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New Energy Vehicle Rental Platform Based on HarmonyOS

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Abstract: Against the global backdrop of heightened concern over climate change and environmental pollution, China has actively answered international calls by setting the ambitious goal of peaking carbon dioxide emissions before 2030 and achieving carbon neutrality before 2060. To attain this objective, the new energy vehicle industry has been elevated to a strategic priority. In 2024, China's new energy vehicle market witnessed an unprecedented surge in prosperity, reaching an annual domestic retail sales volume of 11 million units. Given the immense size of this market, the introduction of a car rental service platform compatible with the Harmony Operating System (HarmonyOS) system to cater to the escalating rental demands of users has emerged as a pressing issue. This paper delves into the development of a new energy vehicle rental service platform based on HarmonyOS, leveraging Ark TypeScript (ArkTS) and Ark User Interface (ArkUI) to achieve interface design optimization and efficient backend management. This innovative approach facilitates more intuitive and convenient daily operations for users, administrators, and staff alike, markedly enhancing system stability and user experience. This platform establishes a practical exemplar for the application of HarmonyOS in vertical industry scenarios. Its modular design philosophy and multi-terminal collaborative architecture demonstrate significant replicability and scalability across industries.

Keywords: HarmonyOS; New Energy Vehicle Rental; ArkTS; ArkUI

1. Introduction

Globally, the vehicle rental market is experiencing robust growth [1]. In 2024, global vehicle rental market sales reached $112.55 billion, and are projected to soar to $209.28 billion by 2031, with a compound annual growth rate of 9.4% during 2025-2031. The global car rental service market sized at $116 billion in 2025 and is expected to climb to approximately $158 billion by 2030, representing a growth rate of about 36.8% from 2025 to 2030. As dominant markets, North America and Europe account for approximately 70% of the global market share. Specifically, the North American market led the global car rental service market in 2025 with a 44% share, followed by Europe at 34% and Asia at 17%. However, the Asian market is anticipated to achieve significantly higher growth rates in the coming years.

In terms of competitive landscape, the global car rental service market is primarily dominated by international giants such as Hertz, Avis Budget Group, and Enterprise Holdings, with the top three companies capturing approximately 55% of the global market share. Meanwhile, emerging local players [2] are springing up, intensifying market competition. Consumer demands are increasingly diversified and personalized, with business travel and individual tourism [3] serving as the main drivers of market growth. Driven by growing environmental awareness, demand for new energy vehiclerentals continues to rise, with the penetration rate of new energy vehicles in the car rental market expected to increase from 15% to around 35% between 2025 and 2030.

China’s car rental market has grown rapidly in recent years. The total market size reached 47.5 billion yuan in 2025, a 15% increase from 2024, and is projected to exceed 80 billion yuan by 2030, with a compound annual growth rate of approximately 12%. First-tier cities such as Beijing, Shanghai, Guangzhou, and Shenzhen account for nearly 60% of the national market share, while second- and third-tier cities are growing at a rapid pace. Large chain rental companies like China Auto Rental and eHi Car Service hold leading positions in the market by virtue of brand influence and high-quality

services. Local rental companies also possess a certain market share due to their in-depth understanding of the local market. Leveraging their familiarity with local markets, these companies deeply tap into customer needs and gain market share by providing localized specialized services. These two types of players—large chains and local operators—compete and complement each other, jointly forming the core competitors in China's car rental market.

Business leasing and leisure leasing constitute the main segments of the Chinese market, accounting for 60% and 40% of the total market, respectively. In business leasing, corporate clients make up over 70% of users, while leisure leasing is dominated by individual users. With the popularization of green travel concepts, the share of new energy vehicle[4] leasing has increased annually, approaching 30% by the end of 2025.

Currently, most car rental platforms still focus on traditional car rental services. For example, companies like China Auto Rental and eHi Car Service integrate traditional fuel-powered vehicles with new energy vehicles, but new energy vehicle rental services face multiple shortcomings. When renting new energy vehicles, users struggle to find suitable charging stations[5], and the market lacks an official energy replenishment site query function that accurately matches vehicle models. Meanwhile, small and medium-sized car rental enterprises, constrained by funding limitations, have insufficient investment in leasing system development, making it difficult to improve operational efficiency and attract users.

