Intelligent In-Vehicle Driver Fatigue System Based on Physiological Sensing: A Postprint of the SYMAGIC Smart Ring Automotive Media Application Case

Authors: Wang Chen, Gao Hongwei, Lü Guilin, Chen Tao, Yuyang Sun

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Abstract

With the development and application of big data, artificial intelligence, and other technologies, the automotive industry is confronting unprecedented challenges. Newly discovered and emphasized technologies alongside changes that have yet to garner sufficient attention are emerging incessantly, with cross-boundary challenges being ubiquitous. Both Xinhua News Agency and automotive enterprises have recognized that a tremendous transformation is imminent. The wearable smart ring system for fatigue driving detection based on physiological signals, developed by Xinhua News Agency, constitutes an in-vehicle scenario-based solution that employs technological means to precisely profile user personas. Through advanced physiological technology and artificial intelligence algorithms, it collects physiological feedback from in-vehicle users while they listen to news, recommending pleasant news or music information when users are alert. When users enter an initial fatigue state, it recommends news or music content capable of alleviating and mitigating fatigue, thereby reducing the occurrence of in-vehicle accidents, thus creating an in-vehicle intelligent information distribution system and ultimately forming an automotive media "headline" platform. Additionally, the system has already achieved the transformation of scientific research achievements and can, through engineering development, monitor users' fatigue status information in real time, as well as physiological state changes while listening to news, assisting media companies in entering the Internet of Vehicles system through technological means. The innovation of the system lies in its intelligent interaction between media content and human physiological signals, transforming the entire process of news production, manufacturing, distribution, collection, and feedback, and will become a paradigm for future intelligent recommendation systems in automotive media.

Full Text

Preamble

Title: An Intelligent In-Vehicle Fatigue Driving System Based on Physiological Sensing—A Case Study of SYMAGIC Smart Ring Application in Vehicle Media

Authors: Wang Chen[1], Gao Hongwei[2]*, Lü Guilin[2], Chen Tao[2], Sun Yuyang[2] (1. State Key Laboratory of Media Convergence Production Technology and Systems, Xinhua News Agency, Beijing 100803; 2. Intelligent Connectivity Development Institute, China FAW Group Corporation, Changchun, Jilin 130012)

Abstract: With the development and application of big data and artificial intelligence technologies, the automotive industry is facing unprecedented challenges. Emerging technologies are constantly being discovered and valued, while other transformative changes have yet to receive sufficient attention, resulting in cross-industry challenges that are omnipresent and timeless. Both Xinhua News Agency and automotive enterprises recognize that a monumental transformation is underway. The wearable smart ring system developed by Xinhua News Agency for fatigue driving detection based on physiological signals represents a vehicle-centric solution that precisely targets user profiles through technological means. By employing advanced physiological technology and artificial intelligence algorithms, the system collects physiological feedback from in-vehicle users while they listen to news, recommending pleasant news or music information when users are alert, and delivering news content or music that can alleviate and mitigate fatigue when users show initial signs of drowsiness. This reduces the occurrence of in-vehicle accidents, creating an intelligent in-vehicle information distribution system that ultimately forms a "headline" platform for vehicle media. Furthermore, the system has already achieved transformation of research outcomes into practical applications, enabling real-time monitoring of user fatigue status information and physiological state changes while listening to news through engineering development. This assists media companies in entering the Internet of Vehicles system through technological means. The innovation of the system lies in its intelligent interaction between media content and human physiological signals, transforming the entire workflow of news production, manufacturing, distribution, collection, and feedback. It will serve as a model for future intelligent recommendation systems in vehicle media.

Keywords: Smart ring system; Intelligent news recommendation; Fatigue driving system; Physiological sensor; Vehicle media

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1. Introduction

The continuous evolution of all-media has given rise to full-process media, holographic media, all-staff media, and all-effective media. Information is ubiquitous, all-encompassing, and utilized by everyone, leading to profound changes in the public opinion ecosystem, media landscape, and communication methods, which present new challenges for news and public opinion work. It is essential to explore the application of artificial intelligence in news collection, production, distribution, reception, and feedback to comprehensively enhance the capacity for public opinion guidance.

China today is not only the world' s largest automotive market but also a frontier for innovation in intelligent connectivity technology and business models. In the field of automotive intelligent connectivity, we find that existing vehicle systems, apart from voice interaction and navigation, lack any product capable of achieving 80% user activity rates. This indicates that the automotive industry urgently needs products that can deliver creative user experiences; otherwise, viable business models cannot be established. As an intelligent mobile terminal, the automobile' s business model formed over the past 130 years will inevitably change. Business models continue to emerge, such as consumer credit models based on internet finance, which help automotive enterprises transform from traditional automotive R&D manufacturers and service providers into innovative business models integrating big data and the internet. According to professional industry reports, by 2022, software and data services from automotive companies will account for 40% of total revenue, with gross profit margins reaching nearly 55%.

