Research on Potential Relationships in the Field of Domestic Mobile Library Based on Keywords Coupling Analysis

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Abstract

With the records about the research on mobile library, this paper attempts to mine and visualizes the potential cooperative relationships between authors based on the coupling analysis of author-keyword, institution-keyword, and journal-keyword. Some conclusions are got. Several representative authors in the research field of mobile library are found by author-keyword coupling analysis and factor analysis. Number of articles, coupling frequency, and the coupling network centrality of the potential cooperation network are correlative. And there are four research themes in this research field: mobile services and applications, WAP technology and mobile library service models, "cloud" computing and user services, digital libraries and mobile information services. These research institutions in this field could be divided into five groups by institution-keyword coupling analysis, while dividing journals of this research field into three dissimilar journal groups with method of journal-keyword coupling analysis.

Keywords

Mobile Library; Potential Cooperative Relationship; Author-Keyword Coupling; Institution-Keyword Coupling; Journal-Keyword Coupling.

1. Introduction

With the rapid development of science and technology, the interdisciplinary and Integrated of different subject .It is necessary to solve complex problems which need people research different areas and subject to work together . Cooperative relations in scientific research has become one of the important factors that affect the ability of scientific research output [1]. However, the majority of domestic scholars are from an external perspective of a research field of cooperation, cannot reveal the deeper cooperation relationship hidden in and strength. Therefore, this study explores the potential cooperative relationship in the domestic mobile library research field on the basis of the previous research.

Mobile library is based on the technology of mobile wireless network and Internet, which can make people avoid the limitation of time and space. It can provides services that carry out information query, browse and get the collection resources through mobile portable devices (smart phones, tablet PCs, MP4, etc.) quickly and flexibly, Access to the collection of resources content [2].

In this paper, besides the author's keyword coupling and mechanism keyword coupling analysis, this paper introduces the journal keyword coupling into the research field of mobile library, and digs out the potential cooperation relationship of mobile library research from three perspectives in the way of knowledge map , On the one hand to help researchers, institutions and other partners to find the right method to reduce the cost of scientific research; the other hand, according to the possibility of scientific research personnel and institutions to predict the mobile library research field of future development trends; , For the scholars to write the target journal articles to provide reference..

2. Data sources and Research methods

2.1 Data sources

This research is based on the CNKI database as the data source, with the theme of "mobile phone library" or "mobile library" for accurate retrieval, literature type selection of journal articles and unlimited time. And retrieval date is on January 5, 2017. Because of the "information journal" has not been included, it's necessary to retrieve its supplement with the same search strategy in the Wanfang database. The retrieved data is refined, through wiping out the literature with no author, published with the name of the editorial department and repeated, and finally I get a total of 913 literature records with authors. In this paper, the information of the 913 documents is used as the data source of the potential cooperative relationship analysis in the field of mobile library research.

2.2 Research method.

The research employs literature metrology method, social network analysis method and the authors, institutions, periodicals coupling method based on keywords to explore potential cooperation, the knowledge structure and research the status quo in the field of mobile library research in China. Social network analysis method is a set of theory and method to analyze all kinds of relations in social network structure and properties, its essence is analyze of the relationship between the actors model by using mathematical thinking analysis and technical [3-4]. The author shows the co citation in the network and the author coupling analysis based on the literature, keywords, author, it usually establishes a potential cooperative relationship with an intermediary measure scale, Morris point out that the term as intermediary measure scale to reveal the author research content has the High superiority [5]. By the same token, the keywords is the height of the condensation of document content, is a set of terms with a certain standard. Based on the keywords the authors indexed in paper to carry on coupling strength calculation and visualization, we can better reveal the contents of the current state.

