

Retraction

Retracted: Human-Computer Interaction of Networked Vehicles Based on Big Data and Hybrid Intelligent Algorithm

Wireless Communications and Mobile Computing

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] J. Shang, H. Liu, and W. Li, "Human-Computer Interaction of Networked Vehicles Based on Big Data and Hybrid Intelligent Algorithm," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 5281132, 13 pages, 2022.

Research Article

Human-Computer Interaction of Networked Vehicles Based on Big Data and Hybrid Intelligent Algorithm

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Intelligent connected vehicle (ICV) refers to realizing the exchange and sharing of intelligent information between vehicles, roads, people, clouds, and so on by carrying advanced on-board sensors, controllers, actuators, and other devices and combining modern communication and network technology. In the age of big data, the information of everything can be transformed into digital resources, and transportation big data has become a basic resource. This paper constructs a big data platform for traffic data processing to realize the function of real-time collection, processing, and analysis of traffic data. Based on the proposed big data platform, the parallel programming framework of MapReduce and HDFS distributed storage system are used to process the real-time vehicle dynamic information in parallel, and the output result is used as the input of running genetic algorithm simulated annealing (GA-SA) for parallel calculation. At the same time, it studies the impact of various elements on users' interactive behavior, constructs the demand framework and design model of automobile human-computer interaction, and then realizes fast and comprehensive search. The experimental results show that the human-computer interaction method of intelligent networked vehicle can find the optimal driving path, transmit it to each networked vehicle through the human-computer interaction system, realize human-computer interaction, reduce the impact of user unintentional operation on redundant motion, reduce the motion error accumulation of the system, and improve the performance of human-computer interaction system.

1. Introduction

Intelligent connected vehicle (ICV) has the functions of complex environment perception, smart decision-making, and collaborative control. It can realize secure, effective, comfortable, and energy-saving driving and finally achieve a novel generation of vehicles that can be operated instead of people. ICV human-computer interaction system needs to realize the two-way accurate communication of intention and information between people, so as to successfully complete the important task of human workshop control transfer in the process of dynamic driving [1]. Nowadays, touch recognition, gesture recognition, gaze recognition, head posture recognition, and speech recognition are the mainstream automotive human-computer interaction command recog-

ognition technology. As material technology, flexible electronic technology and nanotechnology are applied in the field of tactile sensors, and high-performance tactile sensors have been adopted in vehicle human-computer interaction. Static gesture recognition and dynamic gesture recognition [2, 3] are vehicle interactive gesture recognition. Use various advanced vehicle sensors to examine gestures including deeply trained convolutional neural network used to recognize dynamic gesture data. Except the development of more mature offline gesture recognition, breakthroughs in classification precision, response duration, graphics memory consumption, and user availability [4] have been made by online gesture recognition, gaze recognition, and head posture recognition. In the car, gaze recognition is adopted to interactive missions including pointing and selection, which

can improve the interaction rate and decrease the cognitive load and operation burden. It can also serve people with weak limb functions such as the elderly and the disabled [5]. Head pose information is highly related to eye motion information, so head motion information is usually collected at the same time in eye motion information recognition, and the data fusion of the two is taken into account. Speech recognition is the key technology of vehicle human-computer interaction system, which is adopted in automatic navigation, voice search, command control, voice assistant, and other use scenarios [6]. With the application of feedforward deep neural network and deep recursive neural network in the field of natural language processing, the long-term and short-term memory ability of speech dialogue system has been improved, and its intelligence has been improved. As data has become a new factor of production, it is not only a basic resource and strategic resource, but also a novel driving force for developing the new era [7, 8]. The emergence of big data has caused disruptive variations in a lot of fields such as intelligent transportation system (ITS), from intelligent urban planning to the wide application of improving vehicle safety. Artificial intelligence is the product of traditional computer technology under network information technology. The integration of artificial intelligence and big data will get twice the outcome with half the effort. Intelligent optimization algorithm simulates natural and biological phenomena, because in nature, organisms always evolve in the direction most suitable for the environment. According to this principle, intelligent optimization algorithm can find the optimal solution closest to the optimal solution without knowing the mathematical characteristics of the optimal solution [9, 10].

Genetic algorithm (GA) is a branch of evolutionary computing. It is a highly parallel, random search, and adaptive optimization algorithm based on "survival of the fittest and survival of the fittest." Simulated annealing algorithm has the ability of detailed local search. The way of selecting individuals according to probability can preserve the diversity of individuals and jump out of local optimization. The combination of genetic algorithm and simulated annealing algorithm can realize complementary advantages and avoid disadvantages. This paper mainly runs GA-SA through the big data platform, plans the optimal driving path of the connected vehicle, and then transmits it to the connected vehicle again to realize human-computer interaction, so as to save time and cost.

The key contributions of this work are as follows:

- (1) By building a big data platform, this paper realizes the real-time collection and real-time processing of vehicle dynamic information, which makes the data information of planning the optimal path comprehensive and without lag, and has more practical value
- (2) Study the impact of various elements on users' interactive behavior, build the demand framework and design model of automobile human-computer interaction, and then realize fast and comprehensive search

- (3) In this paper, GA-SA is used to plan the optimal path, enhance the global search ability and diversity, and make the results closer to the optimal solution
- (4) In this paper, the man-machine interaction of networked vehicle is realized, and the data parallel processing and calculation are realized. Convey the planned optimal path to each connected vehicle in real time, so as to save various resource costs

The remaining of this paper is sorted out below. Section 2 explores associated work, next to the construction of big data platform framework applied to internet-connected vehicles in Section 3. Human-computer interaction trajectory tracking control of ICV based on dynamic model is discussed in Section 4. Section 5 is about GA-SA application based on big data platform of internet-connected vehicles. Section 6 displays the simulation experimental outcomes, and Section 7 summarizes the paper with a summary and future study directions.

2. Related Work

The major results of vehicle human-computer interaction pay attention to the human-computer interaction instruction recognition technique on basis of bioelectrical signal recognition and expression. Among them, the human-computer interaction instruction recognition technique on basis of bioelectrical signals can sense people's undemonstrative interaction intention, acquire interactive input instructions by the identification, discussion, and characterization of micro bioelectrical signals, and help ordinary drivers and people with physical disabilities realize vehicle control. On basis of various advanced sensors and on-board intelligent computing platforms carried by ICV, combined with state recognition and monitoring technology, a multisensor computing system with active sensing ability is shaped to monitor and identify cognitive load, secondary activities, emotional state, action posture, and fatigue, so as to improve vehicle safety and reliability. As the foundation of enhancing the ability of cars to perceive, know, and exchange with people, information recognition technology depends on a lot of data and computing resources. Under in-vehicle conditions, the design of gesture recognition systems is challenging because of variable driving conditions, complicated backgrounds, and various gestures.

