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Research on Red Tourism Push System based on Collaborative Filtering in Northwest China

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Abstract: Research on red tourism push system based on collaborative filtering in Northwest China. Abstract: In order to improve the service ability of red tourism in Northwest China, we need to carry out personalized itinerary push design, a design model of red tourism push system is proposed based on collaborative filtering. According to the tourists' preference of interest and judgment, the similarity evaluation method is used to extract the tourists' personalized features, and the autocorrelation statistical analysis method is used to automatically match the red tourism itinerary and the tourists' personalized preferences in Northwest China. Combined with the characteristic attributes of tourists and the item attributes of travel itinerary, the decision function of red tourism itinerary push in northwest region is established, and the fuzzy decision method is adopted to realize the automatic push of travel itinerary in northwest area. The software development and design of push system are carried out under Visual DSP++4.5 and embedded Linux kernel. The embedded Linux kernel is constructed under the environment of Internet of things for cross-compiling control of tourism push, which improves the objectiveness and object-oriented of push. The system test results show that the proposed method is more object-oriented, more individualized, and more satisfactory in pushing the red tourism itinerary in Northwest China.

Keywords: Collaborative filtering; Northwest red tourism route; Push system; Embedded Linux; Software design

1. Introduction

The Northwest region is one of the old revolutionary areas in our country, and the red tourism resources are very rich. Most of the red tourism resources are distributed in poor cities (counties and counties), which restricts the development of red tourism and tourism in Northwest China to a great extent. The lack of red funds in Northwest China restricts the development of red tourism in Northwest China. Northwest China is a poor area with poor economic base and limited investment in tourism. And red tourist attractions are mostly located in remote mountain areas, all of which require government funding support[1]. Due to the lack of funds, the red tourism infrastructure construction lags behind, the development and utilization are insufficient, and the construction level is low; revolutionary sites and relics lack effective protection and repair; they are badly damaged, and some of the important sites, the remains are disappearing, a series of problems such as the old and ragged pavilions. The shortage of funds has become one of the important factors restricting the development of red tourism in Northwest China. In order to promote the sustained, healthy and rapid development of red tourism in Northwest China, it is necessary to vigorously develop red tourism in Northwest China. The state attaches importance to patriotism education and encourages the development of red tourism. Red tourist attractions have become propaganda and ideological work and spiritual civilization building patriotism education base. The great attention and support from the central to local governments for the development of red tourism has opened the door to industrialization of red tourism and brought a rare opportunity for the development of red tourism in the old revolutionary areas of Northwest China[2].

The red tourist routes in Northwest China need to meet the diversified tourist demand. With the development of tourism market, tourist demand is becoming more and more individualized and diversified. Characteristic tourism and special tourism are favored by tourists, ecological tourism, nostalgia tourism is popular, red tourism nostalgia, education, with a strong nostalgia color, catering to the preferences of tourists, broad prospects for development. In order to improve the quality of red tourism service in Northwest China, it is necessary to establish a push system of red tourism itinerary in Northwest China according to the tourists' individualized needs, which is conducive to maintaining sufficient tourist resources and reducing the development cost, so as to increase tourism income, and enhance the vitality of red

tourism products, promote the rapid development of tourism. This paper establishes the personalized push system of the red tourism itinerary in Northwest China. According to the preference of tourists' interest, it builds the personalized push model of the tourist-item. It has great significance to improve the efficiency and satisfaction of red tourism browsing in Northwest China.

In order to solve this problem, this paper presents a design model of red tourism push system based on collaborative filtering in Northwest China. According to the tourists' preference of interest, this paper uses similarity evaluation method to extract the personalized features of tourists. Combining with the autocorrelation statistical analysis method, the red tourism itinerary and the tourists' personalized preference are automatically matched, and the fuzzy decision method is adopted to realize the automatic push of red tourism itinerary in Northwest China. The software development and design of the system are carried out in the embedded platform. Finally, the simulation experiment is carried out, which shows the superior performance of this method in improving the accuracy of travel push and the satisfaction of tourists.

