Exploration and Analysis of Sports Information Transmission Paths with Carrier Network using Grey Model

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***Abstract* — Computer network platforms transmit information of sports and other fields. Our research objects in this paper are sports information transmission paths in terms of the 'number' of network users and usage 'rates'. We propose using Grey prediction model to explore and analyze future situations of sports information. Based on historic data to predict the 'number' of users, the results are relatively similar except for bigger gaps between prediction and actual results in 2005. For the usage 'rate', results are again relatively similar except for bigger gaps between prediction and actual results in 2006. Further research is needed to confirm the rationality of the approach and extend the results further.**

Keywords- network carrier; sports information; grey prediction; sports transmission

I. INTRODUCTION

With the increasingly science and technology development today, network has become an important intermediary for people. With the rising fondness for sports, more and more people utilize network to acquire sports information. Timeliness and accuracy of network information is the main cause that making it popular.

In 2008, Qian Qi in the article "Status analysis and future study of mobile phone media in sports transmission", he emphasized that nowadays mobile phone media was an important cooperator to sports transmission that could rapidly and correctly spread sports information and let itself get profits, and thereby mutual benefit and win-win result were achieved. The author studied the status that mobile phone transmitted sports information. It was shown in research results that age group of masses acquired sports information by mobile phone media concentrated on 20 to 45 years old. By far, mobile phone was rather limited in China's development, groups of receivers were not quite satisfactory with contents in mobile phone media, thus, diversity and specificity should be reinforced on mobile phone media information. In the respect of information reliability, verification from supervising departments was deficient in mobile phone media released information. In current stage of mobile phone media, progress in technology was a basic path to expand the utilization range of mobile phone media, and being individual mobile media was an ideal result of development thereof [1-6].

In 2013, Lei Hai-Ping in the article "Study of sports news transmission in Sino microblog", highlighted that Sino microblog built firm foundation for sports news transmission. Taking Sino microblog as research objects, through multiple analytic methods, discussion was made from its applied study, sports transmission and integration of microblog and sports. The Sino microblog's features – small, timely and convenient was stated from its sports development direction. Efforts was made to analyze transmitters and news style thereof by comparing Sino microblog, sports newspaper and sports television these traditional media mean. The author pointed out that sports transmission with media Sino microblog possessed entertainment and global nature. Analysis result showed that certain disadvantages existed in news information, science and technology and information editing, bringing challenge for news reports, since the development duration of Sino microblog was shorter. Targeted at present issues existing in Sino microblog, corresponding instructive suggestions were presented and the future development was showed [7-10].

In 2011, Yu Tong in the article "Comparative study of sports transmission by Chinese broadcast, television and internet", highlighted that broadcast, television and internet these sports transmission ways were later developed in China, more problems were coming across during developing. The article started from all kinds of sports transmission status at home and abroad at present, focused on historical development, economic efficiency and social efficiency of new and traditional media ways explored and analyzed Chinese future sports transmission. It was showed in research results that in the respect of sports news transmission, sports broadcast started earlier, television media developed later, while internet developed latest but with fastest development speed. Sports transmission industry working personnel was obviously different in China and professional quality remained to improve. Vicious competition among all media caused bad effects. As suggested by the author, fair competition should be implemented among all media, interference should be reduced by government, and all-around reformation on economic system should be implemented to save the state from supporting media public institution by appropriation [11-15].

The paper starts from the number of network media users and operating frequency, and predicts future sports information transmission by Chinese network media.

II. MODEL ESTABLISHMENT

Based on the theory of grey prediction model, the model carries out study of the number of users and usage frequency concerning sports information network so that determines the prediction models thereof.

A. Data Collection

Data in Table 1 and Table 2 is from the article "Chinese network media and sports fans interactive developmental study".

TABLE 1. USER SCALE OF SPORTS INFORMATION NETWORK

Year	Number Of People(Ten Thousand People)
2002	1259
2003	4706
2004	5828
2005	7537
2006	7330
2007	15456
2008	23400
2009	26601

From Table 1, it is clear that the number of users in 2009 is the most and that in 2002 is the least. So as to learn the rough tendency of number of users' changes from 2002 to 2009, it draws Figure 1.

