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Construction of an Intelligent Control Platform for Electrical and Electronic Architecture Based on Adaptive Control Algorithm Combining Domain Control Technology and Wireless Sensing

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ABSTRACT

The development of electronic and electrical architectures towards domain centralization makes it difficult for traditional distributed control architectures to meet the functional needs and performance requirements of increasingly complex intelligent devices. This study utilizes a multi-model adaptive control algorithm to assist the domain controller to adjust the control parameters in real time according to the state of the device and environmental changes, and to realize the optimization of the control of the device. The wi-fi wireless networking communication technology is chosen to transmit the real-time data acquired by the sensors to the web page. The electrical and electronic architecture composed of the two combined with each other is carried to the intelligent control platform to realize the functions of sensing, positioning, planning and decision-making of the equipment platform. The study shows that: the algorithm selected in this paper can reach the target speed of the motor within 0.2s in the process of no-load and loaded operation, and the time required for balancing to the load torque is significantly reduced compared with the comparison algorithm. In this paper, the maximum throughput and CPU occupancy of the domain controller + wireless sensor architecture are lower than that of the traditional distributed architecture. And the platform constructed accordingly has no packet loss when the number of packets sent is less than 10000, and the average communication delay is between 0.65 and 1.2ms, which meets the requirements of vehicle wireless control and communication. Through the domain controller based on adaptive control algorithm to regulate the vehicle speed in real time, to ensure the safety distance between the rear vehicle and the front vehicle.

Keywords: adaptive control algorithm, domain controller, wireless sensing, electronic and electrical architecture, intelligent control platform

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1. Introduction

China's automobile ownership is maintaining the trend of increasing year by year, the competitive pressure within the automobile industry is gradually increasing, and consumers' choices of automobiles are not only limited to the performance of traditional automobiles such as space, power, and fuel consumption, but also the degree of automobile intelligence has become an important factor to attract consumers [1-3]. Nowadays, with the development of automobile electrification, intelligence, network connectivity, and sharing, the number of automobile electronic devices is growing exponentially. The design optimization of automotive electronic and electrical architectures can lead to cost reduction, performance enhancement, and efficiency improvement [4-6]. Intelligent Internet-connected vehicles integrate a new generation of information technology represented by artificial intelligence, high-speed networks, 5G communications, Internet and big data, etc., which transforms the automobile from a traditional carrier into an intelligent mobility platform, and the convergence of technologies puts forward higher requirements for automotive hardware, software, and networks [7-10].

Automotive electronic and electrical architecture lays a solid foundation for the vehicle chassis framework [11]. Today's automotive chassis architecture is not only mechanical architecture, in order to realize the assisted driving function and other intelligent functions on the vehicle need to install a large number of inductors, sensors and controllers, but also need a large number of wiring harnesses to connect them together [12-14]. The importance of automotive electronic and electrical architecture becomes apparent, automotive electronic and electrical architecture will be a variety of automotive sensors, sensors, controllers and wiring harness hardware and automotive software organic combination, so that the vehicle's architecture to achieve the simplification of the vehicle at the same time, but also able to improve operational efficiency [15-17].

Automotive electronic and electrical architectures evolve as the functionality of the vehicle increases. Most of the current industry models use distributed architecture, with the development of the intelligent network, the interaction between the systems requires more and more, the realization of intelligent control is more and more difficult, and can not adapt to the future development needs [18-20]. Mainly manifested in the following problems such as independent decision-making of each control system, lack of coordination between systems, lack of trade-offs and global control of vehicle functions, performance indicators, can not meet the increasingly stringent user demand for vehicle economy, power, intelligent driving, etc. Secondly, the safety aspects of the vehicle only based on the operational scenarios of the active and passive safety design, and did not from the functional safety, information safety, and other aspects of the system operational safety Secondly, the safety aspect is only based on the operation scenario for the active and passive safety design of the vehicle, but not from the functional safety, information security and other system operation safety aspects, which can not meet the safety requirements of users in the context of the intelligent network connection. Finally, the coupling of each control system is too strong to realize the separation of hardware and software, and cannot meet the user's needs for rapid iteration and rapid response to new functions and technologies [21-24]. The traditional electrical and electronic solutions can not meet the future needs of the vehicle for communication, safety, intelligence, etc. There is an urgent need to develop a new electrical and electronic architecture, which deeply integrates the new technology of the intelligent Internet, and realizes the requirements of the whole vehicle for environmental protection, safety, energy saving, comfort, etc. [25-26].

Based on domain control, the electrical and electronic architecture platform deeply integrates the new technology of intelligent Internet, realizes centralized decision-making and regionalized control, supports collaborative safety management of the whole vehicle, meets the differentiated and intelligent needs of users in different market segments, and realizes flexible expansion and rapid iteration of functions [27-28]. Domain control architecture is a kind of electronic and electrical architecture that takes centralized decision-making and regionalized control as the function realization method. The development of domain control architecture establishes the V process of design and development of electronic and electrical architecture through requirements research, functional development and component design, network development and validation, and development verification [29].

The article applies the multi-model adaptive control algorithm to combine the domain control technology with wireless sensing, on the basis of which an intelligent control platform for electrical and electronic architecture is built. The sensing layer in the platform consists of multiple wireless sensor nodes, which collect real-time device operation status and environmental information, and transmit them to the domain controller through the wireless communication network. The control layer, composed of multiple domain controllers, centralizes the control of each functional domain of the intelligent devices. The domain controller adopts adaptive control algorithm to estimate the dynamic parameters of the platform in real time to ensure the stability and performance of the platform. And simulation experiments are carried out in the automotive field to simulate and verify the practicality and efficiency of the selected algorithms and the platform built in this paper in the field of vehicle intelligent control.

