A method for the improvement of interactive advertising by means of eye tracking and a fuzzy model

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Abstract: The main goal of research presented in this paper was to increase the effectiveness of communication with interactive advertising, through the use of eye tracking. Experiments were performed to analyze the interest in advertising content, with a different influence on web users. A statistical analysis of results was conducted, and a fuzzy model based on the results was designed and verified. The analysis led to the conclusion that the eye tracking can be used to increase the possibility to create advertising content that is interesting for the larger target group.

Keywords: interactive marketing, advertising, eye tracking, online marketing, neuromarketing

1. Introduction

At the beginning of the 21st century, the theory of neuromarketing generated tremendous interest in the business world, making neuromarketing a distinct field of research that explores the functioning of the human brain in connection with the stimulation of advertising [1]. With the development of this research area, it is possible to measure and analyze human reactions to specific advertisement, by investigating the processes that take place in their brains. The field of neuromarketing allows an advertiser to acquire knowledge about the behavior and reaction of consumers to the product under investigation and the accompanying marketing publicity. Neuromarketing helps to answer the questions regarding the color hierarchy of the packaging, its shape in relation to the product, and the use of music or images in the advertising campaigns. Neuromarketing is included in marketing areas, such as supporting sales and the support for message generation [2]. All these criteria come down to the creation of an advertisement that will individually influence the potential consumer [1, 3].

2. Literature review

Proper marketing management, which is the combination of stationary advertising with internet advertising (using neuromarketing and eye tracking tools), makes it possible to improve competitiveness. Therefore, this study attempts to determine how to create virtual ads that will effectively influence a potential recipient, assuming that most of the audience is virtual [4][6]. Considering that advertising is a major part of the success that an enterprise can achieve, it has been decided to focus on interactive advertising that is more effective than traditional advertising. In this context, the aim of the work is to increase the effective-
ness and modeling of interaction levels of interactive advertising using eye tracking and fuzzy modeling [5].

Conducting research on neuromarketing and artificial intelligence allows researchers to understand the behavior of the human brain more accurately and precisely, when it comes to the incentives provided by advertisers [6].

Both classic marketing and neuromarketing have the same goal: it is the impact on the consumer to make the desired purchases. The concept of neuromarketing was originally used by Ale Smidts in 2002 [7]. This concept is derived from the evolution of the concept of marketing. So, the essence of neuromarketing is research in the field of advertising, and this is expanded by research into the action of the human brain [8]. These studies enable us to have a better understanding of the way that potential buyers act, and to create a more customized product and advertising that will make it more demanding to buy a product [1].

Neuromarketing exists, inter alia, through ophthalmological examination. Eye tracker studies are closely linked to neuromarketing [9]. Such research allows to understand the mechanisms that drive potential consumers to choose and purchase a particular product. Through neuromarketing and the use of eye tracking tools, the business world can further manipulate people by forcibly subduing them to buy data for goods or services. Using the fusion of human emotional reactions with the way that it perceives the world, this provides a reliable method to discover the human response to the stimulus [11]. Thanks to this, experts will be able to create the ideal advertising, which is one that manipulates the audience [3].

Since the launch of advertising campaign planning, managers are struggling to make fundamental decisions regarding planning and coordination of activities, as well as the appropriate use of both material and non-material resources. On the other hand, some of the problems are relatively simple and possible to "bounce" solution universally [9].

Most of the well-known methods are complex and require the management of the objective intuition of the manager [7].

Appropriate and rational decision-making in uncertain conditions has a particular impact on the success of an advertising campaign. Decision support mechanisms can be used to increase the effectiveness of choice [10].

Managing Internet advertising is a difficult area of management because of the quantity, the mass of advertising, and the competition in the Internet age. It is difficult to manage something that is prone to high risk and high probability of failure. Because of the uncertain and incomplete data, there are many unstructured problems in online advertising, which cannot be solved by simple methods, so artificial intelligence techniques are widely used here [10][12].

3. Experiment design

The purpose of this study was to determine if it is possible to use eyetracker results to create a fuzzy model and then to see how this fuzzy model would be useful. A small group of respondents was involved. The results of the research show real interest in advertising, it should be researched on real relics and on a larger group of respondents. The second purpose of this work was to increase the effectiveness and modeling of interaction levels of interactive advertising, using eye tracking and fuzzy modeling. They control the perception and focus of human vision. These studies allowed a group of respondents to be examined regardless of their gender, age and educational background, by reading a text that differs from the topic of banner ads in which the advertisements are placed on the lower left. The intent was not to target the respondent to the subject matter of the advertisement, as they
have to disclose how the ad will affect the researcher in the online environment, regardless of the subject matter.

