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Research on the application of automobile autonomous driving system based on AI technology

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Abstract: With the continuous development of science and technology in China, AI technology is gradually applied in various fields, among which the autonomous driving technology is gradually widely used in transportation, promoting the global autonomous driving test, and tends to be commercial application. The establishment of automobile automation system effectively implements the goal of intelligent automobile development, promotes traffic safety, and responds to the concept of national energy conservation and emission reduction, and realizes the transformation of the automobile industry. Based on this, in this paper, the application value, development status and automation business process of AI technology enabling in automobile driving system are analyzed, so as to provide reference for the application of automobile autonomous driving system under the power of AI technology.

1. Introduction

With the rapid development of intelligent transportation, the automobile autonomous driving system has gradually improved and become the trend leader. At the same time, the effective integration of AI technology can provide strength for the improvement of the automobile autonomous driving system. The effective application of AI technology in environment perception, decision and planning making, information sharing and cloud system of autonomous driving can realize safe, high quality and high performance autonomous driving system, improve the commercial value of autonomous driving, and realize the transformation of the automotive industry. In this regard, the paper proposes the following path for the application of automobile autonomous driving system based on AI technology.

2. AI technology enables value in car driving systems

2.1 Provide conditions for the control of autonomous vehicles

Artificial intelligence is to think and solve practical problems through software, and put forward appropriate decisions. AI intelligent technology can realize similar tasks, and constantly learn and develop through past experience. Among them, the automobile industry is transformed through more complex AI technology. At present, with the continuous development of the city, the road

crisscross, road environment is complex, in the traditional automatic driving, the road learning and contact time is long, and the processor load in the system is not high, in the face of the actual road problems, cannot deal with complex road environment, need to integrate feedback linear nonlinear controller, but in the case of not disturbed, the nonlinear controller will gradually reduce, so it is difficult to form a safe, high performance car automatic driving system. AI technology can effectively improve this problem, can adjust to the change of road environment and the difference between the control of vehicle autonomous driving, and then establish AI intelligent adaptive controller, effectively improve the feedforward neural network of vehicle autonomous driving, and then provide powerful conditions for the control of vehicle autonomous driving [1].

2.2 Provide perceptual support for the vehicle autonomous driving environment

At present, the car collects information mainly through the camera and radar, which has the advantages of high resolution and fast speed, while the radar has the advantages of a wide range of detection and high detection accuracy. However, no matter which form, it will be affected by negative weather and external interference, and cannot reach the expected value of robustness. At the same time, the fluctuation of information data will lead to unstable robustness, which will lead to the safety of autonomous driving. But through AI technology can realize system signal tracking, even in the face of bad weather, auto automatic driving environment for the information collection is still effective, and also gradually adjust the value for the environment, and can clear the stability of the automobile information acquisition device, through the linear weighted neural network online static margin estimation form, and using the nominal and actual state error, etc., to the necessary Lyapunov stability assessment. At the same time, through the fidelity degree of freedom model, the vehicle autonomous driving environment perception system can gradually achieve the expected robustness, and then provide powerful perceptual data for the vehicle autonomous driving environment [2].

2.3 Provide feedback and early warning for the autonomous vehicle driving

In the application of traditional auxiliary driving system, the state of drivers can be perceived and targeted adjustment, which can effectively ensure driving safety. During this period, the system will, on the one hand, place the scheduling variables in the auxiliary driving system database based on the status function of the driver, and on the other hand, it will select the status of the driver, and then give feedback and warning to them [3]. During the actual driving period, the former cannot choose the same function for any state of the driver, while the latter needs to improve the bandwidth of the auxiliary driving system in order to achieve the expected robustness. In this regard, in order to effectively achieve unmanned driving, it is necessary to optimize the driver's perception mode, and AI technology can effectively achieve this goal. Through AI technology, we can feel the posture of drivers, driving time, fatigue, eye scanning, etc., combined with a variety of participation information, establish a more comprehensive perception system, summarize the personality information during driving, and provide corresponding feedback for drivers, so as to ensure the safety of drivers [4].

