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Development and Validation of Vehicle Adaptability Testing in Australia

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ABSTRACT

This study systematically analyzed the special requirements of the Australian market for vehicle adaptability. Firstly, the unique climate environment of Australia (extreme high temperatures, sandstorms, high humidity), road traffic characteristics (narrow lanes, complex signs, frequent roundabouts), and user usage habits (widespread use of trailers, CarPlay dependence, etc.) were elaborated in detail. Secondly, by comparing the differences between China and Australia in environmental testing standards, traffic regulations, and user needs, the shortcomings of the existing testing system in China in dealing with UV aging, dynamic speed limit sign recognition, and right-hand drive human-machine interaction were revealed. Finally, targeted development suggestions were proposed, including verification of special operating conditions (roundabout+ speed bump), optimization of charging compatibility, and cooperation with local operators for adaptive development. The research provides a systematic testing and verification method reference for car companies to enter the Australian market.

KEYWORDS

Australia; Environmental Adaptability; Vehicle Testing; Intelligent Driving; Localization Certification.

1. INTRODUCTION

With the rapid development of the global automotive industry, the adaptability of vehicles in different regions has become a core concern for both manufacturers and consumers. Australia poses a severe challenge to vehicle performance, reliability, and durability due to its unique geographical and climatic conditions, including extreme heat, vast deserts, high humidity coastal areas, as well as complex and variable terrain and road transportation facilities. In this context, developing an adaptive testing system for the Australian market and completing scientific verification is not only crucial for the localization strategy of car companies, but also provides important reference for vehicle testing in similar regions around the world.

2. INTRODUCTION TO AUTOMOTIVE ADAPTABILITY TESTING

2.1. Environmental Adaptability Test

Environmental adaptability testing refers to the systematic verification process of evaluating the performance stability, functional reliability, and material durability of a vehicle by simulating or reproducing the environmental stresses (such as climate, terrain, electromagnetic, etc.) that the vehicle may encounter during its lifecycle. According to the Australian ADR standard requirements [1], vehicles in desert areas are required to undergo a 50 ℃ high-temperature coupled sand and dust test. Its core objectives are:

Failure prevention: exposing design defects in advance;

Standard compliance: Meet the regulatory requirements of the target market;

User experience guarantee: Ensure that the vehicle can maintain basic functions even under extreme conditions.

2.2. Adaptability of Road Traffic Signs

The purpose of road traffic sign adaptability is to verify the vehicle's ability to recognize and respond to road traffic signs in the target country, involving:

Hardware compatibility: Detection sensitivity of car cameras/radars to local identification materials;

Software logic compliance: The speed limit identification algorithm needs to be adapted to the dynamic speed limit rules unique to the testing target area.

The types of experiments include static identification recognition testing (such as unique identification, color compatibility, etc.), dynamic identification response testing (such as variable information sign (VMS) parsing, semantic understanding of temporary construction signs, etc.).

2.3. User Adaptability

User adaptability refers to the specialized optimization and verification of user habits, human characteristics, and cultural preferences in the target market, solving the problem of "vehicle human" interaction matching. Typical scenarios include differences in driving behavior and human-machine engineering requirements.

The types of experiments include human-computer interaction testing, scenario restoration testing, cultural adaptation verification, etc.

3. KEY POINTS OF ADAPTIVE DEVELOPMENT IN AUSTRALIA

The overview of Australia's climate and environment mainly includes terrain, climate, average temperature, extreme temperature, relative humidity, etc.

Terrain: The central part is mostly plains and large self flowing basins, the western part is a low plateau, and the eastern part is a great watershed (mountains and plateaus). Climate: The southeastern and northern coastal regions have a subtropical humid season, while the central and western regions are mostly arid. The southern and western regions have a plateau climate. Average temperature: The average temperature in summer is usually between 13-33 degrees Celsius, and the average temperature in winter is between 0-18 degrees Celsius. Extreme temperature: The highest summer temperature in the desert areas of southern Western Australia can reach over 40 degrees Celsius, while the lowest winter temperature in the southeastern coastal areas is around 0 degrees Celsius. Relative humidity: The relative humidity is higher in summer, usually between 50% and 70%, with the highest in February, while it is lower in winter, usually between 30% and 50%, with the lowest in July.

