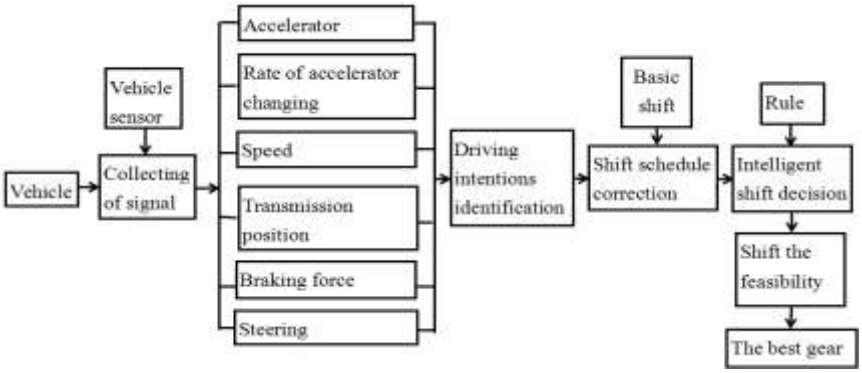

Figure 2 DCT shift control system principle

Among them, the intelligent decision mainly depend on the establishment of the shiftrule base and establishment of the shiftrule base is decidedby expert knowledge and the experience of the best drivers. Of course, it is very hard to establish a complete shift decision rule base, because it needs to be constantly improve through car running process.

The shift feasibility analysis mainlyestimatethe vehicle dynamic performance before shift and after shift based on vehicle dynamic performance requirements, in order to meet the vehicle dynamic performance requirements. At the same time, DCT synchronizer and clutch actuators operating characteristics must be considered, especially the response time of the actuator.

IV. DRIVER INTENTION RECOGNITION SYSTEM CONTAINSRECOGNITION OFDRIVING CYCLE

4.1 the traditional driving intention and driving cycle recognition

Driver intention refers to the driver's operation targetunder the specific driving cycle. Driving intention can be divided into acute acceleration, the acceleration, cruise, deceleration and stop, according to the actual experience of driving.but vehicle driving cycle is extremely complexin the process of actual operation condition, mainly divided into good road, bumpy road, slope road and tortuousroad, etc.

The separate division ,driving intention and driving cycle above, likely to cause staggered phenomenon and difficult decision-making at the end of shift [12]. Due to the identification of driving intention and driving cycleare both carried out by on-board sensor signal. Therefore, it is possible to unify the driving intention and driving cycle identification. According to the driving intention and driving cycle of partition and description of their respective characteristics. Driving intention as the main line is put forwardto simplify the shift the decision making process, and unify the driving intention and driving cycle as the following 5 typical case.

A.Urgent to accelerate

Urgent acceleration intention indicate that the driver urgent requirementto accelerate , generally used for overtaking, with particular emphasis on power performance, and at this time transmission should be downshift early and upshift delay.

B. speed up

From the dynamic point,acceleration resistance can be equivalent to ramp resistance, at this time upshift should be delayed to make full use of the engine driving force, anddownshift timely when engine lack of driving force.

C. cruise

Cruise intentions main characteristic is that the speed change is not obvious, and the driver wants to maintain the status.

D. Deceleration

Even with brakein driving. Driver should limit to upshift and downshift timely to take full advantage of engine auxiliary braking in this process .

E. parking

Characterized by the throttle opening is zero, and with continuous braking signal.

4.2 contains the condition of recognition of driver intention recognition system

The driving intention is hard to use accurate mathematical models to describe, so that the model belongs to the experience model. The theory of fuzzyhas great advantages in processing experience model. Driving intentions usually use fuzzy inference model according to the throttle opening and changing rate, speed, braking signal.Throttle opening and its changing ratecan mostly reflect the driving intention, and the speed of the vehiclemostly reflect the status of vehicle and environment. Braking signal only appears when vehicle is parking or slowdown intention.

Speed, throttle opening and throttle opening rate as input, and thequantified driving intention as the output, combining with skilled driver experience and expert knowledge, the driver intention recognition fuzzy inference model is set up as shown in figure 3.

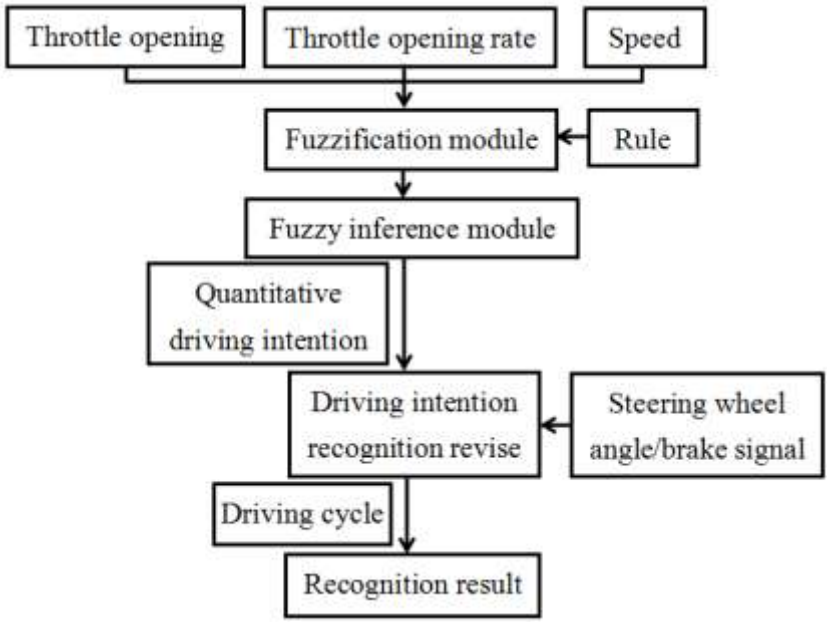

Figure 3 Fuzzy inference model of driving intention recognition

Theory of domain u_a [0 100] is the throttle opening range, the throttle opening were divided into three fuzzy set, the fuzzy language is: {S, M, B}, meaning is: {small, middle, big}.

Theory of domain U_Δ [-100 100] is a throttle opening rate after the equivalent variation range of data processing, the fuzzy language is: {NB, NS, Z, PS, PB}, meaning is: {negatives big ,negative mall , negative, zero, small, big}.

Theory of domain u_v [0100] is the speed range, the speed more than this range according to the boundary treatment, the fuzzy language is: {S, M, B}, meaning is: { small, middle, big}.

U_d is quantitative fuzzy reasoning theory domain value output driver's intentions, the fuzzy language is: {T, D, K, A, C}, meaning is: {parking, deceleration, cruise, acceleration,}. Determine the input and output theory domain and membership function, according to the collection of knowledge and expert experience and skilled driver based on dynamics characteristics in the vehicle, set the driver intention of fuzzy inference rules listed in table 1.

Table 1 driving intention of fuzzy inference rules

Throttle position	Changing rate of throttle position	Speed		
		S	M	B
S	NB	T	T	D
	NS	T	D	D
	Z	K	K	K
	PS	K	A	A
	PB	A	A	C
M	NB	T	T	T
	NS	T	T	T
	Z	K	K	K
	PS	A	A	A
	PB	C	C	C
B	NB	D	D	D
	NS	D	D	D
	Z	K	K	K
	PS	A	A	A
	PB	C	C	C

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