2. Problem Description and Establishment of Red Tourism Recommendation Model in Northwest China

2.1. Evaluation index system of red tourism itinerary push in northwest china

This paper constructs the evaluation index system of the red tourism itinerary push in the northwest region, carries on the individual characteristic mining through the adaptive learning control, and carries on the association rule data mining according to the distributed attribute feature of the red tourism route in the northwest area[3]. Based on the interest preference of tourists and the travel characteristics of red tourism in Northwest China, the paper constructs the information transmission model of red tourism in Northwest China. Assuming that M red tourism routes in Northwest China are $x(k-1),\ldots,x(k-M)$, the estimation of tourist preference attribute characteristic $x_s=\left[x(h_1),\ldots,x(h_N)\right]^T$ is as follows:

$$\hat{x}_s = W_s^T y \tag{1}$$

Where, $\hat{x}_s=\left[\hat{x}(h_1),\ldots,\hat{x}(h_N)\right]^T$, the fuzzy directivity constraint control method is used to deal with the characteristics of red tourism travel in Northwest China. The description formula is shown as follows:

$$\begin{aligned} M_v &= w_1\sum_{i=1}^{m\times n}(H_i-S_i)+M_h w_2\sum_{i=1}^{m\times n}(S_i-V_i) \\ &+w_3\sum_{i=1}^{m\times n}(V_i-H_i) \end{aligned} \tag{2}$$

In the upper form, the characteristic vector set of tourism resources distribution is M_h. by searching for suitable routes for adaptive matching and adopting adaptive equilibrium game strategy, the similarity characteristic information distribution model of red tourism routes in Northwest China is obtained as follows:

$$\begin{aligned} r(t) &= \sum_i\sum_{j=0}^{N_f-1}\sum_{l=0}^{L-1} b_i a_l p(t-iT_s-jT_f-c_jT_c-t_l)+w(t) \\ &= \sum_i\sum_{j=0}^{N_f-1} b_i p_h(t-iT_s-jT_f-c_jT_c-t_0)+w(t) \end{aligned} \tag{3}$$

Where:

$$p_h(t)=\sum_{l=0}^{L-1} a_l p(t-t_{l,0}) \tag{4}$$

In addition, $w(t)$ is the characteristic attribute of tourists. According to the request of tourists, the objective function of personalized push is:

$$r=\frac{M^{-1}\sum_i j_i k_i-\left[M^{-1}\sum_i \frac{1}{2}(j_i+k_i)\right]^2}{M^{-1}\sum_i \frac{1}{2}(j_i^2+k_i^2)-\left[M^{-1}\sum_i \frac{1}{2}(j_i+k_i)\right]^2} \tag{5}$$

The data input information is preprocessed to construct the evaluation index system of the red tourism push in Northwest China[4], as shown in figure 1.

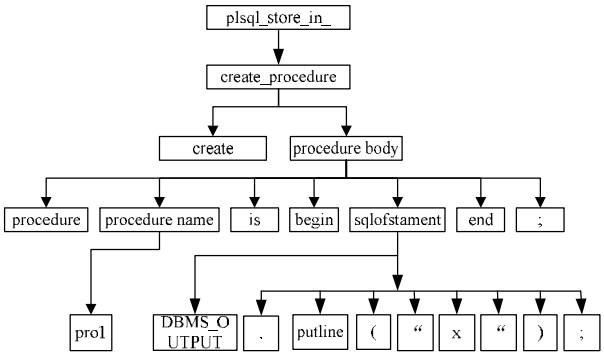

Figure 1. Tree model of personalized index evaluation system for red tourism itinerary in northwest china