Benitez-Garcia et al. [11] proposed a multistream network merging hand and hand-location features, which assisted in discriminating target gestures from natural actions of the hand, since these might not happen in the same 3D spatial location. Akhtar and Wang [12] demonstrated a new WiFi-based device-free method for driver gesture recognition for automotive interface to regulate secondary systems in a vehicle. This computationally efficient framework was on basis of the nature of K-nearest neighbors (KNNs), stimulated in sparse representation parameters for great enhancement in gesture categorization. Zheng et al. [13] proposed a gesture recognition system on basis of frequency-modulated continuous-wave (FMCW)

radar and transformer for an in-vehicle environment. A dataset named Driver Micro Hand Gestures (DriverMHG) initially collected by Kopuklu et al. [14] is made up of RGB, depth, and infrared modalities. A lightweight convolutional neural network- (CNN-) based architecture which operates online efficiently with a sliding window approach was proposed by addressing the challenges for dynamic recognition of micro hand gestures. Li et al. [15] introduced a new hand gesture recognition system on basis of Leap Motion Gen.2. In this system, spatial information was matched and fused to firstly present a spatial fuzzy matching (SFM) algorithm, so as to set up a fused gesture dataset. For dynamic hand recognition, the trajectory of test gesture was initialized fast by proposing an initial frame correction strategy on basis of SFM in terms of the gesture dataset. Li et al. [16] investigated the role of sparsity-driven time-frequency analysis in hand gesture categorization. Sparsity-driven time-frequency analysis was adopted to obtain the time-frequency spectrogram firstly. Then, the extraction of three empirical micro-Doppler features from the time-frequency spectrogram was made, and six kinds of dynamic hand gestures were classified with a support vector machine. Wang and Yang [17] presented a bare-handed gesture recognition approach on basis of extended genetic algorithm. The design of an arm motion estimation approach is made on basis of the fuzzy predictive control theory. Head pose estimation exerts a key effect on attention detection, behavior analysis, human-computer interaction, and eye tracking, etc. Sun and Lu [18] monitored the driver's attention with an effective and robust approach. Firstly, a lightweight network was created with the prevailing object detection algorithm SSD which has inherent capabilities of simultaneous classify and regress. Then, vehicle environments where the ambient light changes dramatically adopted single-scale anchors. Liu et al. [19] put forward a new HPE with convolutional neural network and set up accurate head pose database under 5 degrees angle (HPD5A) for human attention recognition. For verifying the availability and usability of the HPD5A database, the benchmark assessment is made on our database with conventional standard HPE classification approaches with and without principal component analysis. The methods include linear discriminant analysis, K-nearest neighbor, random forest, and Naive Bayes classifiers were adopted. Tan et al. [20] proposed an SER-strengthened traffic efficiency solution for autonomous vehicles in a 5G-enabled space-air-ground integrated network- (SAGIN-) based ITS. Vehicle speech information data is converted into spectrograms and input into an AlexNet network model for the high-level characteristics of the vehicle speech acoustic model. In the meantime, the vehicle speech information data is converted into text information and input into the Bidirectional Encoder Representations from Transformers (BERT) model for the high-level characteristics of the related text model. Vivek and Guddeti [21] proposed a hybrid algorithm applying CSO (Cat Swarm Optimization) with PSO (particle swarm optimization) and GA (genetic algorithm) for emotion recognition (ER). Yilmaz et al. [22] proposed a new hybrid architecture, configuring four wide-scoping pre-trained network models in an improved way, applying a

metaheuristic algorithm. This architecture is made up of the formation of the data set, the design of deep neural network (DNN) architecture, training and improvement of the DNN architecture proposed, and assessment of the trained DNN. Tanberk et al. [23] understood and interpreted videos paying attention to human activity recognition by proposing a hybrid deep model. The proposed architecture was set up by integrating dense optical flow approach and auxiliary movement information in video datasets applying deep learning methodologies. Ozcan and Basturk [24] performed sensor data-based activity recognition applying stacked autoencoders (SAEs). The structural coefficients of SAEs have been improved applying artificial bee colony optimization algorithm (ABC), genetic algorithm, differential evolution algorithm, particle swarm optimization (PSO) algorithm, and an afresh developed hybrid algorithm including PSO and ABC in its internal structure.

Relevant scholars use convolution neural network, cyclic neural network, long-term and short-term memory neural network, and other deep learning approaches to recognize facial expressions for emotion recognition, which is used in vehicle intelligent system. Intelligent multimode human-computer interface can satisfy the demands of various types of vulnerable groups for information accessibility (IA) and make up for the deficiency of physical and cognitive abilities of people with disabilities. Sanders et al. [25] presented the combination of proportional switches for human-computer interaction and sensors with veer modification systems. Control, assist wheelchair drivers and reduced wheelchair veer are improved by the transducers and sensors especially on slopes. The layout design of user interface (UI) is a core problem in creating a better human-computer interaction system for complicated system. Zhao et al. [26] proposed a new human-computer cooperative PSO-based immune algorithm (HCPSO-IA), where the initial population is made up of the initial artificial individuals supplied by human and the initial algorithm individuals were produced by a chaotic measure. Li et al. [27] built a model for the layout design of UI which concerned the significance and use frequency of the layout ingredients. Then, the layout optimization problems were solved by proposing an enhanced bacterial foraging optimization algorithm, including the process of chemotaxis, replicates, and migration. Ding et al. [28] proposed an objective reduction algorithm on basis of adaptive propagating tree clustering. The number of clusters determined adaptively is made by advanced adaptive clustering approach, and the correct cluster of outliers can be made from the perspective of human-computer interaction design. Wang [29] proposed the training response and training learning situation of human-computer interaction and set up the human-computer interaction system of intelligent vehicle-mounted commodities on basis of the Internet of Things. Dimbisoa et al. [30] produced the multiplatform HCI most meeting the demands of the users from an interface skeleton. It provides more widgets and graphical elements to design an interface. Augmented reality (AR) is key for immersive human-computer interaction (HCI). Ma et al. [31] proposed an automated vision data synthesis approach, i.e., background augmentation generative

