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INTEREST BASED ADAPTIVE BILLBOARD CONTENT MANAGEMENT

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Abstract. The street advertising has undergone some significant changes in recent years: traditional billboards are gradually being replaced by electronic display devices (LED screens) that are able to change in real-time the broadcast advertising, thus allows the dynamic content management. This paper aims to develop an adaptive advertising strategy based on the preferences of the people in front of the screen. Each of them has a special application installed on their personal smartphone through which they can configure their interests regarding the broadcast advertising. These interest profiles are then collected by billboards which, based on them, select the most appropriate type of ad to run at that time. The proposed method focus on transformation of a simple display equipment into an intelligent one, capable of adapting the broadcast content to the requirements of the nearby audience and aims to maximize the efficiency of the billboard operation and at the same time bring maximum satisfaction to the target audience. The performance of the method was evaluated using agent based computer simulation.

Keywords: *adaptive content management, digital advertising screens, street advertising.*

Rezumat. Publicitatea stradală a suferit câteva schimbări semnificative în ultimii ani: panourile tradiționale sunt înlocuite treptat cu dispozitive electronice de afișare (ecrane LED) care sunt capabile să modifice în timp real publicitatea difuzată, permițând astfel gestionarea dinamică a conținutului. Această lucrare își propune să dezvolte o strategie de publicitate adaptativă bazată pe preferințele oamenilor din fața ecranului. Fiecare dintre ei are instalată pe smartphone-ul personal o aplicație specială prin care își pot configura interesele cu privire la publicitatea difuzată. Aceste profiluri de interes sunt apoi colectate de panouri publicitare care, pe baza lor, selectează cel mai potrivit tip de anunț pentru a rula în acel moment. Metoda propusă se concentrează pe transformarea unui echipament simplu de afișare într-unul inteligent, capabil să adapteze conținutul difuzat la cerințele publicului din apropiere și are ca scop maximizarea eficienței operațiunii panoului publicitar și, în același timp, să aducă satisfacție maximă țintei public. Performanța metodei a fost evaluată folosind simularea computerizată bazată pe agenți.

Cuvinte cheie: *management adaptiv al conținutului, ecrane de publicitate digitală, publicitate stradală.*

1. Introduction

Street or outdoor advertising, called more recently out of home (OOH) advertising is one of the oldest and simplest methods of promoting products and services. Street advertising is usually represented by billboards designed to display information about products, manufacturers, sellers, services, locations, etc. [1]. They are managed by specialized companies which display that information for a certain period of time. The advertising companies are interested in implementation of new display strategies in order to reach as wide audience as possible and to increase in this way their profits.

In the Republic of Moldova, OOH accounts for approximately 20% of the advertising market volume. The street advertising market in Moldova offers more than 10 formats (billboard, big-board, city-light, LED screens, cubes, clocks, panels, banners, light-boxes at public transport stations, etc.). Also, the street advertising market in the Republic of Moldova has more than 10 operators with a total of over 6000 different advertising billboards.

Advantages of the street advertising:

- More than 70% of people spend most of their time outside their homes.
- Street advertising is the best cost-effective advertising method.
- It has a high visual impact on the people compared to other advertising sources: print media, online press, shops, telephone.
- Continuous display of the message 24/24 hours for all nearby pedestrians and all cars in traffic in the area with the possibility to reach busy, active, and moving people. Statistics show that we spend an average of 1.3 hours per day on the street.
- It is free and doesn't require specific technical means to access it.
- It reaches a lot of nearness people without requiring significant investments.

A more detailed analysis of this topic can be found in [1, 2].

The main disadvantages of the traditional street advertising are the inability to select the target audience and the extremely low volume of disseminated information (laconic text of up to 2-3 sentences, some images, etc.) without the possibility to provide details [3].

Among the factors influencing the efficiency of the billboard are its location, the quality of the content presentation, and, last but not least, the coherence between the broadcasted content and the existing at that time audience near the billboard. As the everyday audience is very heterogeneous, it is practically impossible for traditional billboards to adapt the broadcasted content to present people. More recently, one of the most important factors for increasing efficiency is the use of digital display equipment, its impact on the audience being about 2.5 times higher compared to traditional display. These equipments have marked a new era in the development of the street advertising known as Digital Out Of Home advertising (DOOH) and which offer great possibilities compared to the classic methods. The DOOH was stormy developed in recent years [4, 5].