2.2. Tourist route preference feature extraction

Considering the expectation of tourists, the image of the tour route, the tourist motivation and the satisfaction degree, as the index system of the red tourism itinerary recommendation in Northwest China, the tourists of the

northwest region are taken into account to carry out the red tourism itinerary in the Northwest China. Individual feature mining[5]. Assuming that the edges of the red tourism itinerary mixed push topology graph are directed and the network graph is a directed graph, in the mixed push model of the red tourism itinerary in Northwest China, the tourist set of the element node set is represented by $\{u_1,...,u_N\}$. $\{v_1,...,v_M\}$ represents the set of untrusted nodes, and $R=[R_{u,v}]_{N\times M}$ represents the score matrix of tourist routes. Combining with the auto-correlation statistical analysis method, the red tourism itinerary in Northwest China is automatically matched with the tourists' individual preferences[6]. The matching function is:

$$\max_{x_{a,b,d,p}} \sum_{a\in \mathrm{A}}\sum_{b\in \mathrm{B}}\sum_{d\in \mathrm{D}}\sum_{p\in \mathrm{P}} x_{a,b,d,p}V_p \tag{6}$$

$$\text{s.t.} \sum_{a\in \mathrm{A}}\sum_{d\in \mathrm{D}}\sum_{p\in \mathrm{P}} x_{a,b,d,p}R_p^{bw} \le K_b^{bw}(\mathrm{S}), b\in \mathrm{B} \tag{7}$$

The solution vector of the characteristic distribution set of association rules in northwest red tourist route is obtained, as $P_i=(p_{i1},p_{i2},\mathbf{L}\ p_{iD})$, where:

$$j\in N_i(k), N_i(k)=\{\|x_j(k)-x_i(k)\|<r_d(k)\} \tag{8}$$

The solution vector of the characteristic distribution set of association rules of the first northwest red tourist route is obtained, where:

$$x_i(k+1)=x_i(k)+s(\frac{x_j(k)-x_i(k)}{\|x_j(k)-x_i(k)\|}) \tag{9}$$

Where, $\|\vec{x}\|$ represents the norm of $\vec{x}$, and the association rule of tourist behavior is $P_{ij}^{best}(k)$, and the iteration step is $P_{ij}^{best}(k)$.

3. Optimization of Travel Route Push Algorithm based on Collaborative Filtering

3.1. Collaborative filtering algorithm

Based on the characteristic distribution structure of the red tourism itinerary in Northwest China, the similarity evaluation method is used to extract the personalized features of tourists. The matching probability distribution of tourists' personalized feature requirements is expressed as follows:

$$p(R|T,U,V,s_R^2)=\prod_{i=1}^{n}\prod_{j=1}^{m}\left[N(R_{ij}\left|g(\sum_{k\in N_u}w_{ik}U_k^TV_j),s_T^2\right)\right]^{I_{ij}^R} \tag{10}$$

Combined with the distribution weight of travel itinerary, Bayesian inference is adopted, which can be obtained as:

$$p(y|a,q)=\sum_{k=1}^{K}a_k p_k(y|m_k,\sum\nolimits_k) \tag{11}$$

Based on the calculation of tourist personality attributes and item attributes of travel itinerary[7], the weight of tourist satisfaction under collaborative filtering recommendation model is expressed as follows:

$$\begin{aligned}&p(U,V|R,w,s_w^2,s_U^2,s_V^2)\propto p(R|w,U,V,s_w^2)p(U|s_U^2)p(V|s_V^2)\\&=\prod_{i=1}^{n}\prod_{j=1}^{m}\left[N(R_{ij}\left|g(\sum_{k\in N_u}w_{ik}U_k^TV_j),s_w^2\right)\right]^{I_{ij}^R}\\&\times\prod_{i=1}^{n}N(U_i|0,s_U^2\mathrm{I})\times\prod_{J=1}^{m}N(U_j|0,s_V^2\mathrm{I})\end{aligned} \tag{12}$$