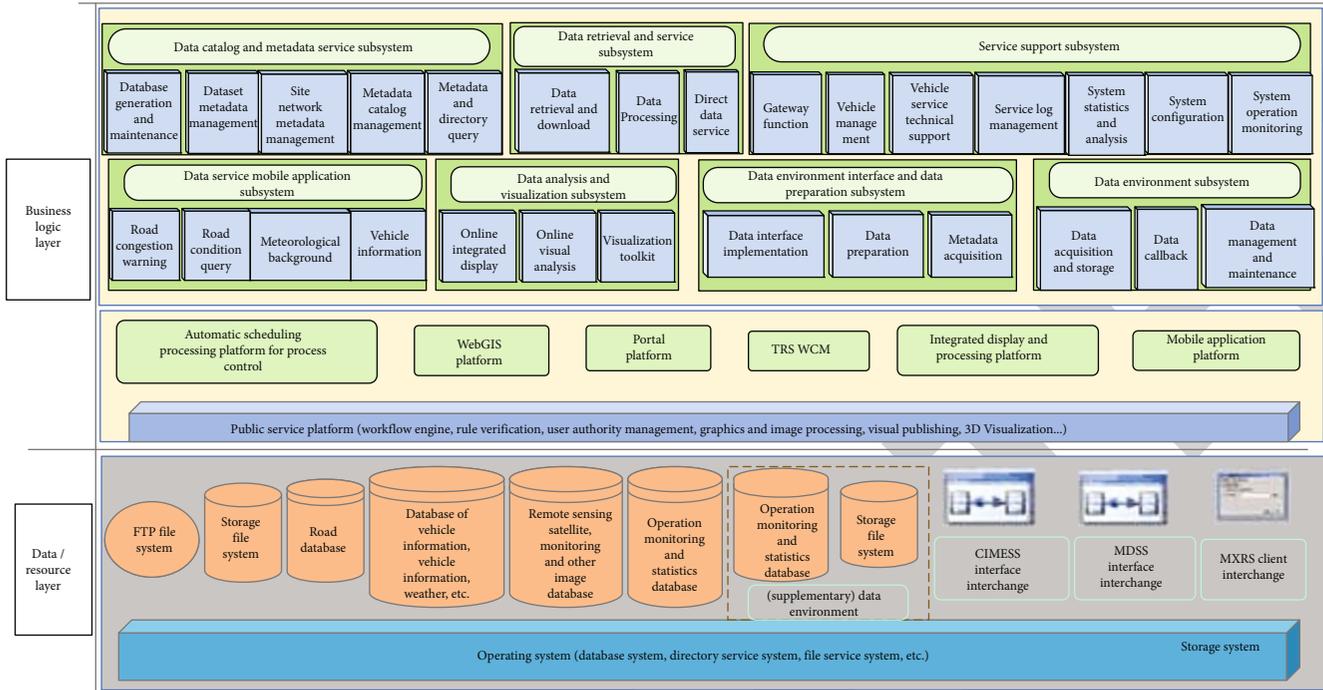


FIGURE 1: Technical architecture of big data visualization platform.

adversarial networks (BAGANs) on basis of 3D modeling and the generative adversarial network (GAN) algorithm. Zhao et al. [32] introduced an immersive system prototype integrating face, gesture, and speech recognition techniques to support multimodal human-computer interaction. Embedded in an indoor room setting, the user facial behavior, body gesture, and spatial location in the room are monitored by developing a multicamera system. A server fuses various sensor inputs in a time-sensitive way so that our system knows who is doing what at where in real time.

With the in-depth application of technology, the derived big data accumulated by ICV on-board interactive system, including the data of condition monitoring, interactive control, personal preference, and networked service, can be used for active learning and adaptation of on-board system. For example, the independent decision-making and active support of on-board human-computer interaction, as well as the behavior prediction on basis of the spatiotemporal features of data and the dynamic adaptation of HMI (human-computer interface), so as to realize the functions of human-computer interaction system function recommendation, directional service, and HMI customization, build an information aware ICV on-board human-computer interaction system to strengthen the added experience value.

3. Construction of Big Data Platform of Internet-Connected Vehicles

This paper constructs an overall solution of big data platform for automobile data processing, which mainly provides the basis for human-computer interaction of networked automobile. Nowadays, there are many channels for collecting data generated during vehicle driving, including

remote sensing satellite, GPS in the vehicle, surveillance camera, and coil, which produce a large amount of data. These data are divided into structured data and unstructured data, and the total amount of data resources continues to grow. The big data visualization platform constructed in this paper includes unified metadata management, distributed ETL management, and scheduling management, realizes big data collection, processing, storage, and external sharing, and has certain data quality management, system self-monitoring, and system self-operation and maintenance capabilities. The construction of big data platform is based on Hadoop cluster, impala cluster, and Oracle cluster. The overall architecture is divided into data source layer, big data platform layer, and application layer. For the effective and steady running of data, the big data visualization platform can carry out the whole process standardized management of data generated during vehicle driving, vehicle machine data, and third-party data resources and quickly gather and exchange quality control and warehousing. The data source layer of the big data platform includes all data related to vehicle driving. Through the classification of the data, it is divided into data blocks, including structured data (vehicle, vehicle data, etc.), unstructured data (remote sensing satellite, radar, etc.), meteorological data, and road spatial data.

The big data platform layer is based on the interface machine cluster to process the data related to vehicle driving, produce rich, and high-quality data products and store them by classification [33]. The distributed ETL tool in the interface machine cluster is used to extract, clean, transform, and merge the original data and then load the data into the data warehouse according to the predefined data warehouse model. The big data platform layer is the core component of the whole big data platform architecture. It should

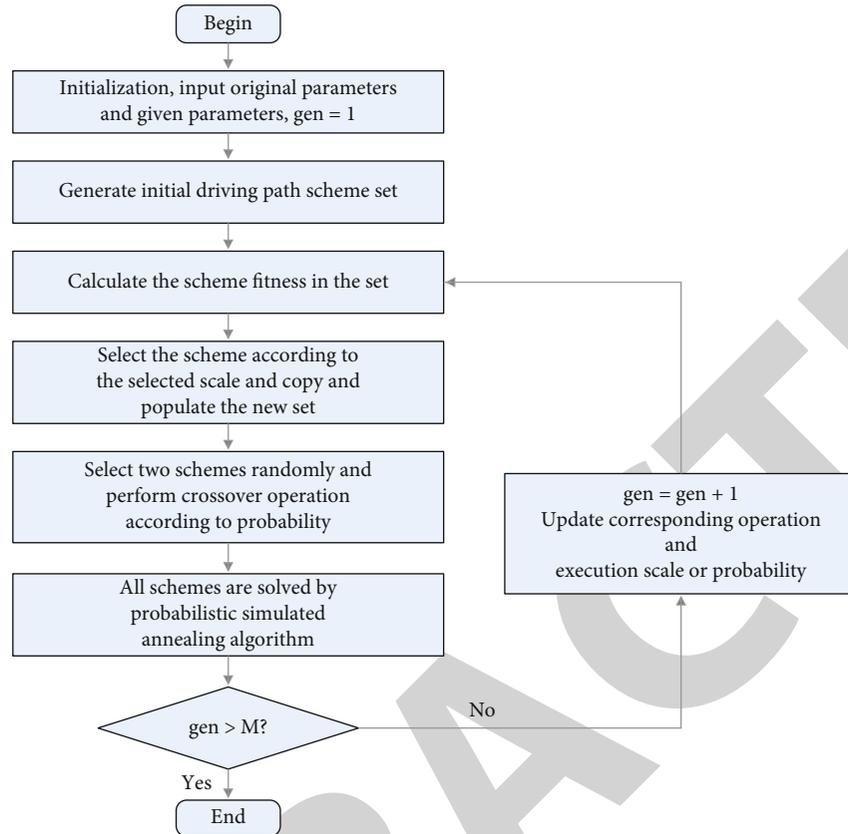


FIGURE 2: GA-SA flow chart.

