

Research on Digital Media Advertising Interactive Design and Communication based on Big Data Technology

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Abstract:

In order to improve the effect of digital media advertising interactive design and communication, this paper combines big data technology to study the digital media advertising interactive design and communication. Moreover, this paper introduces the classic model of advertising communication and its establishment rules, as well as some basic knowledge of the differential dynamics system model used to analyze the advertising communication model. In addition, this paper considers the influence of individual interest differences and communication mechanisms on advertising communication, and establishes an IWSR advertising communication model based on individual interest differences and communication mechanisms. The research shows that the digital media advertising interactive design and communication system based on big data technology proposed in this paper has good results.

Keywords: big data technology; digital media; advertising interaction design; communication

1 INTRODUCTION

Advertising and media have a complementary relationship. Advertising depends on the media, and at the same time allows the media to play the role of carrying and dissemination. Nowadays, in the context of new media, corresponding changes have taken place in the form, communication and creative expression of advertisements. 1) Improving the effect of advertising. The number of traditional advertising spreads may be large, but it may not be able to obtain an effective reach rate. For example, advertisements placed in newspaper media may be viewed by a large number of people, but the number of consumers who will actually buy is not known. In the context of new media, advertisements begin to spread after the target group can be accurately identified, which improves the effective arrival rate of information. 2) Enhancing the creative performance of advertising. Advertisements in the context of new media are not restricted by factors such as space, time, material, etc., and integrate video, sound, text and other expression methods through digital technology. Moreover, high-tech technologies such as human-computer interaction, dynamic images, and artificial intelligence are used. Therefore, creative performance is no longer limited to attracting consumers' attention, but more attention is paid to communication with consumers and increasing consumer participation. 3) Changing the way of expression. Changing the way of expression refers to changing the form of communication between the audience and the advertisement. Traditional advertising usually adopts "persuasion" as the main way of expression, that is, occupying the eyes and ears of consumers through a large number of pages and time, and compulsorily attracting consumers' attention. However, digital technology allows consumers to freely switch between multiple roles and has begun to become part of the elements of advertising. This requires advertising to change its form of dissemination, turning "persuading" consumers into "communication" with consumers. Moreover, contact and communication with users will inevitably become the new focus of advertising design.

Sensory experience pays attention to the user experience brought by the audio-visual language design of online interactive advertisements. First of all, from the perspective of visual design, an excellent design style is very important. It is often the user-friendly interactive animation advertisement. First impression, which requires designers to fully investigate and understand the aesthetic preferences of the target user group before designing advertisements, so as to design and produce online interactive advertisements according to users' aesthetic preferences or other special needs and in combination with the advertiser's corporate culture, so as to make Users are more receptive to the overall design style of the ad and leave a good impression on the ad. The second is to pay attention to the design of auditory language, which is an integral part of sensory experience. Auditory language mainly includes sound effects and background music. Reasonable use of sound effects can increase the authenticity of advertisements and enrich the emotions of users using advertisements. Background music mainly plays a role in rendering and contrasting advertisements. Appropriate use of background music can increase the vividness of advertisements and immerse users in the process of operation. Of course, auditory language should

not be used too much, too much The use of sound effects will interfere with the user's normal browsing of advertising content. In short, sensory experience is the first step for users to experience advertising, and it is the key to whether online interactive advertising can leave a good first impression on users. After the sensory experience brings a good first impression to the user, the interactive experience should play a crucial role. The interactive experience pays more attention to the process of users operating online interactive advertisements, emphasizing the usability and ease of use of the interactive process. , pay attention to user interaction needs, including learning, efficiency, and memory when users operate advertisements. Interaction requirements are the basis of user interaction experience, and it is important to pay attention to whether the interaction process is simple and smooth, and whether users can easily and conveniently complete the task of operation.

This paper combines big data technology to research the digital media advertising interaction design and communication, and improve the effect of advertising interaction and advertising communication.

2 RELATED WORK

"New media" is a colloquial expression, and the rigorous expression of this concept is "digital interactive new media". There are different opinions on the specific definition of new media, and neither the industry nor academia has yet reached a consensus. The so-called new media is actually a relative concept, it is relative to the traditional media, it is an appellation that is generally defined in order to distinguish it from the traditional media. The media form of new media is not static, and the media forms it contains are still in development. With the continuous progress of human activities, the connotation and extension of new media are also constantly enriched and expanded [1]. Literature [2] believes that today's new media mainly refers to: media forms generated and influenced on the basis of computer information processing technology, including online network media and other offline digital media forms. Literature [3] believes that: "New media refers to the new media that appear in the field of social information dissemination and are based on digital technology, which can greatly expand the dissemination of information, greatly accelerate the speed of dissemination, and greatly enrich the way of dissemination, which is completely different from the traditional media. new media". Literature [4] believes that new media is the third media form of human beings that integrates interpersonal media and mass media. Specific characteristics include that each participant has equal and mutual control over the content, can carry out personalized information dissemination on a large scale, and completely relies on digital technology.

In digital interactive advertising, experiential interactive advertising in public places is an emerging form of advertising in recent years. Through modern scientific and technological means, it has abandoned the form of a single audience accepting the advertising screen, and used sound and light control and other forms in the audience. Viewing, hearing, touch and other aspects give the audience more sensory stimulation, and let the audience participate in it [5]. In particular, the self-service terminal in shopping malls is an advertising method that guides consumers' consumption choices in crowded shopping malls, allowing consumers to consume more conveniently, quickly and clearly [6]. Literature [7] mainly demonstrates the related issues of video advertising from the perspective of online video advertising. Literature [8] introduces some basic forms and contents of interactive advertising. Literature [9] studies the communication of interactive advertising information, most of which are related to interactive advertising. The research on advertising mainly focuses on the interactive advertising of interactive TV, online advertising, mobile advertising and other categories. The proposed strategy has not been confirmed by practice, and the academic rationality is relatively strong, and there are few researches on experiential interactive advertising in public places [10]]. As a category of interactive advertising, experiential interactive advertising is a new form of advertising with high technology content and diversified information processing. At this stage, there are not many researches on experiential interactive advertising in public places [11]. Literature [12] expounds the aspect of human-computer interaction in multimedia technology, and literature [13] studies from many aspects. In addition, experiential interactive advertising also involves "Consumption Psychology", "Design Psychology" and so on. disciplines.