The ads used for the study were selected in such a way that they did not attract more attention of the gender or persons with a specific level of education. These advertisements were related to electronic equipment, so they were related to each person and his or her daily life, regardless of the above described aspects of the respondent.

A group of 10 respondents was involved with women and men in the age range of 20-25 among them, with different levels of education - students and working people.

Advertisements were used to conduct the research. These were ads related to electronic equipment. These advertisements were chosen in such a way that their subject was related to the everyday life of the investigated person, so it will not be of much interest because of the age, gender or level of education of the respondent. In the case of advertisements related to motor vehicles or cosmetics, they could pay more attention to a particular group, for example, because of their gender. The test ads used vary from calm to more aggressive. The ads that were tested were static ads in the form of images with a resolution of 400x350, in order to attract attention through colors, marketing passwords, and frequency, not by size. Banners were included in the text deviating significantly from their subject on the bottom left of the pages where this text is located. In the text that was created on a separate presentation used for testing, there are ads with different frequencies per ad on each page, with each slide containing the ad text changing to the next 6 seconds. Table 1 shows a combination of 27 levels of ad interaction. The study required the creation of a separate presentations in which advertisements were posted. Figure 1 shows the ad that was used for the study.

Figure 1. Advertising used for research

Experimental environment consisted of computer hardware, eye tracker and two monitors. 10 respondents were involved in the research. For each user, the eye tracker was calibrated with the view that the device correctly reads the eye sight of the subject. Then, the task of each of the investigated people was to focus on reading the text in which the ads were presented. Intentionally, every respondent was not informed that the text contained
advertisements, so that the viewer's ad was completely voluntary. In this way it was possible to detect if attention was focused on presented marketing content.

After the test, raw data was obtained, and this required analysis. Initially, data was analyzed in Gazepoint software to obtain heat maps and numerical results. Figure 2 represent the most interesting heat maps after the experiment on 10 respondents. Numerical results are presented in Table 1. The order of their inclusion is consistent with the order of placing ads in Table 1. Further statistical analysis was performed in the STATISTICA software.

![Heat maps](image)

Figure 2. Heat maps on ads used for research. Heat maps in A-E illustrate the level of interest in the ad in the research stages: 1. Start of the advertisement, 2. Means of displaying the advertisement, 3. The end of the advertisement

Each of the drawings consists of 3 heat maps. The first one shows interest in the first seconds the ad appears, with the second half of the slide, while the last is at the end of the period.

From visual analysis, it can be concluded that the greatest interest in advertising was observed during the intermediate display of a given slide, while the smallest was in the final time. By visual analysis, it is also possible to see that the element in which respondents paid the most attention when looking at advertising was the product and the button. It is worth mentioning that, by analyzing the results by visual comparison of heat maps, it is impossible to determine which of the elements: product or button was more interested. To investigate this question and to answer the question whether the degree to which the ad flicker increases interest in it, and its effectiveness, the results of the studies listed below in the table were analyzed with the use of statistical methods.

The results in Table 1 have been analyzed. For this purpose, STATISTICA software was used. Analysis based on ANOVA was performed on the obtained results. For testing purposes variable flickering was recorded as follows: no flicker – 1, medium flicker – 2, fast flicker – 3. Results from the analyzed table are as follows: number of ads, first view, total viewing time and a second look at advertising. The confidence level was set at 0.95 and the significance level at 0.05. The results of the statistical analysis are presented in Figure 2.
Table 1. Results for each advertisement

<p>| Advertise- | The number | First look | Total viewing | Total viewing | A second | Percentage |</p>
<table>
<thead>
<tr>
<th>ment ID</th>
<th>ment ID</th>
<th>(number x / 10)</th>
<th>(s)</th>
<th>time(s)</th>
<th>in percent</th>
<th>look</th>
<th>of repetition</th>
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<td>0,97</td>
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<td>0,64</td>
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<td>1,03</td>
<td>0,94</td>
<td>0,37</td>
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<td>1,0</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2A shows the dependence of the number of people interested in the ad displayed and the frequency of the flickering of its elements. The average number of persons interested in advertising was 7 out of 10. It is evident that the lack of flickering of the elements attracted the most interest, but this could be due to the fact that the ad without the flickering elements was displayed first, that is, the initial interest increased, and in the later stages when the flicker was present the respondents were accustomed to it, or annoyed by the intense flickering. In the figure there is also a noticeable drop in interest in the ad. A slightly higher level of audience attention is observed when the ad blinks faster and more aggressively.
Figure 2. Statistical analysis. Analysis of the number of interested viewers, (B) Analysis of the first look, (C) Analysis of the second look, (D) Analysis of the total viewing time.