provide functions such as driving behavior detection, congestion warning, emergency scheduling, optimal path selection, signal light control, and traffic congestion dredging. The current situation of vehicle driving related data storage is relatively complex. In big data processing, many analyses need traditional data and file analysis at the same time. Therefore, the big data platform is built based on the Cloudera framework, comprehensively utilizes the coexistence and combination of traditional database clusters, NoSQL, and other databases, and provides a scalable, comprehensive, and stable data computing framework for massive data, including Spark, Impala, high-performance SQL query engine supporting HDFS, and Hive data warehouse. It can facilitate business personnel to manage the rapidly growing huge air quality data and has a good protection mechanism to guarantee the safety of data. This hybrid architecture requires a lot of ETL processes for data conversion and storage. Figure 1 shows the technical architecture of big data visualization platform.

Since the big data platform will contain a lot of data, data storage, analysis, and application display can be carried out on the basis of the big data platform. For meeting the diversified needs of different businesses, the logical hierarchical method shall be designed in the process of building the platform. It mainly includes business logic layer and data resource layer.

- (1) *Business Logic Layer*. This layer is in charge of the connection between data storage and applications

in the whole system platform. It can define corresponding interfaces, associate different services in the platform, and provide a good access interface for the applications of the upper layer. Data analysis service starts from business requirements and uses the good computing power of big data platform to complete the functions of data conversion, extraction, analysis, and mining.

- (2) *Data Resource Layer*. The storage of various data resources is a significant part of the big data platform. All businesses and displays of the platform need the cooperation of the data resource layer. The data resource layer in the big data platform will adopt the hybrid mode of traditional relational database and distributed file system. Relational data is mainly used in the transportation department to integrate the existing business system data, provide intermediate tables for cleaning and transforming all kinds of data, store data, and mine the information hidden behind the data at the same time. Distributed file system is the main storage mode of big data storage layer. It has two kinds of structured data and unstructured data. It is the main body of the whole data analysis and mining. This layer is in charge of acquiring data from the data source and transforming it into a format appropriate for analysis when necessary. Because the incoming data may have different characteristics, the components in the data change and storage layer must be able to read the data at

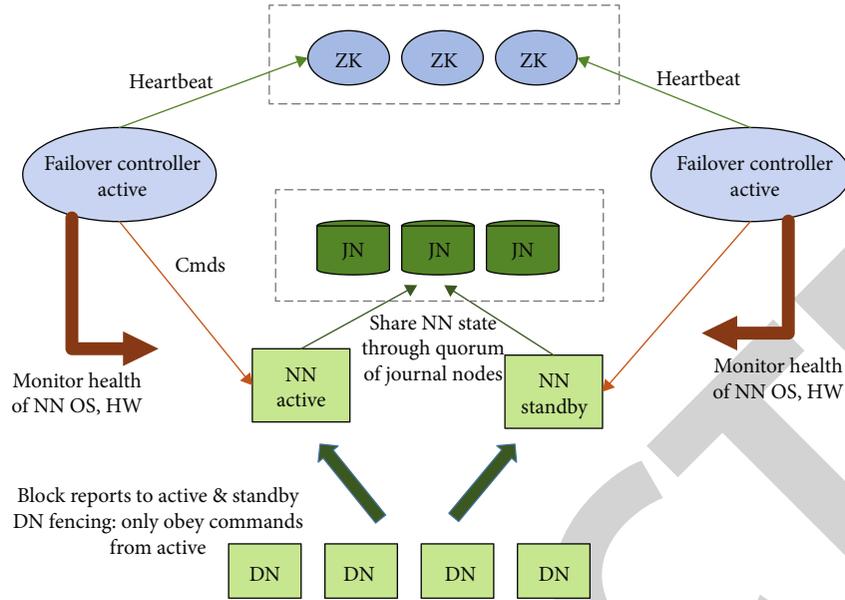


FIGURE 3: HDFS HA structure.

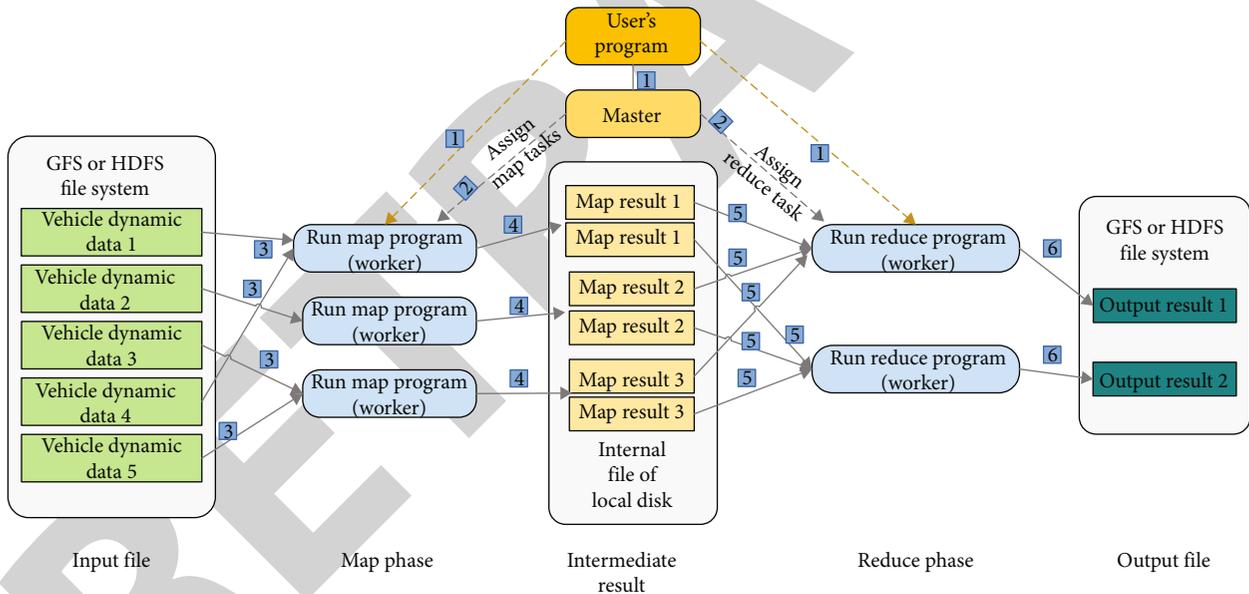


FIGURE 4: Dynamic information processing flow.

different frequencies, formats, sizes, and communication channels and be responsible for modifying the data to the required format for analytical purposes. This component has conversion logic to convert the source data, and the analysis engine will decide the specific data format required, such as image, audio, video, and other binary formats.