The calculation of coupled intensity relation based on word is the key problem in the analysis of coupling network structure. There are three kinds of coupling intensity algorithm: absolute coupling strength method, minimum coupling value weighting method and relative coupling strength method. The minimum coupling weighting algorithm takes the keyword repetition into account, repeats the counting of the keywords, and takes the smaller co-present values of the same keywords, and then accumulates them [6-8]. Ma Ruimin pointed out that the minimum coupling value of the weighted method can more accurately reflect the similarity between the authors [9], so this paper uses the minimum algorithm.

At the same time, the bibliometric method has been used throughout this study, and Price's law has been used to assist the author to find the core authors in the field of mobile library research, and this paper is the main research object of this paper. In addition, in order to reveal the clustering and classification of the coupled network and the research hotspot in this field, this study will use factor analysis, clustering analysis and multidimensional scaling analysis to analyze the coupling mechanism of the authors, institutions and periodicals. The process will be implemented using statistical software SPSS.

3. The overall network analysis

3.1 The overall situation description

There are two kinds of indexes mainly refer to the author's cooperation research: 1) degrees of cooperation, the ratio of the total number of the authors and the total number of papers; (2) the rate of cooperation, the ratio of the total co-authored papers and the total number of essays. Through the statistical analysis, involving 1116 authors of a total of 913 articles, co-authored papers is 274, the number of authors of the participation co-authored is 575 .After computing, the research field of the mobile library cooperation degree is 1.22, the cooperation rate is 30.01%, but the overall cooperation degree is low, need to be further strengthened. The statistical results in table 1 can be seen, the

number of authors which co-authored the article mainly focused on 2 ~ 3, and there are more than cooperation, the highest number of cooperation is eight.

3.2 The core authors

According to the price theory, the number of articles which have the least paper of the core authors is equal to the square root of 0.749 times of the most [10]. According to the formula, the core authors post number should be at least N = 2.59, In this paper, the number of the selected authors of the article as the core authors articles is 3 and above, a total of 42. The author further statistical coupling number of the core author, as shown in table 2 (maximum coupling frequency contains the coupling). The Number of top coupling are Song Xin - majuntao, Song Xin - huangwen, ZhangChengYu -doutianfang, its coupling number are 19, 17, 15 respectively. Maximum coupling times reflected the research content of the similarity between the authors, which has important reference value. Combination can be found in table 2, Song Xin, huangwen, majuntao three authors on the average maximum number of coupling and coupling among the top three, on the one hand, they not only extremely easily with other scholars establish high coupling strength, on the other hand indicates that their research

Table .1 Statistical of Papers Cooperation

Number of authors	Number of documents	Proportion (%)	Cumulative proportion (%)
1	639	69.99	69.99
2	167	18.28	88.27
3	69	7.56	95.83
4	26	2.85	98.68
5	4	0.44	99.12
6	6	0.66	99.78
7	1	0.11	99.89
8	1	0.11	100.00

Table 2 Core Research issued a number of coupling frequency distribution (partial)

Serial number	Author	Article Number	Maximum Coupling times	Sort	Average Coupling times	Sort	Total Number Coupling times
1	Gao Chunling	12	12	12	4.62	10	194
2	Ma Juntao	6	20	1	5.57	2	234
3	Song Xin	6	20	2	5.67	1	238
4	Zhang Aike	6	9	22	4.90	6	206
5	Zhang Chengyu	6	16	5	5.24	4	220
6	Huang	5	18	3	5.31	3	223
7	Li Rui	5	8	23	4.02	19	169
8	Mao Yihong	5	8	25	3.86	23	162
9	Ming Jun Ren	5	8	26	4.29	12	180
10	Wang Hui	5	15	6	4.79	8	201

4. Potential partnership mining

The type of cooperation can be divided into external cooperation and potential cooperation, the cooperation in the work directly referred to as external relations of cooperation, relying on the same

keywords or other keywords to form a relationship known as the potential cooperative relations [11-12]. Through external cooperation, the potential cooperation network in a certain field can be found in depth, which can reveal the common research contents and knowledge exchange in this field.