3. The development status of automobile autonomous driving technology and the commercial process of autonomous driving at home and abroad

3.1 Development status of automobile autonomous vehicle driving technology

The automobile autonomous driving system belongs to the electromechanical integration and the

artificial information physical fusion system, including perception, decision-making, execution subsystem, etc., and includes environment perception, control execution, V2X communication and other technologies in the automobile autonomous driving system, as shown in Figure 1. The realization of environmental sensing technology is to understand the traffic environment and the vehicle status through cameras, GPS and 5G network; the decision planning technology is to perform the functions of traffic prediction, behavior decision and feedback signal output on the basis of the perception system; the control execution technology is to use the line control actuator to implement feedback control output signals and the V2X technology is to integrate the information of the vehicle and the outside world to provide real-time and accurate communication service for the auto automatic driving system, and then provide planning for the development of the above technologies. At present, China's autonomous driving technology is in the stage of gradual development, but there are still some differences between the level of China's autonomous driving technology and that of foreign countries, because the technologies are in the stage of gradual optimization, and the control of the autonomous driving system's driving ability in various environments, which leads to the contrast of the system behavior [5].

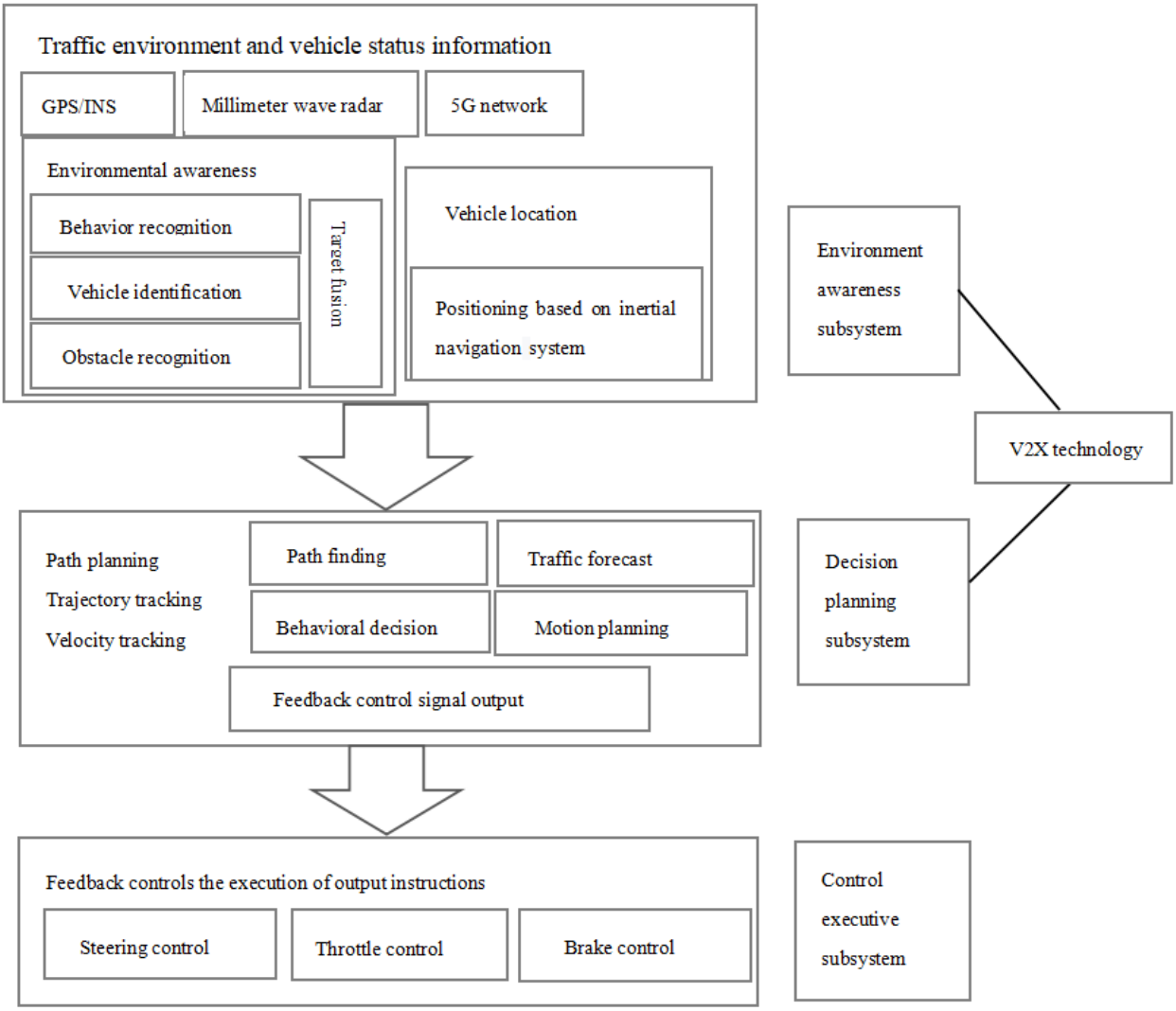

Figure 1: Strayer structure diagram of autonomous vehicles

3.2 Commercial process of autonomous driving at home and abroad

Autonomous driving has gradually regional commercial development, in foreign countries have gradually carry out commercial pilot, including the automated driving technology earlier, in every position, and during the period of 2024, already can be accompanied by no safety officer, 24 hours service, and is expected to achieve unmanned network about car. On the basis of vehicle enterprise technology, Germany has gradually established the autonomous driving policy to realize the legal road operation of intelligent network vehicles, and gradually promote the unmanned and commercialization of autonomous driving in the future. It will achieve L4 level supporting guarantee system during 2024, and it is expected to gradually realize the pilot of autonomous driving in 2025.