2. Combination of domain control technology and wireless sensing under adaptive algorithms

2.1. Domain controller technology

Definition of domain controller [30]: a control unit that can support the centralization of hierarchical software within a specific functional domain, reduces the system complexity that may result from the increase of cross-domain functionality, and has sufficient computational, storage, and communication resources to enable software updates. In this paper, adaptive control algorithms are combined with domain control technology to improve the level of intelligence and robustness of control platforms for electronic and electrical appliances architecture. And based on the domain controller design scheme of functional domain, the electronic and electrical architecture is divided into multiple system domains, and the control method combining domain control and distributed control is adopted.

For example, the power domain in the electrical and electronic architecture adopts distributed control, with the VCU as the core controller, integrating torque control functions, and driving the front and rear motors through the front and rear motor controllers to realize drive and energy recovery. At the same time, the VCU distributes the energy usage of the power battery according to the battery power, current and voltage information fed back from the BMS for high-voltage energy management. During the charging process, VCU calculates the charging current and charging time according to the charging status feedback from the charging machine to realize charging control.

As for the intelligent network domain, the intelligent network function is mainly concentrated in the communication domain controller, which has a 5G module to quickly realize data transmission with the external base station, and integrates the V2X function to realize data interaction and V2X communication to provide auxiliary information for intelligent control.

2.2. Wireless Sensor Network Design

2.2.1. Wireless Sensor Network Composition Structure. Wireless sensor networks [31] are divided into four major functional modules:

Data acquisition module, the function is mainly to collect data.

Data transmission module, the function is to transmit data and exchange information.

Data processing module, the function is to manage the routing protocol, assign tasks, summarize the transmitted data, classify and process, optimize and finally give to the host computer.

Power module, sensor nodes, wireless communication network and the use of users form a wireless sensing network.

Wireless communication network is the core of the wireless sensor network brain, play the role of communication between the associated sensor nodes, modules and users, through the setting of the same protocol provisions, so that the sensor nodes collected information data in the modules to maintain the transmission, and ultimately brought together to the network database to store, call.

2.2.2. Choice of Wireless Networking Methods. wi-fi wireless networking communication, its signal is converted from the wired network, wireless router access ADSL or broadband and other wired network, the router becomes a hotspot, the device connects to the hotspot will be able to access the Internet network. Set up low cost, low difficulty, cost-effective, users can simply and quickly connect to the Internet and share network resources. In this paper, to realize real-time data visualization, need networking stability, fast transmission rate networking, choose wi-fi wireless networking communication, the data collected by the node terminal transmission to the web server Internet database storage, for web page display.

3. Multi-model adaptive control algorithms

3.1. Recognizing the set of models

The commonly used multi-model adaptive control [32] for nonlinear systems mainly consists of three parts: N parallel discriminative model $\{I_{j=1}^{N}\}$, a nonlinear controller set $\{u(\hat{x}(t)),\hat{\theta}_j(t))\}$ and switching logic, in which the switching logic selects an appropriate controller in the controller set based on the performance of the discriminative model and controls the whole system. As for the design of the discriminative model, it can be divided into adaptive discriminative model and deterministic discriminative model according to whether the parameters of the discriminative model change adaptively or not. In this paper, the following two cases are mainly considered:

1) When all the discriminative models are adaptive discriminative models, the design of the i th discriminative model has the following form:

$$I_i:\begin{cases}\dot{\hat{x}}_i(t)=f\left(\hat{x}_i(t)\right)+bF\left(\hat{x}_i(t)\right)\hat{\theta}_i(t)+g\left(\hat{x}_i(t)\right)u(t)+L_i\tilde{y}_i(t)\\ \hat{y}_i(t)=C\hat{x}_i(t)\\ u_i\left(\hat{x}_i(t),\hat{\theta}_i(t)\right)+\beta\left(\hat{x}_i(t),\hat{\theta}_i(t)\right)\end{cases}\tag{1}$$

where $\tilde{y}_i(t)=C\hat{x}_i(t)-y(t)$ is the output estimation error.

The adaptive discrimination models used in this paper all have the form described in Eq. (1), and the set of discrimination models $\{I_{j=1}^{N}\}$ and the controlled object Σ have the same control input.

2) When there are $N-1$ deterministic identification models and one adaptive identification model, all identification models have the same expression form as Eq. (1). At the same time, the parameter update law is no longer needed for the deterministic discriminative models.

3.2. Switching rate and stability analysis

In the design of the switching rate, the main purpose is to design the corresponding performance index function for each discriminative model, and conduct real-time online evaluation of the performance of each discriminative model according to this index function, and select the appropriate controller according to the performance index of the set of discriminative models, which can be used to implement the control of the controlled object.

In this paper, since the system state is unknown, resulting in the state estimation error can not be obtained in real time, so the output estimation error is used as a performance measure, and the output error of the i st discriminative model is noted as:

$$\varepsilon_i(t) = y_i(t) - y(t) \quad (2)$$

where y_i is the output of the i nd discriminative model and y is the output of the controlled object. In order to measure the performance of the discriminative model, the following commonly used performance metrics are used in this paper:

$$J_{L_i} = \pi_1 \varepsilon_i(t)^2 + \pi_2 \int_0^t \varepsilon_i(\tau)^2 d\tau, \pi_1, \pi_2 > 0 \\ i = 1, 2, \cdots, N \quad (3)$$

This index takes into account both the transient output error and the cumulative error of the discriminative model. This performance index, which can well respond to the discriminative model's discriminative performance of the controlled object, can realize better control performance in the multi-model control algorithm.

Stability is the basic requirement of the control system, and in the multi-model switching adaptive control algorithm, the stability of the system depends largely on the design of the switching rate. In this paper, the flow of multi-model switching adaptive control algorithm is as follows:

Initialization: a controller u_i is randomly selected and added to the system closed loop, notation $I_c = u_i$, where I_c denotes the system controller.