The automotive infotainment system serves as the platform for vehicle media information delivery. Audio-visual content, navigation, payment, and other services all generate indirect or direct interactive behaviors with users on this platform. Regarding audio-visual content information services, service providers currently remain in a traditional one-way communication state. Although they have achieved content production and distribution functions, they have yet to find effective ways to collect and feedback user information consumption behaviors. Automotive user information data is difficult to open to third-party service companies. Consequently, many content service providers collect very limited customer information in the vehicle media service domain, making it challenging to guide content production based on data mining results in vehicle media content services. Some content service providers even resort to capital-intensive approaches to provide in-vehicle services, and viable business models have yet to be established.

On the other hand, although automotive enterprises possess user data across various dimensions due to their focus on vehicle manufacturing, most automak-

ers, lacking understanding of content production services, struggle to cross over into the information consumption service sector to consider content monetization models. This creates a situation where those with data do not know how to use it to guide content production, while those without data lack data support during content production. Although this gap between the two sides has temporarily reached a balance in the current vehicle media service ecosystem, it is not conducive to the long-term healthy development of the vehicle media ecosystem. Therefore, content service providers need to find their own service model that can be deeply integrated with existing automotive enterprise businesses without causing significant disruption to the current balance, until the model proves viable and generates profit. This will allow automotive enterprises and other service providers to see the direction and opportunities, gradually replacing the existing balance and forming a new ecological model.

2. Current Status and Trends of Vehicle Media News Information

With the arrival of the 5G era, traditional media distribution methods are no longer confined to paper terminals, leading to collective decline across the industry. Many traditional media have developed their own web and mobile versions to find new paths. However, radio media stands out as a thriving exception, achieving comprehensive content packaging capabilities through media convergence that combines online and offline approaches, while continuing the credibility of traditional broadcast media. The analysis reveals two main reasons: First, radio broadcast media can extend to diversified scenarios and find different terminals for distribution, such as mobile phones and Bluetooth speakers, thereby attracting more followers. Second, due to high-quality content production in news, music, culture, tourism, and other areas, radio can link with many industries.

In the advertising market, vehicle media advertising performs well, ranking first in the automotive industry according to research, far exceeding retail services, finance, pharmaceuticals, health products, and real estate enterprises. The reason lies in the fact that automotive terminals can rival mobile phones in quantity, with many families owning 1-2 vehicles. Once the number of automotive terminals reaches a certain scale, it naturally becomes an area where advertisers are willing to invest. As a common saying in advertising goes: "Traffic determines sales volume, and customer groups determine purchasing power."

The excellent performance of vehicle media advertising in the advertising market stems not only from its own media value but also from the fact that as a primary terminal, the in-vehicle system reaches over 60% of private car owners, enhancing the communication value of broadcast media. This reach rate is second only to mobile phones. Therefore, from another perspective, the reason why radio broadcasting can maintain its vitality from traditional radio models to the present day is largely due to automobiles. Because of automobiles, people have established a strong and long-term relationship with vehicle media. Since

drivers need to concentrate on driving behavior and road conditions, listening to vehicle media information services allows them to focus on the task at hand while keeping their eyes on the road ahead. Therefore, although many previous technology services such as cassette players and CD players briefly appeared in automotive central control systems, vehicle media audio services have ultimately gained a foothold. In multi-tasking driving environments, drivers' inherent entertainment needs can only be satisfied at the listening level, enabling vehicle media audio services to achieve immortality within automobiles. Although the arrival of the autonomous driving era may pose certain threats to vehicle media audio services, we firmly believe that vehicle media audio services will exist in automotive infotainment systems for a considerable period with tenacious vitality.

With the arrival of the 5G era, the combination of mobile devices, social media, big data, sensors, and positioning systems provides more possibilities. Future scenarios such as travel, payment, leisure, and entertainment can all be deeply integrated with content. Currently, mainstream media remains on web pages and mobile phones. To understand user needs in specific scenarios and deliver content or services that match user requirements, mainstream media needs to enhance its ability to "adapt to scenarios."

The vehicle media jointly created by Xinhua News Agency and China FAW is based on in-vehicle scenarios that precisely target user profiles through technological means. By employing advanced physiological technology and artificial intelligence algorithms, it transforms how in-vehicle user groups understand mainstream media content, thereby changing the relationship between mainstream media and automotive enterprises, and ultimately creating future media business formats and ecological models [Figure 1: see original paper].