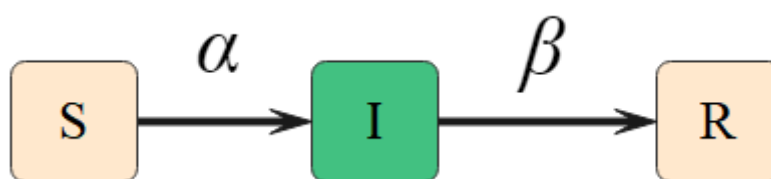
Literature [14] believes that perceptual quality has four main characteristics: abstraction, subjectivity, non-comprehension and relativity. Perceived quality is abstract. Consumers obtain a perceptual evaluation of the overall quality of branded products. This evaluation is not aimed at a single aspect of the product, but a comprehensive quality evaluation. The evaluation results have no specific and quantifiable indicators [15].

Perceived quality has a subjective attribute, which refers to the personal subjective evaluation of the brand by consumers based on brand information, their own purchase or use experience, and the evaluation is mixed with subjective factors such as consumers' own interests and pLiteratures [16]. Literature [17] pointed out that perceived quality is consumers' subjective comments on brand quality based on the one-sided information they have about the brand. Non-comprehensiveness, on the one hand, means that the indicators that consumers rely on for evaluation are one-sided, because consumers cannot obtain comprehensive information about the brand, and even if they can obtain comprehensive information, the cost may be too high, which is not worth the loss; On the other hand, it means that the evaluation results made by consumers are not comprehensive, and it is difficult to be objective and comprehensive because of personal subjective emotional factors [18]. Relativity means that when consumers evaluate brand quality, they often use other brands as a Literature, and the perceived quality is relative to other brands. Literature [19] pointed out that the higher the degree of exceeding customer quality expectations, the higher the perceived quality.

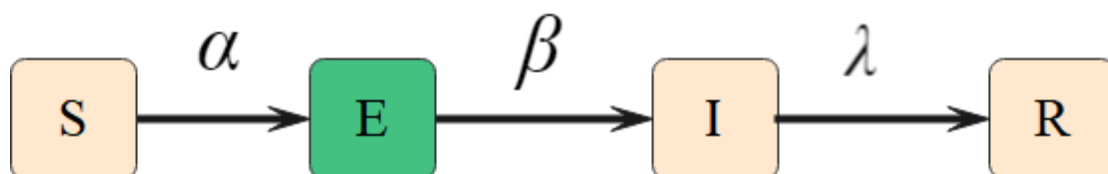
3 INTERACTIVE ADVERTISING COMMUNICATION MODEL

The SIR model of interactive advertising is based on the warehouse modeling method of epidemiology. The population in the interactive advertising communication network is divided according to the status of each population: Spreader S (that is, the group of people fully believes in the interactive advertisement and will spread the interactive advertisement with a certain probability), Ignorant I (that is, the group of people is in the blind zone of interactive advertising and has never been exposed to interactive advertising), and Removal R (that is, the group does not believe in interactive advertising at all). Therefore, all individuals in the entire communication network are divided into 3 warehouses. Due to the influence of various external or internal factors, the people in the three warehouses are not static, but will change their state with a certain probability, thus moving between the warehouses. In order to express this kind of phenomenon more accurately and clearly, the general method adopted is to express the probability of crowd transfer between warehouses with mathematical parameters. In the SIR interactive advertising dissemination model, considering the influence of Spreader on Ignorant, Ignorant will be affected with a certain probability to spread interactive advertising and become a Spreader. Here, the influence of the Spreader (that is, the probability of being infected by the ignore) is represented by the parameter α . Human beings have certain thinking abilities as higher creatures and there are many interference factors in the external environment. Based on this, it is believed that Spreader will recognize the interactive advertisement with a certain probability to understand the truth and stop spreading the interactive advertisement, which becomes a Removal. Here, the recovery rate of Spreader is represented by the parameter β .

According to the above state division and the transfer rate between warehouses, the SIR propagation model is obtained, as shown in Figure 1(a).



(a) State transition diagram of SIR propagation model



(b) State transition diagram of SEIR propagation model

Figure 1 State transition diagram of the propagation model

According to the above transition state, the differential dynamics system of the SIR interactive advertising

propagation model is obtained, as shown in formula (1).

$$\begin{cases} \frac{dS}{dt} = -aSI; \\ \frac{dI}{dt} = aSI - \beta I; \\ \frac{dR}{dt} = \beta I. \end{cases} \quad (1)$$

The rules for determining the division of warehouses and the transfer rate between warehouses in the SEIR model are similar to those of the SIR model. The improvement of the SEIR model lies in the addition of the lurker state warehouse E. In this division, it is believed that an individual has a certain incubation period for the dissemination of interactive advertisements (the incubation period of similar diseases), that is, when an individual receives an interactive advertisement for the first time, it may not immediately spread the interactive advertisement. At this time, the individual is in a latent state, and when the same individual accepts interactive advertisements for many times or after a certain period of precipitation, he believes in interactive advertisements and spreads interactive advertisements and becomes a Spreader. The state transition of SEIR interactive advertising model is shown in Figure 2.

According to the above state transition diagram, the differential dynamics system of the SEIR interactive advertising propagation model is obtained, as shown in formula (2).

$$\begin{cases} \frac{dS}{dt} = aSE; \\ \frac{dE}{dt} = aSE - \beta E; \\ \frac{dI}{dt} = \beta E - \lambda I; \\ \frac{dR}{dt} = \lambda I \end{cases} \quad (2)$$

Compared with the SIR model, the SEIR model has improved warehouse division, which makes the interactive advertising communication model more in line with the actual situation of the crowd when the interactive advertisement is spread among the crowd. Based on this, in the follow-up interactive advertising communication research, many researchers regard the possible state of the crowd in the interactive advertising communication process as the main basis for dividing warehouses. Although the SEIR model is superior to the SIR model in terms of warehouse division, there is still a problem that the research on the influence factors of interactive advertising is too simplistic.

Although the two interactive advertising communication models mentioned above have certain shortcomings, the significance of these two models is very important in the entire interactive advertising communication research process. The reason is that the two models have laid the foundation for the research method of using warehouse modeling method to analyze interactive advertising communication to a certain extent, which is of milestone significance. Understanding the establishment process and analysis methods of these two models is of instructive significance for the establishment and analysis of subsequent interactive advertising communication models.