In addition to the business logic layer and data resource layer, there are also data application and data collection. Data application is mainly for data analysis, mining, and business integration. Specific applications include driving behavior detection, congestion warning, emergency scheduling, optimal path selection, signal light control, traffic con-

gestion dredging, and mobile client. The application of big data platform is mainly in the business applications developed based on the big data platform. The data extracted from the big data platform layer will be applied to a number of smart transportation-related applications, which can meet a variety of applications such as road condition query and traffic congestion warning. Data collection is to extract, clean, transform, and load all kinds of information and convert all kinds of data into a unified format, so that it can prepare for the data storage layer. Data collection includes the data system and the extraction of metadata. The data will not only include the basic data of all kinds of vehicles and vehicles but also include meteorological service data and road spatial data.

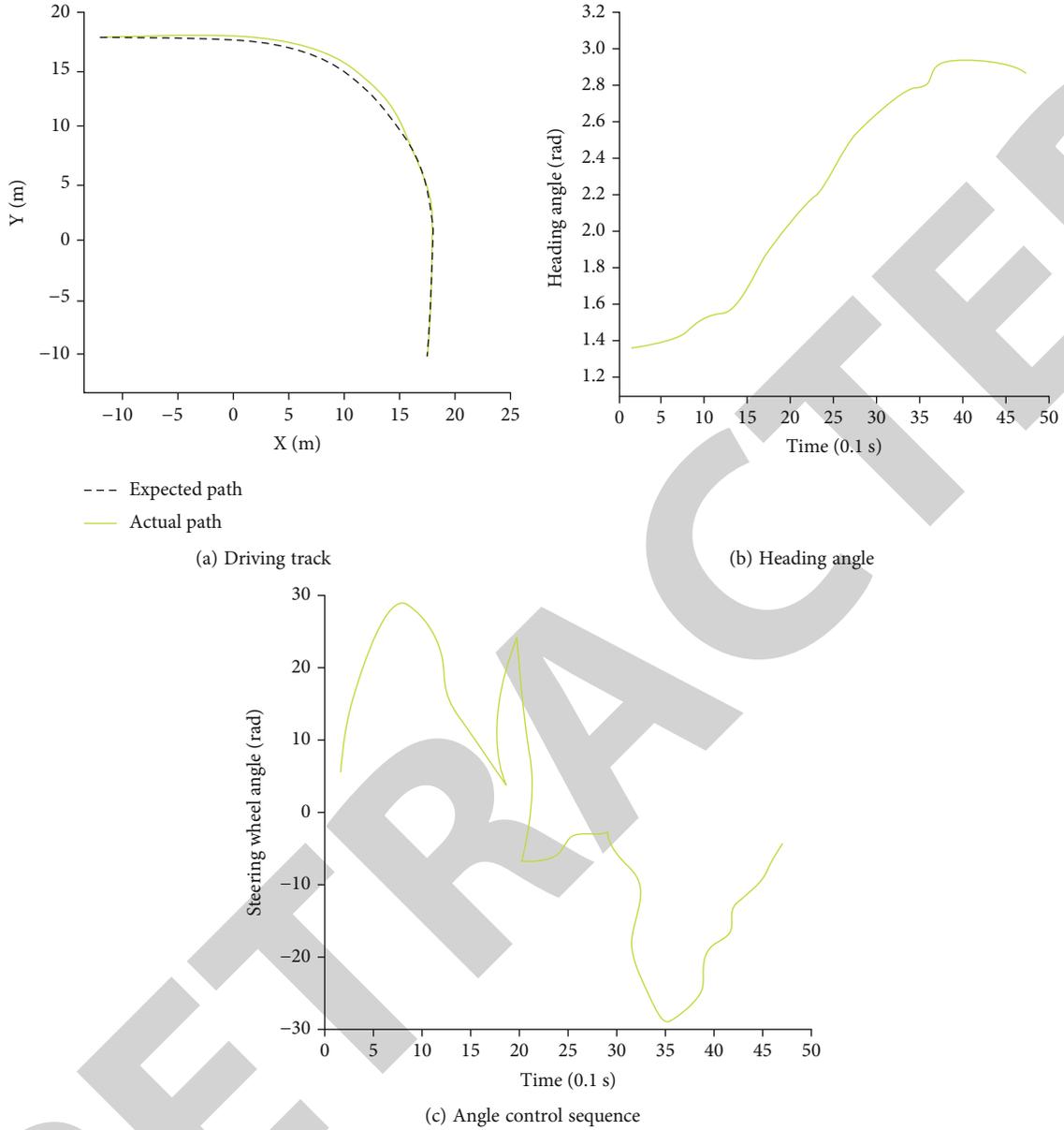


FIGURE 5: Cubic polynomial trajectory planning.

4. Human-Computer Interaction Trajectory Tracking Control of ICV Based on Dynamic Model

As the state of roads and vehicles changes with time, the online model of human-computer interaction of networked vehicles will improve the performance of automatic driving. Artificial intelligence shows great potential through data model. The human-computer interaction kinematics model of intelligent networked vehicle mainly establishes the relationship between vehicle position, speed, and control quantity according to the law of vehicle motion and studies the characteristics of human-computer interaction.

4.1. Adaptive Sliding Window Design. The trajectory planning obtains the trajectory and expected state of a distance

in front of the vehicle, but not all the information is required by the controller. In order to facilitate the management of information, a sliding window is designed for information management, and the window size is changed according to the current vehicle speed. The controller determines the sliding point according to the window size.

Firstly, the feasible trajectory is generated in the vehicle coordinate system. The trajectory curve is a cubic equation, as shown in Equation (1).

$$Y = a_3x^3 + a_2x^2 + a_1x + a_0, \quad (1)$$

in which a_0, a_1, a_2, a_3 is polynomial coefficient, x is the horizontal axis coordinate of the path, and Y is the vertical axis coordinate corresponding to x .