3. Developed In-Vehicle Media System

Based on the current status of information consumption in vehicle systems, the Xinhua News Agency Convergence Media Future Research Institute started with in-vehicle fatigue driving monitoring, generating a big data system of news physiological tags by real-time monitoring of drivers' fatigue status and physiological reactions while listening to information consumption, and providing intelligent recommendations for news distribution. This new tag system can subsequently guide the entire workflow of news content production, distribution, collection, and feedback, thereby forming industry standards for vehicle media content production and guiding other content service providers on how to produce better and higher-quality content to provide better services for vehicle media information consumption, further creating a new vehicle media ecosystem.

According to previous research findings, the development of in-vehicle fatigue driving systems has employed several different methods, including vehicle data analysis, camera data analysis, and physiological data analysis. Among these, physiological data monitoring of driver fatigue is considered the most accurate

method, though many research results remain confined to laboratories without existing industry products available on the market [1-2]. The Xinhua News Agency Convergence Media Future Research Institute, in collaboration with FAW Intelligent Connectivity Development Institute, directly integrated Xinhua' s "SYMAGIC Smart Ring" with the vehicle infotainment system, deploying intelligent physiological algorithms and recommendation algorithms on FAW' s private cloud. Xinhua' s nine content channels were deployed on FAW' s cloud via API, directly providing news services on two models of the FAW Hongqi H9 [Figure 2: see original paper].

The news distribution system for Hongqi H9 pushes different news to the infotainment system based on the physiological signal status from the smart ring for user consumption. After wearing the smart ring, it automatically connects to the infotainment system via Bluetooth. On the infotainment system, users can see news intelligently recommended by the cloud based on their physiological status, with news automatically playing on the vehicle terminal. In addition to various news tags, the cloud database system also adds user physiological status tags to each news item. With this new tag system, algorithm scientists can further analyze which news is effective in alleviating user fatigue and which news is suitable for keeping users in an alert driving state. After clustering, in-depth mining can be conducted on news content, news length, and news broadcast voices, thereby providing guidance for vehicle media content production. This is expected to generate standards for vehicle media news content production and better guide vehicle media content producers in creating and processing news and other information.

The intelligent in-vehicle fatigue driving system based on physiological sensing developed by both parties has disrupted the traditional one-way distribution model of current vehicle media news, creating a new vehicle media ecosystem. The news tags annotated with physiological data tags have transformed the previous content-based annotation method into one based on human physiological feedback. This can be provided to vehicle media content service providers as a basis for intelligent information service recommendations. The system has successfully assisted Xinhua News Agency in entering the Internet of Vehicles media information intelligent distribution field through high-tech means, completely changing the vehicle media information consumption ecosystem and creating a vehicle media headline intelligent distribution platform. This provides a model for future vehicle media information service modes and can introduce more business models to assist content producers and automotive enterprises in providing better information consumption services for users.

3.1 System Development

The core technology teams from Xinhua News Agency and China FAW followed standard software engineering processes to develop mobile applications and cloud servers. The development process was first tested in the automotive enterprise' s SIT environment. After development, a stable version was released

and tested before finally switching to the automotive enterprise' s UAT actual usage environment.

The entire R&D process lasted nine months, encompassing user research, hardware development, data collection, algorithm development, and software development (infotainment applications and cloud servers).

3.2 Actual Usage of Vehicle Media

The interaction between Xinhua' s nine news channels and the smart ring was successfully launched on two models of the FAW Hongqi H9.

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Author Biographies

Wang Chen (1981-), female, from Anhui, Deputy Director of State Key Laboratory of Media Convergence Production Technology and Systems, Xinhua News Agency & Deputy Dean of Xinhua Convergence Media Future Research Institute. Research interests: affective computing and artificial intelligence.

Gao Hongwei (1982-), male, from Heilongjiang, Director of Vehicle Networking Institute, Intelligent Connectivity Development Institute. Research interests: Internet of Vehicles.

Lü Guilin (1980-), male, from Nanyang, Henan, Senior Director of Vehicle Networking Institute, Intelligent Connectivity Development Institute. Research interests: networking services.

Chen Tao (1984-), male, from Tengzhou, Shandong, Director of Vehicle Networking Institute, Intelligent Connectivity Development Institute. Research interests: networking applications.

Sun Yuyang (1989-), male, from Nong' an, Jilin, Supervisor of Vehicle Networking Institute, Intelligent Connectivity Development Institute. Research interests: cloud services.

(*Corresponding author)

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