Advance Journal of Food Science and Technology 11(7): 526-528, 2016
DOI:10.19026/ajfst.11.2674
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: July 29, 2015 Accepted: August 20, 2015 Published: July 05, 2016

Research Article

The Application of Multi-objective Optimizing Fuzzy Control in Food Transporting Vehicles' Dynamic Control

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Abstract: As for the optimal control of vehicles food transporting in dynamic process, there is a dynamic control strategy about optimizing drivability. This study starts from fuzzy control theory and discusses the dynamic control of food transporting vehicles through the illustration of current situation and existing problems of the dynamic control of food transporting vehicles.

Keywords: Dynamic control, food transporting vehicles

INTRODUCTION

In recent years, with the development of economy, transportation demand gradually increases. Severe problems such as traffic jam, traffic accidents and environmental degradation have appeared in the world. It brings about Intelligent Transportation System. ITS is to comprehensively apply advanced IT, computer technology, data communication technology, sensor technology electronic control technology, automatic control technology, management and artificial intelligence in transportation, service control and vehicles manufacture, which reinforces the relationship among vehicles, roads and users (Ayed *et al*., 2002). In this way, it forms a timing, precise and efficient transportation system. ITS is aiming at increasing convenience and comfort by mitigating traffic jam and decreasing traffic accidents. It uses traffic information system, communication networks, positioning system and intelligent analysis and route selection.

General introduction of fuzzy control theory: In 1965, Professor Zadeh (1965) published two papers named Fuzzy Sets and Fuzzy Sets and Fuzzy systems, which establish fuzzy sets theories and application. Some scholars introduced fuzzy sets into control system soon and put forward the concept of fuzzy control. They began theoretical research on fuzzy control, lab simulation and application of industrial project. British scholars Mamdnai and Asilina (1974) first used fuzzy language to form fuzzy controller in 1974 and then applied it in boiler and steam engine controlling and achieved success. This pioneering work marked the birth of fuzzy control. In 1979, Chinese scholars also began research on fuzzy controller and made an achievement in the definition, performance, algorithm, stability, scale self-regulation of fuzzy controller (Jing-Ling, 1979).

Although it's just 40 years before the fuzzy control system was put forward, the development is quite rapid. Since 80s, controlled objects in automatic control system become more complicated. It is reflected not only in multiple input and output, time-varying characteristic of parameter and severe nonlinearity. What's more, for most controlled objects, acquired knowledge relatively decreases, while requirements for control performance gradually increase. These conditions make more requirements for fuzzy control theories and application research.

MATERIALS AND METHODS

Current situation and existing problems in dynamic control of food transporting vehicles: Hybrid power vehicles with dividing power have the advantage of structure of tandem and parallel type. It uses electric power and machinery power flow to transmit the power of engine. This can effectively improve fuel economy and emission performance; also improve dramatically vehicles' drivability. Control strategy is the core technology of hybrid power vehicles, which mainly involves two types that are based on rules and optimization. Methods based on optimization can get optima or quasi-optimal control effect and have become the highlight of present study. However, the existing strategy is mainly aiming at improving fuel economy and discharge performance, less considering vehicles' drivability. Although researchers consider the influence of engine to drivability and guarantee vehicles' drivability by introducing penalty function. Also

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researchers systematically introduce vehicles' drivability when vehicles are starting, accelerating, cruising, braking, veering and shifting. Besides, researchers introduce control problems of drivability and put forward a comprehensive control strategy that considers both drivability and fuel economy. Clerc and Kennedy (2002) mainly studies drivability of hybrid power vehicles in typical process of starting, status switching, shifting and braking.

Pareto rules: This part discusses the establishment of Pareto rules in multi-objective fuzzy control system. Firstly we see system output response as a function of system input and time. Then we define the support degree of rules to a certain target. Finally, in rule sets with same response areas and base points and different output. We find partly optimal rules according to support degree of rules to target and establish Pareto rule sets. The following are basic definition:

Definition 1 (controlled quantity and output quantity): System controlled quantity: the quantity of control to controlled object, its change can influence the output of controlled object, which is called controlled quantity for short. Its data range is physical quantity.

System output quantity: The output of controlled object, it can change with the controlled quantity of system, which is called output quantity for short. Its data range is physical quantity.

Definition 2: Control algorithm and control system, called mapping:

$$f : I \times X \rightarrow U$$
$$\forall (t, x) \in I \times X, (t, x) \rightarrow u = f(t, x)$$

This is a control algorithm. Here $I \subseteq [0, +\infty]$ is finite or infinite interval. X is system measurement domain, this system control measurement domain. Because control algorithm decides response process of system state, the process corresponds to timing curve, which is called system state path under the effect of control algorithm f.

RESULTS AND DISCUSSION

Dynamic control of food transporting vehicles: Engine connects with input axis through former transmission case; output axis connects with wheels through later transmission case. Machine A and B have four-quadrant operational capability, which can be in state of generating electricity and motoring. If clutch C is separated and brake D is united, the system is in EVT1 model, which is mainly used in the stage of low speed. If clutch C is united and brake D is separated, the system is in EVT2 model, which is mainly used in the stage of medium or high speed. Compared with single mode configuration, double mode configuration can guarantee drivability and increase speed, which is suitable for heavy vehicles (Fig. 1).