In recent years, China has gradually launched intelligent vehicle autonomous driving services, which has attracted the attention of the government, related enterprises and the society. Moreover, the country has improved the development of the autonomous driving industry and improved the corresponding policies of autonomous driving. During 2021, the Ministry of Public Security and the Ministry of Transport will gradually promulgate the autonomous driving management policies, and determine the testing activities of autonomous driving for cars. During 2024, in order to realize the large-scale and commercialization of high-level autonomous driving, the pilot project of "vehicle, road and cloud integration" of intelligent connected vehicles will be gradually established. In 2024, various policies will be gradually improved. The driverless pilot projects have been established in many cities to promote the maturity of autonomous driving technology and improve driving safety. As shown in Table 1, it is the development policy and practice of autonomous driving in some cities in China.

Table 1: Development policies and practices of autonomous driving in some cities in China

city	Policy and Practice	Practice time	Achieving results
Wuhan	Continuous release of intelligent connected vehicle test roads by batch	The latest batch of road network formula time in December, 2023	The cumulative mileage of open test roads in Wuhan has exceeded 3378.7km (one-way mileage), covering 12 administrative districts of Wuhan, with a radiation area of about 3,000 km 2, covering a population of more than 7.7 million
	Autonomous airport connection service	In August, 2023	Baidu Radish Fast Run is the first time in China to realize the autonomous driving travel connection service from urban areas to airports, and it is also the first time for the domestic autonomous driving to connect expressways and urban roads
	Support and realize the demonstration operation of intelligent connected vehicles across the Yangtze River	In February, 2024	Baidu Radish Fast Run took the lead in crossing the Yangsigang Yangtze River Bridge and Wuhan Baishazhou Bridge, connecting the Jiangbei region and the Jiangnan region
	Support the 7 * 24-hour commercial pilot program of autonomous driving	In March, 2024	Baidu Radish Fast Run in some areas of Wuhan Jiangbei autonomous driving travel service time expanded to 7 * 24 hours, the implementation of day and night uninterrupted autonomous driving travel