The differential system is as formula (3):

$$\frac{dX}{dt} = f(X), \quad t \geq 0, X \in D \subseteq \mathbb{R}^n, \quad (3)$$

We assume that system 3 is smooth, where D is an open interval and is positively unchanged, and

$f : D \rightarrow \mathbb{R}^n$ is continuously differentiable.

$$(1) \quad \bar{X} \in D;$$

$$(2) \quad f(\bar{X}) = 0;$$

Then $\bar{X}$ is the equilibrium point of the equation $\frac{dX}{dt} = f(X)$.

In order to prove the local asymptotic stability of the equilibrium point, the following two theorems need to be used. The basic contents of the two theorems are now described as follows:

Theorem 1 Hurwitz criterion

The feature polynomial of matrix H is:

$$p(\lambda) = a_0 \lambda^n + a_1 \lambda^{n-1} + \dots + a_n = 0, a_0 > 0,$$

$a_i = 0 (n+1 \leq i \leq 2n-1)$, and there is:

$$\Delta_1 = a_1, \quad \Delta_2 = \begin{vmatrix} a_1 & a_0 \\ a_3 & a_2 \end{vmatrix}, \quad \Delta_3 = \begin{vmatrix} a_1 & a_0 & 0 \\ a_3 & a_2 & a_1 \\ a_5 & a_4 & a_3 \end{vmatrix}, \dots$$

$$\Delta_n = \begin{vmatrix} a_1 & a_0 & 0 & 0 & \dots & 0 \\ a_3 & a_2 & a_1 & a_0 & \dots & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{2n-1} & a_{2n-2} & a_{2n-3} & a_{2n-4} & \dots & a_{2n} \end{vmatrix}.$$

If $\Delta_i > 0 (1 \leq i \leq n)$ is always true, then the real parts of the eigenvalues of the matrix H are all negative numbers, that is, if and only if $\Delta_i > 0 (1 \leq i \leq n)$, there is $\lambda < 0$.

Theorem 2 Lyapunov's stability theorem

$\bar{X}$ is the equilibrium point of system (3), and $f_x(\bar{X})$ is the Jacobian matrix of f at $\bar{X}$. If the real parts of the eigenvalues of $f_x(\bar{X})$ are all negative numbers, then $\bar{X}$ is locally asymptotically stable.

When proving the local asymptotic stability of the equilibrium point of the differential dynamics system model, theorem 1 and theorem 2 need to be used in combination.

To prove the global asymptotic stability of the equilibrium point, the following theorems need to be used:

Theorem 3 LaSalle's invariance principle

$\bar{X}$ is the balance point of the system (3). V is defined as a smooth and positive definite function on D, if the function V satisfies:

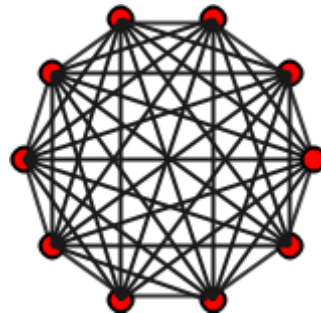
$$(1) \quad V(\bar{X}) \rightarrow \infty (\|\bar{X}\| \rightarrow \infty);$$

$$(2) \quad V_x(\bar{X}) \cdot f(\bar{X}) \leq 0 (\bar{X} \in D);$$

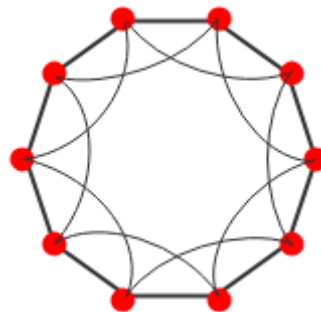
$$(3) \quad \text{The set } \{\bar{X} \in D : V_x(\bar{X}) \cdot f(\bar{X}) = 0\} \text{ contains no other orbitals except for the ordinary orbit } \bar{X} \equiv 0.$$

Then the equilibrium point $\bar{X}$ is gradually stable globally.

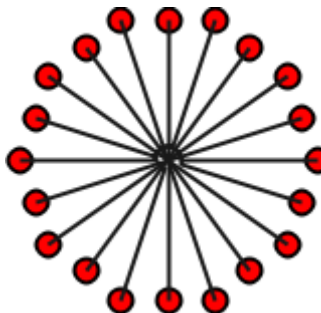
The rule network is the simplest and most understandable network among complex networks: the degrees of all nodes are generated according to the same rule and all nodes have the same degree. Common regular network structures are: global coupling network, K-nearest neighbor coupling network and star coupling network, as shown in Figure 3.



(a) Global coupling network



(b) k-nearest-neighbor-coupled network



(c) Starshaped coupling network

Figure 2 Three common rule networks

In the global coupling network, each node is connected to all nodes except itself. That is, if the total number of nodes in the network is N , the degree of each node is $N-1$. It can be seen that the clustering coefficient of the global coupling network is high and the average path is short. This network is similar to the interpersonal relationship in a small group, such as a certain class in a school or a certain department in a company, but it is not suitable for the interpersonal relationship in a large-scale group.

When tracing the origin of the concept of "small world network", one has to mention Stanley Milgram's "six degrees of division" theory. That is, if we want to establish contact with any stranger, there will be no more than 6 people who will act as a bridge in the process of establishing a relationship. That is, we only need up to 5 introducers to establish contact with any stranger. This is the definition of the famous six-degree segmentation theory, also known as the small world theory, as shown in Figure 3.