4.1 Coupling Analysis of Authors' Keywords

4.1.1 Potential Authors Collaborative Network Analysis

By extracting key words from the core author group literatures, and combining them semantically, deleting the keywords such as the concept is too large, and selecting keywords whose frequency is more than 5, 62 high frequency keywords can be obtained. In Excel, we use the self-compiled VBA program to generate 42 × 62 author-keyword matrix, and then use the minimum algorithm to generate the author-coupling matrix based on keywords. The matrix is imported into NETDRAW for visualization, as shown in Figure 1. The node size in Fig. 1 represents the center degree, and the thick line represents the number of coupling times between the authors. The color of the nodes is differentiated by K-cores, among which blue is the largest group. In this group, the number of authors is the largest and it has a strong influence in the field of mobile library research.

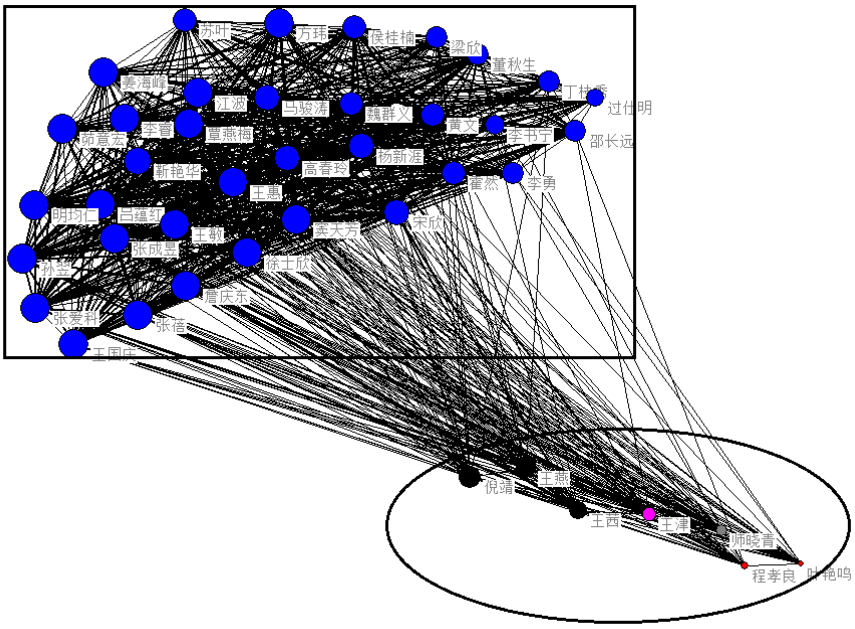

Fig.1 Authors Keywords Coupling network diagram

The density of the author's coupling network is 3.4425, and the overall network structure is very compact, the connectivity is very high and the potential cooperation is very frequent. As seen from Figure 1, the domestic mobile library research field has two important research force, namely the research team composed of the authors in the upper left rectangle box and the research team surrounded by authors in the lower right of the ellipse. These 42 authors are representative authors in the field of mobile library research, and generally have strong research vigor in this field. Among them, the authors on the rectangular frame have the highest degree of activity, constitute an important research strength of this research field. By K-cores analysis we found that the K-cores are 34, that is, the authors establish a coupling relationship with another 34 authors, the center of the higher ranking of the core authors are basically in this research force, such as Song Xin, Ma Juntao, Jiang Bo, and Jiang Haifeng and so on. The authors in the ellipses are less important, and their K-cores are between 27 and 30. They also have a high degree of activity.