3.1. Typical Driving Habits

There are significant differences between Australian users and domestic users in terms of charging habits, driving habits, winter tire usage, electrical operation, multimedia needs, towing and towing.

Charging station: Slow charging stations in the Australia New Zealand region are not equipped with charging cables. Users need to purchase their own charging cables and interfaces, and install them at

their own expense (car manufacturers usually provide products for purchase, with a cable length of 6-8m). It is necessary to verify and pay attention to the charging adaptability.

Tires: Australia uses mostly all season tires, New Zealand uses a small amount of winter tires, and there is no mandatory requirement from the government.

Double flash light usage: Double flash light is not frequently used in non emergency situations, and may be used as a signal in some areas (such as giving way to oncoming vehicles).

Window lifting logic: The lifting operation buttons for vehicles in the Australia New Zealand region are consistent with those in China, and currently there are no products with the same lever mechanism as our company.

High frequency use of Carplay: The intelligent cockpit configuration of Australia and New Zealand cars is generally not high. Research on right-hand drive human-machine interaction shows that Carplay has a usage rate of 85% in Australia, and there are special operating habits. Users highly rely on Carplay functions in their daily lives, which requires special attention in functional testing.

Frequent use of Waze: Australian and New Zealand car owners use this software almost every day to avoid traffic penalties and various traffic situation alerts.

Habitual use of towing devices: Users can be seen using towing trailers (RVs, yachts, motorcycles, horses, etc.) everywhere in Australia and New Zealand. Even when not towing, the towing device will still be installed on the vehicle, and adaptability testing should be emphasized for verification.

Throttle: Due to the mountainous terrain in many cities in the Australia New Zealand region and frequent uphill and downhill driving, the accelerator pedal is used more deeply for vehicles to start quickly, especially for Melbourne residents who drive more aggressively.

Differences in cockpit structure: Some domestic brands (BYD, MG, etc.) have a translational design for the engine hood switch, lighting components, and wiper components, while foreign brands have a mirrored design on the driver's side (TOYOTA, Ford, Hyundai, etc.). Local residents may not be accustomed to it, and it is recommended to make changes in the future.

Abuse: Young people in Australia and New Zealand like to forcefully open and close car doors, lying on open doors, and need adaptability verification.

Fig 1. Australian towing trailer scene

3.2. Road Traffic Conditions

3.2.1. Road Facilities

The road infrastructure in Australia is worse than in China, with narrower lanes for urban, suburban, and mountain roads, and comparable widths for highways, but with poorer road conditions; The vehicle speed limit is similar to that in China.

Highway: The road conditions on highways are generally average, with two lanes in both directions, and some highways have one lane on one side; The maximum speed limit on highways is 110km/h. The speed limit for bends and sections with poor road conditions is 80km/h (partially 95km/h, varying).

Rural and suburban roads: The condition of national highways, suburban roads, and rural roads is generally average, with one-way 2-lane or 1-lane roads and slight bumps on the road surface; Part of the road surface has no middle marking line; Most of the road markings are unclear. The speed limit is generally 60km/h, and residential areas and schools generally have a speed limit of 40km/h. It is necessary to focus on verifying the working conditions of urban and rural roads.

Urban roads: The road conditions in Australian cities are generally very narrow and mixed with bike lanes and tram lanes; There are many deceleration zones and ramps around the island; Elevated roads and tunnels are inferior to Chongqing. Most roads have vehicles parked on both sides and no median line. Possible triggering of driving assistance functions, with a focus on verifying urban road conditions. The traffic jam situation is not as severe as in China, with mild slow-moving during peak hours and no prolonged inactivity. On average, the driver waits for 2 red lights (about 2 minutes) during peak hours.