A lot of new approaches for advertising management based on DOOH technologies have been proposed aiming to improve the effectiveness and to touch better the targeted audience [6-9]

This article proposes an innovative person-centric adaptive method (according to classification proposed in [10]) of organizing street advertising which, been based on modern technological displaying equipment and smart technologies, is able to collect the information about the composition of the people in front of the billboard and adapts in real time the broadcasted content to the interest of as many as possible people.

2. Description of the proposed method

In this article we will analyze the operation of a billboard with digital display (LED screen, plasma screen, projector, etc.) on which are displayed advertising information that is perceived by pedestrians passing in front of the billboard (Figure 1).

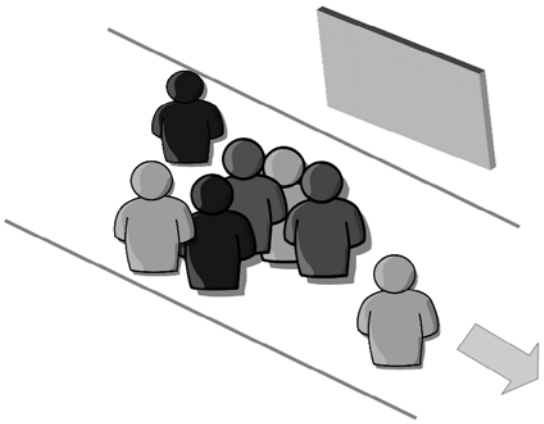

Figure 1. Traditional billboard.

The efficiency of this approach is relatively low for the simple reason that the same information is disseminated for a long time (weeks or even months) and the public passing on the street tends to be largely the same (people leaving and returning home from service, those walking through the street near the house, etc.). The proportion of these people can be considerable, reaching in some cases 80-90%. Which means that the informative value of the display decreases day after day, hence the low efficiency of this approach. It depends largely on the location of the billboard and can be quite high in places where the public varies a lot every day (near stations, markets, shopping malls, etc.).

Equipping the billboard with a digital display screen greatly reduces these problems because the information displayed can be changed more often, thus maintaining pedestrians' interest in it. The advertising company can run advertising for several products for the same duration, which leads to a considerable increase if the revenue.

The proposed method aims to increase the efficiency of the billboard by adapting in real time the strategy of the content dissemination to the surrounding public. Assuming that the most part of pedestrians have a smartphone capable to connect to WiFi wireless network (IEEE 802.11), this equipment can be used, in addition to all, as a source of information about the preferences of its owner. In order to define his preferences, the user will be asked to install on his phone a mobile application available in the store (Google Play for Android operating system and iTunes for Apple products). That proposal should be attractive in order to interest the user to accept it (a smart marketing solution is required here). It could also include other useful services (eg weather forecast display, exchange rate, etc.). When installing the application, a questionnaire will be launched. By answering the asked questions (checking the answers in a proposed list) the user will create his profile that will specify his preferences and interests. This mobile profile that doesn't contain any personal information (name, phone number, address, email, etc.) may be broadcasted on-demand if requested by another application on the network or may be continuously broadcasted by the application in order to discover certain services in the proximity network (for example, to search in the network some people with similar preferences). It is very important to establish the structure of the questionnaire, which should be neither too voluminous with the risk of boring the user

when completing it, nor too short to avoid an incomplete and uninformative profile. In order to simplify the structure of the questionnaire, users' preferences will be divided into categories (e.g. sports products, mobile phones, women's clothing, footwear, household appliances, etc.). The user profile will be specified through a list of selected categories in the questionnaire. It will start with the most favorite categories followed by others arranged in descending order according to the degree of the preference. It may also be proposed to set the weights for each category in the list. The definition of the content and of the optimal structure of the questionnaire requires a more rigorous analysis and will not be discussed further in this article. The simplest strategy for running advertising is to use a circular algorithm (Round Robin type) displaying the advertising one by one for a certain duration for each of the categories on the server. The same policy can be applied to products that fall into the same category. This method is a traditional one and ensures an equal display time for each product in the long run. It is not adaptive and does not take into account the audience composition next to the billboard. Its only advantage is the simplicity and the fairness of the display resources sharing between the promoted products.