Double molding power dividing hybrid power system: Fig. 2 gives a basic process of integrated control. Firstly we need to determine demanding power according to pedal aperture of drivers. Meanwhile, we determine power range of each part according to running status and control algorithm of vehicles. Then we conduct performance computation of drivability and judge whether it satisfies the requirement of drivability. If it is satisfied, that is LD = 0 has solution, then we can optimize fuel economy based on it. It not, then we conduct the optimization of drivability. Finally, according to result, we use control algorithm to get timely control variable and then apply to hybrid power vehicles. We can see that in this control strategy, we firstly guarantee drivability. Due to the multi-degree freedom of vehicles, we can optimize fuel economy on the condition of satisfying drivability. At this time, LD = 0 is constraint condition. Besides, in order to guarantee the stability of system, we need to control inertia power of engine.

Control strategies (Driver, power demand, calculation of drivability, satisfying drivability. Fuel economy, control algorithm, control factor, hybrid-power vehicles, running state, range of power, optimization of drivability) In order to measure the control effect of optimizing strategy, we compare it with traditional strategy. They have same simulation

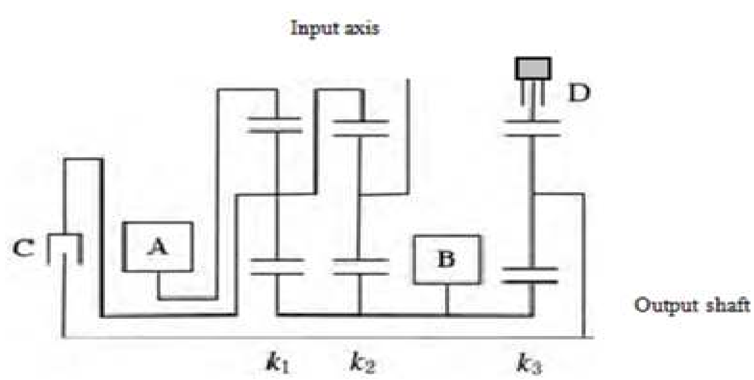

Fig. 1: Hybrid power system with double mode split power

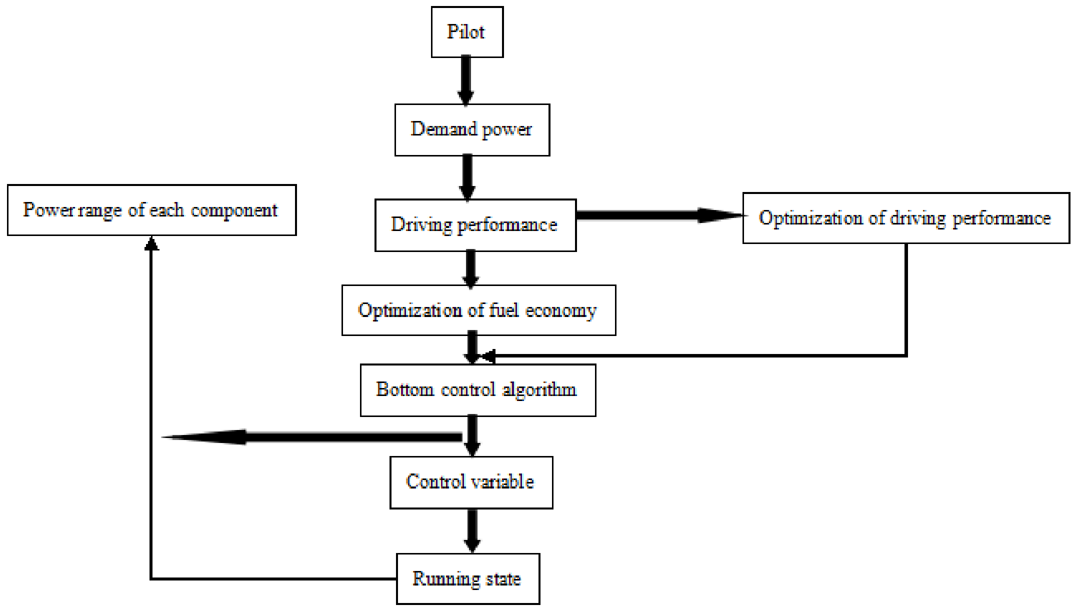

Fig. 2: The flow chart of controlling strategy

Table 1: Strategy comparison

Performance index	Traditional strategy	The strategy of this paper	Improvement effect
Fuel consumption of 100 km (L)	27.61	26.89	2.6%
Driving performance (KW▪ H)	18.74	12.58	32.9%

platform and just MATLAM control algorithm is replaced. The comparing result is as follows (Table 1).

CONCLUSION

We can see that compared with traditional strategy, this strategy decreases 2.6% fuel. (This paper studies heavy vehicles, its fuel consumption is about 29.5 L) this is because of considering speed regulation constraint of engine, so that we guarantee the following of target speed. Besides, this study gives priority to drivability, compared with strategy only considering fuel economy, its drivability is increased by 32.9%.

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