Mountain roads: Australian mountain roads are mainly concentrated in the eastern and southern regions, with most of them being national forest parks. The roads are very narrow and have many bends, generally extending for more than 10km. Many bicycle enthusiasts ride on mountain roads and need to verify the extreme mountain road conditions.

Fig 2. Australian Highways, Rural Roads, Urban Roads, and Mountain Roads (from left to right)

3.2.2. Traffic Signs

There are many differences between Australian traffic signs, such as yield signs, traffic light rules, electronic speed limit signs, and lane markings, compared to domestic traffic signs. There are significant challenges for driving assistance systems to recognize and execute actions.

Roundabout signage: There are a large number of roundabouts at intersections and ramps (speed limited sections) in Australia, which can divert vehicles or force them to slow down;

Time limited speed: There are time limited speed signs in key areas such as schools. If schools only limit speed during school and school hours, it will be difficult for the visual system to recognize.

Yield signs: Yield signs (circular STOP, GIVEN Way, inverted triangle yield signs) can be seen everywhere in Australia, mostly located at speed bumps around roundabouts. If encountering this sign, stop for 3 seconds to yield.

Traffic light setting: The main difference is that there are red lights on both sides of the intersection in all four directions, indicating straight ahead, left turn, and right turn, making it difficult for the visual system to recognize.

Electronic speed limit signs: The Australian AS 1742.1 standard [3] has significant differences in the specifications of dynamic electronic speed limit signs compared to the domestic GB 5768. They are more common on highways and often dynamically adjust according to traffic flow conditions, posing challenges for speed limit recognition in intelligent driving functions.

HOOK TURN (two-stage right turn) sign: There are many HOOK TURN signs in Melbourne, which require a quick start through traffic lights.

Road Narrowing Sign: The continuous line in the center of the road poses a challenge for visual system recognition.

Pedestrian giving way: There are pedestrian giving way signs on sidewalks in New Zealand, and if there are pedestrians on the roadside, they must stop and give way.

Fig 3. Temporarily transformed electronic speed limit signs, intricate traffic lights, yield signs, and roundabouts (from left to right)

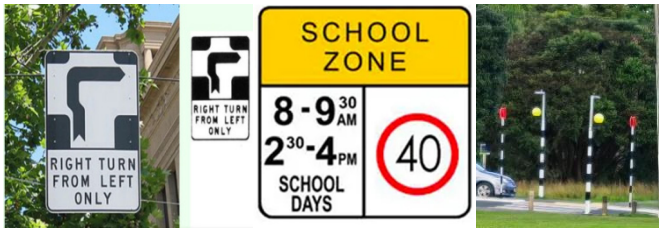

Fig 4. HOOK TURN, timed speed limit, yielding pedestrians (from left to right)

3.3. Charging Infrastructure

The infrastructure construction of charging stations in Australia is still growing rapidly. Currently, the number of public charging stations is close to 100000, of which slow charging stations account for more than 90%. It is expected to reach 1.8 million by 2030; More than 60% of the total population are concentrated in cities on the east coast, such as Melbourne, Sydney, and Brisbane.

Number of charging stations: Currently, Melbourne has the highest number of public charging stations, exceeding 20000; Sydney, Brisbane, Perth, Adelaide, and Canberra have the highest number of charging stations.

Distribution of charging stations: Currently, over 90% of public charging stations in Australia are AC slow charging stations, and almost all of them in cities are slow charging stations; Almost all DC fast charging stations are located in highway service areas and suburban charging stations.

Charging pile power: According to research, the power of slow charging piles is basically 22kw and 11kw, with almost no 7kw seen; fast charging piles are basically 50-350kw. The Chargefax report [4] shows that the proportion of 22kW slow charging piles in Australia is over 90%.

Main operators: Mainstream charging station operators in Australia include Tesla, RNMA , Chargefox, AMPOL, Schneider, EVIE, Tritium, DCRN, SPAC, JOLT (7kwh Currently, there are over 20 operator brands, including free ones.