Switching rate: assuming that switching of the system controller occurs at moment $t = t_1$, then at moment $t > t_1$, if $t - t_1 > \tau_D$ and $\min_{1 \le i \le N} J_{t_t} \le J_{t_e}$ are satisfied, where τ_D is the lag time, then $I_i = \arg\min n_{1 \le i \le N} J_{t_i}(t)$ is selected and $I_c = u_i$ is set. The specific design of the lag time τ_D here will be given in the later analysis for specific design ideas and details.

Stability: for the above multi-model switching adaptive control strategy, if the above multi-model switching adaptive control strategy is used, there are for any system initial conditions, all signals of the system and the set of discriminative models are bounded and the invariant domain $\left\{(x, \tilde{x}) \middle| \|x\| < \kappa, \tilde{x} = 0\right\}$ is asymptotically stable.

4. Construction of an intelligent control platform for electrical and electronic architecture

Based on the establishment of the platform's functional requirements in the early stage, the functional nodes of perception, localization, planning, decision-making, execution, etc. are acquired within the simulation platform, and the installation of the corresponding functional packages within the nodes is completed, which facilitates the testing and data analysis based on the different communication architectures built in practice in the later stage. We obtain the platform system model file through the ROS open source platform, and create the simulation environment directly in Gazebo by adding built-in components to complete the basic simulation environment construction.

4.1. Platform system model

4.1.1. Simulation Modeling. Based on the URDF file and XACRO file of ROS, the 3D structural model of the platform is built in RVIZ in the following steps:

1) Create a workspace based on the built ROS subsystem and initialize it.
2) Create functional packages corresponding to the workspace and configure the dependency packages of URDF and XACRO files.
3) Modify the URDF file and XACRO file of the built model.
4) Write the model startup file to start the state release and motion control nodes.
5) Run the startup file to change the reference coordinate system of the model in RVIZ and add components to complete the model construction.

4.1.2. Simulation environment simulation. The specific steps to build the simulation environment for the platform in Gazebo based on the URDF file and XACRO file of ROS are:
1) Create the ROS function package, add the dependency urdf, xacro, gazebo_ros, gazebo_ros_control, gazebo_plugins of the function package.
2) Set the inertia matrix of the model component, write the startup file of the model, and will load the model file content to the parameter server for model building in Gazebo.
3) Add the built-in components directly to create the simulation environment, save and run.

4.2. Platform system functions

4.2.1. Sensory functions. Based on the open source characteristics of ROS to obtain the function package files corresponding to the perception function nodes, there are camera function packages, radar function packages and so on. At the same time, take the perception function device radar sensor as an example, write the configuration file of radar on the basis of the platform device model obtained above, and add the radar sensor configuration for the model. Launch Gazebo to view the platform model, also after completing the radar function configuration, other core function configurations within the perception node are carried out sequentially.

4.2.2. Positioning functions. Localization is to project the position of the platform itself in the simulation environment, the intelligent platform needs to move according to the set route in the navigation, through the localization can judge whether the actual running trajectory of the platform equipment is in line with the expected planning route. The ROS function package provides the probabilistic localization system of AMCL (adaptive Monte Carlo Localization), which can be used to project the position of the platform according to the existing map using a particle filter. The ROS package provides AMCL (adaptive Monte Carlo Localization) probabilistic localization system, which can be used to project the platform position according to the existing map using particle filter.

4.2.3. Planning decision-making functions. Path planning is an important component of platform device simulation in ROS. move_base function is provided in the navigation package navigation of ROS to realize the platform's own positioning function. move_base node can provide path planning function for each installed platform, which is based on the target location set by the node in the early stage, and then moves to the target location. The move_base node can provide path planning function for each installation platform, the node will move to the target location according to the target location set by the node in the previous period, and at the same time, it will provide real-time feedback to the platform's status information.

4.2.4. Executive functions. The basic process of motion control is to first create a new execution control file under the URDF file, add corresponding kinematics and dynamics attribute files for each component of the platform model in turn, then integrate this file into the XACRO file, start Gazebo and publish messages to control the platform motion, and at the same time, you can also realize the motion control of the platform by obtaining the published motion command topics to realize the platform movement in the simulation environment.

4.3. Intelligent control platform design for domain control technology and wireless sensing

4.3.1. Distributed electrical and electronic architecture design. After the function acquisition is completed, it is necessary to complete the top-level architecture design, and at the same time, the communication logic of data interaction between the functional nodes is clarified. The platform adopts layered architecture design, and the distributed system architecture for domain control technology and wireless sensing is shown in Figure 1.

The sensor hardware within the sensing function node independently completes the collection of relevant raw sensing information, screening and preliminary data processing under the corresponding driver, and the node calculates, processes and distributes the sensing data. At the same time, time-synchronized data fusion is carried out within the perception function node to generate time-sequence-consistent perception fusion information, which is transmitted to the localization and planning function node together with the relevant offline storage information, thus providing the localization and planning function node with the data required for the relevant computation tasks.

The localization function node accepts the data processed by the perception node, such as the visual binocular camera and the IMU, to carry out its own localization, and at the same time, this function node needs to complete part of the driving function, and outputs its own localization information in real time so that it can be read by the planning and decision-making function node.

The planning function node interacts with the perception and localization function nodes in real time to acquire the road and traffic participant characteristics, and synchronizes the acquired data frames in time to complete the local path planning task.

The decision-making function node interacts with the perception and localization function nodes in real time to obtain the relevant feature information of the road and traffic participants, and performs traffic scene pattern recognition to reflect the traffic scene at the current moment in a timely and effective manner.

The execution function node interacts with the planning and decision-making function node to obtain the relevant dynamics control execution instructions, analyzes the real-time instructions based on its own physical hardware parameters to complete the execution of specific motor actions, and outputs the operation information for use by the platform system at the same time.