The next step of the statistical analysis was to examine the dependence of the first respondent's view on the flickering of the elements of the advertisement. The graph depicting this relationship is presented in Figure 2B. The average time of the first look is between 1.4 and 1.6 seconds. In this case, the aggressive and rapid flickering of the elements of the ad caused the respondents to pay more attention to the displayed ad more quickly than the less aggressive or non-aggressive flicker. Thus, it can be argued that the aggressive flicker of the advertisement makes the viewer's attention attracted faster than his or her slow frequency, or lack thereof.

In the next phase the goal of the statistical analysis was to study the relationship between the first look of the respondents and the frequency of advertising flicker. This correlation is shown in Figure 2C. It can be seen that, on average, about 4-5 people returned to the ad displayed again. Most of the people returned to the direction of advertising because of the absence of flickering. A slightly larger increase in the number of returnees to the ad was observed when the displayed ad was flickering rapidly.

The last element emphasized in statistical analysis was the fusion between the total viewable time of the ads being displayed by the respondents and the flickering of the ads used to perform the experiment. This result is shown in Figure 2D. It is noticeable to increase the total viewing time of an advertisement when the frequency of its flickering increases. When an ad does not contain any flickering elements, or the flickering of its elements is smooth, its viewing time is constant and falls within 1.2 seconds.
Figure 3. Membership functions. (A) Membership function of flicker – output (It is assumed that the ad on the output can have 3 degrees of flickering: none(1), medium(2), fast(3)), (B) Membership function of first look – input (It is assumed that the seconds that the respondent looked at the ad would be classified as: none(0), slow(1), medium(2), fast(3)), (C) Membership function of total viewing time (It is assumed that the total viewing time was classified as: none (0), low (1), lot (2), a lot of (3)), (D) Membership function of second look (It was assumed that the number of people who once looked in the direction of advertising was classified as: none (0-2), a few (0-4), few (2-6), medium (4-8), lot (6-10), a lot (8-10)), (E) Membership function of total number of interested (It was assumed that the total number of people interested in advertising was classified: none (0-2), a few (0-4), few (2-6), medium (4-8), lot (6-10), a lot (8-10))
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Statistical analysis was done to check statistical significance. Statistical significance was checked for the following parameters: Number of interested and flicking; Second look and flicking; Total viewing time and flicking; First look and flicking. The statistical analysis revealed a statistically significant relationship between the characteristics of interactive advertising, such as the frequency of flicker, and the interest of respondents, including information on the different phases of advertising interest. Demonstrating the close relationship between the analyzed data confirmed the legitimacy of the fuzzy model that was shown in the next steps. In the next step, based on expert knowledge, a model for fuzzy inference has been developed. It can help decision-makers to manage advertising campaigns in a more organised way, but with more complex tools based on their intuition. To create such inference model, it was necessary to isolate the membership function - entry and exit. These functions are based on the results of Table 1, and are ultimately shown in Figure 3.

The next step was to create a rules table. Rules should be supplemented by an expert in the field. Two tables were created: one shows the relationship between the first look and the second look, the second the number of people interested in the total viewing time. As a general rule, we want our ad to be watched by as many people as possible. We would like them to look at the elements as quickly as possible, and return to it very often. This assumption was made by creating rules tables, followed by the steps of fuzzy inference process. The table was supplemented by the author's knowledge.