The decision function of Red Tourism itinerary push in Northwest China is established as C_{uv}^*:

$$C_{uv}^*=\sqrt{\frac{d_{in}(v)}{d_{out}(u)+d_{in}(v)}}\times C_{uv} \tag{13}$$

Matrix decomposition technology is used to make fuzzy decision for tourists and travel itinerary[8], the fuzzy decision process is obtained as follows:

$$\begin{aligned}x_i(t)=&\sum_{k=1}^{p}\sum_{l=0}^{2}j_{kl}[w_{i1}^l,\mathbf{L},w_{in}^l][x_1(t-k),\mathbf{L},x_n(t-k)]^T\\&-\sum_{k=1}^{q}\sum_{l=0}^{2}q_{kl}[w_{i1}^l,\mathbf{L},w_{in}^l][e_1(t-k),\mathbf{L},e_n(t-k)]^T+e_i(t)\end{aligned} \tag{14}$$

The upper formula is expanded by Taylor series:

$$x_i(t)=x_i^1(t)+x_i^2(t)+x_i^3(t) \tag{15}$$

Combined with the decision function of red tourism push in Northwest China, the descriptive statistical analysis method is used, the attribute set of travel itinerary push is obtained as follows:

3.2. Decision output of the red tourism itinerary push in northwest china

The fuzzy decision method is adopted to realize the automatic push of the red tourism itinerary in the northwest region. The revised weights of the push model are calculated as follows:

$$\overline{R}_{ik}=\sum_{j\in N_u}C_{i,j}^*R_{jk} \tag{16}$$

The fuzzy directivity constraint control method is used to cluster the red tourism itinerary characteristics in Northwest China. The trust relationship between the red tourism itinerary and the tourists in the northwest region is expressed as $A\to B$, $B\to C$, and the joint association feature distribution is presented as:

$$MSD_{a\to b}=1-\frac{\sum_{i=1}^{|I_{a,b}|}\sqrt{(d_{a,i}-\bar{d}_a)^2+(d_{b,i}-\bar{d}_b)^2}}{|I_{a,b}|\times\sum_{i=1}^{|I_{a,b}|}\left[\sqrt{(d_{a,i}-\bar{d}_a)^2}+\sqrt{(d_{b,i}-\bar{d}_b)^2}\right]} \quad (17)$$

The fuzzy C-means algorithm is used to fuse the characteristic quantity of the cluster output, and the mutual information of the distribution of the red tourism itinerary in the northwest region is outputted as follows:

$$I(Q,S)=H(Q)-H(Q|S) \quad (18)$$

Where

$$H(Q|s_i)=-\sum_j\left[p_{sq}(s_i,q_j)\Big/p_s(s_i)\right]\log_2\left[p_{sq}(s_i,q_j)\Big/p_s(s_i)\right] \quad (19)$$

The satisfaction score of travel promotion can be expressed as:

$$\begin{pmatrix}\bar{R}_{i,1}\\ \bar{R}_{i,2}\\ \cdots\\ \bar{R}_{i,m}\end{pmatrix}=\begin{pmatrix}R_{1,1} & R_{2,1} & \cdots & R_{n,1}\\ R_{2,1} & R_{2,2} & \cdots & R_{n,2}\\ \cdots & \cdots & \cdots & \cdots\\ R_{1,K} & R_{2,K} & \cdots & R_{n,m}\end{pmatrix}\begin{pmatrix}C^*_{i,1}\\ C^*_{i,2}\\ \cdots\\ C^*_{i,n}\end{pmatrix} \quad (20)$$

According to collaborative filtering, combined with tourists' personalized requirements and behavior characteristics information, the red tourism itinerary can be pushed automatically.

4. Software Development and Design of the System

The software design of the red tourism push system in Northwest China is carried out under the kernel of embedded Linux. In the software development, the program loading module and the tourist information collection module are mainly used. The tourism travel recommendation module and the information processing module are designed in detail. In order to realize the design of the red tourism itinerary push system in Northwest China, the overall design framework of the system is analyzed. The red tourism push system in Northwest China is mainly divided into information perception module, tourist information storage module, information processing module, push buffer module and so on. The overall structure block diagram of the system is shown in Figure 2.
According to the above hierarchical design, the push system of red tourism itinerary is divided into three layers: perceptual layer, network layer and application layer. The hierarchical structure model and multi-backup mode are used to connect the cloud storage services recommended by the red tourism itinerary in Northwest China. Based on the virtualization management of storage resources in the red tourism push system in Northwest China, the online data storage and business access are realized through a hierarchical structure and multi-backup mode, and the software implementation flow of the system is shown in Figure 3.