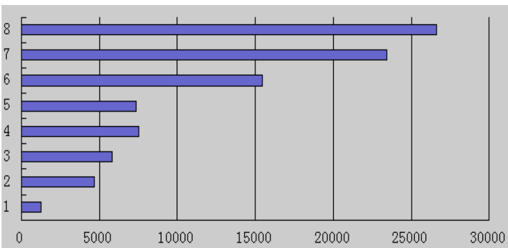

Figure 1. Sports information network subscribers

In Figure 1, mark "1-8" represent 2002 —2009, it is clear that the number of users are growing by year from 2002 —2009 but varies in increasing ranges.

From Table 2, it is clear that the highest usage rate of network media is in 2009, and latest of that in 2002. So as to learn rough tendency of network media usage rate from 2002—2009, it draws Figure 2.

In Figure 2, mark "1—8" represents 2002 —2009, it is clear that eight years' network media usage rate overall shows increasing tendency, however, the differences among increasing ranges are bigger, while reducing tendency showing in some year.

Grey system $GM(1,1)$ model is in accordance with lots of known data, ranking these data according to time, fitting according to differential equations to draw near time sequence described dynamic process, by parity of reasoning, arriving at prediction target value. Such fitting method obtained model is time sequence one order differential equation.

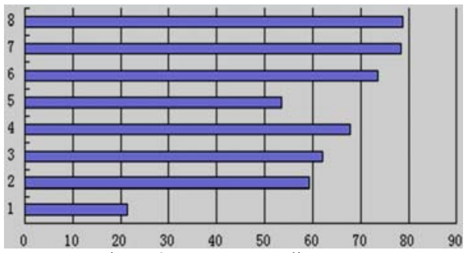

Figure 2. Internet media usage.

TABLE 2. USAGE RATE OF NETWORK MEDIA

Year	**Usage Rate (%)**
2002	21.3
2003	59.2
2004	62
2005	67.9
2006	53.5
2007	73.6
2008	78.5
2009	78.7

B. Grey Model Concepts

Grey model contains two concepts that are respectively AGO and $IAGO$

(1) $1-AGO$ Represents accumulated generating operation number; it refers to one time accumulated generating operation. Record original sequence as:

$$X^{(0)} = \{X^{(0)}(1), X^{(0)}(2), \cdots, X^{(0)}(n)\} \tag{1}$$

One time accumulated generating operation sequence is:

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), \cdots, X^{(1)}(n)\} \tag{2}$$

Among them,

$$x^{(1)}(k) = \sum_{i=0}^{k} x^{(0)}(i) = x^{(1)}(k-1) + x^{(0)}(k) \tag{3}$$

(2) $IAGO$ Represents inverse accumulated generating operation number, it is inverse operation of accumulated generating operation. Record original sequence as:

$$X^{(1)} = \{X^{(1)}(1), X^{(1)}(2), \cdots, X^{(1)}(n)\} \tag{4}$$

One-time inverse accumulated generating operation sequence is:

$$X^{(0)} = \{X^{(0)}(1), X^{(0)}(2), \cdots, X^{(0)}(n)\} \tag{5}$$

Among them, $x^{(1)}(0)=0$

$$x^{(0)}(k)=x^{(1)}(k)-x^{(1)}(k-1) \tag{6}$$

C. $GM(1,1)$ Models

It represents one order, one variable grey system model. Use $X^{(0)}$ to express sequence that needs modeling, $X^{(1)}$ is $X^{(0)}$ $1-AGO$ sequence, then it has:

$$x^{(1)}(k)=\sum_{i=0}^{k}x^{(0)}(i) \tag{7}$$

Regard $Z^{(1)}$ as $X^{(1)}$ adjoining neighborhood mean value $(MEAN)$ generating sequence:

$$z^{(1)}(k)=\frac{x^{(1)}(k)+x^{(1)}(k-1)}{2} \tag{8}$$

Then it can establish grey differential equation:

$$x^{(0)}(k)+az^{(1)}(k)=b \tag{9}$$

Record $\hat{a}=(a,b)^T$, then grey differential equations least square estimated parameter sequence meets following formula:

$$\hat{a}=\left(B^TB\right)^{-1}B^TY_n \tag{10}$$

Among them,

$$B=\begin{bmatrix}-z^{(1)}(2) & 1\\ -z^{(1)}(3) & 1\\ \vdots & \vdots\\ -z^{(1)}(n) & 1\end{bmatrix} \tag{11}$$

$$Y_n=\begin{bmatrix}x^{(1)}(2)\\ x^{(1)}(3)\\ \vdots\\ x^{(1)}(n)\end{bmatrix} \tag{12}$$

Call $\frac{dx^{(1)}}{dt}+ax^{(1)}=b$ as grey differential equation $x^{(0)}(k)+az^{(1)}(k)=b$ whitening equation, is also called silhouette equation.