![Table 4. Rules representing the number of interested users and total time of viewing. B - none, BM - a few, Š - medium, D - lot, BD - a lot, W - slow, SZ - fast, M - few](image)

The combinations selected in Figure 4 are most desirable from the perspective of the advertising manager and advertising companies. The following fuzzy reasoning is illustrated below, with the assumption that: flicker \( \in <1,2,3> \), first look \( \in <0,1,2,3> \), re-look \( \in <0,1,2,3,4, 5,6,7,8,9,10> \) (This is due to the classification of parameters based on expert knowledge Fig.3). Based on these parameters, the fuzzy inference is presented below (Equation 1).

\[
M_\mu(\text{Flicker}) = 0.5M_\mu(S) + 0.5M_\mu(S) + 0.5M_\mu(S) + 0.5M_\mu(S)
\]

\[
M_\mu(\text{Flicker}) = 0.5M_\mu(S)
\]

\[
\text{Flicker} = (0.5 \cdot 0.5) : 0.5 = 0.5
\]

where \( M_\mu(\text{Flicker}) \) – a flicking, \( M_\mu \) – degree of flickering of individual parameters.

It has come to our attention that, when we want potential viewers to look at the ads as quickly as possible, and as often as they come back to us, our flicker needs to be set at medium level. The combinations shown in the Figure 5 are also most desirable from the perspective of the advertising manager and advertising companies.
The following fuzzy inference is described below, with the assumption that: flicker ∈ <1,2,3>, first total viewing time ∈ <0,1,2,3>, number of interested ∈ <0,1,2,3, 4,5,6,7,8,9,10>.(This is due to the classification of parameters based on expert knowledge Fig.3). Based on these parameters, the fuzzy inference is presented below. (Equation 2)

\[
M_\mu(\text{Flicker}) = 0,5M_\mu(S) + 0,5M_\mu(S) + 0,5M_\mu(S) + 0,5M_\mu(S)
\]

\[
M_\mu(\text{Flicker}) = 0,5M_\mu(S)
\]

\[
\text{Flicker} = (0,5 \cdot 0,5) : 0,5 = 0,5
\]

where \(M_\mu(\text{Flicker})\) – a flicking, \(M_\mu\) – degree of flickering of individual parameters.

As a result in the first case, when we wanted the maximum number of people interested in displaying the ad while viewing it, and the frequency of viewing it as high as possible, the frequency of the flickering of the elements could neither be constant nor very aggressive.

4. Conclusions

As a result of the research conducted on the basis of visual analysis using the heat maps in Figure 1, it can be stated that the greatest interest in displayed advertisement occurs in the intermediate time of its display. In the final stage, the interest in advertising decreases. This is probably because the viewer is getting bored with the ad at the last stage. By manually analyzing Table 1 with the results obtained after the study, it is noticeable that, on average, about 7 out of 10 respondents were interested in advertisements. This is 70%, of which as many as 6 people expressed a renewed willingness to return to the visual area of advertisement. The first look at the ad through the respondents was about 1.48 seconds, and the total time spent on advertising by respondents was around 1.20 seconds.

A statistical analysis has shown that the greatest interest in displaying an ad occurs when the elements of the ad are persistent and do not flicker, but as mentioned earlier, this could be due to the fact that the fixed ad was shown first, which could have had the greatest impact on the ad. Also, the number of people looking back on the ad is highest in the absence of flickering of individual ad elements. By analyzing the time when respondents first looked at the ads they displayed, it was the shortest with the greatest flicker, and so is the total time spent viewing ads by respondents - it is highest with the highest flashing frequency.

Fuzzy inference model showed that the key is to capture the attention of the largest number of viewers to the ad displayed, then to stop their eyesight as long as possible, and to make them look at her at the first sight and often look back, the frequency of individual elements of advertising must be moderate.
The main goal of this study was to analyze the results obtained through the research conducted to answer the question whether eye tracking is a tool by which it is possible to increase the interactive advertising message.

The purpose of the work was achieved through a literature review and the involvement of 10 respondents, and the results of their research, which resulted in statistical analysis and fuzzy inference.

The work included key concepts closely related to neuromarketing, eye tracking, and a number of methods that could be used to carry out the measurements used in the study at a later stage. It turned out that their use helps to achieve the intended effect from the perspective of advertising companies.

Time constraints allowed only for a study of 10 respondents. However, it was enough to carry out an analysis that confirmed that eye tracking is a useful tool for creating virtual advertising, that can be more effective than traditional advertising through research and analysis.

Further development of this work could extend the research in such a way that we could see the impact of the size of the advertisement or its placement on the website. The extension of the topic could possibly consist in obtaining further research results that could be related to the perceived emotions of the advertiser.

References