A Proposal of Advertising System Algorithm for Personal Mobility in the Concept of MasS(Mobility as a Service)

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Abstract

This study introduces an innovative advertising provision system leveraging personal vehicles. This system involves several key components: a user recruitment module that enlists vehicle owners, an advertising database storing advertiser content, a user characteristic identification module that collects and analyses data on driving regions, vehicle types, and driving times, an allocation module for customizing and assigning advertising content to each vehicle, and a payment module to compensate users for displaying advertisements. By integrating these elements into a centralized control server, the system allows for precise customization of advertisements based on individual driving patterns and vehicle specifics. This approach ensures that ads are displayed in alignment with the user's actual driving conditions, optimizing visibility and engagement. The system also provides a substantial revenue opportunity for users who allow their personal vehicles to be used as advertising platforms. This dual benefit—enhanced advertising effectiveness for advertisers and increased earnings for users—demonstrates the system's value and appeal. The personal vehicle-based advertising system stands out for its ability to adapt advertisements dynamically based on detailed user data, including traffic conditions and driving times. This flexibility ensures that ads are not only contextually relevant but also comply with regulatory standards, enhancing overall effectiveness. In summary, this study represents a significant advancement in mobile advertising, combining advanced technology with customized solutions to create a more effective and rewarding advertising experience. Future developments could further enhance the system by incorporating real-time analytics and expanding advertising formats to maximize impact

Keywords: *Personal Vehicle Advertising, Targeted Advertising, Digital out of home (DOOH) Advertising, Advanced Advertising Technology*

INTRODUCTION

Currently, billboards are typically attached to public transportation vehicles such as buses and taxis, with advertisements displayed on their sides, especially around doors. These methods are widely used across various regions for advertising purposes. However, advertising on personal vehicles, such as passenger cars, trucks, and SUVs owned by private individuals, is generally prohibited due to the lack of specific domestic regulations. In contrast, many countries, including the United States, Russia, the United Kingdom, Mexico, Indonesia, and India, have developed markets for personal vehicle advertising. For instance, in the U.S., platforms like “CARVERTISE” facilitate advertisements on personal vehicles, while the UK utilizes “STICKER RIDE” for similar purposes. In South Korea, recent legal interpretations suggest that the restrictions imposed by the Outdoor Advertisement Management Act might infringe

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on personal freedom of expression. This has led to discussions about potential revisions to allow advertising on personal vehicles in the future. Car advertising is new and unique form of Out-of-home advertising and presents a unique opportunity for advertisers to reach a variety of targeted audience profiles [1]

Although there is a broad range of modern formats and types, out-of-home (OOH) advertising has not been adequately addressed in academic research. The literature on this subject is scarce, with very few studies available. Past studies have focused mostly on the effectiveness of traditional outdoor advertising or free-standing billboards [2], [3], [4], [5], [6], [7], [8], [9], [10] and only recently explored transit advertising media such as taxi advertising [11] airport advertising [12] and advertising at subway train stations [13]. None of these studies have explored the effectiveness of vehicle-based advertising in emerging markets like south Korea.

Although it's just the beginning, several studies have already been conducted on personal vehicle advertising by examining existing domestic research and practices. Existing studies propose systems for renting advertising space on personal vehicles as follows: Vehicle owners register their cars as personal advertising vehicles, input their vehicle registration information, and enter into contracts with advertisers. They use a driver terminal to receive advertising requests and information about advertising installation companies. Advertisers use an advertiser terminal to search for personal advertising vehicles based on input search criteria and rent the advertising space. An intermediary server facilitates the attachment of advertising content to the selected personal vehicle and manages the advertising process throughout the rental period.

However, current technologies focus primarily on connecting vehicle owners with advertisers but lack means to assess advertising efficiency factors, such as the vehicle's driving regions and times. This limitation affects the effectiveness of the advertising. Therefore, there is a growing need to develop a new advertising system that not only allocates ads to personal vehicles but also analyzes the vehicle’s driving patterns and times to deliver targeted ads. This system should offer an intuitive and streamlined process for ad allocation and display, enhancing the overall effectiveness of advertising.