			service
Beijing	Unmanned driving commercial pilot services will be allowed	In July, 2023	Baidu Radish Fast Run and Ma Zhixing are allowed to implement driverless commercial demonstration services in the policy pilot zone
	Continue to promote the opening of the road network and scenes	In January, 2024	We will launch high-level autonomous driving demonstration zones, establish 4.0 phased tasks, and gradually open autonomous driving services at airports and railway stations
	We will support the demonstration application of autonomous driving on expressways, and set up pilot connection services at airports	In February, 2024	Baidu Radish Fast Run, Ma Zhixing and other people started the manned demonstration application of Yizhuang Economic Development Zone to Daxing Airport, which is the first time for Beijing to set up highway autonomous driving for the public
Shenzhen	Allow for commercial services for driverless vehicles	In June, 2023	In June 2023, Baidu Radish Kuai Run and Antu Zhixing were allowed to carry out driverless commercial pilot travel services in Pingshan District, Shenzhen. In February 2024, Bao 'an District of Shenzhen issued the Administrative Measures for the Pilot commercialization of Intelligent Connected Vehicles in Bao' an District of Shenzhen City. Baidu Radish Kuai Run, Ma Zhixing and Antu Zhixing allow the first batch of driverless commercial pilot travel services; the total open road of Baoan District is over 200km, including Baoan Central Center, Shenzhen Baoan International Airport.
Shanghai	Allow the establishment of driverless road tests	In July, 2023	Baidu Radish Fast Run, Antu Zhixing and others allow road tests of driverless intelligent connected vehicles in Pudong New Area.
Hangzhou	Set up autonomous high-speed rail stations and airport connection services	In January, 2024	In January 2024, Antu Zhixing set up the country's first demonstration operation line of intelligent connected automobile high-speed railway station in central urban areas.
	Intelligent and connected vehicle testing is open throughout the city	In April, 2024	In April 2024, Hangzhou issued the Regulations on Promoting Testing and Application of Intelligent Connected Vehicles. Hangzhou will open from May 1,2024, a total of 3474 km ²in the city as the test and application area of intelligent and connected vehicles

4. The application path of the automotive autonomous driving system based on AI technology

4.1 Environmental perception

During the practical application of AI technology, the automobile autonomous driving system can improve the perception degree of the environment. Environmental perception technology is one of the common application scenarios in AI autonomous driving, which can realize the detection of pedestrians. After extracting image features, the support vector machine algorithm is used to detect pedestrians. In lidar, vehicle camera and other technologies, lidar can implement data clustering processing, and linear regression algorithm and support vector machine algorithm can be used in the identification of lane lines and traffic signs, as shown in Figure 2, and the rear framework can be applied to the detection of rural road conditions. However, due to the complex driving environment at present, the traditional perception technology cannot support the demand of autonomous driving, so it is necessary to improve the image processing technology and improve the level of perception technology [6].

For example, during the period of automobile autonomous driving, it is necessary to obtain the tracks of pedestrians and vehicles, and combine the corresponding data and information to realize the automatic driving behavior. Therefore, in the system perception module, the perception ability of the system environment should be gradually improved. In the integration of AI technology, HOG feature technology can be acquired to sense the trajectory of pedestrians and vehicles, and after the collection of information, the autonomous driving routes and forms of cars can be formulated. At the same time, the lidar and camera in the system can collect traffic signs, lane lines, etc. After collecting information, the artificial neural network can calculate to improve the system learning image processing, improve the perception technology, and establish an automatic perception decision-making system, so as to realize automatic driving control.