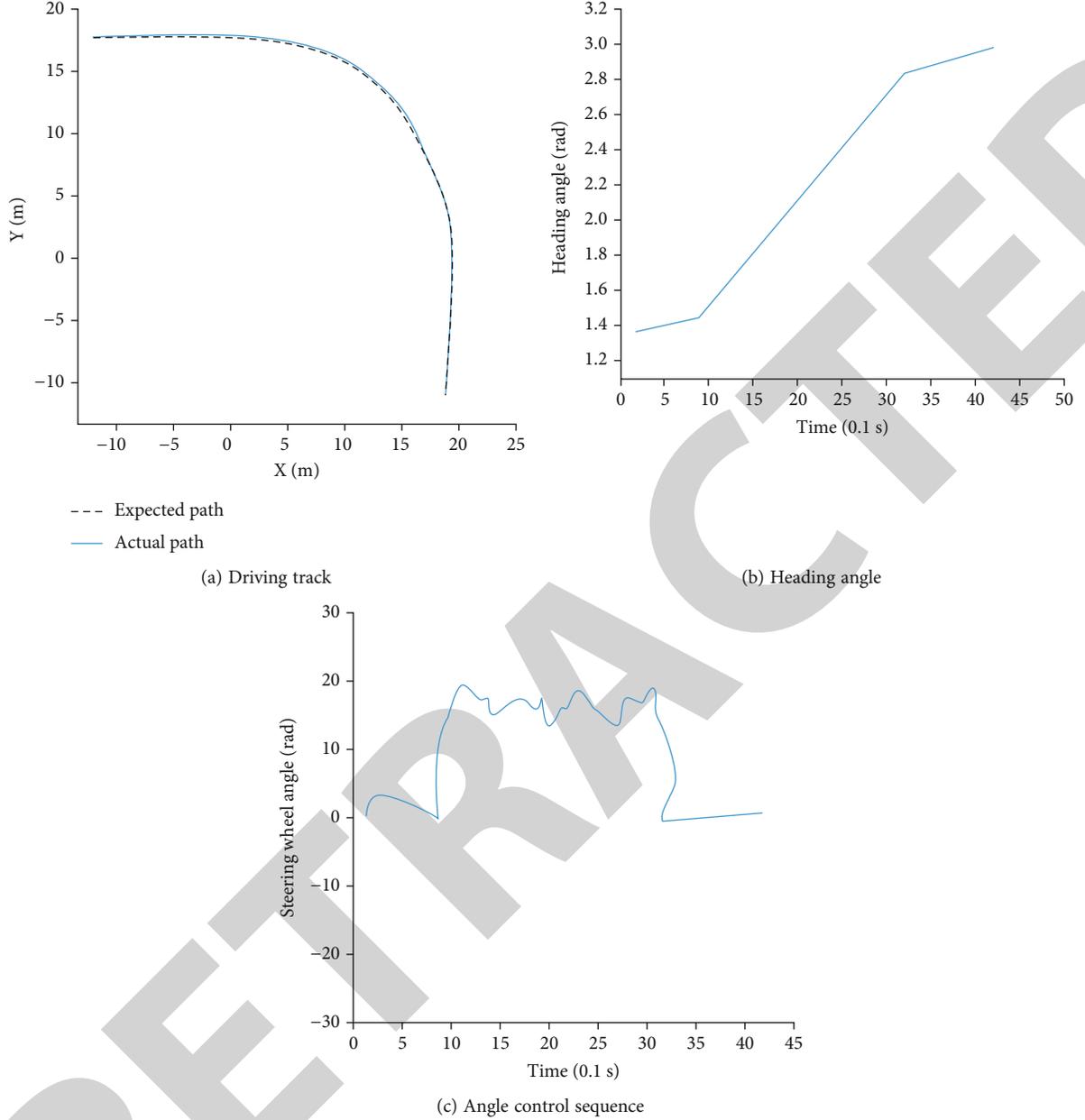


FIGURE 6: End to end trajectory planning.

The selection of window size l is related to the current vehicle speed v_r , sliding time T_p , and current vehicle state. The calculation formula is as follows:

$$l = v_r T_p + C, \quad (2)$$

in which C is a threshold value selected according to the vehicle state. If the road curvature is large, a smaller value is usually selected. If the road curvature is small, a larger value is selected.

The sliding point (x_d, y_d, θ_d) is selected in the path according to the size of the sliding window, and the heading of the point is calculated according to Equation (3). In the vehicle coordinate system, the heading error of the desired

point is the heading error between the current position of the vehicle and the sliding point.

$$\begin{cases} Y' = 3a_3x^2 + 2a_2x + a_1, \\ l = \int_{x_0}^{x_d} \sqrt{1 + Y'^2} dx, \\ \theta_d = \arctan Y', \end{cases} \quad (3)$$

in which Y' represents the first derivative of the trajectory, x_d represents the abscissa of the sliding point, x_0 is the origin of the trajectory, and $x \in [x_0, x_d]$.

In the trajectory tracking control method, the expected wheel angle is calculated according to the error between