Against this backdrop, this study proposes the development of a platform designed to enable the use of personal vehicles for advertising. This platform aims to integrate a system that attaches billboards displaying image or video content to personal vehicles, ensuring compliance with traffic safety regulations while providing a new advertising avenue for users.

MATERIALS & METHODS

The advertising provision system using personal vehicles according to this study comprises several key components. Firstly, a User Collection Module recruits individual who own personal vehicles. An Advertising Database stores the advertising content provided by advertisers. The User Profile Module gathers and generates information specific to each user, including their driving region, vehicle type, and

driving times. The Allocation Module assigns advertising content to each personal vehicle based on the user profile information. Finally, the Payment Module handles and processes payments to users for displaying the advertisements. The system is managed by a Central Control Server, which integrates all these modules, and each personal vehicle is equipped with an advertising board to display the assigned ad content. Additional features of the system include an advertising board that displays content through blinking light sources, controlled by an Advertising Board Drive Module. Each personal vehicle is also fitted with a Black Box containing a front camera that captures and generates images of the front view. This data is analyzed by a Vehicle Count Module to assess the distribution of other vehicles in front of the personal vehicle. The advertising board module includes a size adjustment component (21) that adjusts the size of the advertising content based on the number of vehicles detected by the vehicle count module (30).

Figure 1 illustrates the configuration of the advertising provision system according to the present study. As shown in figure 1, the system is primarily composed of a Central Control Server (100) and a Personal Vehicle (1). The Central Control Server (100) is operated by the business entity responsible for overseeing or mediating personal vehicle advertising, such as an advertising brokerage company or an advertising management company. This server facilitates the core advertising functions of the system.

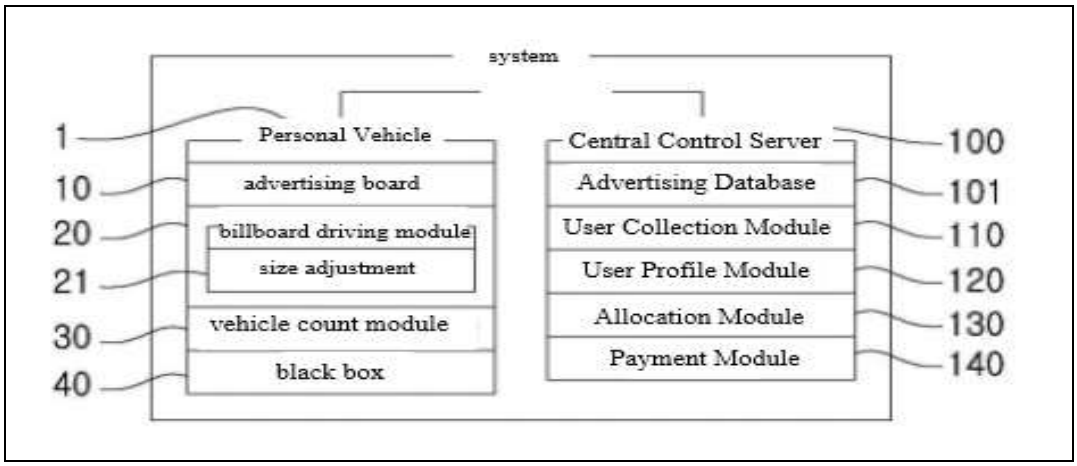

Figure 1. Configuration of the Advertising Provision System

The Central Control Server (100) includes communication components and transmission means for interacting with and transmitting information to user devices, such as smartphones owned by personal vehicle users. It is equipped with hardware that includes a CPU and storage means. The CPU executes software that enables a series of modules and their specific functions, which will be detailed later. In essence, the Central Control Server (100) is built on hardware that includes a central processing unit (CPU) and storage devices such as memory and hard disks. Software is installed

on this hardware to perform various tasks, and this software will be described in terms of its modules, components, and interfaces.