Table 3. Keyword-based author coupling Network relation Node centrality (partial)

Serial number	Author	NrmDegree	Author	nBetweenness	Author	nCloseness
1	Song Xin	27.985	Jiang Bo	2.428	Jiang Bo	83.592

2	Ma Juntao	27.471	Jiang Haifeng	2.420	Jiang Haifeng	80.374
3	Sun Yi	26.316	Wang Guoqing	2.398	WangGuoqing	75.497
4	Huang	26.316	Dou Tianfang	2.398	DouTianfang	74.964
5	ZhangChengyu	26.187	Fang Wei	2.273	Fang Wei	71.390
6	Zhang Aike	25.289	Sun Yi	2.187	Sun Yi	68.895
7	Wang Hui	23.877	Qin Yanmei	2.019	Qin Yanmei	64.269
8	Dou Tianfang	23.877	Lv Yunhong	1.946	Lv Yunhong	64.180
9	Gao Chunling	23.363	Wang Hui	1.921	Wang Hui	59.762
10	Xu Shixin	23.235	Mao Yihong	1.899	Mao Yihong	57.307

Combining Table 2 and 3, it is found that Jiangbo is the most important author in the field of mobile library research, which has the highest rankings of the middle of the centrality and close to the centrality among the 42 authors. This indicates that he is an absolute influential scholar in the field of research, occupying an absolute dominant position in resource control. Followed by Jiang Haifeng, Wang Guoqing and other authors, their middle of the center and close are less central. Song Xin is another important author of mobile library research whit the highest degree of central, which indicates that her coupling relationship with other authors is maximum; but her the rankings of middle and close of the center were dropped to 25 and 23, which indicates that her resource control and influence of mobile library research are far less than Jiang Bo etc. In addition, we found that six of the authors in the top 10 of the published articles number appeared in the top ten of the degree centrality and in the middle of the centrality and close to the centrality of the top 10 are only two. And the center-centered ranking is consistent with the nearness of centralism. Then whether there is a certain correlation between the numbers of articles issued, the degree centrality, the middle of the centrality and close to the centrality? For this, this paper carried out a correlation analysis, as seen from Table 4.

Table 4. Correlation between the numbers of issued, the average number of coupling, the maximum number of times with the center of the coupling

	Article Number	Average coupling times	Maximum coupling times	Degree centrality	Intermediate centrality	Approach centrality
Article Number	1.000	0.711**	0.540**	0.744**	0.141	0.270
Average coupling times	0.711**	1.000	0.890**	0.995**	0.465**	0.629**
Maximum coupling times	0.540**	0.890**	1.000	0.859**	0.310**	0.455**
Degree centrality	0.744**	0.995**	0.859**	1.000	0.467**	0.637**
Intermediate centrality	0.141	0.465**	0.310**	0.467**	1.000	0.918**
Approach centrality	0.270	0.629**	0.455**	0.637**	0.918**	1.000
**. The correlation was significant when the confidence level (both sides) was 0.01						

Table 4 shows the correlation between the number of documents and the average coupling times, the maximum coupling times and the three centralizations. We can draw the following conclusions: (1) The correlation coefficient between the number of papers and average coupling times is 0.711, and the correlation coefficient with the maximum coupling times is 0.540, indicating that there is a strong correlation between them. Compared with the maximum coupling times, the higher the number of articles are published, the higher the average coupling times are produced. At the same time, the

correlation coefficient between the average coupling times and the maximum coupling times is 0.890, indicating that the correlation between them is very high, and the authors with high average coupling times are also popular in the maximum coupling times. (2) The correlation coefficients of the number of papers, the average coupling times, the maximum coupling times and the three centralizations are (0.744, 0.141, 0.270), (0.995, 0.465, 0.629), (0.859, 0.310, 0.455). Analysis shows that the correlation between the average number of coupling and the centralizations is the strongest, the second strongest correlation is the maximum number of coupling, and the influence of the number of papers is the lowest. Meanwhile, the correlation coefficient between the average coupling times and the degree centrality is 0.995, which is the strongest. The average coupling times is also higher with the central centralizations, which indicates that the higher the average coupling times is, the better the resources with control are. (3) The analysis of the correlation coefficient of centralizations showed that the correlation between the central centralizations and the near centralizations is the most significant, which was 0.918, and this is in line between the central centralizations and the near centralizations ranking.