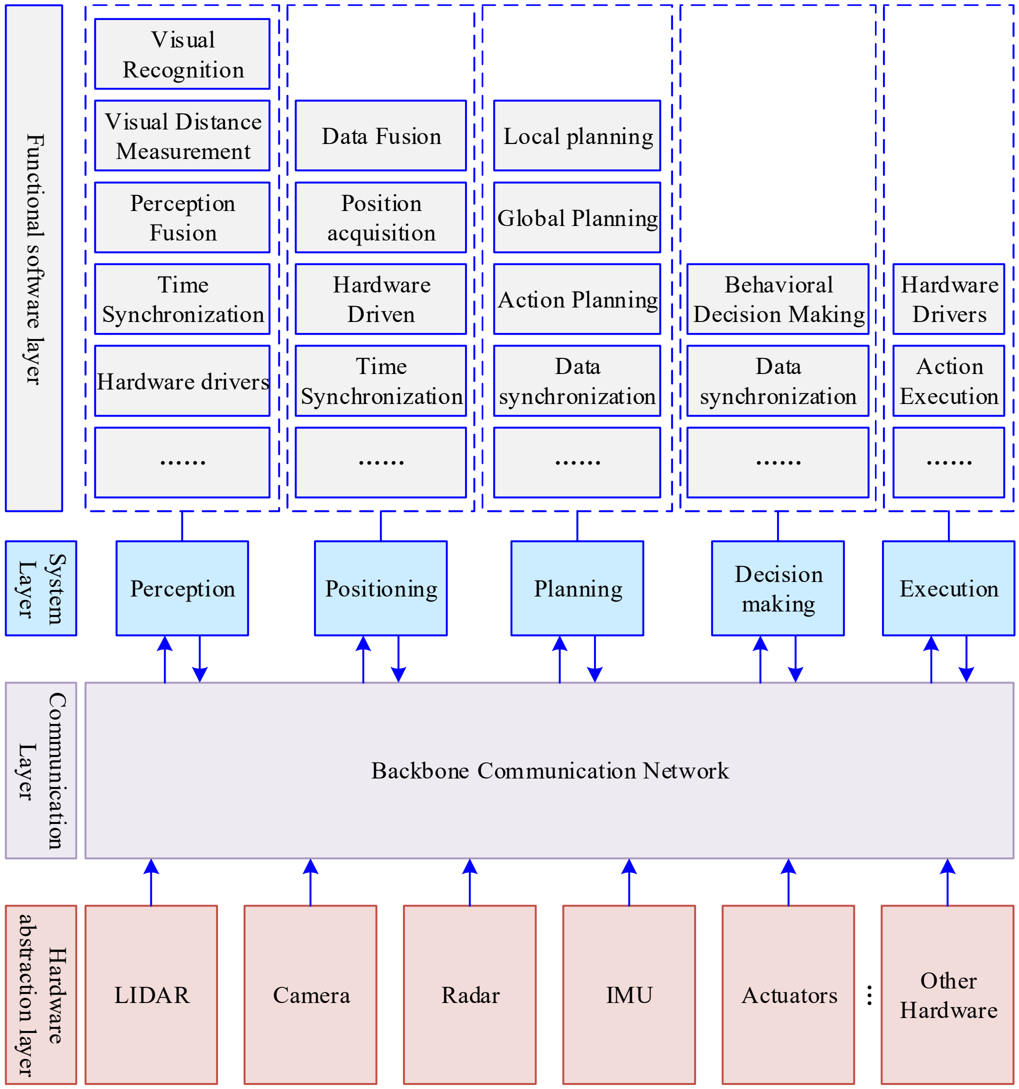

Fig. 1. Distributed electronic electrical architecture

4.3.2. Intelligent control platform workflow. The intelligent control platform operation process is shown in Figure 2.

1) The platform starts, completes the startup of each functional node, and carries out system node detection to determine whether all nodes have started successfully. If there is a fault, start the faulty node state characterization and re-perform the system troubleshooting.

2) After the platform starts successfully, establish the current task of intelligent electric equipment, carry out global path planning, and each functional node works according to the set communication logic.

3) Cyclically determine whether the work task goal is completed or not, and if the judgment is completed, the platform ends operation and enters the standby mode. Judgment is not completed then each functional node keeps the current state to continue running.

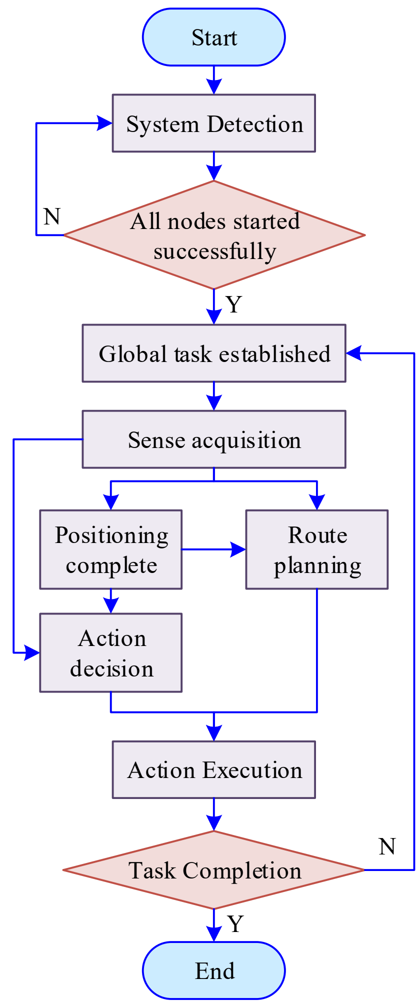

Fig. 2. Intelligent control platform running process

5. Simulation of vehicle intelligent control effect simulation experiment analysis

This section takes an automobile as an example and uses the intelligent control platform constructed above to simulate, test and analyze the control algorithms, performance indexes and reliability of the platform, so as to provide a reference basis for the testing and optimization of the actual application of the intelligent platform.

