Design of Intelligent Driving System for Variable Speed Vehicle Based on Big Data Analysis

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Abstract. The traditional intelligent drive system of variable speed vehicle has the problem of low precision of driving target, so the intelligent drive system of variable speed vehicle based on big data analysis is designed. The hardware structure of intelligent driving system of variable speed vehicle is designed, and the hardware framework of the system is derived on the basis of the hardware structure, so as to complete the hardware design of intelligent driving system of variable speed vehicle. Respectively for automated driving simulation component library, automotive autopilot system protection module, the automatic speed control driving system design, complete the autopilot system software design, through software and hardware design to realize variable speed motor intelligent automatic driving system design. Experimental contrast can be seen that is based on the analysis of the large data variable speed auto intelligent automatic driving system compared with the traditional automatic driving method, driving the target precision increased by 15%, and has high effectiveness.

Keywords: Big data · Variable speed vehicle · Automatic driving · Intelligence

1 Introduction

With the development of Internet technology, the influx of massive data has made achievements in machine learning, data mining and other related fields. The big data era has rounded the door of artificial intelligence for years of silence, combined with statistical methodology, information theory, probability theory and other disciplines, a new Internet era is coming. In recent years, both enterprises, universities and scientific research institutions have invested a lot of manpower and material resources in the field of artificial intelligence to do forward-looking research. This also confirms that a wave of artificial intelligence sweeping the world with big data technology is coming to the face [1]. Auto driving (ATO) technology plays an important role in the modern urban traffic control system. It can control the speed of vehicle driving in two destinations, and its control effect has a direct impact on various performance indicators. Different

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control algorithms are applied to the automatic driving of automobiles, and their control effects are different. Therefore, both now and in the future, it is necessary to study the effective algorithm of automatic driving control, so as to maximize the operation of the vehicle. The traditional research on auto autopilot algorithm is based on off-line simulation based on Simulink. The simulation of pure software is not carried out in real time simulation environment. It can not realize real-time data generation, exchange and processing, and is detached from real car and vehicle equipment, and is helpful to the development of actual ATO products small [2]. A more real simulation environment is needed to study the ATO algorithm, and the control algorithm is placed in the real time system environment. The simulation data is generated and interactive in real time. It can also be connected to the real physical interface with the vehicle or other vehicle equipment. It has a more real and visual inspection control effect and the development of ATO products great help.

2 Design of Intelligent Driving System for Variable Speed Vehicle Based on Big Data Analysis

2.1 Hardware Structure Design of Automatic Driving System for Variable Speed Vehicle

The vehicle operation control system (ATC) consists of three parts: automobile overspeed protection system (ATP) auto driving system (ATO) and auto monitoring system (ATS). ATP completes the safety control of the car operation. Under the supervision of the ATP, ATO instead of the driver makes the car run efficiently and energy saving. ATS is responsible for monitoring the car system, so that the car describes the working process of the ATO system according to the scheduled time table transport 1 (Fig. 1):

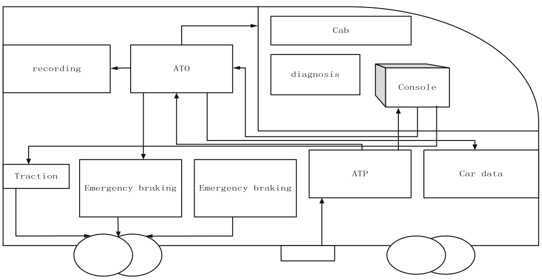

Fig. 1. Principle of intelligent automatic driving system for variable speed vehicle

ATO gets the command from ATS to run the vehicle, which is sent by the ground and transmitted through ATP. ATP passes useful information after processing to ATO, displays relevant information, and constantly monitors the work of ATO. ATO uses useful information to calculate the speed of the operation, obtain the control quantity, and execute the control command. At the same time, the driver can input the car information from the console and send the transmission equipment from the vehicle to the ground after the arrival of the control information and the control information to the station. The driver is transmitted to the ATS from the ground loop line [3]. ATS based on this car information, after determining the car's new task, once again through the ground transmission equipment to the ATO in the interval run, each to the track signal exchange, ATO receives new ground information, so that the speed adjustment such as ATO failure, then cut off the ATO person Working, ATP and ATS work [4].