The Central Control Server (100) also contains temporary and/or permanent storage for processing signals (or data), which may include RAM (Random Access Memory) and ROM (Read-Only Memory), though these are not explicitly shown in the figure. The processor in the Central Control Server (100) may include one or more cores (not shown), a graphics processing unit (not shown), and/or other components with signal transmission and reception pathways, such as buses. The memory stores programs (one or more instructions) necessary for executing and controlling the various modules or components, which will be described later. These programs may be organized into multiple modules based on their functions.

The methods or algorithms described in relation to the embodiment of this research can be implemented directly in hardware, as software modules executed by hardware, or through a combination of both. Software modules may reside on various computer-readable storage media, including RAM (Random Access Memory), ROM (Read Only Memory), EPROM (Erasable Programmable ROM), EEPROM (Electrically Erasable Programmable ROM), flash memory, hard disks, removable disks, CD-ROMs, or any other form of computer-readable medium known in the art.

The configuration of such "modules," "components," or "interfaces" refers to software or hardware, such as FPGA (Field-Programmable Gate Array) or ASIC (Application-Specific Integrated Circuit), that is installed and stored on the Central Control Server's (100) storage and executed via the CPU and memory. This configuration is not limited to hardware alone; it may also involve addressable storage media or one or more processors used to perform specific functions. The functions provided by such "modules," "components," or "interfaces" can be integrated into fewer components or further divided into additional components and modules.

Furthermore, the Central Control Server (100) may include a website or a mobile application (hereinafter referred to as "app") to facilitate information exchange with users. Through these platforms, the server can receive various types of information from users or provide information to them.

RESULT

The Central Control Server (100) comprises several key components which are User Collection Module (110), Advertising Database (101), User Profile Module (120), Allocation Module (130), and Payment Module (140). User Collection Module (110) recruits users who own personal vehicles (1). It provides information about advertising opportunities, potential earnings, and obligations through a website or app. Users can indicate their interest by selecting an "Enroll" icon, after which they are presented with advertising terms and enter into a contract with the advertiser. Advertising Database (101) stores various types of advertising content intended for display on personal vehicles. The Central Control Server (100) integrates with advertiser servers to manage

and access this content, which is categorized into formats such as images, videos, and different types of advertisements related to food, essentials, or healthcare. User Profile Module (120) gathers and processes user information, including driving region, vehicle type, and driving hours. This data helps determine the appropriate size and placement of advertisements. Users enter this information through a website or app, and the module can also use vehicle central systems (e.g., ECU) or GPS data to verify and update driving patterns and locations, thus creating accurate user profiles. Using the user profile information, Allocation Module (130) assigns specific advertising content from the database to each personal vehicle. It matches the attributes of ads—such as display time, location, and size—with user characteristics to ensure appropriate ad placements. Ads are categorized by factors like time of day or region, and the module ensures that they meet the size and display requirements for each vehicle. Payment Module (140) manages and processes payments to users for displaying advertisements. Payment amounts are determined based on various criteria, including user profile information. Payments are typically transferred to the user's bank account, as provided during registration. In essence, the system streamlines user recruitment, manages advertising content, assigns ads to personal vehicles based on detailed user profiles, and handles payment processing for ad display.

Figures 2 and 3 illustrate examples of advertising boards on personal vehicles according to this study. Figure 2 depicts an example where the advertising board (10) attached to the side of a personal vehicle (1) displays advertising content in the form of a printed banner. This banner features the advertisement content as a static image. Figure 3 shows another example where the advertising board (10) is not limited to a printed banner but instead utilizes light sources to display the advertising content. This can be achieved with a dynamic display device, such as an LED screen, which emits light to visually present the advertisement. In summary, the advertising board (10) can either be a static printed banner as shown in Figure 2 or a light-based display, such as an LED screen, as shown in Figure 3, providing flexibility in how the advertisement content is presented on the personal vehicle (1).