5.1. Evaluation of rotational speed control effect of multi-model adaptive control algorithm

In order to verify the effect of the multi-model adaptive control algorithm selected in this paper, the double-loop proportional-integral control algorithm (double-loop PI), and the model-free adaptive control algorithm (MFAC) are selected for comparison, and the following electrical and electronic intelligent control simulation experiments are carried out.

Setting the target speed as 3000 r/min, first, the simulation experiment is carried out under no-load operation, i.e., the load torque is set to 0 N-m. The speed and torque curves during operation are shown in Fig. 3. From the figure, it can be seen that the actual rotational speed regulated by each algorithm for the motor during vehicle operation gradually rises from 0 r/min and stabilizes to near the target rotational speed. The overshoot-free control of rotational speed is realized, and the steady-state error is less than 0.1%, of which the regulation time of the 0.1% error band of this paper's algorithms is 0.17s (smaller than the regulation time of the double-loop proportional-integral control algorithm and the model-free adaptive control). In addition, under the control of each algorithm, the vehicle motor electromagnetic torque dynamics are balanced to the vicinity of the load torque. And the time used by this paper's algorithm to reach the load torque is only 0.23s, which is 25.88% and 45.28% shorter than that of the double-loop proportional-integral control algorithm and model-free adaptive control algorithm, respectively.

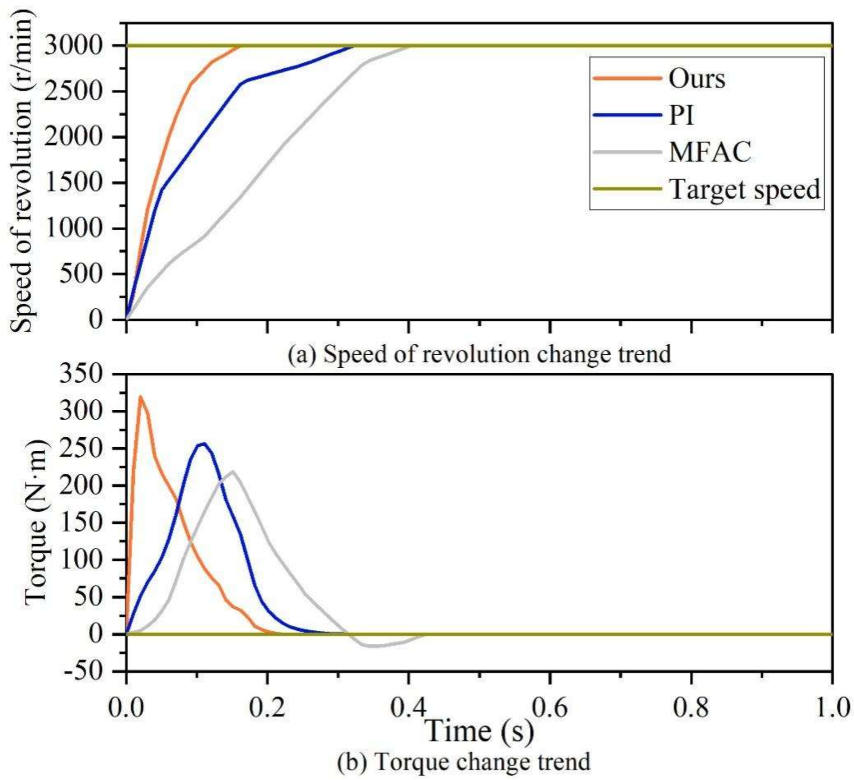

Fig. 3. The speed of the torque and the torque curve in the running process

Then, simulation experiments are carried out under loaded operation, i.e., the load torque is set to 50 N-m. The speed and torque curves during loaded operation are shown in Fig. 4. In the figure, the actual rotational speed regulated by this paper's algorithm gradually rises from 0r/min and stabilizes near the target rotational speed, which also realizes the rotational speed control without overshooting, and the steady-state error is less than 0.1%, and the regulation time of the 0.1% error band is 0.18s, which is shorter than that of the double-loop proportional-integral control algorithm and the model-less adaptive control algorithm, respectively, by 0.14s, and 0.23s. In terms of the electromagnetic torque, the algorithm of this paper also shows the best control effect, only 0.2s can be dynamically balanced to the load torque neighborhood.