Based on above analysis, it has following relationships:

(1) Solution of whitening equation $\frac{dx^{(1)}}{dt}+ax^{(1)}=b$ is also called time response equation:

$$\hat{x}^{(1)}(t)=\left(x^{(1)}(0)-\frac{b}{a}\right)e^{-at}+\frac{b}{a} \tag{13}$$

(2) $GM(1,1)$ Grey differential equation $x^{(0)}(k)+az^{(1)}(k)=b$ time response sequence is:

$$\hat{x}^{(1)}(k+1)=\left[x^{(1)}(0)-\frac{b}{a}\right]e^{-ak}+\frac{b}{a},\ k=1,2,\cdots,n \tag{14}$$

(3) Select $x^{(1)}(0)=x^{(0)}(1)$, then:

$$\hat{x}^{(1)}(k+1)=\left[x^{(0)}(1)-\frac{b}{a}\right]e^{-ak}+\frac{b}{a},\ k=1,2,\cdots,n \tag{15}$$

(4) Restore the value and can get:

$$\hat{x}^{(0)}(k+1)=\hat{x}^{(1)}(k+1)-\hat{x}^{(1)}(k) \tag{16}$$

Formula (16) is prediction equation.

III. Computational Procedures of Users' Amount

Taking prediction process of sports information network media users' amount changes as an example, state the model's actual prediction process.

A. Ultimate Ratio Verification

Establish time sequence concerning users' amount changing rate as following:

$$x^{(0)}=(x^{(0)}(1),x^{(0)}(1),\cdots,x^{(0)}(1))$$
$$=(1259,4706,5828,7537,7330,15456,23400,26601)$$

Solve ultimate ratio $\lambda(k)$

$$\lambda(k)=\frac{x^{(0)}(k-1)}{x^{(0)}(k)} \tag{17}$$

$$\lambda=(\lambda(2),\lambda(3),\cdots,\lambda(8))$$
$$=(0.27,0.81,0.77,1.03,0.47,0.66,0.88) \tag{18}$$

By (18), it is clear that all ultimate ratios cannot meet dropping in admissible coverage $(e^{-\frac{2}{8+1}},e^{\frac{2}{8+2}})$, do conversion handling with sequence $x^{(0)}$, the purpose is to let it to drop in admissible coverage. Take constant $c=20000$, make translation conversion:

$$y^{(0)}(k)=x^{(0)}(k)+20000,k=1,2,\cdots,n \tag{19}$$

Then ultimate ratio is:

$$\lambda=(0.86,0.95,0.94,1.00,0.77,0.82,0.93) \tag{20}$$

(2) Ultimate ratio judgment

By (20), we can know $\lambda \in (0.77,1.24)$, therefore it can use $y^{(0)}(k)$ to make $GM(1,1)$ model prediction.

$GM(1,1)$ Modeling

For original data $y^{(0)}$, make one time accumulation, that:

$y^{(1)} = (21259, 45965, 71793, 99330, 126660, 162116, 205516, 224787)$

Construct data matrix B and data vector Y:

$$B = \begin{bmatrix} -\frac{1}{2}(y^{(1)}(1)+y^{(1)}(2)) & 1 \\ -\frac{1}{2}(y^{(1)}(2)+y^{(1)}(3)) & 1 \\ \vdots & \vdots \\ -\frac{1}{2}(y^{(1)}(7)+y^{(1)}(8)) & 1 \end{bmatrix}, Y = \begin{bmatrix} y^{(0)}(2) \\ y^{(0)}(3) \\ \vdots \\ y^{(0)}(8) \end{bmatrix} \quad (21)$$