Figure 2. Example of the Advertising Board

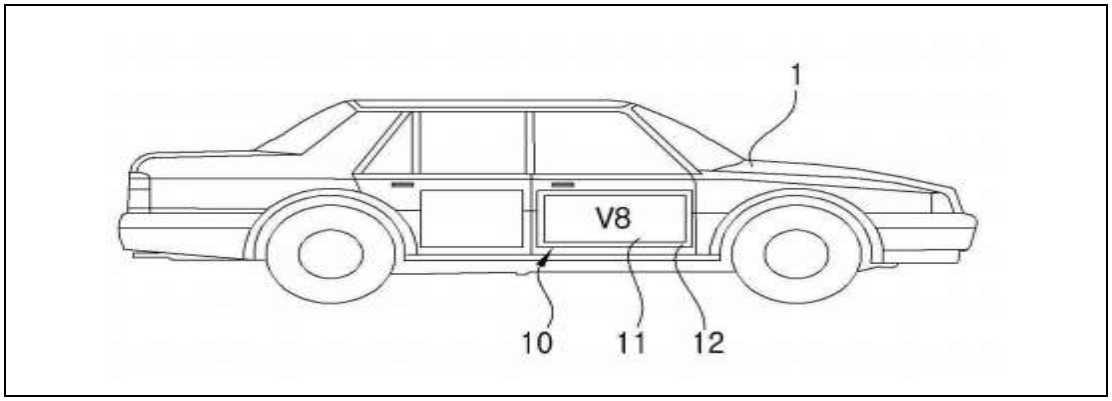

Figure 3. Example of a light-based display

The advertisement content displayed on personal vehicle (1) can be varied in terms of size, content, and format, as long as it complies with relevant legal regulations. This flexibility allows for a range of presentation styles and dimensions for the advertisements. The advertisement provision system described allows for targeted ad placement by evaluating the type (size) of the personal vehicle (1), its driving area, and driving times. By tailoring advertising content based on these factors, the system enhances advertising efficiency, increasing both advertiser profits and user earnings from ad fees.

The advertisement board (10) in this system can use multiple light sources to display content. For example, the board might be implemented with LED screens or OLED panels, which can show dynamic and colorful advertisements. This capability goes beyond simple image formats, enabling the display of more engaging and varied ad content.

To manage the light sources, the system uses a driving unit known as the billboard driving module (20). This module can be integrated into the billboard (10) itself or linked to the vehicle's central system, such as the ECU. The module controls the billboard’s light patterns, including flashing, timing, and illumination intensity, and can be operated through controls on the vehicle's instrument panel. The billboard (10) can adjust the size of the displayed advertisement based on various factors. For instance, if the billboard uses an LED array, it can vary the advertisement size by controlling which LEDs are illuminated. This allows the advertisement to scale according to visibility and effectiveness, such as adapting to traffic conditions.

Figure 4 shows an example of adjusting the billboard size in conjunction with the vehicle’s black box. The black box (40) includes a front camera (41) that captures images of the vehicle’s front view. This camera, along with additional side (42) and rear (43) cameras, collects data on the number of surrounding vehicles.

