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# Innovative Practices for IoT Scenarios: A Case Study of Driverless Shared Cars

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**Abstract:** As a new type of digital product, driverless shared cars will become an important part of the intelligent public transportation system. This paper aims to use driverless shared vehicles to carry out a comprehensive digital transformation of transportation, that is, to remotely control the driverless through the man-machine interface, and turn the taxi into a remote-controlled car controlled by a remote center. Compared with existing technology and business models, the technical framework and operational idea of driverless shared cars proposed in this paper have great advantages. It can not only reduce per capita carbon emissions and travel costs, but also promote efficient management of transportation and cities. This study can be also adapted to various countries in the world due to its flexibility. After summarizing and analyzing different driverless and shared car technology schemes, this paper predicts the profitability of cruise taxis after adopting this model, puts forward feasible design schemes, and looks forward to its development prospects all over the world.

## 1. Introduction

In the traditional transportation industry, there are often problems such as an imbalance of supply and demand, misallocation of resources, route planning errors, and huge maintenance spending in the peak period. In addition, there are also a series of safety hazards such as tired driving and night riding. These problems affect traffic efficiency and people's travel safety, driverless cars and shared cars with algorithm scheduling are important ways to solve them. However, the most pressing problem to be solved at present is the safety of driverless cars, which is exactly what our project's advanced technology and scientific operations can achieve.

In recent years, researchers make great efforts to improve driverless technology and shared car technology, there are relatively mature technologies in the world. The Full-Self-Driving technology has been applied to commercial usages, and the number of car-sharing users has doubled in two to three years[1]. However, the combination of the two technologies is still relatively rare. This project intends to carry out solution that combines the two technologies, that is, to remotely drive driverless vehicles through the car-machine interface, and turn taxis into remote-controlled cars controlled by remote centers. This approach will fill a gap in current research.

The development of driverless shared cars is divided into four stages. The 1.0 mode is manual driving based on manual scheduling. The 2.0 mode is manual driving based on intelligent scheduling. Mode 3.0 is intelligent driving with manual intervention. The 4.0 model, which is also the model developed in this case, is an intelligent control driverless car based on a big data platform for intelligent analysis and scheduling.

For the more mature cases currently launched in the industry, Uber's Internet online ride-hailing platform has achieved a relatively good 2.0 model. Many Internet companies and universities are also improving a series of technical systems for the 3.0 model, and research in this area has begun since 2001. And for 4.0 mode. At least there are no mature and pilot cases in the market. The concept of the whole system, including the weakness of the legislative, is also worth more time to explore. At present, the legislative system, insurance liability, and traffic regulations all over the world in this aspect of unmanned driving are weak, and there is no systematic case. The implementation of this project will also fill a gap at the legal and technical level to a certain extent.

This study adopts a comprehensive apporach to coordinate two technologies to achieve real-time shared fast travel and save costs, which is based on IoT engineering, and its research strategy is to use existing technology platforms to carry out data connectivity and integration, effectively apply it to the vehicle platform independently developed by the project, and realize the reasonable scheduling and distribution of vehicles through remote control. The findings of this study highlight the importance of big data technology to

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transportation innovation and social development. Therefore, it can be used to promote the scientific management and decision-making of smart cities.

## 2. Business model analysis and its solution

In terms of the existing business models, the traditional car rental business model and the online car rental business model both have many problems. The following SWOT analysis is based on the traditional car rental business model. For its competitive advantage, its management is more flexible, and the market access threshold is low. For its disadvantage, it is more obvious: with international fuel prices soaring today, traditional fuel-powered vehicles' fuel consumption has reached 3 to 4 times that of pure electric vehicles. For scheduling and the way of attracting customers, it is also behind the current scheduling and dispatching system used in online car booking. Taxi drivers are also under pressure from their competitors to catch potential passengers on the street. The SWOT analysis of the traditional taxi industry is shown in Figure 1.


**Figure. 1.** SWOT matrix of traditional rental cars

In this regard, we propose the driverless shared car model and carry out a SWOT matrix analysis on it.

The competitive advantages of the new scheme lie in the new energy pure electric, its low operating expenses, and through our flexible scheduling algorithm, the empty driving distance is reduced, so that it can achieve 75% lower fares than ordinary taxis. These rates are very attractive[2].

As for its competitive disadvantage, it is due to the up-front investment required to introduce such a system, which cannot be operated once the license is obtained like traditional taxis. Such venture capital, including the maturity of autonomous driving technology, is also a great risk for this new model.

The opportunity to share driverless cars depends on the current strong support of the government, the opening of pilot parks in many cities, and operating subsidies. In the future, it is believed that such a model will gradually replace traditional taxis. The dividend of the scheduling algorithm has been reflected in the ride-hailing platform represented by Didi Chuxing, because the online ride-hailing platform will issue scheduling instructions to the driver, guiding them to operate where the relationship between resource needs is more balanced, which reduces some empty driving distance.