One way to improve the efficiency of this system would be to adapt the broadcasted content to the preferences of the audience near the billboard. For this purpose, it is proposed to equip the advertising screen with a WiFi access point that will be open (unsecured) and that will support the connection without security key of any equipment in the radio sensitivity area with a radius that can reach up to 100 meters. Given the omnidirectional nature of radio coverage for traditional access points, the billboard should be installed at the side of the road so that pedestrians pass only in front of it and not have the rear access. Another solution would be to use a directed broadcast access point (which transmits and receives radio waves only in a certain direction or which uses shielding elements to limit emissions/receptions in/from unwanted directions). The panel will also contain a server with some installed applications for ensuring the logic of the system work, including a video streaming server and the information to be broadcasted. The advertised content may be modified in real time through the network. The information about the promoted products is classified in the same categories that were specified in the questionnaire. When it is decided to launch the display of a certain category, a product in this category will be selected according to a predefined algorithm and that information will be displayed on the screen.

When the pedestrian enter into the radio sensitivity area near the panel he will automatically connect to the access point and the server will receive his profile. The appearance of the pedestrian will be counted by entering his profile in a list and by increment a variable that corresponds to the number of present users in front of the billboard. From this moment the server will start monitoring the presence of the respective equipment in the sensitivity area, this being possible because its IP address is known being assigned to it by the DHCP server on the access point. Presence monitoring is done by transmitting through the network at regular intervals of short messages (pings) to which the mobile equipment will respond confirming its presence. From the moment when no confirmations are received from the respective mobile phone, it is removed from the list and the presence variable is decremented. The proposed system is shown in Figure 2. Pedestrians move in the billboard direction, reach the sensitivity area and then leave it continuing their way.

Given that we have N categories of advertising, we expect to have near the panel up to N groups of pedestrians, each of which will correspond to one of the categories defined above.

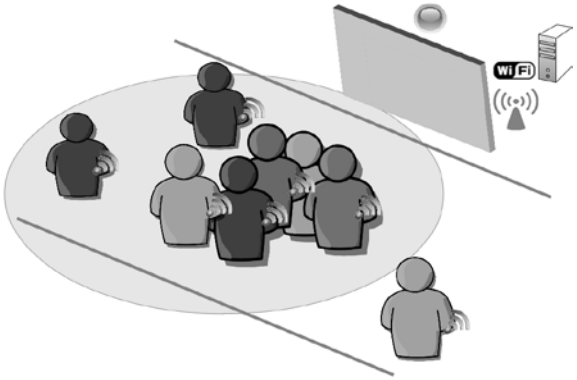

Figure 2. Billboard with adaptive content management.

The groups are monitored separately to know in real time the number of pedestrians in each of them. The application that manages the advertising display performs the following functions: receives user profiles with their preferences and interests, continuously monitors their presence, counts the audience in the area of radio sensitivity, makes decisions about real-time content be displayed on the advertising screen, etc. For simplicity, we'll assume that the ad delivery time for all products in all categories is the same (for example, 30 seconds). That means the information displayed on the screen must change every 30 seconds regardless of the evolution of other factors.

The decision on the content been broadcasted in the next time interval is based on the data collected in the previous interval. Advertising will be broadcasted for the category that has the largest presence in front of the panel and at the same time information will be collected about the composition of the audience that will be used in the next time slot.

3. Effectiveness estimating of the method

The methods of advertising effectiveness estimation are very different: from conducting a survey on its quality [11] to assessing its impact on the sales volume of the advertised products [12]. In this article we will use a specific evaluation method based on results obtained by simulation, that would show us the efficiency of our method in relation to other methods. We aimed to use an agent-oriented approach for simulation [13] and to implement our model using a specialized software: GAMA platform [14,15], a modeling and simulation development environment for building spatially explicit agent-based simulations. This approach makes possible to describe each agent and its spatial movement through its attributes and behavior. In this case, each pedestrian and the ads screen are represented by specific agents that interact with each other, thus realizing the logic of the system operation.

We have to define some technical parameters of the analyzed system before the simulation. We will simplify the initial model described in the previous chapter by reducing the number of advised product categories to 4 assuming that a user can request only one category (the simplest case). Consequently, we will have only 4 groups of pedestrians who will move in both directions in front of the billboard. The sensitivity area will be a square with the size 50x50 meters, the speed of pedestrians will be from 0.5 m/s (slow pedestrians) to 1.5 m/s (fast pedestrians). The pedestrian speed and his moving direction will be chosen randomly. Pedestrian arrivals are independent, there are 4 types of pedestrians (one for each category). Pedestrians can move in any direction, they are counted at the entrance on the sensitivity area and at the exit of this area.