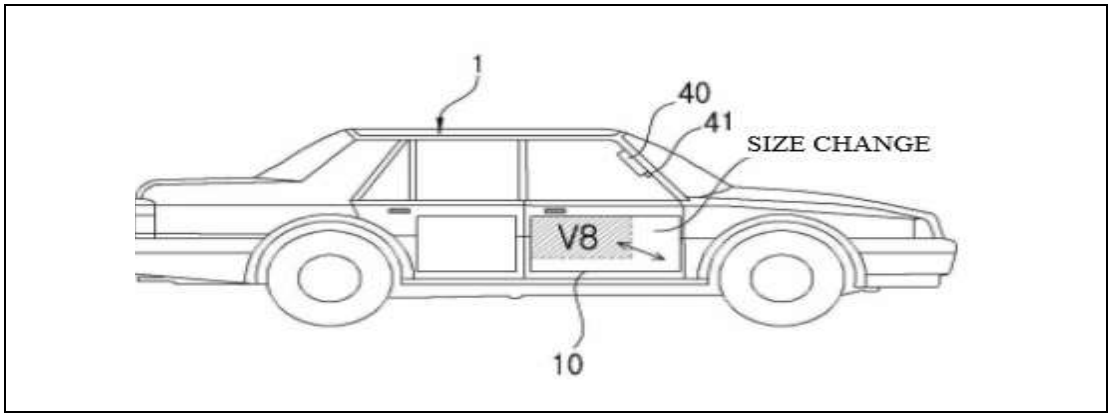

Figure 4. Adjusting the Billboard Size in Conjunction with the Vehicle's Black Box

The vehicle population identification module (30) analyzes the front image to determine the number of nearby vehicles. It generates a front numerical value based on the density of vehicles, which is then used to adjust the advertisement size. The module can also use image analysis programs to assess vehicle presence and quantity.

Figure 5 illustrates how the billboard's size adjustment is based on traffic conditions. For example, if the front numerical value indicates heavy traffic (level 3), the billboard will display a larger advertisement. Conversely, in lighter traffic conditions (level 1), the advertisement size will be reduced. This approach ensures that the advertisement is optimized for visibility and effectiveness while adhering to legal standards.

In summary, the system utilizes advanced technology to dynamically adjust advertisement content on personal vehicles, maximizing advertising impact and efficiency while maintaining compliance with regulatory requirements.

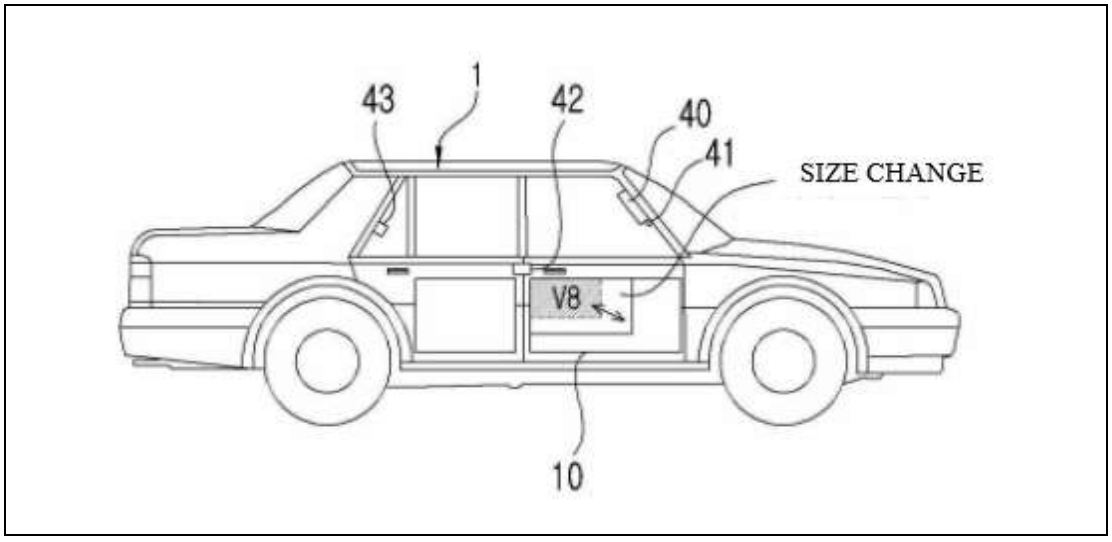

Figure 5. Billboard's Size Adjustment

The overall numerical value, referred to as the "comprehensive value," is calculated using the following formula:

Formula 1 $$S = \frac{1}{2}\left(tanh\left(\frac{A+10}{10}\right) + \sqrt{2B \times C}\right.$$

S represents the comprehensive number, A denotes the forward number,

B stands for the lateral number,

C is the backward number.