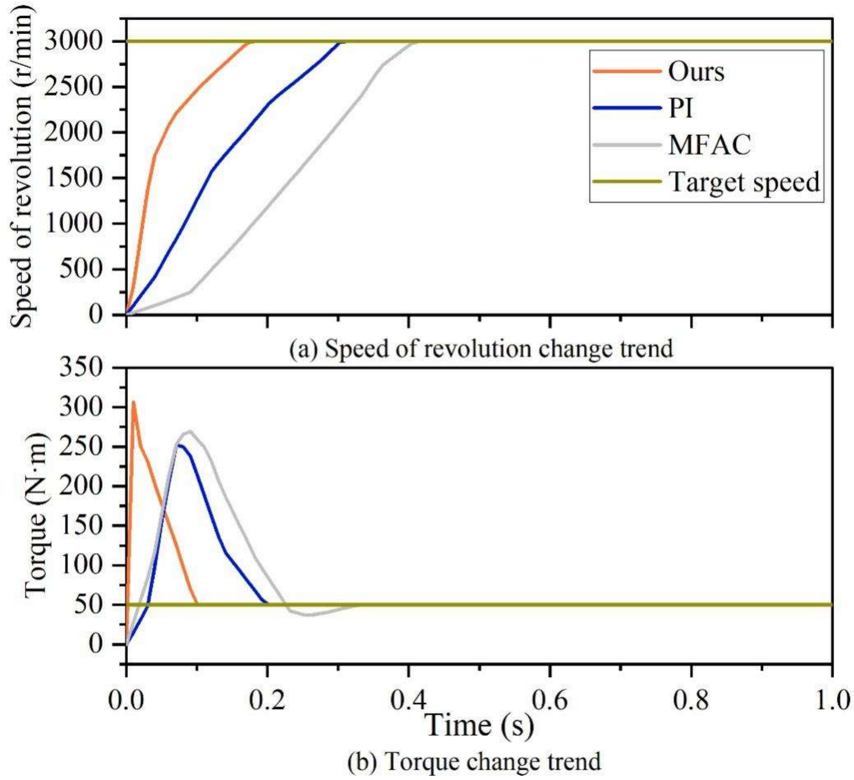

Fig. 4. The speed of the torque and the torque curve

5.2. Functional Verification of Gateway Throughput and CUP Occupancy

In order to compare the performance of the combined domain controller+wireless sensing EE architecture with the traditional distributed architecture under the adaptive algorithm, and to compare the gateway throughput and CPU utilization, the 2 architectures are tested in the same scenario. Select the unmanned mode on the human-computer interaction interface, defined as the industrial control computer sends commands to slowly rotate the drive system and drive the steering system in the form of sinusoidal waveforms, and set this test task to be called periodically, once every 100 ms.

Under the scenario of message cross-domain realization of multi-function, the gateway throughput and CPU occupancy of the 2 architectures are shown in Fig. 5 and Fig. 6, respectively. Combining the two figures, it can be seen that the maximum throughput of the traditional distributed architecture stays around 1.7 kbit/s, and the occupancy of CPU is 44%~48%. The maximum throughput of the domain controller+wireless sensing architecture is around 0.43kbit/s, with a CPU occupancy of 18%~23%. Multiple execution actions are generated by the same test task to simulate the data transmission of unmanned vehicles in dynamic projects such as straight-line acceleration, figure-of-eight loop and high-speed trajectory, etc. Since the traditional distributed architecture does not have the concept of functional domains, the data throughput is large corresponding to the low utilization of resources. The domain controller+wireless sensing architecture can encapsulate the same dynamic test task in one structure, and call the corresponding domain controller in real time to complete the execution action. In summary, the domain controller + wireless sensing architecture is better than the traditional distributed architecture in terms of performance, and the resource utilization rate is significantly lower than the traditional distributed architecture under the same dynamic task.

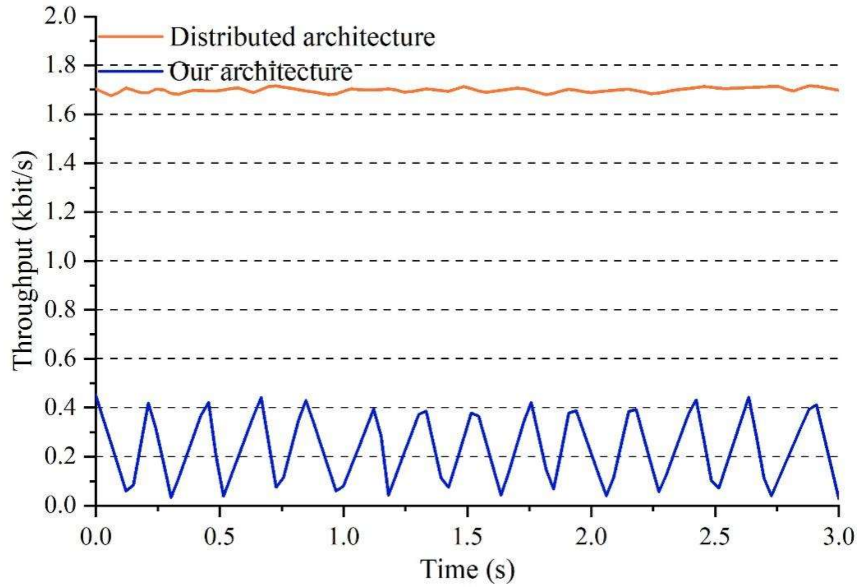

Fig. 5. Two architectural gateway throughput test results

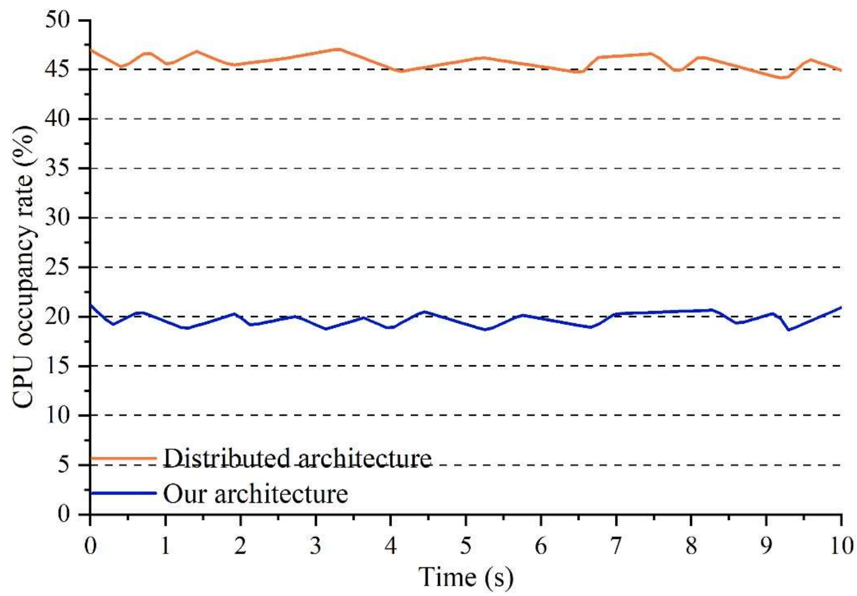

Fig. 6. Two kinds of architecture CPU occupancy rate test results

5.3. Wireless Central Gateway Packet Loss Rate and Communication Delay Offline Testing

Simulated tests such as data packet loss rate and communication delay of the central gateway are conducted in a laboratory environment, where a new wiring harness is simulated and the central gateway, domain controller, safety loop, and important actuators are installed in the specified locations according to the regulations. Vehicle data packet loss and communication delay tests are conducted on the platform of this paper.