Charging pile brands: At present, there are more than 30 mainstream charging pile brands surveyed in Australia, including Tesla, Hypercharger, ABB, Tritium, Delta, Evbox, Schneider, etc.

Charging pile payment: By using Mobility+and ShellRecarge, over 90% of charging pile operators can be covered. Charging cards or apps can be used to bind credit cards for payment, with charging fees ranging from 0.4-2 Australian dollars per kilowatt hour.

Slow charging is the main method in urban areas, with most charging available for free but requiring paid parking (AUD 13-20/hour); Some outdoor open areas have fast charging stations, with charging fees mostly ranging from AUD 0.4-1.2/kWh, and additional parking fees (AUD 13-20/hour) need to be paid.

Larger high-speed service areas are equipped with fast charging stations, with fees generally ranging from AUD 0.6-0.8/kWh. Parking is free, but the density is relatively low, with intervals of around 100-200km.

Differential analysis: RNMA and Chargefax brands are only unique to Australia, while TRITIUM and AMPOL charging stations have a high proportion and require special verification.

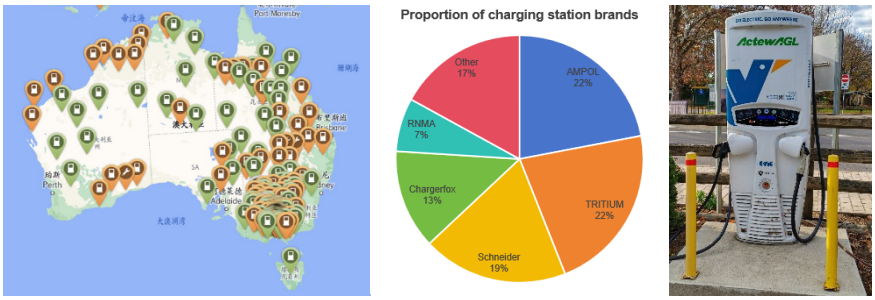

Fig 5. Overall distribution of charging stations in Australia, proportion of charging station brands, and real-life pictures of charging stations (from left to right)

3.4. Special Road Scenarios

3.4.1. User Adaptability

There are 9 special user adaptation scenarios in Australia that require special attention when developing and verifying environmental adaptability in Australia.

Loop driving scenario: There are a large number of roundabouts at intersections and ramps in Australia (where speed limits are required), and vehicles will quickly slow down before accelerating to pass through. The decision-making algorithm in the roundabout scenario needs to be specially optimized [7] to cope with the special working conditions of high-frequency roundabouts in Australia. Adaptive working conditions require the addition of a special scenario for loop driving.

Special scenario for speed bumps: There will be 10-15cm protruding platform speed bumps at intersections, and local drivers will impact and pass through. Adaptive working conditions require the addition of a special scenario for speed bumps.

Extreme Mountain Road Scene: There are many natural parks in the southeastern region of Australia, mostly narrow mountain roads. Local residents will bring trailers up the mountain for hiking or camping, and the adaptability conditions need to be verified by the Extreme Mountain Road Trailer Special Verification.

Typical urban and rural road scenarios: The road conditions of rural roads and national highways around the city are poor, with many potholes and road changes, which need to be verified in the adaptive urban and rural road conditions.

Railway track scenario: Research has found that railway tracks and highways commonly coexist in Australian cities, and cars will travel on the tracks, which needs to be verified in adaptive urban road conditions.

Parking Buildings and Underground Garage Scenarios: Parking buildings are located around the CBD and require continuous uphill and curved paths. Some lower parking garages are located deeper and require long downhill and curved paths, with a focus on verifying continuous turning scenarios.

Parking scenario: There is no front line at the front of Australian parking spaces, and automatic parking cannot recognize the T-corner. Targeted development is needed.

HERE map verification: HERE map shows significant differences in performance compared to Google in Australia, with some one-way and road closure information not predicted in advance. Therefore, Google navigation comparison testing needs to be fully enabled during adaptability testing.