Therefore, developing a new energy vehicle leasing service platform on the HarmonyOS ecosystem represents a strategically significant initiative. This platform will not only deliver intelligent, seamlessly integrated mobility services to customers but also foster the scalable growth of the new energy vehicle industry and drive technological innovation.

2. Related Technologies

The front-end interface of this system is built using the ArkUI framework, a native UI solution specially designed by Huawei for HarmonyOS[6,7,8] application development. ArkUI [9,10] provides a complete UI development infrastructure, enabling efficient interface construction and interactive design through concise declarative syntax and a rich component system. Aiming at different application scenarios and technical backgrounds, the ArkUI framework offers two development paradigms: the declarative development paradigm based on ArkTS and the JS-compatible Web-like development paradigm. For building high-performance and highly maintainable full-scenario applications, ArkTS [11] is the preferred choice; the JS paradigm is more suitable for teams with existing Web development experience to quickly migrate. Considering that the system needs to support full-scenario device adaptation (including mobile phones, tablets, smart screens, etc.) and pursue extreme performance, this system adopts the declarative development paradigm based on ArkTS. The system backend uses ArkData's data management solution to achieve persistent storage of application data and cross-device synchronization. ArkData is a unified data access framework provided by HarmonyOS, offering multiple storage methods such as relational databases and key-value databases. Through this design, developers can focus on business logic implementation without worrying about the complexity of underlying data management, while obtaining high-performance, secure, and reliable data storage solutions.

Therefore, here are the detailed steps to create a project for this system on the AppGallery Connect platform: First, create a new project on the AppGallery Connect platform and establish an association with the locally developed project. Ensure that the package name of the local project precisely matches the one entered on the platform, then proceed to apply for all necessary services. After successfully creating and linking the project, navigate to the Application Programming Interface (API) management interface. Here, submit applications for the location services, positioning services, and map services that the system requires. Once the service permissions are granted, additional items need to be obtained: apply for a debugging certificate, APP ID, device UDID, and Profile file. Subsequently, acquire essential development credentials, including the project ID, client ID, API key, APP ID, OAuth 2.0 client ID, SHA256 certificate, and public key fingerprint. Download all these pieces of information to your local device. Bind them to the local project, disable the automatic signature feature, and manually input the downloaded

signature, certificate, and public key fingerprint. Only after completing these steps can the project fully utilize the location, positioning, and map services.

3. System Design

This system provides a service platform developed for new energy vehicles to support the operations of car rental enterprises. It integrates modules such as user login/registration, vehicle management, employee task allocation, user information management, and order settlement, serving as a bridge between the enterprise's daily external operations and internal management needs. Administrators can adjust real-time data on vehicle inventory, operational status, user information management, and employee scheduling according to actual conditions. Employees can carry out tasks based on assigned duties, while users can modify personal information, query nearby energy replenishment stations, and plan routes, among other functions.

3.1 Overall Design

The system is introduced from two parts: front-end design and back-end management.

3.1.1 Front-end design

The ArkUI framework is primarily used to place corresponding controls in the overall layout of the pages. For different page structures, Row containers and Column containers are employed to achieve linear layouts, while layered layouts, relative layouts, and lists are used to reasonably arrange components.

3.1.2 Back-end design

The back-end focuses on information transmission between components, planning the lifecycle of pages, and handling navigation jumps for various operations through page routing. The ArkData database technology is integrated to implement CRUD (Create, Read, Update, Delete) operations on data. APIs from third-party software are accessed to provide map services.

3.2 System Functional Design

The system is structured into three primary modules: Administrator Terminal, Employee Terminal, and User Terminal. Each module's functional design is detailed below:

3.2.1 Administrator terminal

Core Functionality: Comprehensive system data management and control. Encompasses management of four major data categories (vehicles, users, employees, orders) with support for data querying, CRUD operations, and business process approvals.