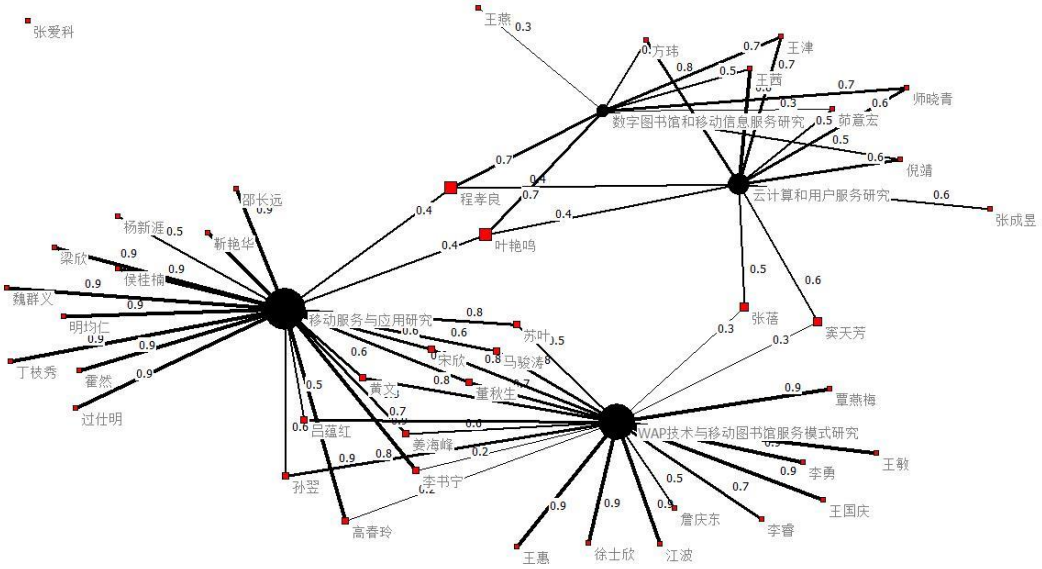

Fig.2 Authors and factor networks with factor loading greater than 0.2

4.1.2 Research topic analysis

Transform the author's coupling matrix into spearman correlation matrix, and have an factor analysis on the correlation matrix. The factors of principal component extraction are used to carry out the rotation by direct skewing. Finally, four factors are extracted, and the cumulative contribution rate is 92.996% and the fitting result is very satisfactory. The factor structure matrix reflects the relevance of the author to the research topic by the author's contribution to a particular topic and the relevance between them [4]. Therefore, a further NETDRAW visualization of the structural matrix is performed, with a factor load of 0.2 or more. The figure, the circle node represents the factor, the square node represents the author, the node size represents the center height, and the number next to the line of the factor to the author represents the load value. The thickness of the connection between the author and the factor expresses the factor load the size of the value. Because Zhang Aiken focuses on the empirical research of "211 Project" mobile library, the load of all four factors is below 0.2, so it becomes an isolated point.

Through the factor analysis, this paper divides 42 core authors into four research topics and do statistics on the indexed keywords of the research group, the author names the four research topics: mobile services and application research, WAP technology and mobile Library service model research, cloud computing and user service research, digital library and mobile information service research. Among them, mobile service and application research, WAP technology and mobile library service model research are two main research topics in the field of mobile library research, including the largest number of authors (22 and 21), digital library and mobile information Service research

authors are the least, only nine. As can be seen from the thickness of the lines in Fig. 2, these authors have higher factor loading values, and most of them have a high coupling relationship with the rest of the authors. Most of the authors focus on one topic of study and are more active in the field. In addition, Figure 2 also shows authors across a number of research fields, such as Gao Chunling, Jiang Haifeng across two research topics, Cheng Xiaoliang, Ye Yanming across three research areas. These authors, while are not exclusive to a particular field, act as a bridge between the various themes and strengthen the linkages between them so that they are not too isolated. At the same time it shows that there is a close relationship between the various research topics.