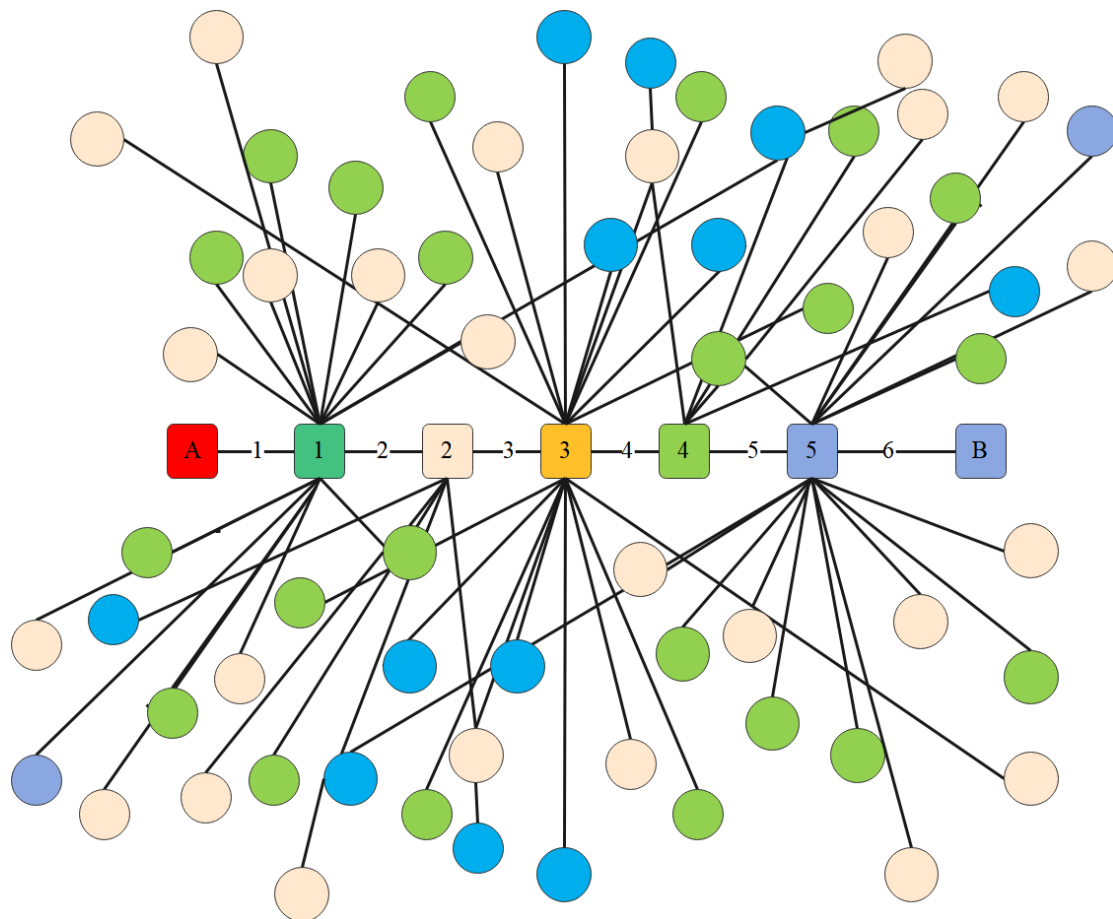


Figure 3 Schematic diagram of six-degree segmentation theory

Typical representatives of the small world network model are: WS small world network, proposed by Watts and Strogatz; NW small world network, proposed by Newman and Watts.

WS small world network construction rules:

- (1) It first constructs a regular network: It assumes that the total number of nodes in the network is N , and first generates the K -nearest neighbor coupling network according.
- (2) It then randomizes the reconnection: It randomly selects any side in the network with probability p , and reconnects the side when any end of the side is fixed. That is, it randomly selects another end point to reconnect the edge. When performing reconnection operations, it is necessary to ensure that the resulting network does not have double edges and self-loops.

From the above network generation rules, it is not difficult to find that there are two special networks in the final generated WS small world network. When $p=0$, a completely regular network is generated. When $p=1$, a completely random network is generated. It can be seen that in the process of constructing WS small world network, the value of probability p will determine the final structure of the generated network. Figure 4 shows a completely regular network, a WS small world network, or a completely random network.

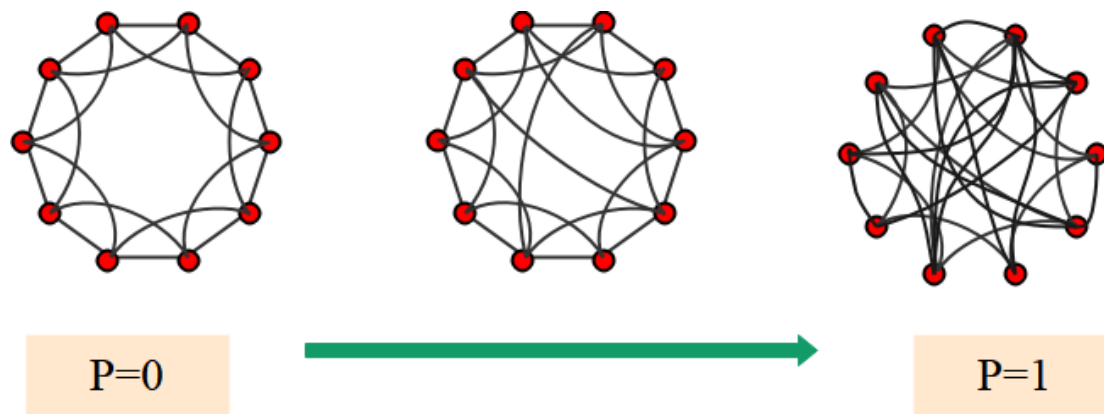


Figure 4 The relationship between the probability value p and the generated network structure

When interactive advertising is widely spread in social networks, the spread of interactive advertising Spreader will directly affect the final spread of interactive advertising. Interactive advertising dissemination of individual differences in living environment, education level, work field, etc. will have a great impact on the interests and preferences of individuals. Moreover, in most cases, the individual's interests and preferences will determine the individual's behavior. This is reflected in the dissemination behavior of interactive advertisements, which may be due to the differences in the communication strength of each interactive advertisement communication individual of the same interactive advertisement. Based on this consideration, the communication individuals in the traditional interactive advertising communication model will be divided more accurately, and the communication individuals will be divided into strong communication individuals and weak communication individuals of interactive advertising according to the strength of the communication individuals to spread interactive advertisements. Furthermore, by referring to the warehouse modeling method in communication science, the population in the communication network is divided into 4 categories:

- (1) Ignorant I: I-node, which refers to individuals who have not received interactive advertisements.
- (2) Weak Spreader W: W-node, which refers to individuals with low interest in interacting with advertising information.
- (3) Strong Spreader S: S-node, which refers to individuals with high interest in interacting with advertising information.
- (4) Spreader R: R-node, which refers to an individual who clears or clarifies interactive advertising information.