2.2 Hardware Framework of Intelligent Automatic Driving System for Transmission Vehicles

In order to ensure the extensibility of the designed system, the system is based on the idea of model base, and adopts the object-oriented simulation method. In order to make the system independent of the specific column control system, the processing of the actual system component module is like the data processing of the database, and the system is separated into an independent model unit. The components of model units and model libraries constitute the structure of the intelligent driving system of the whole system, as shown in Fig. 2:

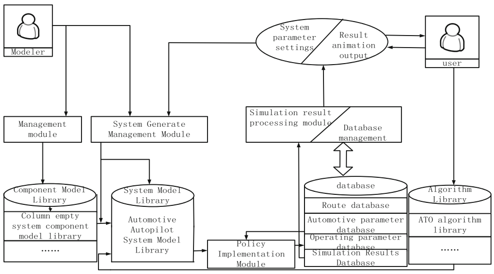

Fig. 2. Intelligent automatic driving system framework for transmission vehicles

The system framework is mainly divided into user interface layer, management layer and database. The component database contains the model of the component of the column control system. It can be said that the component database is the orderly management of the object library that consists of the column control system. The rationality of the decomposition of the system object directly affects the extensibility and the modifiable system database of the system in the future, and contains various columns connected by the component. Control system model, users can choose the required column control system model for simulation database to provide all kinds of data required for the simulation process of the column control system, and include a simulation result database.

3 Software Design of Intelligent Automatic Driving System for Variable Speed Vehicle

3.1 Design of Autopilot Simulation Component Library

The model library in the simulator uses hierarchical design. The component model library is composed of subsystems which are controlled by the car. Each subsystem is a component package, such as auto driving package containing several components that constitute a subsystem, each component has a hierarchical structure, may be a class or contain it. All kinds of classes, from simple to complex, macro to micro, from components to component packages are only an organization method of objects or classes in a system. It is a part of components that make up a variety of systems that can be connected to the required system from the required components from the different component packages to the required system [5]. The structure design of the automatic driving simulation component library is shown in Fig. 3.

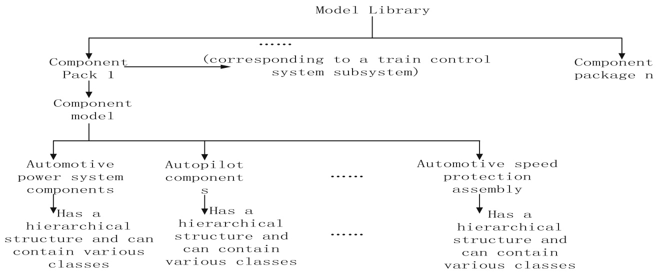

Fig. 3. Component library

3.2 Design of Auto Driving System Protection Module

Taking into account the safety of the automatic driving system, the ATO system should be operated under the security protection of the ATP system. It is mainly reflected in the generation of the ATO target velocity curve based on the ATP protection curve, and the speed generation is reduced according to the characteristics of vehicle and line conditions. Then first, there is a ATP protection curve. The ATP protection curve mainly includes ATP emergency braking curve and ATP emergency braking trigger curve [6]. The ATP emergency braking curve is a curve that the vehicle can never exceed. If the speed of the vehicle exceeds the speed of the ATP emergency braking curve, there will be danger. ATP emergency braking triggering curve is to ensure that the car does not touch the ATP emergency braking curve. When the speed of the vehicle exceeds the speed of the ATP emergency brake trigger curve, the vehicle immediately implements the emergency brake, which is a process of triggering tight braking. The emergency braking triggering curve should consider the braking characteristics of the vehicle itself, such as the time of traction and cut-off, the delay of braking establishment, and the current speed of the vehicle. We should also consider the slope value [7] of the line conditions of the vehicle. Because of the safety protection, the worst case should be considered. The current speed of the car is the maximum speed that the car can reach when the curve is designed, and the line slope is the maximum slope on the line. Each point on the ATP emergency braking trigger curve reaches the ATP emergency braking curve through the traction and cut-off stage and the braking establishment stage. In addition, in the low speed limit zone to the high speed limit area, we must ensure that the tail speed limit is low and the trigger speed will jump. Figure 4 is the schematic diagram of the protection module of the autopilot system:

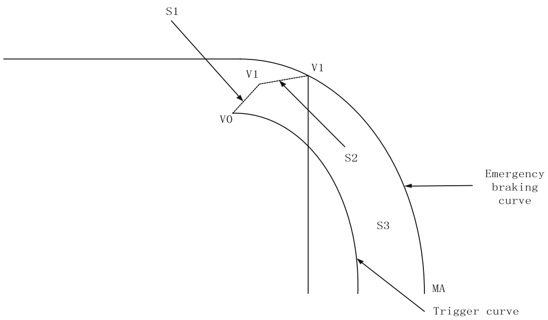

Fig. 4. Principle of auto driving system protection module

Figure 4 shows the ATP emergency braking curve and trigger curve at MA. ATP emergency braking curve generation method is: according to the fixed braking rate B, line speed limit V, according to:

$$v^2 = 2 * b * s \tag{1}$$

The location of the deceleration point should be calculated, and the curve of the deceleration part will be generated, which is combined with the static speed limit curve of the line to generate the ATP emergency braking curve. The method of generating ATP emergency brake trigger curve is: S_1 is the distance that the car walks in the time delay of traction and cut off, and S_2 is the distance [8] for the vehicle braking time delay. S_3 is the distance from the V_2 point to the MA point on the emergency braking curve. According to the basic physical formula, S_1, S_2 and S_3 are respectively expressed:

$$s_1 + s_2 + s_3 = s \tag{2}$$

S is the distance from the MA point to the current distance, $F(V0) = S$, S has known. There is only one V_0 for the unknown quantity, V_0 can be solved by one element two times equation. The formula for calculating the trigger speed of the constant speed part of the circuit is:

$$V_0 = V_{Lim} - A_1 * T_1 - A_2 * T_2 \quad (3)$$

V_{Lim} is the emergency braking speed for the current point. A_1 is the maximum traction acceleration of the vehicle, T_1 is the traction cut off time of the vehicle, and A_2 is the acceleration of the vehicle in braking delay time. T_2 sets up a delay for the brake of the car. V_0 is the trigger speed for the current point. Then it is judged whether the emergency speed limit of the current point is generated by the falling edge or by the static speed limit. If the current emergency speed limit is generated by the falling edge, it is possible to calculate the corresponding speed of the falling edge at a fixed braking rate of 0. As the false MA point corresponding to this falling edge. The current triggering speed can be obtained according to the basic model. But to make a judgement, if the trigger speed is less than the corresponding trigger speed of the falling edge. Then take the big. If the current emergency speed limit is generated by static speed limits, V_0 is obtained. Then find the false MA point on the falling edge above which the minimum speed limit is generated. V_1 [9] is calculated according to the basic model. Compare V_0 and V_1, take small. ATP emergency braking speed limit and trigger speed limit have been completed.