(1) Vehicle information management

Information Display: The vehicle management page on the APP presents comprehensive vehicle details, including:

1) Basic Attributes: Vehicle ID, license plate number, brand, model, vehicle type, dimensions, color, seating capacity.

2) Performance Parameters: Energy type, range, horsepower, total mileage.

3) Operational Status: Rental price, availability status (available/rented/under maintenance), official contact.

Operational Features:

1) Search bar supports quick keyword-based retrieval by vehicle ID, license plate, brand, etc.

2) CRUD operations: Add new vehicle profiles, modify existing records, delete decommissioned vehicles.

(2) User information management

Data Dimensions: Mobile number, username, password, ID number, security question.

Operational Functions:

1) Search bar supports precise query by mobile number, username, or ID number.

2) Enable creation of new user accounts (e.g., backend registration), modification of user profiles, and deletion of abnormal accounts.

(3)Employee Information Management

Data Dimensions: Employee ID, name, password, phone number, job title, ID number, address.

Operational Functions:

1) Search bar supports quick filtering by employee ID, name, or job title.

2) Manage employee accounts (e.g., create/delete accounts during onboarding/offboarding) and modify permission settings.

(4) Order Information Management

Data Dimensions:

1) Basic Info: Order number, brand, model, mobile number, contact person, ID number.

2) Time & Price: Start date, end date, rental duration, daily rate, total price (including coupon deductions).

3) Process Info: Pick-up/drop-off addresses, license plate number, total mileage, vehicle status (pending pickup/in use/returned).

4) Evaluation System: Order rating, service feedback.

Operational Functions:

1) Search bar supports exact retrieval by order

number.
2) Order approval (e.g., verify vehicle status and user eligibility), delete invalid orders.
3.2.2 Employee terminal
Core Functionality: Order execution and service support.
(1)Order Management
Information Display: Synchronized with administrator-side order data, showing full-order details.
Operational Functions:
1) Search bar supports order number-based retrieval.
2) Approve orders (e.g., confirm pick-up/drop-off times and vehicle status), delete erroneous orders.
3) Mark order status (e.g., "vehicle delivered," "vehicle received").
(2)Navigation Functionality
Integration Capability: Accesses third-party map APIs (e.g., Amap, Baidu Maps).
Operation Flow:
1) Enter pick-up/drop-off addresses to jump directly to the map app with one click.
2) Automatically generates route plans.
3) Real-time navigation assists employees in completing door-to-door vehicle delivery.
(2)Contact Directory
Data Content: Lists official customer service hotlines for automakers and insurance companies.
Interaction Design: Tapping a number directly triggers the system dialing function.
3.2.3 User terminal
Core Functionality: Self-service throughout the car rental process. Covers vehicle inquiry, order creation, navigation, and evaluation to enhance the user experience.
(1)View Vehicle Models Information
Interaction Design:
1) Home page search bar supports filtering by brand, model, and price range.
2) Rotating banners of popular vehicle models (implemented via the Swiper component), with clicks on images leading to model detail pages.
3) Detail pages display vehicle images, parameters, rental prices, and availability periods.
(2) Fill in Rental Information Form
Functionality Implementation:
1) Pick-up location selection: Uses the HarmonyOS NEXT Map Kit component to support cascading selection of country/province/city/district/street.
2) Rental time selection: Date picker component automatically calculates rental days and total price.
(3)Confirm Order
Information Display:
1) User information: Mobile number, ID number
2) Rental details: Pick-up/drop-off times and locations, vehicle model.
3) Price breakdown: Original price, coupon deduction amount, actual total payment.
Operational Functions:
1) Select coupons (system automatically matches available coupons).
2) Confirm and submit orders, supporting online payment.
(4)Map and Navigation
Function Integration:
1) Real-time positioning of the current location to search for nearby charging stations and gas stations.
2) After selecting a destination, jump to a third-party map application with automatic transmission of address parameters.
(5)Contact Directory
Functional Design:
1) Displays customer service numbers for automakers and insurance companies.
2) Clicking a number automatically copies it to the dial pad for one-click calling.
(6)Order Information and Evaluation
Information Inquiry: Order detail pages show full-process records (e.g., pick-up time, mileage driven, return status).
Evaluation System: After order completion, users can rate vehicle performance and service quality (1-5 stars).