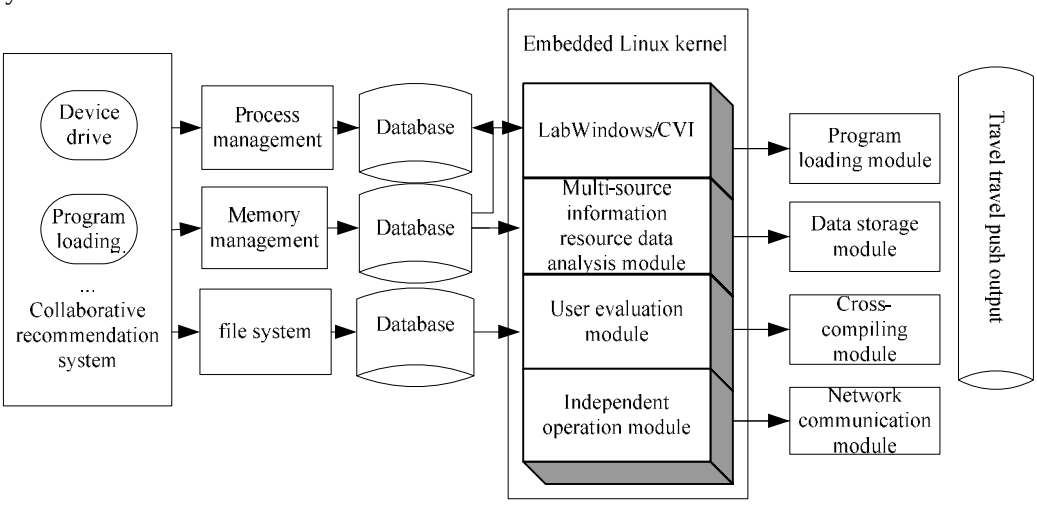

Figure 2. Block diagram of the overall architecture of the system

5. Simulation Experiment and Result Analysis

In order to test the application performance of this method in the implementation of red tourism push in Northwest China, the simulation experiment is carried out. The experiment is constructed based on the Matlab simulation platform, and the soft push system is carried

out under the Visual DSP++4.5 and embedded Linux kernel. Under the environment of Internet of things, the embedded Linux kernel is constructed to cross compile and control the travel itinerary push. The sample size of red tourism itinerary is 2000, the scale of training sample is 500, and the learning of cooperative recommendation is repeated. The number of generations is 20. According to the above simulation environment and parameter setting, the red tourism route push simulation in Northwest China is carried out, and the accuracy of the push is compared, and the result is shown in Figure 3.