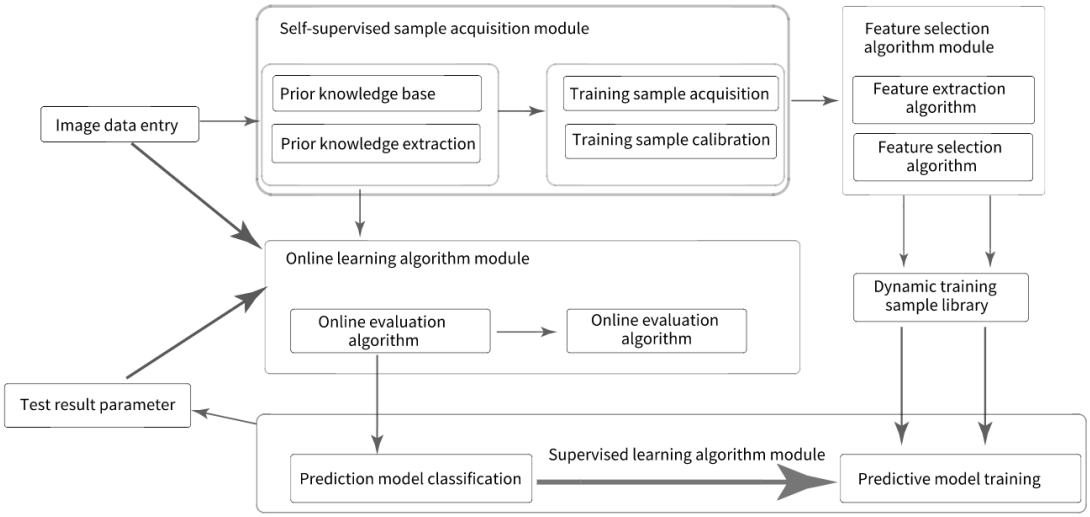

Figure 2: Unstructured road detection framework for machine learning

4.2 Decision-making and planning aspects

AI technology has the characteristics of simulating human decision-making through intelligent algorithms. AI technology is integrated into the automobile autonomous driving system to realize self-decision-making and planning. In the automobile autonomous driving system, after the gradual application of various AI algorithms such as state machine, decision tree and Bayes, the automatic

learning ability of the system and the complex road decision-making ability can be improved, so that the road conditions can be interpreted in detail on complex roads, and a good job of road route guidance can be done. As shown in Figure 3, during the execution control of the system, it can realize obstacle avoidance and search through the situation of the road, map planning, environmental planning, etc., and finally control the route and behavior of the vehicle, so as to realize the autonomous driving [7] of the vehicle.

For example, during the period of autonomous driving, the autonomous driving system will establish learning algorithms, prediction models, etc., through AI intelligent technology, and then train the model repeatedly. In the model, after collecting the image data through the front-end module and understanding the road information, the knowledge base is used to extract and test the various information to clarify the road condition. If the road condition is not recorded in the database, the prediction and management should be implemented through the prediction model. Subsequently, the road condition is evaluated online, and if the problems are found and rectified in time to ensure the safety of autonomous driving and the systematic decision-making and planning.

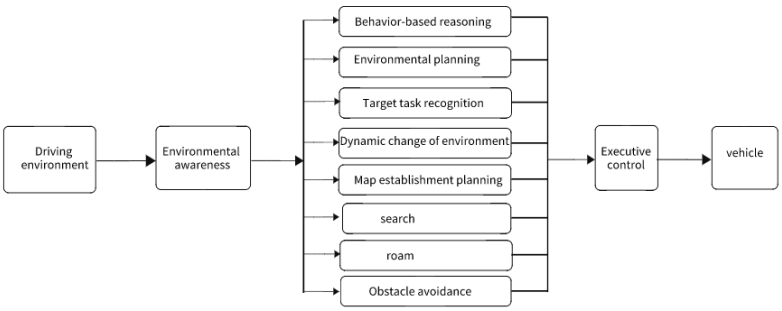

Figure 3: Decision-making and planning diagram

4.3 Information sharing

The application of AI technology in the automobile automatic driving system can re-establish the traffic ecosystem and realize information sharing, and the information sharing of AI technology can have an impact on the driving of vehicles and ensure the safety of network traffic [8]. First of all, the integration of AI technology and wireless communication technology can establish the Internet of vehicles, as the core of the intelligent transportation system, to promote the communication between vehicles. In this system, vehicles can share their information such as position and direction online, and other vehicles can gradually adjust their driving direction combined with the information, so as to reduce the collision risk of vehicles and improve traffic safety. Secondly, the integration of AI technology and 3 D sensing technology can improve the observation of the surrounding environment of the system, and the road conditions can be detected in real time through the camera and radar systems. If there are potential risks, the vehicle route can be adjusted in time to then face emergencies. Finally, AI technology can analyze the terrain and environment in detail, so that the system can timely adjust the speed and distance of the vehicle during the perception of threat, thus ensuring the safety of autonomous driving. In addition, AI technology can establish an effective connection between the driver and the car [9].

For example, AI technology can share information with the system to simulate the connection between the driver and the car, and directly control the vehicle input. For example, AI technology can comprehensively analyze the data in the vehicle and the driving situation of the vehicle. If there is a danger, the AI will send the warning to the driver operating platform in time through the on-board voice system, and open the emergency braking to ensure the driving safety of the vehicle. At the same time, the vehicle will send a warning to the driver through lights, sound, etc., and does

not pass the safety belt preparation, automatic braking, avoidance behavior, etc., can timely respond to the vehicle when the driver does not find the danger. Therefore, the learning and information sharing of AI technology can integrate radar, visual sensing and data, and obtain other information through the camera, such as radio detection and ranging, etc. If a car has a lane departure or road accident during autonomous driving, it will be warned in time.