4. System Implementation

4.1 Login and Registration

When the system is launched, it first enters a splash ad interface, which automatically navigates to the system login interface via page routing after 5 seconds. As shown in Figure 1, ordinary users can directly enter their account credentials to log in. If unregistered, users need to click "User Registration" to enter the registration interface, create an account, and then return to the login page. Administrators and employees can respectively click "Administrator Login" and "Employee Login" to access the system backend management interface.

4.2 Functional Realization

The home page is the first interface users

encounter when using the system. Placing core functions, relevant images, text, and other information on the home page can effectively attract users' attention and achieve the goal of key promotion. The following sections detail the implementation of the user home page. The component layout effect of the home page is shown in Figure 2.

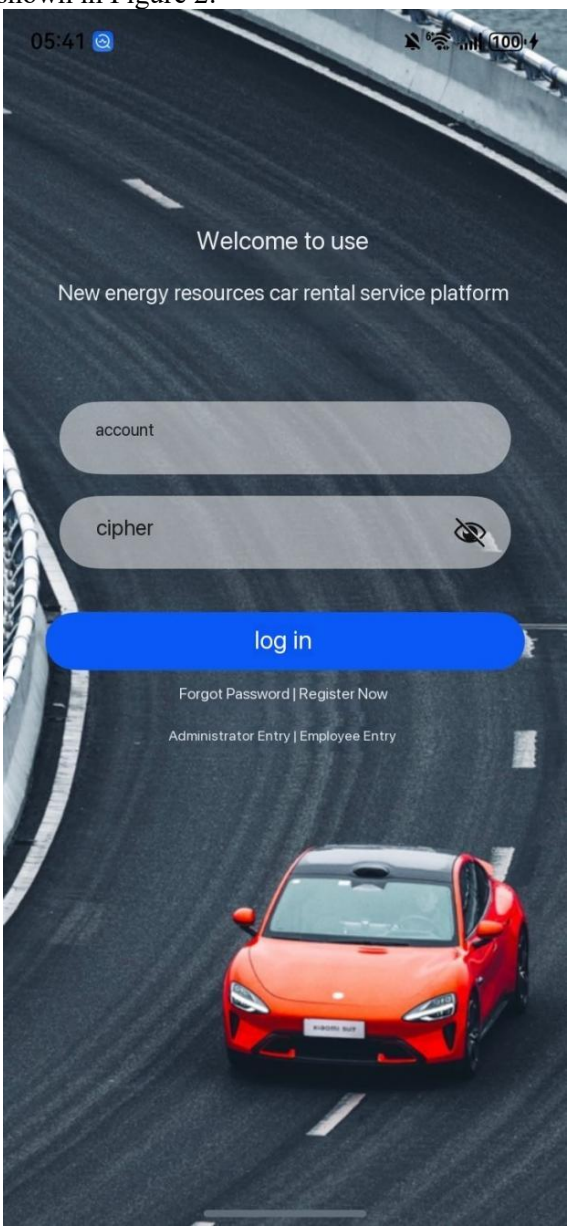

Figure 1. Login Interface

A search box control (search widget) is designed on the home page to facilitate users in searching for relevant vehicle model information. This control aligns the search box and search button on the same horizontal line, with a magnifying glass icon positioned on the left, significantly enhancing visual comfort for users. The design is intuitive, making it easy for users to identify the search function.