The threat is the profitability of similar AI driving platforms and the entire network backend. Furthermore, the unclear policies and legislation at present will also create some uncertainty about such a model. Fierce competition from peers also poses a threat. Major companies such as Didi and Baidu are actively developing similar resource scheduling algorithms, and Tesla and Google are developing corresponding driverless systems. The SWOT analysis for the future of the driverless shared car industry is shown in Figure 2.

In short, this project provides an interconnected interface for the great computing system, combining driverless technology with the high-intensity computing power of cloud computing.

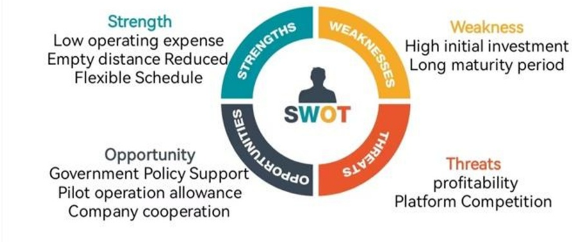


**Figure. 2.** SWOT matrix of driverless shared cars

## 3. Shared car implementation scheme based on the Internet of Things tech

### 3.1. Hardware structure of automatic shared cars

#### *3.1.1. Vehicle body and control system*

As a vehicle for automatic vehicles, the vehicle includes traditional vehicle components, such as batteries, chassis, motors and body. The control system controls the car through the electrical signal of the master computer, different from the traditional way of manual decision-making and physical control of the car. The control system is responsible for converting the control instructions of the computing unit into the actual actions of the vehicle, such as acceleration, steering, and braking.

#### *3.1.2. Sensor*

Commonly used sensors transmit data back to the main controller of the car through embedded design, and then forward or process the data according to the different needs of data processing. These massive data generated in milliseconds will also be used for the implementation of complex algorithms such as obstacle avoidance and path planning. In addition to sensors that sense the outside space, positioning and navigation systems used to determine the vehicle's position and orientation are also sensor modules required for automatic cars. GPS or RTK module is a common positioning system that receives satellite signals to determine a vehicle's latitude longitude and altitude. The INS (Inertial Navigation System) estimates a vehicle's position and direction by measuring its acceleration and angular velocity.

#### *3.1.3. On-board computer/main control*

The main control is the control core of the driverless car, which is responsible for processing the large amount of data collected by the sensors and making corresponding decisions.

At present, the main control of driverless shared cars includes two different forms of data processing: one is local computing, that is, path planning and obstacle avoidance operations are completed locally; The second is to use edge computing/cloud computing to upload sensor data around the car body to the connected cloud platform for processing; The execution data is returned. The benefit of this is that the manufacturing cost of a single vehicle is reduced, but the data latency is increased. Under the conditions of the existing 4G network, the delay will not meet the planning needs of the complex road surface, but with the further development of communication technology, at the speed of 5G and 5.5G communication, cloud computing will be able to replace the function of the on-board local controller[3].

#### *3.1.4. Communication & data transmission systems*

The communication and data/image transmission systems of unmanned systems need to meet their requirements for communication and data transmission with other vehicles, traffic infrastructure, and remote cloud servers.

Common means of communication in driverless cars currently include wireless network technologies such as 4G, 5G, and Wi-Fi. In addition, with the development of edge-computing technology, several vehicles in the same area can form a data interconnection communication network through the mesh AD-hoc networking protocol to meet the needs of edge computing: according to the remaining computing power of each vehicle's main control, the relevant computing resources are reasonably allocated to meet the huge amount of data computation required by the driverless system.

#### *3.1.5. Safety system*

The safety system is the last line of safety defense for the operation of driverless cars, including but not limited to anti-collision systems and emergency braking systems.

The anti-collision system is an active obstacle avoidance system, which is realized through the coordination of various sensors equipped with the body. When suspicious objects are detected around, the system will automatically adjust the heading and speed of the car to avoid collision. When the active obstacle avoidance system cannot avoid imminent danger, the passive safety system comes into effect, usually the emergency braking system, by working with the car's ABS anti-lock system and anti-skid system.

### 3.2. Automatic car-sharing software framework

#### *3.2.1. Sensing layer*

The sensing layer is the infrastructure of the unmanned system and is responsible for collecting and extracting relevant information from the environment. Sensors at the hardware level collect data in milliseconds and feedback to the software side, including radar, positioning, vision, and other modules. Through these data fusion calculations, you can determine your exact position relative to the external environment.