These values (A, B, C) are natural numbers (i.e., positive integers).

Formula 2 $$X_1 = X_0 \times S$$

X_1 is the size of the billboard (square meters),

X_0 is the reference size of the billboard (square meter)

Formula 1 essentially assigns the lowest weight to the forward number because a driver positioned in front of the personal vehicle (1) would have difficulty seeing the vehicle without turning around. Conversely, drivers positioned to the side and rear of the vehicle can more easily see it, which is why the lateral number receives the highest weight and the rear number receives a relatively high weight as well. Additionally, the forward number is processed using a hyperbolic tangent function to apply a nonlinear proportion based on its magnitude. This approach ensures that even if the forward number increases, the comprehensive number converges within a certain range due to the properties of the hyperbolic tangent function. In contrast, the lateral and rear numbers are set to proportionally increase linearly based on their magnitude. Furthermore, to prevent excessive variations in advertisement size due to changes in the number of surrounding vehicles, the forward, lateral, and rear numbers are constrained within a natural number range of 1 to 3. This range has been determined through extensive trial and error to balance practical advertisement size adjustments.

The present study addresses several key challenges in the field of mobile advertising by introducing a versatile and adaptive advertising system for personal vehicles. By recruiting vehicle owners and analyzing their driving patterns, the system tailors advertising content to match user characteristics and optimize visibility, thus significantly enhancing advertising efficiency. The integration of dynamic advertising boards, capable of displaying both static and multimedia content, represents a substantial advancement over traditional advertising methods.

Additionally, the system's ability to adjust the size of advertisements based on the surrounding vehicle density ensures that the advertising content remains effective and

visible under varying traffic conditions. This adaptive approach not only maximizes the impact of advertisements but also ensures compliance with regulatory standards. Furthermore, the use of durable materials for the electronic display board housing guarantees the longevity and reliability of the advertising infrastructure.

Overall, this study offers a comprehensive solution that enhances the effectiveness of mobile advertising, providing benefits to advertisers, vehicle owners, and the broader community. The system's adaptability, combined with its innovative use of technology, sets a new standard in the realm of vehicle-based advertising.

DISCUSSION

The innovative advertising system presented here represents a significant step forward in mobile advertising technology. One of the core strengths of the system is its ability to customize advertising content based on detailed user profiles, which are generated by analyzing driving regions and times. This level of personalization ensures that advertisements are relevant to the target audience, potentially leading to higher engagement rates and better returns on investment for advertisers.

The inclusion of dynamic, light-based advertising boards that support both static images and video content marks a departure from traditional print-based advertisements. This versatility allows for more engaging and eye-catching ads, which can be particularly effective in capturing the attention of drivers and pedestrians alike. By employing advanced light source technology, such as LED or OLED panels, the system can deliver high-quality visual experiences while adhering to regulatory standards concerning brightness and visibility.

Moreover, the system's ability to adjust advertisement sizes based on traffic density is a noteworthy feature. By using the number of surrounding vehicles to inform these adjustments, the system ensures that the advertisement remains appropriately scaled and visible, regardless of traffic conditions. This dynamic sizing capability is crucial for maintaining the effectiveness of the advertisement and preventing issues such as overexposure or obscurity.

The durability of the electronic display board's housing is another important consideration addressed by this study. The use of robust materials for the board's construction helps ensure that it can withstand the rigors of everyday use, including exposure to various weather conditions and physical impacts. This focus on durability is essential for maintaining the system's operational integrity and longevity.

In summary, this study offers a sophisticated and adaptable solution for mobile advertising, combining advanced technology with practical functionality. Future developments could further refine the system's capabilities, such as incorporating real-time analytics to continuously optimize advertising strategies or expanding the range of multimedia content formats. As the advertising landscape evolves, this system provides a solid foundation for innovative approaches to vehicle-based advertising.

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