$I(t)$, $W(t)$, $S(t)$, $R(t)$ respectively represent the proportions of the four groups of people at time t . In this chapter, $I(t)$, $W(t)$, $S(t)$, $R(t)$ Denoted by I , W , S , and R respectively. As shown in Figure 5, Ignorant people are infected as strong or weak Spreader with different probabilities; Spreader is converted to Spreader with a certain probability.

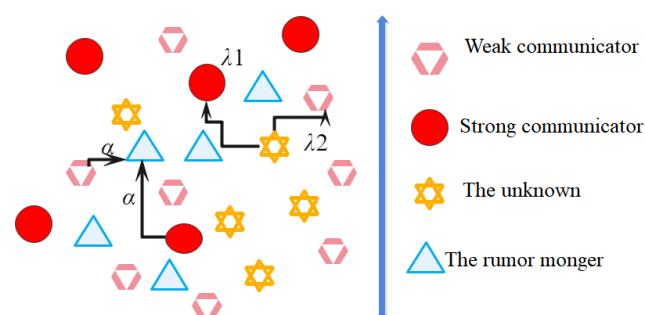


Figure 5 Ignorant becomes a strong Spreader or a weak Spreader with different probabilities, and the Spreader becomes a Spreader with a certain probability

The conversion rules between warehouses in the IWSR interactive advertising model are described as follows:

(1) Newly joined individuals become ignorant in the communication network with probability δ ; the four groups of people in the communication network move out of the communication network with the same probability.

(2) Under the influence of various dissemination information, strong Spreader suspects interactive advertising and turns into weak Spreader with probability β .

(3) Strong Spreader S affects unknown I with probability λ_2 to make it a strong Spreader; weak Spreader W affects unknown I with probability λ_1 to make it a weak Spreader, and $\lambda_2 > \lambda_1$ can be assumed.

(4) Affected by the government's dissemination of information, each Spreader chooses with probability a to believe that the government stops disseminating interactive advertising and becomes Spreader R in view of the authority of the government.

According to the above state transition rules, the state transition diagram of interactive advertisement propagation in the propagation network is obtained, as shown in Figure 6.

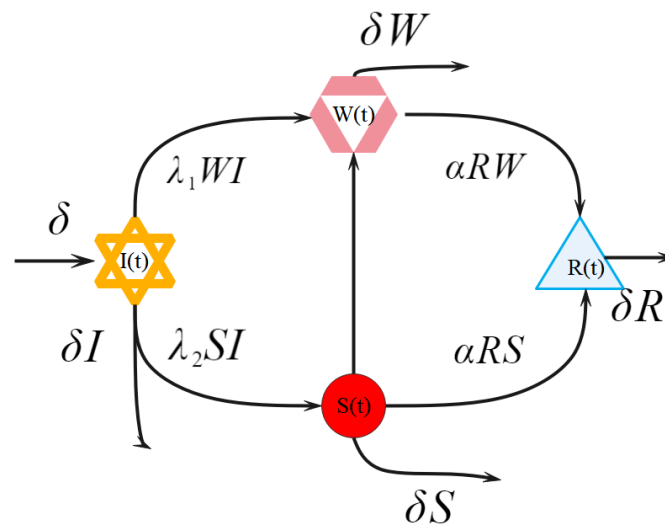


Figure 6 The state transition diagram between the warehouses during the spread of interactive advertisements

According to Figure 6, the differential dynamic equation model of interactive advertising is established

$$\begin{cases} \frac{dI}{dt} = \delta - \lambda_1 WI - \lambda_2 SI - \delta I; \\ \frac{dW}{dt} = \lambda_1 WI + \beta S - aRW - \delta W; \\ \frac{dS}{dt} = \lambda_2 SI - \beta S - aRS - \delta S; \\ \frac{dR}{dt} = aRW + aRS - \delta R. \end{cases} \quad (4)$$

Based on the definition of the basic reproduction number in communication science, the basic reproduction number of the interactive advertising propagation model is defined as the number of unknowns infected by a single interactive advertising Spreader in its propagation cycle. According to the method proposed by Watmough, the basic reproduction number of the interactive advertising propagation model is:

$$\mathfrak{R}_0 = \max \left\{ \frac{\lambda_1}{\delta}, \frac{\lambda_2}{\delta + \beta} \right\} \quad (5)$$

It can be seen from equation (4) that the scale of the propagation network remains constant, and it assumes $I(t) + S(t) + W(t) + R(t) \equiv 1$, and formula (4) is transformed into:

$$\begin{cases} \frac{dI}{dt} = \delta - \lambda_1 WI - \lambda_2 SI - \delta I \\ \frac{dW}{dt} = \lambda_1 WI + \beta S - \alpha(1 - I - W - S)W - \delta W \\ \frac{dS}{dt} = \lambda_2 SI - \beta S - \alpha(1 - I - W - S)S - \delta S \end{cases} \quad (6)$$

We assume that each parameter is a positive number, the initial condition is $I \geq 0, W \geq 0, S \geq 0$, and the positive invariant set is $\Omega = \{(I, W, S) : I \geq 0, W \geq 0, S \geq 0, I + W + S \leq 1\}$.

After a simple calculation, the balance point of the system is obtained:

(1) When $\mathfrak{R}_0 < 1$, the system (3) has a non-propagation equilibrium point $E_0 = (I, W, S) = (1, 0, 0)$.