3.3 Design of Speed Control Module for Auto Autopilot System

The principle of speed control module of autopilot system is mainly that the target speed curve of ATO should be generated under the restriction of ATP emergency braking triggering curve. First, in the speed monitoring phase of the ceiling, the target speed curve of ATO is minus 5 km/h of the ATP emergency braking trigger curve. In the stage of vehicle speed reduction from high speed limit zone to low speed limit zone, the ATO target speed curve should be decelerated at a suitable deceleration rate and slowed down to a low speed limit area in advance. And in the parking phase, according to the target deceleration, there are two ways of parking. The first is that when the absolute value of the deceleration is large, the distance between the brake and the stop is smaller. The car must first reduce the speed to the limit speed of the station, and go into the station, and stop at the distance to the distance from the stop point calculated according to the speed and speed. The second situation is that when the absolute value of the speed reduction is not large, the parking distance is longer, the car will stop at the station, that is, the car will stop at the station and stop [10]. To sum up, we should design the target speed curve of ATO according to different situations. When the target velocity curve of ATO is generated, an appropriate controller can be designed to track the target speed curve and control the operation of the vehicle. ATO control car operation, there is a set of evaluation system to evaluate the performance of ATO. This evaluation system can evaluate the performance indexes of ATO respectively. Finally, the performance of ATO is evaluated by assigning weight coefficient to each performance index. The speed control module of the autopilot system is mainly concerned with three aspects: its safety, vehicle energy consumption and parking accuracy. First, in security, security is the speed limit that requires the car to not exceed the line. It can record the number of emergency braking times in the whole car as a standard for evaluating safety. Security is very important. If the whole process triggers emergency braking, it shows that ATO's algorithm still has a lot of shortcomings and needs improvement. If the emergency brake is not triggered throughout the whole process, the safety is 1 and the emergency braking is triggered, and the safety is 0. Set NEB to trigger the number of emergency braking. The evaluation function of security is:

$$s_1 = \left\{ \begin{array}{ll} 1 & \text{neb} = 0 \\ 0 & \text{neb} >= 1 \end{array} \right\} \tag{4}$$

In terms of energy consumption, the main indicator records the whole process of energy consumption. The formula for calculating energy consumption at each time is $P = F * v$, and because $F = M * a$, a can get $P = M * a * v$ according to gear and current speed. The total energy consumption of the whole process is P accumulation at every moment. A P and K can be set up to evaluate the performance index function of energy consumption. That is:

$$s_2 = \left\{ \begin{array}{ll} 1 & \sum \text{p} <= \text{p0} * \text{t} \\ 1 - (\sum \text{p} - \text{p0} * \text{t}) * \frac{k}{t} & p0 * t < \sum p <= \left(\frac{1}{k} + p0\right) * t \\ 0 & \sum \text{p} > \left(\frac{1}{\text{k}} + \text{p0}\right) * \text{t} \end{array} \right\} \tag{5}$$

In which P_0 and K are undetermined, and t is the time for the car to run. It can also directly record the whole energy consumption P and the evaluation criteria as a function of energy consumption. But this cumulative value is related to time. When comparing the energy consumption of different ATO algorithms, the running time should be consistent. According to the experience value, P_0 is $4M$, $K = 1/(16M * \text{t})$.

Parking accuracy can record parking time specific location points and the specified parking points error to record parking accuracy. The parking accuracy is within 30 cm, which needs to be improved beyond 30 cm. When parking error is s, the evaluation index of parking accuracy is:

$$s_5 = \left\{ \begin{array}{ll} 1 & \Delta s < 10 \\ -0.05 * \Delta s + 1.5 & 10 <= -\Delta s <= 30 \\ 0 & \Delta s >= 30 \end{array} \right\} \tag{6}$$

The range of the results of the above function is 0–1. The greater the value, the better the performance of ATO.

The evaluation function of each performance index is S_1, the weight is A_1, the evaluation function of energy consumption is S_2, the weight is A_2, the evaluation function of the degree of precision is S_3, the weight is A_3, the evaluation function of the comfort degree is S_4, the weight is A_1, the evaluation function of the parking precision is S_5, and the weight is A_5, A_1, A_2. The actual line needs different values for different requirements. The evaluation function of the ATO algorithm is:

$$s = a_1 * s_1 + a_2 * s_2 + a_3 * s_3 + a_4 * s_4 + a_5 * s_5 \tag{7}$$

In general, A_1, A_2, A_3, A_4 and A_5 can be set to 0.2. After the completion of the hardware and software design, the intelligent driving system of variable speed vehicle is designed.