Trailer scenario: Almost every household in Australia has a trailer demand (goods, ships, RVs, etc.), which requires special trailer verification.

Fig 6. Australian roundabout, speed bumps, ultra narrow mountain roads, and parking lots (from left to right)

3.4.2. Smart Driving Special Scenarios

Through on-site visits and research, dozens of typical intelligent driving scenarios in Australia have been identified and need to be incorporated into intelligent driving testing conditions. The following are typical test scenarios for intelligent driving in Australia.

Narrow lane scenario on urban roads: The lanes in the city are relatively narrow, with a width of 2-2.2 meters, and it is necessary to focus on lane keeping in the intelligent driving special testing scenario.

Electronic speed limit sign scenario: In Australian highways and urban expressways, the electronic speed limit of the gantry often changes, and the speed limit recognition function needs to be focused on in the intelligent driving special testing scenario.

Artificial speed limit sign scenario: In case of temporary construction, construction personnel may hold parking/speed limit signs to manually limit the speed. It is necessary to pay attention to the speed limit recognition function in the intelligent driving special testing scenario.

Scenes without centerlines and edges: Many roads in urban areas and highways have no centerlines or edges, and there are vehicles blocking the edges on both sides of the road. Lane recognition testing in intelligent driving special tests needs to be given special attention;

Scenario of lane disappearance: In rural roads, there may be scenes where the middle lane suddenly disappears or the lane becomes blurry. It is necessary to verify whether the functional logic is normal in the intelligent driving special test.

Fig 7. Australian ultra narrow lanes, electronic speed limit signs, blurred lane markings, and no center lane routes (from left to right)

Fig 8. Expressway+bicycle lane, diagonal zebra crossing (from left to right)

Roundabout driving scenario: There are many roundabout driving conditions on urban and rural roads in Australia, and vehicles entering the roundabout need to slow down or stop to give way. The decision-making algorithm in the roundabout scenario needs to be specially optimized [5] to cope with the special working conditions of high-frequency roundabouts in Australia.

Diagonal zebra crossing scenario: In urban and rural areas, as well as highways in Australia, there are lane separation lines with a diagonal zebra crossing style, which poses a risk of lane departure. Therefore, it is necessary to pay attention to lane keeping in the intelligent driving special test.

Scenario without parking head line: There is no front end line in Australian parking spaces, and automatic parking cannot recognize the T-corner. Targeted development of automatic parking function is needed.

Bicycle lane recognition: There are narrow bicycle lanes along urban and highway lanes, and there may be misidentification of lane keeping for intelligent driving functions, which requires special verification.

3.5. Other Experimental Information in Australia

Mainstream car models: small cars, station wagons SUV, Pickup trucks are the main ones, and there are almost no three box cars visible.

Mainstream telecommunications operators: Telstra, Optus, Vodafone, etc.

Network status: The common Internet signals of vehicles such as intercity highways and national natural parks are relatively poor, and navigation and network signals are often lost.

In car mobile phone interface: The mainstream mobile phone interfaces in the car are mainly USB interface and AUX interface, with Type-C interface being relatively rare.

Mainstream smartphone brands: The top 5 smartphone brands in Australia are Samsung, Apple, Oppo, Huawei VIVO， Apple and Samsung dominate (over 60%).

Mainstream multimedia apps include Carplay, DAB, Radio, Waze, etc. Navigation maps often use Google Maps waze, Amigo.

4S dealership maintenance: Wild animals such as kangaroos often appear on national highways and expressways, and collisions between vehicles and animals occur frequently. SUV and pickup trucks with off-road properties are often equipped with front anti-collision modules.