(2) When $\mathfrak{R}_0 > 1$, in addition to E_0 , the system (3) has 4 interactive advertising propagation balance points $E_i = (I_i^*, W_i^*, S_i^*) (i = 1, 2, 3, 4)$, which are:

$$\begin{aligned} E_1 &= \left(\frac{\delta}{\lambda_1}, \frac{\lambda_1 - \delta}{\lambda_1}, 0 \right), \quad E_2 = \left(\frac{\alpha}{\lambda_1 + \alpha}, \frac{\delta}{\alpha}, 0 \right), \\ E_3 &= \left(\frac{\beta + \delta}{\lambda_2}, W_3^*, S_3^* \right), \quad E_4 = \left(\frac{\beta + \alpha}{\lambda_2 + \alpha}, W_4^*, S_4^* \right). \end{aligned}$$

Among them,

$$\begin{aligned} W_3^* &= \frac{\beta(\lambda_2 - \beta - \delta)}{(\beta + \delta)(\lambda_2 - \lambda_1)}, \quad S_3^* = \frac{(\beta + \delta - \lambda_2)(\beta\lambda_1 + \delta\lambda_1 - \delta\lambda_2)}{\lambda_2(\beta + \delta)(\lambda_2 - \lambda_1)}, \\ W_4^* &= \frac{(\alpha + \lambda_2)\beta\delta}{\alpha(\beta + \alpha)(\lambda_2 - \lambda_1)}, \quad S_4^* = \frac{\delta(\alpha(\lambda_2 - \lambda_1) - \beta(\lambda_1 + \alpha))}{\alpha(\beta + \alpha)(\lambda_2 - \lambda_1)}. \end{aligned}$$

After the equilibrium point of the system is obtained, the local asymptotic stability of the equilibrium point will be analyzed.

The three main conclusions drawn for the local asymptotic stability of the equilibrium point of the system are as follows:

Conclusion 1 When $\mathfrak{R}_0 < 1$, E_0 gradually stabilizes locally within Ω .

Conclusion 2 When $\mathfrak{R}_0 > 1, \frac{\alpha(\lambda_1 - \delta)}{\delta\lambda_1} < 1, \frac{\lambda_2\delta}{\lambda_1(\beta + \delta)} < 1$, E_1 gradually stabilizes locally within Ω .

Conclusion 3 When $\mathfrak{R}_0 > 1, \frac{\alpha\delta}{\lambda_1(\alpha - \delta)} < 1, \frac{\alpha(\lambda_2 - \lambda_1)}{\beta(\lambda_1 + \alpha)} < 1$, E_2 gradually stabilizes locally in Ω .

The Jacobi matrix of system (3) is:

$$J = \begin{pmatrix} J^{11} & -\lambda_1 I & -\lambda_2 I \\ \lambda_1 W + \alpha W & J^{22} & \beta + \alpha W \\ \lambda_2 S + \alpha S & \alpha S & J^{33} \end{pmatrix}, \quad (7)$$

Among them,

$$\begin{aligned} J^{11} &= -\lambda_1 W - \lambda_2 S - \delta, & J^{22} &= \lambda_1 I - \alpha(1 - I - W - S) + \alpha W - \delta, \\ J^{33} &= \lambda_2 I - \beta - \alpha(1 - I - W - S) + \alpha S - \delta. \end{aligned}$$

The proof process of conclusion 1 is as follows:

The matrix corresponding to formula (7) at E_0 is:

$$J_0 = \begin{pmatrix} -\delta & -\lambda_1 & -\lambda_2 \\ 0 & \lambda_1 - \delta & \beta \\ 0 & 0 & \lambda_2 - \beta - \delta \end{pmatrix},$$

We set:

$$M_0 = -J_0 = \begin{pmatrix} \delta & \lambda_1 & \lambda_2 \\ 0 & -\lambda_1 + \delta & -\beta \\ 0 & 0 & -\lambda_2 + \beta + \delta \end{pmatrix}.$$

If $\Delta_i (i = 1, 2, 3)$ is defined as the order i -order principal of M_0 , then

$$\begin{aligned} \Delta_1 &= |\delta| = \delta, \Delta_2 = \begin{vmatrix} \delta & \lambda_1 \\ 0 & \delta - \lambda_1 \end{vmatrix} = \delta(\delta - \lambda_1), \\ \Delta_3 &= \begin{vmatrix} \delta & \lambda_1 & \lambda_2 \\ 0 & -\lambda_1 + \delta & -\beta \\ 0 & 0 & -\lambda_2 + \beta + \delta \end{vmatrix} = \delta(-\lambda_1 + \delta)(-\lambda_2 + \beta + \delta). \end{aligned}$$

Therefore, when $\Re_0 = \max \left\{ \frac{\lambda_1}{\delta}, \frac{\lambda_2}{\delta + \beta} \right\} < 1$, $\Delta_1 > 0, \Delta_2 > 0, \Delta_3 > 0$. Then M_0 is a positive definite

matrix, the eigenvalues of $M_0 = -J_0$ obtained from J_0 are all negative, and E_0 is locally asymptotically stable according to the Hurwitz criterion.

The proof process of Conclusion 2 is as follows:

The matrix corresponding to formula (7) at E_1 is:

$$J_1 = \begin{pmatrix} -\lambda_1 & -\delta & -\frac{\lambda_2 \delta}{\lambda_1} \\ J_1^{21} & \frac{\alpha(\lambda_1 - \delta)}{\lambda_1} & J_1^{23} \\ 0 & 0 & J_1^{33} \end{pmatrix},$$

Among them,

$$J_1^{21} = \frac{(\lambda_1 - \delta)(\lambda_1 + \alpha)}{\lambda_1}, J_1^{23} = \frac{\alpha(\lambda_1 - \delta) + \beta\lambda_1}{\lambda_1}, J_1^{33} = \frac{\lambda_2\delta - \lambda_1(\beta + \delta)}{\lambda_1}$$

We set:

$$M_1 = -J_1 = \begin{pmatrix} \lambda_1 & \delta & \frac{\lambda_2\delta}{\lambda_1} \\ -J_1^{21} & \frac{\alpha(-\lambda_1 + \delta)}{\lambda_1} & -J_1^{23} \\ 0 & 0 & -J_1^{33} \end{pmatrix},$$

$\Delta_i (i = 1, 2, 3)$ is the order i -order principal of M_1 , then:

$$\Delta_1 = |\lambda_1| = \lambda_1, \quad \Delta_2 = \begin{vmatrix} \lambda_1 & \delta \\ -J_1^{21} & (\alpha(\delta - \lambda_1))/\lambda_1 \end{vmatrix},$$

$$\Delta_3 = \begin{vmatrix} \lambda_1 & \delta & \frac{\lambda_2\delta}{\lambda_1} \\ -J_1^{21} & \frac{\alpha(-\lambda_1 + \delta)}{\lambda_1} & -J_1^{23} \\ 0 & 0 & -J_1^{33} \end{vmatrix} = -J_1^{33} \times \Delta_2 = \frac{(\delta - \lambda_1)(\lambda_1(\alpha - \delta) - \alpha\delta)}{\lambda_1}.$$