4 Experimental Analysis

4.1 Experimental Process

In order to verify the effectiveness of the intelligent driving system of the variable speed vehicle, the following comparative experiments are designed. Taking the same driving route of the same car as the experiment object, it is divided into two groups, of which the intelligent automatic driving system of the variable speed vehicle is the experimental group and the traditional method is used as the control group. On the premise of controlling the single variable, the change data of two groups of automobile driving changes are recorded, the difference between the line of the car and the target route is recorded, and the difference between the vehicle route and the target route is recorded, and the difference between the vehicle route and the target route is recorded. The difference of vehicle target difference. The corresponding conditions were set for the two sets of experimental data. In order to ensure the fairness of the experiment, the parameters of the experimental group and the control group were always consistent. In order to verify the difference between the intelligent automatic driving system and the traditional method of the transmission, the experimental group will operate the intelligent automatic driving system of the transmission vehicle according to the demand, while the traditional data detection is mainly handled manually.

4.2 Comparison of Difference Between Vehicle Route and Target Route

At the same time, the experimental group and the control group recorded the same traffic route and the target road change data, and compared the accuracy of the record. After recording 0–40 s, the difference between the change data of the route and the target route and the actual route data was also recorded. In order to avoid interference caused by sudden events, the experimental group and the control group have the same processing parameters. The concrete results are as follows (Fig. 5):

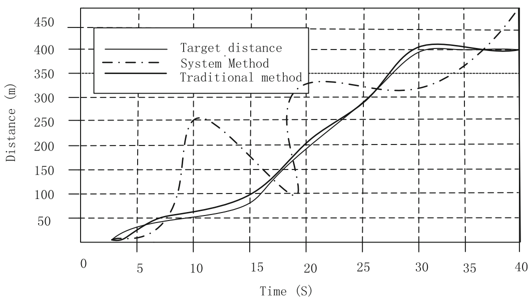

Fig. 5. Comparison of the difference between the route and the target route

With the increase of time, the experimental group has been in a relatively stable state, and the accuracy rate of data records is high, and the rate of data difference of the experimental group is about 4%. The overall efficiency of the control group was unstable, while the control group had a difference of 20%. Therefore, it can be proved that compared with the traditional method, the automatic driving system of variable speed vehicle can get a 19% increase in accuracy.

4.3 Comparison of Difference Between Parking Targets

The same data were processed in the experimental group and the control group at the same time, and the difference of parking target was recorded after 150 times. In order to avoid interference caused by sudden events, the experimental group and the control group have the same processing parameters. The concrete results are as follows (Fig. 6):

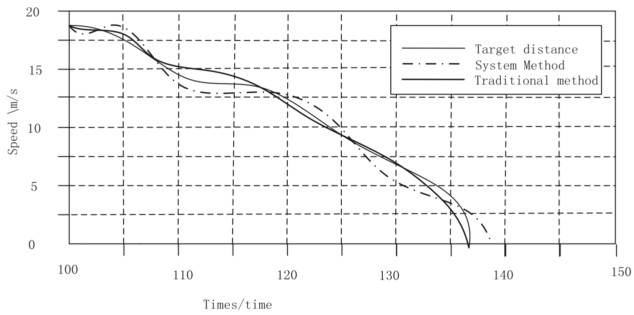

Fig. 6. Comparison of the difference between parking targets

Compared to the above picture, in the process of the difference of the parking target data, with the increase of the number of parking, the difference of the parking target of the intelligent automatic driving system of the transmission car is less than 5%. In the control group, with the increasing number of parking, the difference of parking targets was large, and the difference of parking targets was about 10%. Therefore, it can be proved that the automatic driving system of variable speed vehicle can effectively reduce the difference of parking targets.

5 Concluding Remarks

With the development of Internet technology, scientific research institutions have invested a lot of manpower and material resources in the field of artificial intelligence to do prospective research. Auto driving (ATO) technology plays an important role in the modern urban traffic control system. It can control the speed of car driving in two destinations and its control effect. Fruit has a direct impact on various performance indicators. Different control algorithms are applied to the automatic driving of automobiles, and their control effects are different. Therefore, both now and in the future, it is necessary to study the effective algorithm of automatic driving control, so as to maximize the operation of the vehicle. In the design process, the system framework is designed based on the working principle of the intelligent driving system of the variable speed vehicle. In the software design part, based on the design of the auto driving simulation component library, the auto driving protection module and the speed control module are designed to complete the design of the intelligent automatic driving system of the transmission vehicle based on the large data analysis.

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