#### *3.2.2. Decision level*

The decision layer receives the information from the perception layer, combines the feedback from the path planning and control layer, and issues decision instructions through algorithms. Decision instructions can include following, overtaking, accelerating, braking, decelerating, steering, turning, and other action instructions. The decision layer usually includes a series of control algorithms, which need to comprehensively consider the current state of the vehicle, traffic conditions, destination information and other factors fed back by the perception layer to make the optimal driving decision. The decision layer is not necessarily loaded in the master control of the driverless car, but may also be deployed in the cloud and transmitted/uploaded to the master control of the car through a high-speed data transmission network.

#### *3.2.3. Control layer*

The control layer implements specific control operations on the vehicle according to the instructions issued by the decision layer. The decision-making level is often the control of different variables, such as the position ring of the motor, the speed ring, the current ring, or the corresponding link of the steering gear. The automobile executive mechanism, such as the motor drive, after receiving the information processed by the decision level, performs the corresponding operation according to the corresponding information instruction (usually transmitted in the form of CAN/CANopen and other buses). To realize the closed-loop control, the control layer needs to collect the real-time state of the controlled object to realize the negative feedback real-time control and ensure that the motor is free from overclocking.

#### *3.2.4. Human-computer interaction layer*

Since the driverless shared car carries passengers, a series of macro instructions, such as destination, interior environment, door control, parking, and other operations need to be realized through the human-computer interaction layer, and the passenger user's instructions are transmitted to the perception layer through the UI interface, transmitted to the decision-making layer[4]. The layer involves related QT program interface design and visual operation development.

## 4. The expected impact of the business model of driverless shared car

### 4.1. Impact on staff

This project adopts decentralized intelligent driving with centralized control. The personnel is relatively streamlined, and only a small number of dispatch and maintenance personnel are required to be on standby on the road, while technical personnel can carry out centralized control operations at the headquarters or maintenance center.

### 4.2. Impact on the enterprise

The expected service model of this project is vehicle calling based on a mobile APP. Based on this model, compared with the traditional taxi platform, this project highlights the brand effect of the enterprise itself and thus has a far-reaching impact on the communication, management, and knowledge of the enterprise.

### 4.3. Impact on consumers or users

In terms of the impact on consumers, the most significant change is the reduction in travel costs. Compared with the higher price of taxis, driverless shared cars save a lot of labor costs, so the freight is estimated to be reduced to about 0.5-0.7 yuan per kilometer[5]. In addition, because this project adopts the booking mode based entirely on the Internet platform call, it can provide passengers with a better budget and make appointments more conveniently, which saves passengers' travel and waiting time. Another positive effect is that possible problems such as kidnapping and harassment have been eliminated in this model.

### 4.4. Impact on environmental protection and traffic

In terms of environmental protection, since the project adopts pure electric vehicles, it is not only convenient for the driverless system to control it, but also conducive to green travel and low-carbon emissions. In terms of traffic, a reasonable resource allocation algorithm also reduces the empty load rate of vehicles on the road during peak hours, which has a positive impact on the development of social health traffic. Of course, there is a risk of replacing traditional taxis or online car-hailing.

### 4.5. Future management innovation direction

The future innovation of this project lies in the organic "sharing" of driverless shared cars, that is, different passengers share different sections of the same car. Similarly, driverless shared cars calculate the most reasonable resource allocation through optimized algorithms, further, reduce operating costs, and carry out reasonable scheduling to achieve ride-sharing under the premise of making full use of ride space. The advantages of the future development of driverless shared cars are shown in Figure 3.

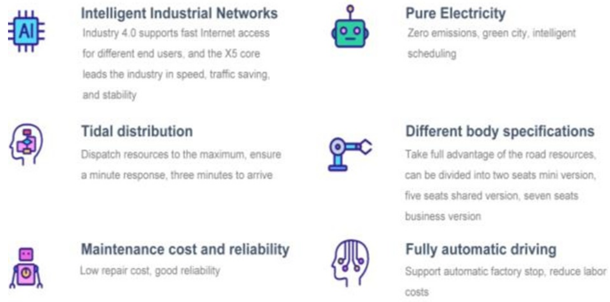


**Figure. 3.** Future development characteristics of the driverless shared car project

## 5. Conclusion

So far, the industry has a relatively perfect algorithm and technical system for autonomous driving technology and shared car scheduling technology, but the integration between the two has not yet been a typical case in the world. The model of combining driverless driving and shared cars proposed in this paper defines the technical interface between driverless technology and shared taxi technology, and demonstrates the changes brought by the combination of the two to the taxi industry: travel costs are reduced, and carbon emissions per person are reduced. In addition, this paper demonstrates the realization of driverless shared cars at the technical level, puts forward the real-time control and scheduling technology based on vehicle networking technology, and discusses the safety of driverless shared cars. Although there is no successful commercial application of driverless shared cars at present, this paper proves that under the tide of globalization, the distance from commercial operation of this scheme is not far away.

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