Therefore, when $\Re_0 > 1, \frac{\alpha(\lambda_1 - \delta)}{\delta\lambda_1} < 1, \frac{\lambda_2\delta}{\lambda_1(\beta + \delta)} < 1$, $\Delta_1 > 0, \Delta_2 > 0, \Delta_3 > 0$. Then M_1 is a positive definite matrix, the eigenvalues of J_1 are all negative, and E_1 is locally asymptotically stable according to the Hurwitz criterion. The proof process of conclusion 3 is as follows:

The matrix corresponding to formula (7) at E_2 is

$$J_2 = \begin{pmatrix} \frac{-\delta(\lambda_1 + \alpha)}{\alpha} & -\frac{\lambda_1\alpha}{\lambda_1 + \alpha} & -\frac{\lambda_2\alpha}{\lambda_1 + \alpha} \\ \frac{\delta(\lambda_1 + \alpha)}{\alpha} & \delta & \beta + \delta \\ 0 & 0 & J_2^{33} \end{pmatrix},$$

Among them,

$$J_2^{33} = \frac{\alpha(\lambda_2 - \lambda_1)}{\lambda_1 + \alpha} - \beta$$

We set:

$$M_2 = -J_2 = \begin{pmatrix} \frac{\delta(\lambda_1 + \alpha)}{\alpha} & \frac{\lambda_1 \alpha}{\lambda_1 + \alpha} & \frac{\lambda_2 \alpha}{\lambda_1 + \alpha} \\ -\frac{\delta(\lambda_1 + \alpha)}{\alpha} & -\delta & -\beta - \delta \\ 0 & 0 & -J_2^{33} \end{pmatrix},$$

$\Delta_i (i = 1, 2, 3)$ is the order i -order principal of M_1 , then

$$\Delta_1 = \left| \frac{\delta(\lambda_1 + \alpha)}{\alpha} \right| = \frac{\delta(\lambda_1 + \alpha)}{\alpha},$$

$$\Delta_2 = \begin{vmatrix} \frac{\delta(\lambda_1 + \alpha)}{\alpha} & \frac{\lambda_1 \alpha}{\lambda_1 + \alpha} \\ -\frac{\delta(\lambda_1 + \alpha)}{\alpha} & -\delta \end{vmatrix} = \frac{\delta}{\alpha} (\lambda_1 \alpha - \lambda_1 \delta - \alpha \delta),$$

$$\Delta_3 = \begin{vmatrix} \frac{\delta(\lambda_1 + \alpha)}{\alpha} & \frac{\delta_1 \alpha}{\lambda_1 + \alpha} & \frac{\lambda_2 \alpha}{\lambda_1 + \alpha} \\ -\frac{\delta(\lambda_1 + \alpha)}{\alpha} & -\delta & -\beta - \delta \\ 0 & 0 & -\frac{\alpha(\lambda_2 - \lambda_1)}{\lambda_1 + \alpha} + \beta \end{vmatrix} = -J_2^{33} \times \Delta_2.$$

When $\Re_0 > 1, \frac{\alpha \delta}{\lambda_1(\alpha - \delta)} < 1$ and $\frac{\alpha(\lambda_2 - \lambda_1)}{\beta(\lambda_1 + \alpha)} < 1$, $\Delta_1 > 0, \Delta_2 > 0, \Delta_3 > 0$. Then, M_2 is a positive definite matrix, the eigenvalues of J_2 are all negative, and E_2 is locally asymptotically stable according to the Hurwitz criterion.

Conclusion 4 When $\Re_0 < 1, \frac{\lambda_1}{\delta} > \frac{\lambda_2}{\beta + \delta}$, E_0 is gradually stable globally within Ω .

Conclusion 5 When $\Re_0 > 1$, E_1 is globally asymptotically stable within Ω' , and there is

$$\Omega' = \left\{ (I, W, S) : I \leq \frac{\delta}{\lambda_1}, W \geq 0, S \geq 0, I + W + S \leq 1 \right\}^\circ$$

The proof process of conclusion 4 is as follows:

For the equilibrium point E_0 , the Lyapunov function is constructed.

$$V(W, S) = W + \mu S.$$

Among them, μ is a normal number, $V \geq 0$ is always established, and if and only if $W = 0, S = 0$, $V = 0$ is established, then

$$\begin{aligned}\left. \frac{dV}{dt} \right|_{(3.3)} &= W' + \mu S' \\ &= \delta W \delta I \left(\frac{\lambda_1}{\delta} - \frac{1}{I} \right) + \mu \frac{\lambda_2}{\lambda_1} S I \left(\frac{\lambda_1}{\delta} - \frac{1}{I} \right) \\ &\quad + \left(\frac{\lambda_2 - \lambda_1}{\lambda_1} \mu \delta + \beta - \mu \beta \right) S - \alpha R W - \mu \alpha R S.\end{aligned}$$

If $\mu = \frac{\beta \lambda_1}{\lambda_1 \beta + (\lambda_1 - \lambda_2) \delta}$, then

$$\begin{aligned}\left. \frac{dV}{dt} \right|_{(3.3)} &= \delta W \delta I \left(\frac{\lambda_1}{\delta} - \frac{1}{I} \right) + \frac{\beta \lambda_1}{\lambda_1 \beta + (\lambda_1 - \lambda_2) \delta} \times \frac{\lambda_2}{\lambda_1} S I \left(\frac{\lambda_1}{\delta} - \frac{1}{I} \right) \\ &\quad - \alpha R W - \frac{\beta \lambda_1}{\lambda_1 \beta + (\lambda_1 - \lambda_2) \delta} \alpha R S\end{aligned}$$

When $\Re_0 < 1, \frac{\lambda_1}{\delta} > \frac{\lambda_2}{\beta + \delta}$, $V' \leq 0$ always holds in Ω , and if and only when $W = 0, S = 0$, $V' = 0$

holds. According to the principle of LaSalle invariant set and the principle of limit equation, E_0 is globally asymptotically stable in Ω .