4.4 Cloud system of automobile autonomous driving

Cloud technology enables vehicles to analyze vehicle models and environment through cloud computing during the autonomous driving period, and promote dynamic system evaluation, and make scientific decisions through vehicle cloud technology and AI strategy, so as to ensure safe driving. By collecting and calculating the data in the automotive autonomous driving system, the cloud intelligent data carrying strategy can reduce the computing pressure in driving and store a large amount of driving data, thus deepening the implementation of AI technology in the automotive autonomous driving system. At the same time, the cloud system can adopt diversified data analysis, clarify the data structure, distribution law, time change, etc., and establish a data network through data organization, etc., to identify and integrate the data sources, and make full use of the system data resources. In addition, under the joint implementation of cloud computing and vehicle collaboration technology, the effectiveness of on-board intelligent devices and cloud servers can be improved in the case of autonomous driving, thus improving the safety of vehicle and data processing [10].

For example figure 4, in a variety of road and operating environment, car during the autopilot system will according to the traffic awareness, path planning, etc., driving tasks, through the cloud vehicle system can through vehicle sensors, collect a large amount of data, and the data transmitted to the cloud database, and real-time processing data, and realize the data management and analysis, make the car in highly complex cases can achieve intelligent decision.

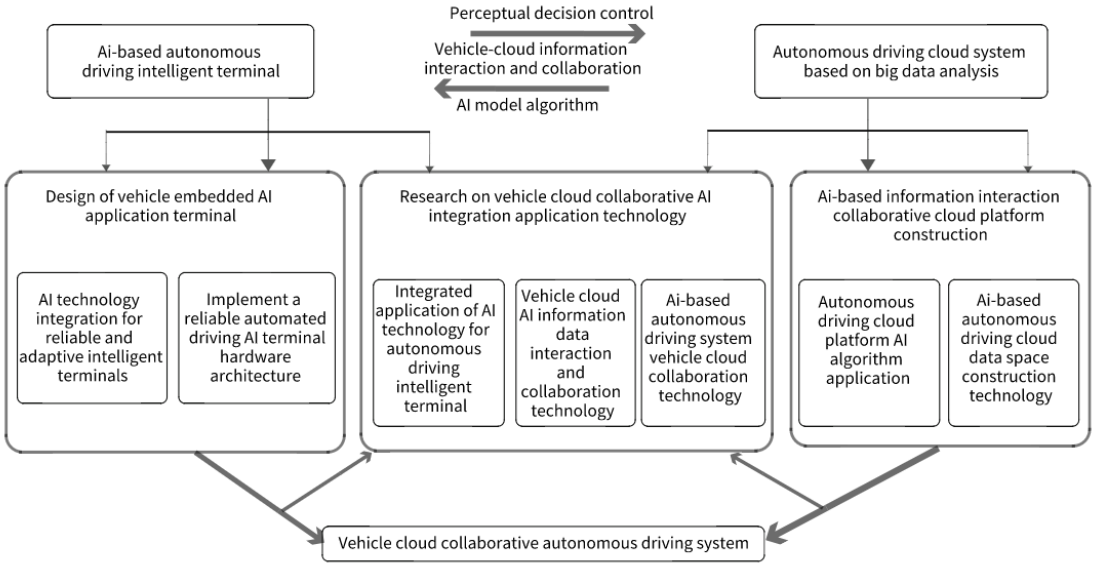

Figure 4: Schematic diagram of the vehicle cloud collaborative autonomous driving system architecture scheme based on AI

To sum up, with the continuous development of intelligent technology in our country, widely used in life and work, the AI technology in the automatic driving system, for car autopilot control, environmental perception, driving feedback warning support, and under the application of AI

technology, decision-making planning, information sharing, cloud system, analyzes the driving environment and road conditions, ensure the safety of automatic driving, promote the improvement of automatic driving performance.

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