4.2 Author-keyword Coupling Analysis

Through the coupling analysis between the issuing organization and the keywords, the clustering based on the similarity degree of the keywords and the screening of the cooperative institutions can reveal the relevance of the research topics' inter-institutional. In order to provide guidelines for finding potential partners and strengthening cooperation and exchange [13].

The number of core-authors group's institution is 52. Cluster analysis is based on the characteristics of the things themselves to study the classification of individuals, the principle is the same class of individuals have greater similarity, different individuals are very different. The system coupling matrix is transformed into spearman correlation matrix, and clustered in SPSS to get the cluster tree. Through the coupling of keywords, due to geographical location and communication restrictions have never worked together, are linked together with similar research. As can be seen from Figure 3, 52 studies were divided into 5 study groups at threshold 5.

Group 1 consists of Jinggangshan University, Jinggangshan University Library, belonging to the same agency or regional cooperation, and no cooperate with other agencies. Its research content is only the university library and service innovation two aspects. There are 11 organizations including Chengdu University of Technology and its library, Nanjing Forestry University Library and Peking University in Group 2, which are distributed in six provinces such as Sichuan, Jiangsu and Shandong. The potential cooperation area is wider. The main research topics are the development, application of the mobile phone library under the 3G technology, and the library service as well as the reader service and so on. Group 3 is also composed of 11 organizations, such as Tsinghua University Library, Nanjing Agricultural University, Fuzhou University and its library, the main research topics are mobile library platform construction, user services and digital resources integration and so on. There are only 7 organizations in Group 4, mainly studying the service mode of mobile library. There are 21 organizations in Group 5, and most of them are located in economically developed areas such as Jiangsu, Fujian, Beijing and Shanghai. The theme of the group is flexible:, in which, mobile library applications and service models, university libraries, WAP technology, information services and other themes are more prominent. The statistics show that there are 31 libraries in 53 research institutions, which shows that university library is the main force in the field of mobile library research.

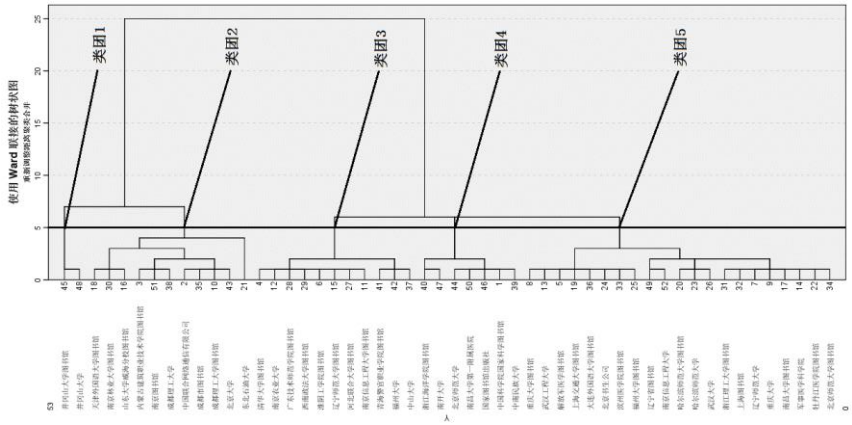

Fig.3 Coupling clustering diagram of mechanism keywords

4.3 Key words coupling analysis

Scientific journals are important carriers of scientific activities and are effective platforms for scholars to exchange knowledge [14]. Academic journals by coupling the same key words to form a coupling relationship, the strength of the relationship between the content of the journal can reveal the closeness of the relationship between the content of periodical research. The coupling analysis can be used to excavate the linkages between journals, which is of great value in investigating the internal knowledge structure and research status of the subjects [15].