The proof of conclusion 5 is as follows:

For the equilibrium point E_1 , the Lyapunov function is constructed.

$$V(I, W) = \frac{1}{2} (I - I_1^*)^2 + \frac{1}{2} k (W - W_1^*)^2.$$

Among them, k is a normal number, $V \geq 0$ always holds, and if and only if $I = I_1^*, W = W_1^*$, $V = 0$ holds, then

$$\begin{aligned}\left. \frac{dV}{dt} \right|_{(3.3)} &= (I - I_1^*) I' + k (W - W_1^*) W' \\ &= -\lambda_1 W (I - I_1^*)^2 - \lambda_1 I_1^* (W - W_1^*) (I - I_1^*) - \lambda_2 S (I - I_1^*)^2 - \delta (I - I_1^*)^2 \\ &\quad + k \lambda_1 I (W - W_1^*) + k \lambda_1 W_1^* (I - I_1^*) (W - W_1^*) - k \alpha R (W - W_1^*)^2 - k \delta (W - W_1^*)^2 \\ &= -\lambda_1 W (I - I_1^*)^2 - \lambda_2 S (I - I_1^*)^2 - \delta (I - I_1^*)^2 + (k \lambda_1 W_1^* - \lambda_1 I_1^*) (I - I_1^*) (W - W_1^*) \\ &\quad + k (\lambda_1 I - \alpha R - \delta) (W - W_1^*)^2.\end{aligned}$$

$k = \delta / (\lambda_1 - \delta)$, then

$$\left. \frac{dV}{dt} \right|_{(3.3)} = -\lambda_1 W (I - I_1^*)^2 - \lambda_2 S (I - I_1^*)^2 - \delta (I - I_1^*)^2 + k (\lambda_1 I - \alpha R - \delta) (W - W_1^*)^2.$$

Thus, $V' \leq 0$ is always true in Ω' , and if and only if $I = \frac{\delta}{\lambda_1}, W = \frac{\lambda_1 - \delta}{\lambda_1}$, $V' = 0$ is true. According to

the principle of LaSalle invariant set and the principle of limit equation, E_1 is globally asymptotically stable.

4 RESEARCH ON DIGITAL MEDIA ADVERTISING INTERACTIVE DESIGN AND COMMUNICATION BASED ON BIG DATA TECHNOLOGY

As shown in Figure 7, the three basic elements of digital media advertising interaction based on big data technology are display, system and interaction mode.

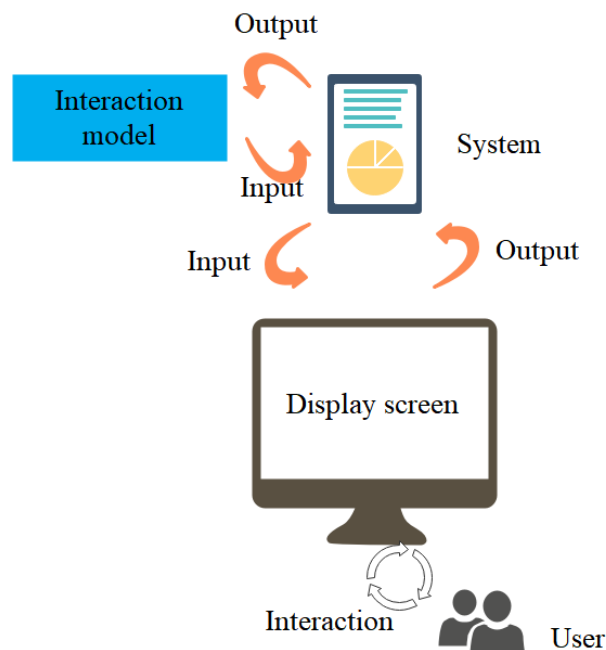


Figure 7 Three basic parts of effective advertising in an interactive system

On the basis of the above research, the digital media advertising interactive design and communication system based on big data technology proposed in this paper is verified, and the effectiveness of this system is verified through cluster analysis, and the results shown in Figure 8 below are obtained.

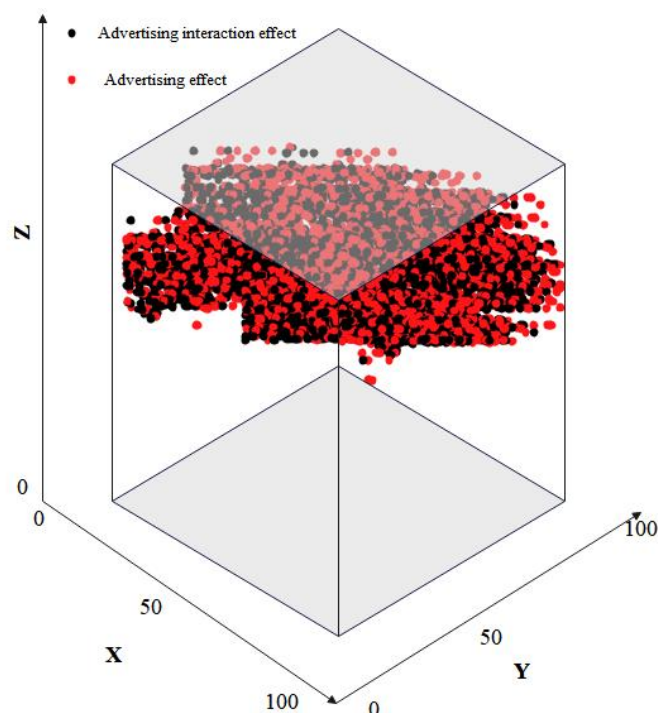


Figure 8 Cluster analysis of the effect of digital media advertising interactive design and communication system based on big data technology

From the above research, it can be seen that the digital media advertising interactive design and communication system based on big data technology proposed in this paper has good results.

5 CONCLUSION

For a successful online interactive advertisement, having a good user experience is the key to determining the success of the interactive advertisement. The user experience manifestations of online interactive advertising are mainly divided into three categories: sensory experience, interactive experience and emotional experience. Sensory experience is mainly to provide users with an audio-visual experience from the perspective of artistic design, and mainly emphasizes the comfort of users using advertisements from the aesthetic aspect. Interactive experience mainly provides relevant experience from user behavior operations, and emphasizes the usability and ease of use of advertisements in the process of being operated by users. Emotional experience mainly provides an experience from the psychological and emotional aspects of the user, so that the user is friendly to the product after using the advertisement. This article combines big data technology to study the digital media advertising interactive design communication. The research shows that the digital media advertising interactive design and communication system based on big data technology proposed in this paper has good results.

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