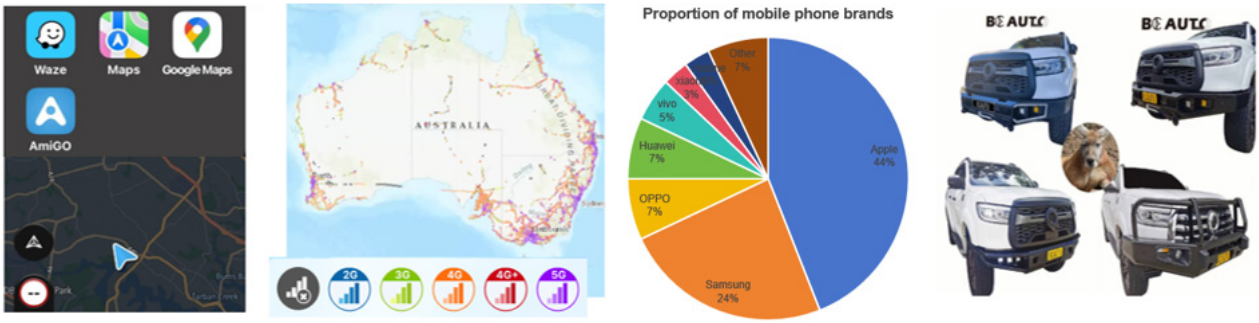

Fig 9. Distribution of commonly used car navigation apps, mobile network operators, mobile market share, and vehicle collision prevention front-end renovation (from left to right)

4. COMPARATIVE ANALYSIS OF ADAPTABILITY TESTING SYSTEMS AT HOME AND ABROAD

4.1. Differences in Environmental Adaptability

Table 1. Differences in Environmental Adaptability

Dimension	Typical Test Requirements in China	Australia's Special Needs	technology gap
High Temperature Test	Steady state at 40 ℃ (GB/T 12546)	50 ℃ transient+sand dust coupling (Western Australian desert)	The transient response model of the cooling system is missing
Salt spray corrosion	96 hour neutral salt spray (GB/T 10125)	200 hours of acidic salt spray (coastal industrial zone)	The coating process standard needs to be upgraded
Charging facilities	National standard 7kW slow charging dominant	22kW slow charging+self provided cable (high user cost)	Insufficient compatibility verification of charging interface

4.2. Differences between Traffic Signs and Intelligent Driving Systems

4.2.1. Identification and Recognition:

(1) China relies on high-definition reflective signs (GB 5768), while Australia needs to deal with fading signs (UV aging) and dynamic electronic signs;

(2) In the circular island scenario, the triggering rate of AEB in China is 0.1 times per thousand kilometers, while in Australia it reaches 2.3 times (target object screening algorithm needs to be optimized).

(3) User interaction: Mandarin is the main language for voice control in China, while the Australian English accent leads to a 12% increase in command misidentification rate (such as misjudging "Navigate to Sydney" as "Navigate to cinema").

4.3. Comparison of Standard Systems

(1) China: GB/T 30340-2023 emphasizes the reliability of the basic environment, but lacks special provisions for the right-hand drive market. The latest research by the China Automotive Center [6] points out that there are verification gaps in the GB/T standard in dealing with ultraviolet aging;

(2) EU: ECE R13 does not cover regional scenarios such as kangaroo collision testing;

(3) Australia: ADR 35/06 has strict requirements for trailer stability (requiring an additional 15% verification cost).

5. SUMMARY AND SUGGESTIONS

Environmental dimension: Australia's composite environmental stress (high temperature+ sand and dust+salt spray) requires the establishment of a multi physics field coupling test method; Regulatory dimension: Dynamic speed limit signs and trailer regulations are the main bottlenecks for localizing intelligent driving systems; User dimension: Right steering operation habits and CarPlay dependency require deep adaptation of HMI design.

6. COUNTERMEASURES OF CAR COMPANIES

Develop an Australian exclusive test spectrum (such as the "roundabout+speed bump" cycle condition); Cooperate with local operator (Chargefax) for charging compatibility certification.

7. STANDARD OPTIMIZATION

Promote the integration of ADR and ISO standards, and add a clause for "accelerated UV aging test".

8. FUTURE TO EXPLORE:

AI based real-time learning system for traffic signs (dealing with dynamic speed limit signs); Shortening the path of user behavior big data-driven adaptive testing (such as Melbourne emergency acceleration clustering analysis).

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