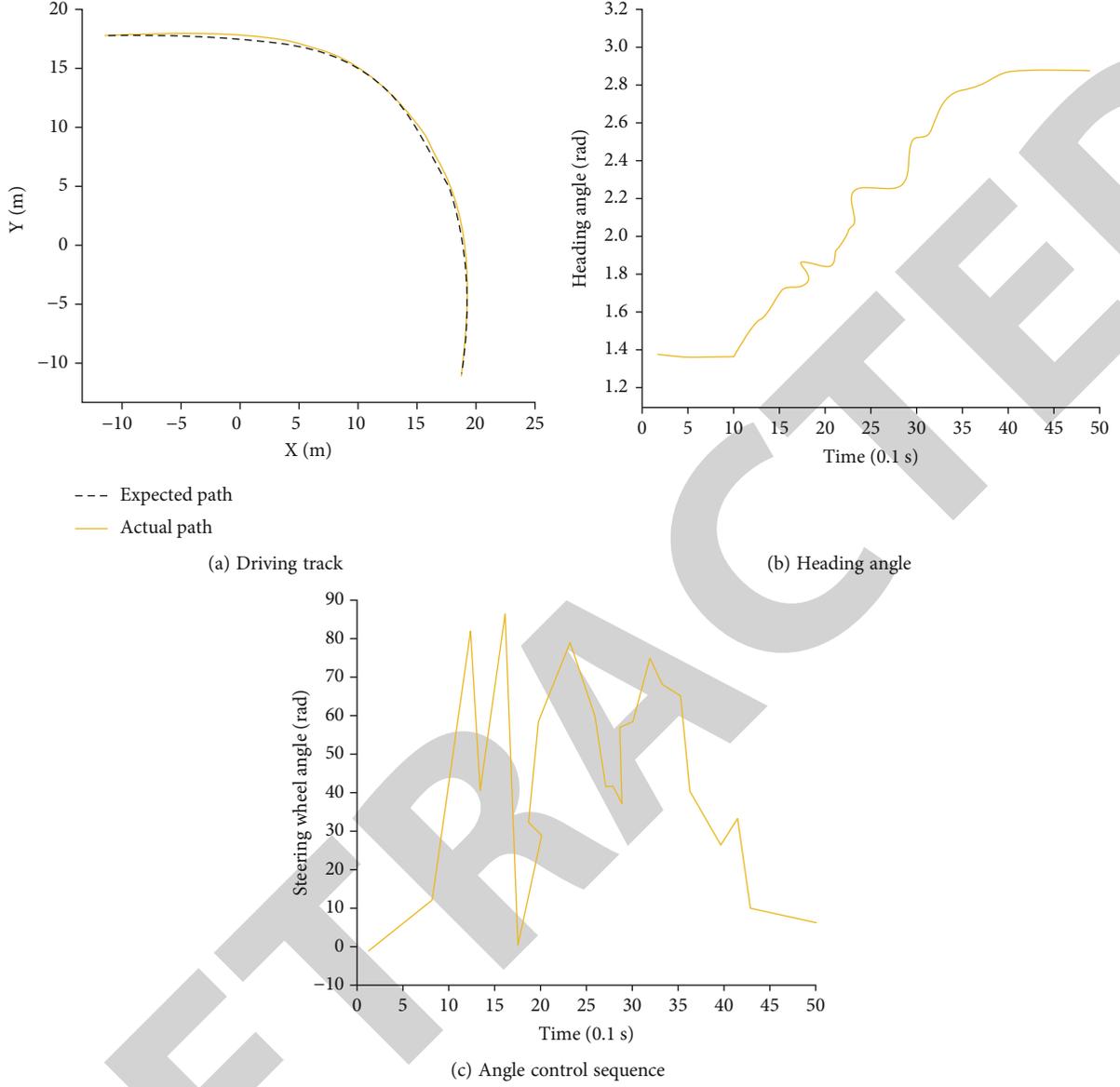


FIGURE 7: Our method.

the vehicle heading and the heading of the sliding point. Because the coordinate system of the planned track is the vehicle coordinate system, θ_d is the error. Calculation formula of expected wheel angle is as follows:

$$\delta = k\theta_d, \quad (4)$$

in which k is the proportional coefficient, and the appropriate value can be selected according to the commissioning experience. Each control cycle corresponds to a sliding window. When the vehicle reaches the next state $t + T_R$, the sliding window is updated according to the current state of the vehicle.

4.2. Model Compensation Based on Heading Prediction. The controller controls the front wheel deflection angle of the

vehicle by controlling the steering wheel angle. The heading angle of the front wheel deflection angle can be expressed as follows:

$$\theta_{Fs} = \delta_f + \theta_k, \quad (5)$$

in which θ_k is the real-time heading angle of the vehicle and δ_f is the front wheel deflection angle. Usually, the front wheel deflection angle is not easy to obtain directly, but a functional association between the steering wheel angle and the front wheel deflection angle is found: $\delta_f = f(\delta_k)$ and δ_k are the steering wheel angle. According to the data of steering wheel angle and front wheel deflection angle, the least square method is used for linear fitting to obtain

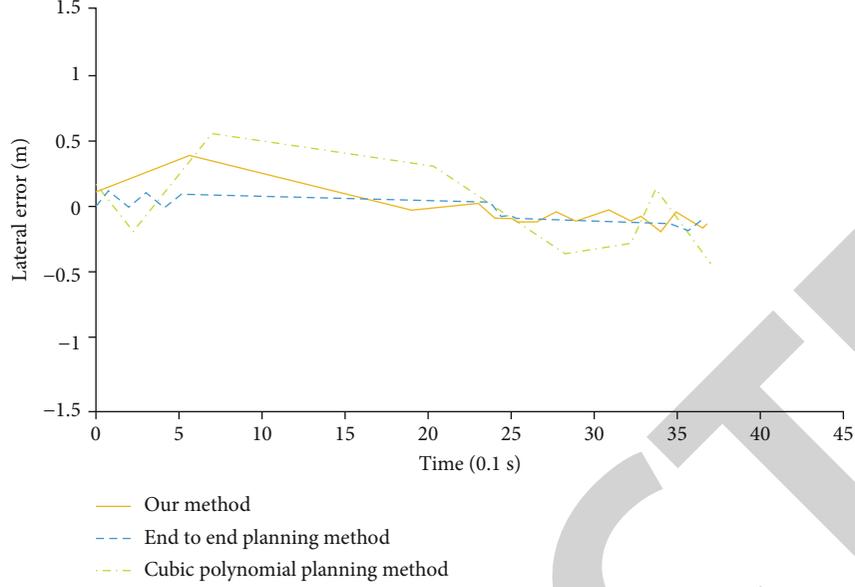


FIGURE 8: The lateral error comparison results.

the equation:

$$\delta_f = \frac{\delta_k}{k}, \quad (6)$$

in which k is the transmission coefficient.

According to the vehicle kinematics model, the change of heading in the T_g in the same period is sampled from one actuator:

$$\Delta\varphi = \frac{v_r T_g}{R}, \quad (7)$$

in which R is the radius of the front wheel around the motion center, which is obtained from the geometric relationship:

$$R = \frac{d}{\sin(\delta_f)}. \quad (8)$$

Simultaneous Equations (7) and (8) can obtain the following:

$$\Delta\varphi = \frac{v_r T_g \sin \delta_f}{d}, \quad (9)$$

in which v_r and δ_f are measured in the current sampling period, respectively. Therefore, the heading angle of the front wheel in the next sampling period is as follows:

$$\theta_r = \theta + \Delta\varphi. \quad (10)$$

At the beginning of the next control cycle, the error $\Delta\theta$ between the wheel heading and the desired wheel heading is used as the compensation amount of the desired wheel

angle, and the calculation formula of the wheel angle is as follows:

$$\delta = k\theta_d + \Delta\theta. \quad (11)$$

Whether in virtual environment or real environment, the tasks of intelligent driving vehicles include going straight, changing lanes, turning corners, and ramps. Therefore, this paper abstracts the model of intelligent driving vehicle performing tasks in the real environment, migrates it to the virtual environment, and maps it to the location area corresponding to the ring map in the virtual environment. Then, the optimal intelligent driving strategy is used to plan the control trajectory sequence that can complete the driving task, including the control sequence and its corresponding driving trajectory. Finally, through human-computer interaction, the planning instructions are executed in the real environment to complete the driving task.

5. GA-SA Application Based on Big Data Platform of Internet-Connected Vehicles

5.1. The Process of GA-SA Algorithm. GA-SA is a hybrid algorithm formed by combining and optimizing genetic algorithm and simulated annealing algorithm. The mutation operation in genetic algorithm is the operation to ensure the local search accuracy of genetic algorithm. This operation is replaced by simulated annealing algorithm in this paper. In addition, the scale of population selection, the probability of individual crossover, and the probability of simulated annealing for each individual of the population are dynamically set to ensure a large global search range in the early stage of algorithm implementation and a large number of iterative optimization for a relatively fixed population in the middle and late stage of algorithm implementation, so as to ensure the performance of the algorithm as much as

possible in terms of search range and solution accuracy. The basic idea of GA-SA is as follows:

Step 1. Initialize the algorithm environment, input the original parameters, and set the algorithm parameters: population size NP, initial selection size ns, initial crossover probability p_c , initial simulated annealing algorithm execution probability p_s , linear parameters k_1 , k_2 , and k_3 , and evolutionary algebra M . Iterated algebra $gen = 1$.

Step 2. Randomly produce the primary population.