The author edits the journals of the core authors, removing the non-library academic journals, and finally selects 27 journals, among which are the core journals. The coupling matrix is introduced into SPSS, and the distance is selected from the data. The Z-score is selected by the Euclidean distance metric method and the normalization method, as shown in Fig. In this case, Stress value is 0.139, smaller; RSQ is 0.921, the value is greater than 0.6, so the clustering effect is very good. As can be seen from Figure 4, the domestic mobile library research journals based on the similarity between keywords can be clustered into three categories.

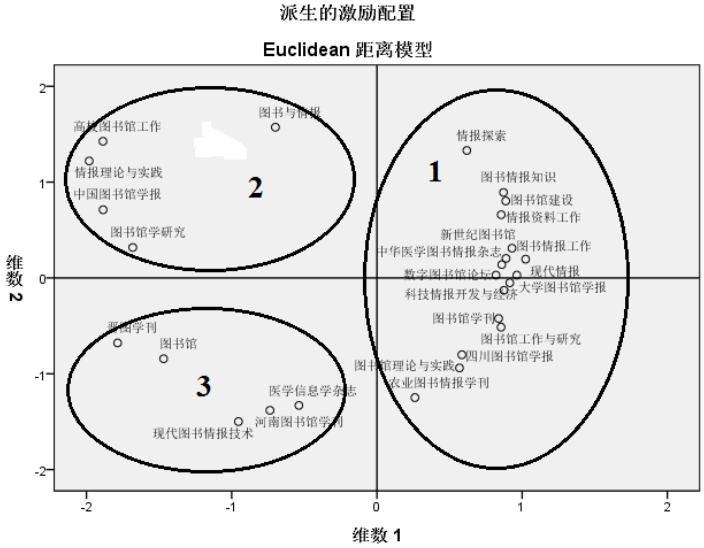

Figure 4 Key words coupling network Multidimensional scaling analysis

Cluster 1 includes 17 journals, such as "Library and Information Work", "Information Work", "Library Construction" and "Journal of Academic Libraries", which are the main journals in the field of mobile library research. Between the content of the study has a strong correlation. Through the statistical key words, the research contents of this cluster are mainly mobile library service mode, digital library, university library, user service and information service, especially service model, digital library and user service research.

Cluster 2 includes five journals, "Journal of Library and Information Science", "Library and Information", "Information Theory and Practice", "Library Science Research" and "University Library Work", mobile information service and digital resource construction. The subject of such research.

Cluster 3 includes five kinds of journals: "Library", "Modern Library and Information Technology", "Henan Library Journal", "Journal of Medical Informatics" and "Jin Tu Journal". The main research contents are based on WAP Technology for mobile library information services.

Through the research of the topic similarity, this paper analyzes the journals in the three research branches of the mobile library and the journals in the branches, and provides the reference for the scholars to select the target journals accurately. In addition, through similar topic journals clustering, the study of mobile library within the disciplinary structure, can improve the field of knowledge dissemination and communication efficiency.

5. Conclusion

In this paper, we use the social network analysis, the author, organization and periodical coupling analysis to research the potential cooperation relationship in the field of mobile library research. The following conclusions:

(1) The statistical analysis shows that the overall cooperation degree of mobile library research is 1.22, the cooperation rate is 30.01%, and the cooperation degree is low. Through the author keyword coupling analysis, mining mobile library research field two research strength. Jiang Bo, Jiang Haifeng and Song Xin are the representative authors in this field. There is a certain correlation between the number of articles published, the number of coupling times and the centrality. This paper explores four research themes: mobile service and application research, WAP technology and mobile library service model research, cloud computing and user service research, digital library and mobile information service research.

(2) Fifty-two research institutions were clustered into five research groups by means of keyword coupling analysis. Among the 52 research institutions, there are 31 libraries, accounting for 59.62% of the total. The university library is the main body of the mobile library.

(3) Based on the keyword coupling of periodicals, the paper divides the journals into three categories: the mobile library service model, the digital library, and so on. The scale is the largest one; the mobile information service and the digital resource construction are the subjects Cluster 2, and cluster 3, which is based on WAP technology, is the research content of mobile library information service.

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