1) Packet loss test: With the help of ATKKPING software, a certain amount of data is sent within 100s and the number of packets is recorded, and the results of packet loss test data are shown in Table 1. According to the test results, it can be deduced that the packet loss rate is 0% when the number of packets sent in 100s is less than 10000, i.e., there is no packet loss when the data interval is more than 10ms. When the data sending interval is further reduced, the packet loss rate starts to increase, and when the number of packets sent is 100000, the packet loss rate is 0.036%, but it is still within the controllable range of the system.

Table 1. Test the results of the packet test

Sending package	Receiving package	Packet loss/(%)
1000	1000	0%
2000	2000	0%
4000	4000	0%
10000	10000	0%
20000	19998	0.01%
50000	49990	0.02%
100000	99964	0.036%

2) Delay test: Record the maximum delay time and minimum delay time in each communication, and remove the maximum delay time and minimum delay time in each communication, and find the average value of other delay times to get the average delay time. The communication maximum delay time, minimum delay time and average delay time test results are shown in Figure 7. From the figure, it can be seen that the maximum delay of this platform in the communication process does not exceed 6ms, while the minimum delay is basically distributed in about 0.5ms, and the average delay is between 0.65 and 1.2ms. The average delay time is less than 2ms, which meets the requirements of the maximum delay under the vehicle driverless intelligent control mode, and the average delay time fluctuation is small, and the delay jitter is controllable, which meets the real-time requirements of the Ethernet communication of the central gateway for vehicle intelligent control.

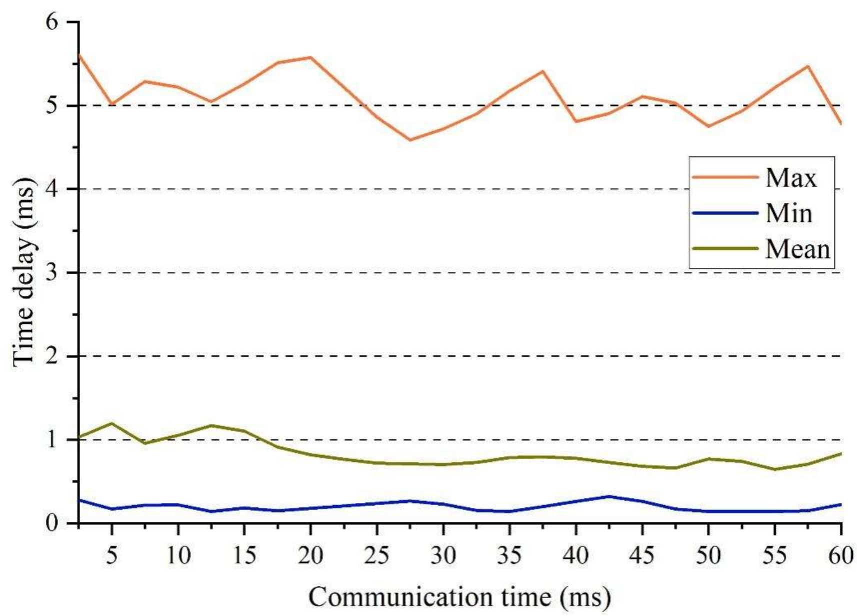

Fig. 7. Communication maximum delay, minimum delay and average delay test

5.4. Feasibility Analysis of Adaptive Cruise Control Function for Intelligent Platforms

In this section, the domain control technology with wireless sensing combined with the electronic and electrical architecture platform of adaptive control algorithm designed above is tested for the self-driving domain function of the electronic and electrical architecture of the intelligent networked vehicle, and the vehicle adaptive cruise control function is verified by using the AURELION virtual scene software and the ControlDesk real-time function test software.

Run the multi-model adaptive control algorithm on the test platform, and use Simulink to monitor the speed of the front vehicle and the speed of the rear vehicle in the virtual scene during the simulation process, and the results of the speed simulation test and verification of the domain control technology based on adaptive control algorithm and wireless sensing combined with the electronic and electrical architecture intelligent control platform are shown in Figure 8. The results show that the rear car can better adaptive cruise to the front car, that is, with the change of the speed of the front car, the rear car speed can make timely speed up or speed down feedback. For example, during the running time of 180~240s, the speed of the front vehicle shows a trend of "increase-decrease", with the speed increasing from 33.73km/h to 38.15km/h and then decreasing to 28.42km/h. The speed of the rear vehicle changes in a similar way, and finally decreases from 34.18km/h to 30.40km/h. It shows that the platform in this paper adopts advanced algorithms to make the vehicle domain controller can quickly process the wireless sensor data, adjust the speed and distance in real time to ensure that a safe distance is maintained with the front vehicle, which verifies the feasibility of the simulation test of the electronic and electrical architecture intelligent control platform constructed in this paper.