Step 3. Calculate the fitness of individuals in the current population, select $n_s + \lceil gen/k_1 \rceil$ individuals, and copy some individuals to fill the new population.

Step 4. Pair all individuals in the current population in pairs and cross operate according to the probability $p_c - k_2 gen$.

Step 5. Perform simulated annealing with probability $p_s + k_3 gen$ for all individuals in the current population.

Step 6. $gen = gen + 1$, and if $gen < M$, the algorithm will be terminated; otherwise, go to Step 3.

The implementation process of GA-SA is shown in Figure 2:

If the intelligent optimization method needs to expand the search range and improve the solution accuracy, it is bound to increase the amount of computation. Therefore, GA-SA is a trade-off between search scope and search accuracy on the premise of maintaining the same order of magnitude of computation. In the early stage of execution, the hybrid algorithm expands the search range as much as possible to avoid the algorithm falling into the local optimal solution. In the middle and late stage of execution, the population is stabilized as much as possible according to the setting of dynamic probability, so that the simulated annealing algorithm has as many times of execution as possible for each individual and improves the search accuracy in the individual field. Because the search in each individual field is independent, it can also ensure the search range of the algorithm in the middle and later stage. At the same time, GA-SA is simple to implement, inherits the robustness and potential parallelism of genetic algorithm, and has high practical value.

5.2. Application of GA-SA in Hadoop Framework. On basis of the big data platform, this paper applies GA-SA to establish the optimal path selection module of networked vehicles, select the optimal path, and then realize human-computer interaction. In the field of big data, Hadoop is one of the most famous big data processing frameworks. It stores, processes, and analyzes big data in a reliable, efficient, and scalable way. Under the big data platform, in order to effectively collect and sort out the relevant information generated by vehicle driving, a special data collector needs to be used. At the same time, the data collector will form a data collector node together with data aggregation and filter,

which is responsible for receiving the information data mapped by the data flow. The offline processing of big data platform, namely, Hadoop distributed storage (HDFS)+distributed computing (MapReduce) framework, is used to statistically analyze massive data and solve the single node limit. HDFS is a highly fault-tolerant distributed file system, which can offer high-throughput data access and is appropriate for the storage of massive automobile data. This research report adopts the HDFS HA distributed cluster deployment mode to solve the existing single point of failure problem and ensure the stability of the networked vehicle storage and processing system. The structure of HDFS HA is shown in Figure 3.

After the real-time collected vehicle-related data is distributed and stored, the relevant data is cleaned, and the valuable data is extracted from the massive vehicle data according to the optimal path algorithm. Using the built-in distributed file system, after completing the corresponding distributed computing work, the processing of all vehicle dynamic information data is abstracted into map function and reduce function. The map function needs to complete the task segmentation. After the task decomposition is completed by the map function, the processing of many tasks and the summary of processing results need to be uniformly handed over to the reduce function. The dynamic information processing flow is shown in Figure 4.

In the big data platform hybrid optimization algorithm, after the collection of vehicle-related data processing, create the corresponding alarm. At this time, the above vehicle driving dynamic data processed by MapReduce, that is, the output file of MapReduce, static data, road spatial information, etc., are used as the input data of the optimal path selection module, and each network connected vehicle line is generated by GA-SA traversal; the controller transmits the newly generated route lines and other relevant additional information to each vehicle, so that the route information data of network connected vehicles can be dynamically updated. Finally, through the optimal path selection module of networked vehicles, the driving cost of the overall networked vehicles is minimized.

6. Experimental Results and Analysis

On basis of the scenarios in the human-computer interaction decision-making of networked vehicles, intelligent driving tasks generally include straight driving, lane changing and overtaking, and curve (ramp) driving. Intelligent driving vehicles drive and learn in the map. The strategies of intelligent driving include straight driving, lane changing, and turning. In the virtual environment, the intelligent driving vehicle obtains the optimal intelligent driving strategy through algorithm training, completes the turning action with a radius of 20m from the middle lane, and obtains the position track mapped to the intelligent networked vehicle in the virtual environment according to the ranging beam. Figures 5–7 are the planning control sequence and real track calculated by several algorithms, and Figure 5 is the cubic polynomial method, Figure 6 shows the end-to-

end trajectory planning method, and Figure 7 shows the GA-SA method in this paper.

The simulation experiment sets the fixed reference point in the virtual environment as the reference target of local tasks according to different subtasks such as lane keeping, lane changing and turning. According to the destination goal of driving task and the location of intelligent driving vehicle in the real environment, the model migration strategy is mapped to the virtual environment, so as to acquire the useful path planning of intelligent driving vehicle. The lateral error comparison results of the three methods are shown in Figure 8.

According to the travel path and expected path of the three methods in Figure 8, under the operation command optimization of GA-SA hybrid algorithm, the minimum transverse error of completing curve driving is ± 5 cm, the motion error is significantly reduced, and the convergence trend is obvious. This is because the operation instructions are optimized by GA-SA, so that redundant operations such as out of bounds, fallback, detour, and deviation are filtered and optimized. Then, the optimized instructions are transformed into the motion instructions of the human-computer interaction end indicator through coordinate conversion and scaling operation, so the redundant motion is greatly reduced, so the motion error of the end is relatively small and converges to the expected error range quickly. Therefore, it can be concluded that the method proposed in this paper reduces the problem of relative motion error accumulation in the networked vehicle human-computer interaction and cooperation system to a great extent, enhances the user's interaction experience, and also shows superior performance in the time consumption of human-computer interaction and multicooperation system.

7. Conclusion and Future Work

Human-machine interaction refers to the data exchange between human and machine through a specific sensor and interface to realize mutual understanding under the support of certain interaction technology. With the continuous expansion of human-computer interaction applications, the environment of human-computer interaction is becoming more and more complex, and users have higher and higher requirements for the naturalness and accuracy of human-computer interaction. Integrating artificial intelligence into the key technology of human-computer interaction is an important way to overcome the current bottleneck of human-computer interaction technology. By constructing the traffic big data platform, this paper researches the impact of various elements on users' interactive behavior, constructs the human-computer interaction demand framework and design model of intelligent networked vehicles, uses Hadoop big data technology to process real-time data and realize GA-SA algorithm, finds the optimal driving path of networked vehicles, and transmits it to networked vehicles through the human-computer interaction system. Simulation results show the effectiveness and robustness of the proposed algorithm. The future work of this paper is as follows:

- (1) This paper only considers a hybrid intelligent algorithm and does not fuse the algorithms from multiple angles. More attempts in algorithm fusion will be made in the follow-up research to make the results closer to the global optimal solution
- (2) There is still a gap between the human-computer interaction effect based on intelligent algorithm and the real one. In the future, it is necessary to further improve the learning and recognition ability of human-computer interaction
- (3) Multiangle research using big data platform needs to study human learning mechanisms such as induction, extraction, and summary, so as to realize more human-computer interaction applications

Data Availability

The simulation experiment data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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