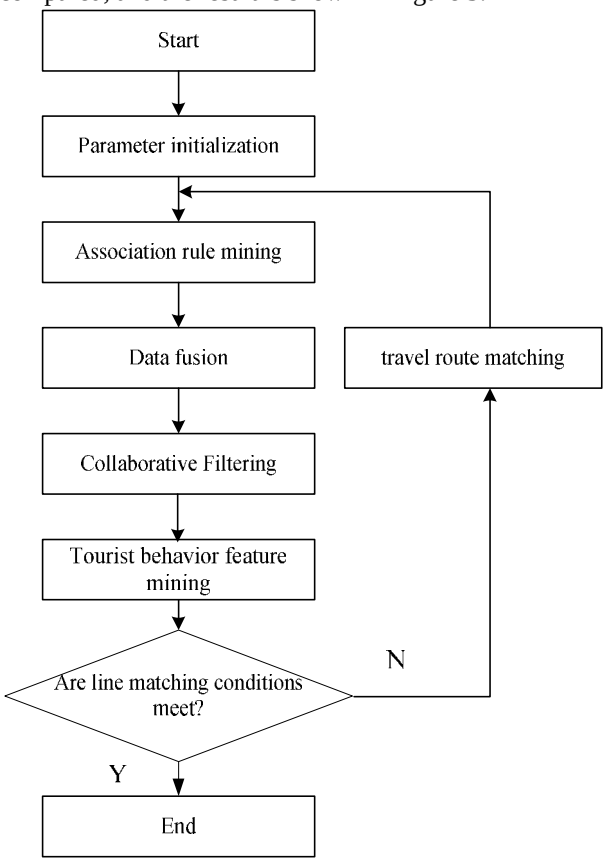

Figure 3. System software development and implementation process

Figure 4 shows that the accuracy of using this method to push the red tour itinerary in Northwest China is higher, and the comparison of time cost of further test is obtained, which is shown in figure 5. The analysis figure 5 shows that the method of this paper is carried out in the push the red tourism itinerary in Northwest China. The time spent on pushing red tourism in the north is relatively short. In this paper, the method of pushing the red tourism itinerary in Northwest China has the advantages of better object-oriented, more individualized customization ability and higher degree of satisfaction.

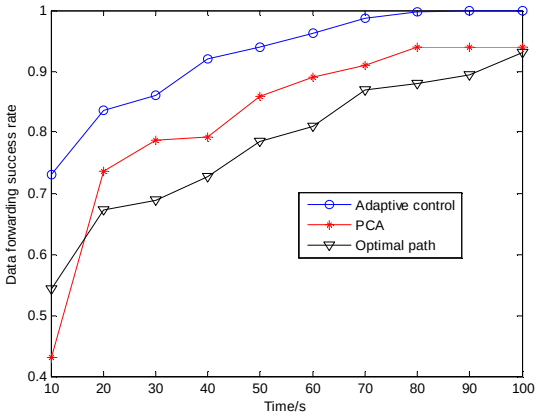

Figure 4. Comparison of data forwarding accuracy of travel itinerary push

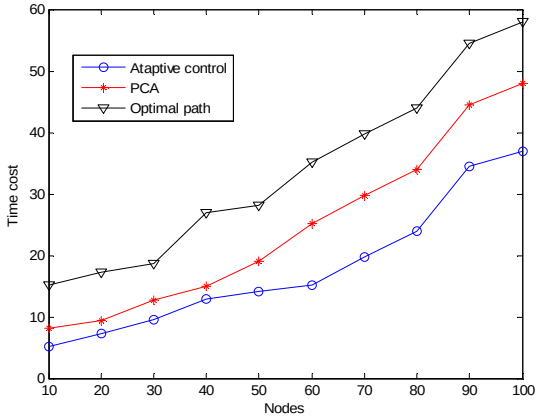

Figure 5. Comparison of time overhead

6. Conclusions

In this paper, a design model of red tourism push system is proposed based on collaborative filtering. According to the tourists' preference of interest and judgment, the similarity evaluation method is used to extract the tourists' personalized features, and the autocorrelation statistical analysis method is used to automatically match the red tourism itinerary and the tourists' personalized preferences in Northwest China. Combined with the characteristic attributes of tourists and the item attributes of travel itinerary, the decision function of red tourism itinerary push in northwest region is established, and the fuzzy decision method is adopted to realize the automatic push of red tourism itinerary in northwest area. The software development and design of push system are carried out under Visual DSP++4.5 and embedded Linux kernel. The embedded Linux kernel is constructed under the environment of Internet of things for cross-compiling control of travel push, which improves the objectiveness and

object-oriented of push. The system test results show that the proposed method is more object-oriented, more individualized, and more satisfactory in pushing the red tourism itinerary in Northwest China. It has good application value in practice.

7. Acknowledgment

Vaue and tourist behavior of red tourist in Northwest Chi na (16CGL032).

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