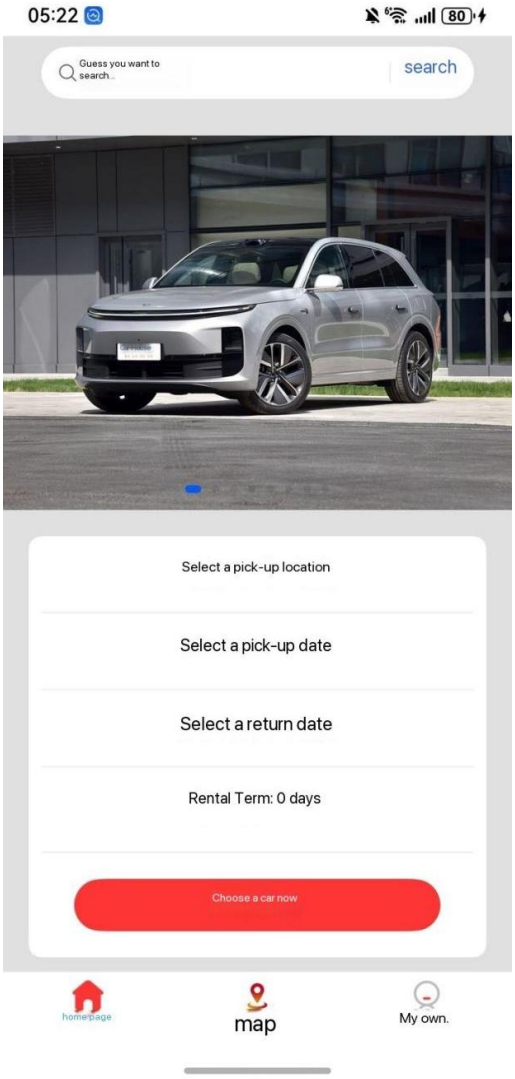

Figure 2. User Home Page

Below the search box is the vehicle model display area, which showcases images of popular vehicle models. Striking images can attract users' interest and facilitate their selection of vehicle models. Images in this area are displayed in a carousel format using the Swiper component. Swiper is a container component that, when multiple sub-components are added, can cycle through and display these sub-components. By placing images to be displayed in each sub-component, the loop attribute can be set to control whether to play in a loop and define the time interval for looping. In addition to automatic carousel playback, users can also manually slide through the images. When the image content is relatively large and not permanently fixed, instead of local storage, images should be hosted online and accessed via their corresponding URLs (Uniform Resource Locators). This approach solves the problem of excessive local storage consumption by images.

For selecting the pickup city's administrative division, users can click on "Pickup City" to choose relevant information such as country, province, city, district, and street where the pickup location is situated. This function is implemented through the Map Kit (map service) component of HarmonyOS NEXT. The component supports viewing the lower-level administrative divisions of the selected area and recommending popular cities and regions. The selectDistrict() method triggers the administrative division selection page, while the DistrictSelectResult() method returns the user-selected division information to pre-set parameters. The returned information must then be filtered using the JSON.stringify() method to exclude extraneous data, yielding the final text information.

4.3 Technical Implementation Notes

The Tabs component is implemented using HarmonyOS's ArkUI framework, supporting smooth tab switching and responsive layout adaptation across screen sizes.

Page routing between tabs and sub-pages is managed via the @ohos.router module, ensuring seamless navigation and proper lifecycle management for each page.

Login states are persisted using DistributedData (HarmonyOS's distributed data management) to maintain user sessions across app restarts and multi-device scenarios.

5. Conclusion

This study presents a new energy vehicle rental service platform developed on the HarmonyOS ecosystem. By leveraging ArkTS, the native programming language, and ArkUI, the dedicated framework, the platform achieves intuitive interface design and streamlined backend management. As a result, it significantly enhances operational efficiency for users, administrators, and employees while ensuring robust system stability.

The platform comprehensively covers the entire lifecycle of new energy vehicle rental, from vehicle selection and order processing to service completion. More importantly, it innovatively integrates map-based navigation with real-time charging station query features, directly tackling the critical challenge of energy replenishment faced by users. This seamless integration not only optimizes the user experience but also positions the platform as a practical solution for the evolving demands of the new energy vehicle rental market.

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