Calculate $\hat{u}$:

$$\hat{u} = (a,b)^T = (B^T B)^{-1} B^T Y = \begin{pmatrix} -0.0133 \\ 198.4947 \end{pmatrix} \quad (22)$$

Then, it has $a = -0.123959$, $b = 17961.66$

Establish models:

$$\frac{dy^{(1)}}{dt} - 0.123959 y^{(1)} = 17961.66 \quad (23)$$

It solves

$$y^{(1)}(k+1) = (y^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a} \quad (24)$$

$$= -144900 + 166159 e^{0.123959k}$$

Solve generating sequence value $\hat{y}^{(1)}(k+1)$ and model restoring value $\hat{y}^{(0)}(k+1)$:

Let $k = 1,2,3,4,5,6,7,8$, by formula (24), it can calculate and get $\hat{y}^{(1)}$, from which it takes

$$\hat{y}^{(1)}(1) = \hat{y}^{(0)}(1) = y^{(0)}(1) = 250.39 \quad (25)$$

According to $\hat{y}^{(0)}(k) = \hat{y}^{(1)}(k) - \hat{y}^{(0)}(k-1)$, it takes $k = 2,3,4,\cdots 8$, and it can get

$\hat{y}^{(0)} = (\hat{y}^{(0)}(1), \hat{y}^{(0)}(2), \cdots \hat{y}^{(0)}(8)) =$

$(21259\ 21928\ 24822\ 28098\ 31806\ 36003\ 40754\ 46133)$

Most of points have little difference from original points except for extremely specific points. In order to clearly express, comparison has been made between testing and actual results, and Figure 3 has been drawn.

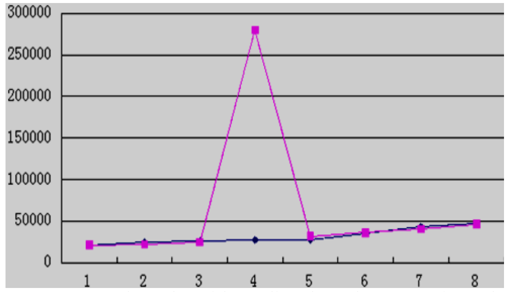

Figure 3. Actual results with predicted results comparison chart.

From Figure 3, it is clear that most of results are similar except for larger gaps existing in prediction results in 2005.

B. Prediction Model of Usage Rate

Establish time sequence concerning user' amount changing rate as following:

$x^{(0)} = (x^{(0)}(1), x^{(0)}(1), \cdots, x^{(0)}(1))$

$= (21.3, 59.2, 62, 67.9, 53.5, 73.6, 78.5, 78.7)$

Use *Matlab* program to calculate, obtained result is as following:

$y^{(1)}(k+1) = -1041.48 + 1062.78 e^{0.0526k}$

With the formula, predicted result is:

$(21.3, 57.4, 60.5, 63.8, 67.2, 70.8, 74.7, 78.7)$

Most of points have little difference from original points except for extremely specific points. Thus, accuracy of predicted model is proved, the comparison of actual and predicted results as shown in Figure 4.

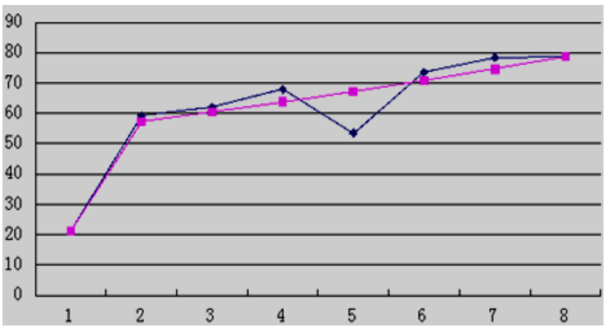

Figure 4. Actual results with predicted results comparison chart.

From Figure 4, it is clear that results gets closer, with the exception that predicted result has larger deviation with actual result in 2006.

IV. Conclusion

There are wider utilization ranges and fewer constraint factors in grey prediction model so that it could be used in multiple fields. Grey prediction model is applied into sports information network utilization study from the number of users and usage rate related to network information. The result shows that most of points' predicted result is basically the same as actual result, with the exception of extremely specific points. In predicted problems, it is normal that individual points' predicted result is incorrect due to bigger gap in actual data.

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