In Figure 2 the product categories are coded by color: we have pedestrians belonging to each of the 4 categories (so 4 different colors or gray degrees in our case) and the screen

can also broadcast 4 categories of advertising that correspond to those colors (the color of the light on the screen in Figure 2 corresponds to the color of the broadcast category at a certain time). We will set the duration of a time slot equal to 30 seconds (it corresponds to the duration of the advertisement for a product belonging to one of the categories), and the simulation time in the example analyzed below is 700 minutes. The simulation environment and the respective process are shown in Figure 3: pedestrians cross the sensitivity area of the billboard moving in arbitrary directions. The system monitors and counts these movements and establishes the category of advertising currently broadcasted taking into account the largest group (the color of the square that corresponds to the ads screen in Figure 3).

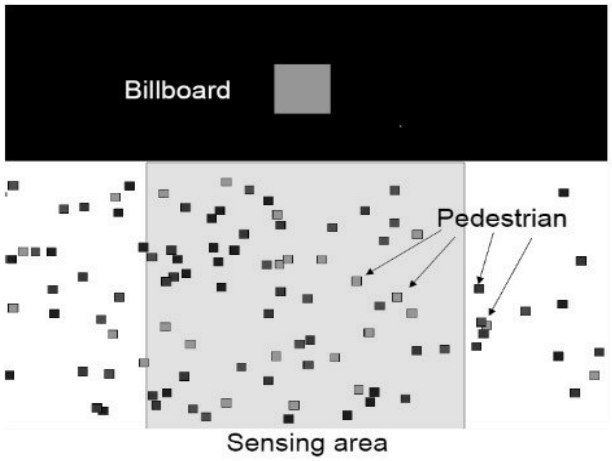

Figure 3. Simulation environment and the system simulation (pedestrian movement, dynamic content changing) in GAMA platform.

In Figure 4 are shown the evolution of the groups and the state of the screen: at the top is the number of pedestrians in the 4 groups (4 different colors), and at the bottom are presented the timers for each time slot, their color indicates the category advertising displayed on the screen in that time slot.

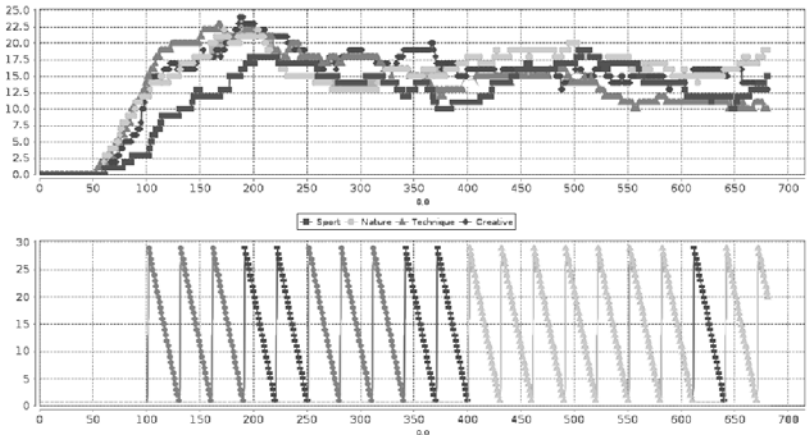

Figure 4. The evolution of the groups and of the screen status over the time.

During the simulation for each pedestrian we will calculate the satisfaction index defined by the ratio between the display time of his favorite advertisement and the total duration of his presence in the sensitivity area in front of the screen. The range of variation of this index: [0,1]. The average of these values will be used to estimate the overall system performance index: the overall average satisfaction. The index allows us to compare different system configurations: the larger it is, the more efficient is the system.

Following the long-term similar simulation of the system described above and the one with circular screen allocation, it turned out that the first one is on average 15-20 percent more efficient than the Round Robin system.

4. Conclusions

The main purpose of the article is to propose a solution that would allow an adaptive management of the content broadcast through billboards based on digital display equipment using information collected in real time about the preferences and the interests of the people in front of the screen. The obtained results are encouraging, they demonstrate the feasibility of the proposed method and its adaptability in real time. The new proposed performance index allows the comparison of results for different configurations of the analyzed system.
In the future, a more detailed and realistic simulation of the proposed method is foreseen: several product categories and profiles with multiple weighted preferences, more complex pedestrian flows with grouped arrivals, studying the possibility of integrating the method at the level of billboard network.

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Conflicts of Interest. The authors declare no conflict of interest.

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