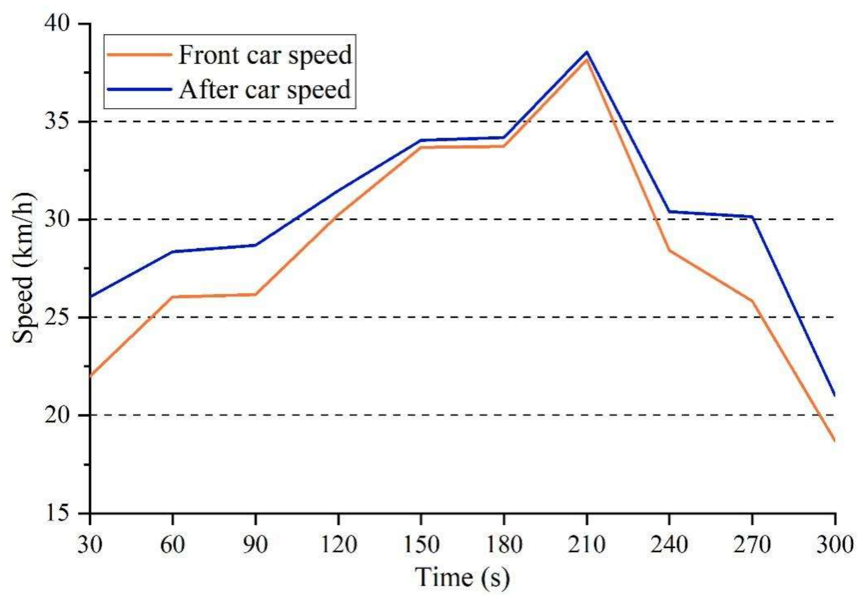

Fig. 8. Electronic electrical architecture simulation test results

In addition, this section also verifies the creep function of the intelligent control platform constructed in this paper when releasing the gas and brake pedals after engaging the D gear. Initial state settings are made for power, gear, brake pedal opening, gas pedal opening and key gear, and the creep function test results are obtained by experimenting the relevant operation steps as shown in Fig. 9. From the figure, we can see that at t=11 seconds, hang the D gear, at t=15 seconds, release the brake pedal, at the same time, the intelligent control platform began to request torque, in the throttle for 0 state, the maximum torque request for 50N-m, and then the vehicle speed rises slowly and steadily at 5km/h, the vehicle can be the whole vehicle to achieve creeping state, which proves that this paper's platform can meet the creeping design standard requirements.

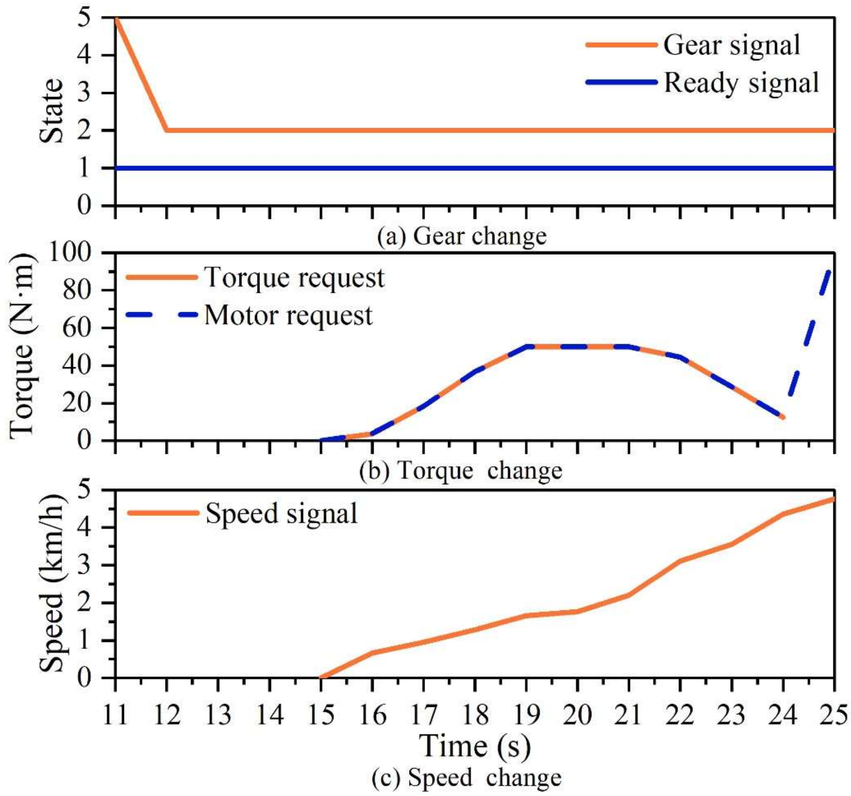

Fig. 9. Creep function test results

6. Conclusion

This paper proposes an intelligent control platform construction scheme for electrical and electronic architecture based on adaptive control algorithm combining domain control technology and wireless sensing to realize intelligent, networked and efficient equipment control. The road condition data is collected in real time by wireless sensors, and the multi-model adaptive control algorithm is established according to the physical characteristics of equipment control. The algorithm is utilized to estimate the parameters of the data, update the control law according to the estimated parameters, and generate intelligent control signals. The adaptive control algorithm is integrated into the intelligent control platform, and the performance of the control algorithm is tested in the simulation environment using the vehicle as a medium.

1) The algorithm in this paper achieves an error of less than 0.1% between the motor's stabilized speed and the target speed under no-load operation of the vehicle, with an adjustment time of 0.17 s. The time taken to reach the load torque is shortened by 25.88% to 45.28% compared with the comparison algorithm.

2) In this paper, the maximum throughput of the domain controller + wireless sensing electronic and electrical architecture is 0.43kbit/s, and the occupancy rate of CPU is 18%~23%, which is better than the traditional distributed architecture.

3) When the number of packets sent is 100000, the platform packet loss rate reaches the maximum (0.036%), and the maximum delay of communication does not exceed 6ms, and the average delay is between 0.65~1.2ms.

4) The platform in this paper can adjust the speed of the rear vehicle in real time to ensure that a relatively safe distance is maintained with the front vehicle, and the creeping state of the vehicle can be realized through this platform.

Research on domain control technology based on adaptive control algorithm to improve the precision and robustness of equipment control. Wireless sensing nodes are adopted to simplify the equipment harness arrangement and improve the scalability of the system. The intelligent control platform constructed provides technical support for the future development of intelligent networked devices.

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