Visual Atlas Analysis of Distance Measurement Research Literature Based on CiteSpace Literature Bibliometrics

Yunhui Zeng
Zhuhai Branch, Guangdong Institute of Special Equipment Inspection and Research, No.133, Renminxi Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Xiaoming Lin[*]
Zhuhai Branch, Guangdong Institute of Special Equipment Inspection and Research, No.133, Renminxi Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Li Huang
School of Intelligent Science and Engineering, Jinan University, No. 206, Qianshan Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Yilin Chen
School of Intelligent Science and Engineering, Jinan University, No. 206, Qianshan Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Fan Guo
Translation college, Jinan University, No. 206, Qianshan Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Hongfei Guo
College of Internet of Things and Logistics Engineering, Jinan University, No. 206, Qianshan Road, Xiangzhou District, Zhuhai City, Guangdong Province, China

Abstract
Based on 25668 literatures in the field of distance measurement research and application from 2015 to 2018, this paper uses CiteSpace information visualization software to visualize the distance measurement research literature. From the point of view of bibliometrics, this paper analyzes the visual atlas of countries, disciplines, research institutions, fund support, literature keywords and research frontiers of distance measurement methods. The literature information in the research and application fields of distance measurement at home and abroad in recent years is compared and analyzed. Information is used to evaluate the research progress and development trend of distance measurement, in order to provide literature reference for the relevant personnel engaged in distance measurement research.

Keywords: Distance measurement; Citespace; Bibliometrics; Visualization atlas.

1. Introduction
The development of modern science and technology has promoted the wide application of distance measurement technology. Distance measurement technology is widely used in direction control and positioning control system, which brings great convenience to the implementation of projects such as surveying and mapping as well as machinery and has a broad market. New ranging technologies, such as laser ranging, microwave radar ranging, ultrasonic ranging and infrared ranging, have appeared in mechanical engineering. At the same time, ranging technology is also widely used in the fields of information technology and biomedicine.
Source: https://wenku.baidu.com/view/b402abc6852458fb760b565b.html

At the present stage, scholars at home and abroad have made some achievements in distance measurement research. Barrau et al. Proposing a method to accurately measures the distance of using standard ZigBee equipment to make up for the shortcomings of the original broadband [1]. Sato et al. introduces a method to measure the obstacle distance around the hemispherical region of unmanned aerial vehicle (UAV) based on infrared depth sensor to ensure the applicability of the anti-collision system [2]. Yang Quanchao et al. puts forward a new method and device for measuring the braking distance of roller based on speed sensor [3]. Zhang Shensheng et al. introduces how to accurately confirm the safety switch of cone drum progressive anti-falling safety device in daily inspection and the effectiveness of anti-falling device, and raises the solution by measuring the braking distance [4]. Zhao Yong et al. adopts a new image feature extraction method based on the complexity of image string and the general image distance (UID) algorithm for image classification and recognition [5]. Haselich et al. uses 3D laser distance measurement to track pedestrians based on confidence in unstructured environments [6]. Since 1991, especially after 2000, there has been a surge in the literature related to distance measurement, which reaches a new height in 2015-2018 keeping the number of literatures more than 6000 every year and continuing to grow. However, scholars at

*Corresponding Author

home and abroad have studied the principle, method and application of distance measurement, yet less from the perspective of bibliometrics.

In order to understand the current research status and research trend of global distance measurement, this paper uses the method of bibliometrics, taking 25668 literatures related to distance measurement which are collected by Web of Science database as the research object and analyzing their vital atlas by means of information visualization software CiteSpace. It intends to reveal the distribution of hot countries, institutions and disciplines in distance measurement research, and the present situation, hot spots as well as trend frontiers of research and development, providing a certain reference for related research. .

2. Research Methods and Data Sources

2.1. Research Methods

Bibliometrics, which takes literature as the object of study and draws the support from its various characteristics, uses mathematical and statistical methods to describe, evaluate, and predict the present situation and development trend of a professional discipline. CiteSpace is an information visualization software developed jointly by Professor Chen Chaomei of the School of Information Science and Technology of Dreiser University and the WISE Laboratory of Dalian University of Technology. It is a Java application for analyzing and visualizing co-citation network which has been widely used in literature citation network analysis in recent years.

CiteSpace is a software for visual analysis of knowledge atlas. Based on the determination of research frontiers from topics, abstracts, search terms and burst terms, the time variation trend of subject research frontiers and the relationship between research frontiers and their knowledge basis are analyzed, and the internal relations between different research frontiers are found. When CiteSpace analyzes a certain subject or field, it can draw a visual scientific knowledge graph of the subject field through Cited Reference and keyword co-occurrence analysis. The temporal pattern TimezoneView, which emphasizes the research frontier and its knowledge base, can be generated to explore the frontier hotspots and their evolution process. Through the visual presentation of the literature, the evolution path of the subject frontier and the classical basic literature can be intuitively identified. By using CiteSpace to find the research status, progress, frontier and corresponding knowledge base of the subject field, researchers can identify and discover the new trends and trends in this field from the scientific literature.

2.2. Data Sources

The analysis data comes from the Web of Science TM core set database in Web of Science. Log on to the Web of Science home page and enter the subject word "graphene" and "coat "in the basic retrieval. In order to get the latest amount of published literatures in the data collection, all the literatures are counted, and the relevant statistics are made in different years. Up to the time of data collection, Web of Science has included 81969 literatures related to distance measurement. Because the complete data of the literatures in 2019 cannot be got when collecting data so in order to get the latest research hotspot of distance measurement, the time span is set at 2015 - 2018, to explore the progress of related research in the past four years. Then the refined retrieval is carried out, the "Web of Science TM Core Collection" database is selected and the retrieval results are 25668 literature records. After marking the retrieval data, enter the Web of Science TM core collection to collate the retrieval results, select the full description format with references, download and store it in plain text format with "* download.txt" as the file name. The retrieval time is March 25, 2019.

2.3. Step Analysis

Excel software is used to analyze the number of literatures from 2015 to 2018 to present the time variation trend of the number of literatures published in graphene coating research. Through the information visualization software CiteSpace in the literature measurement method, this paper analyzes the hot countries, research institutions, subject distribution, co-citation literature and frontier of the research literature.

Set the downloaded data with the file name "download.txt" to import Citespace, TimeSlicing from 2015-2018, YearsPerSlice to 1 year, and TermSource to Title, Abstract, DE, Keywords. TermType, NodeTypes, Links, Thresholding, Pruning, Visualization, etc., which are analyzed according to the angles of time, country, institution, subject, key hotword and cited literature. Then the visual knowledge graph of graphene coating research literature can be generated and the research status and frontier of graphene coatings are analyzed through atlas.
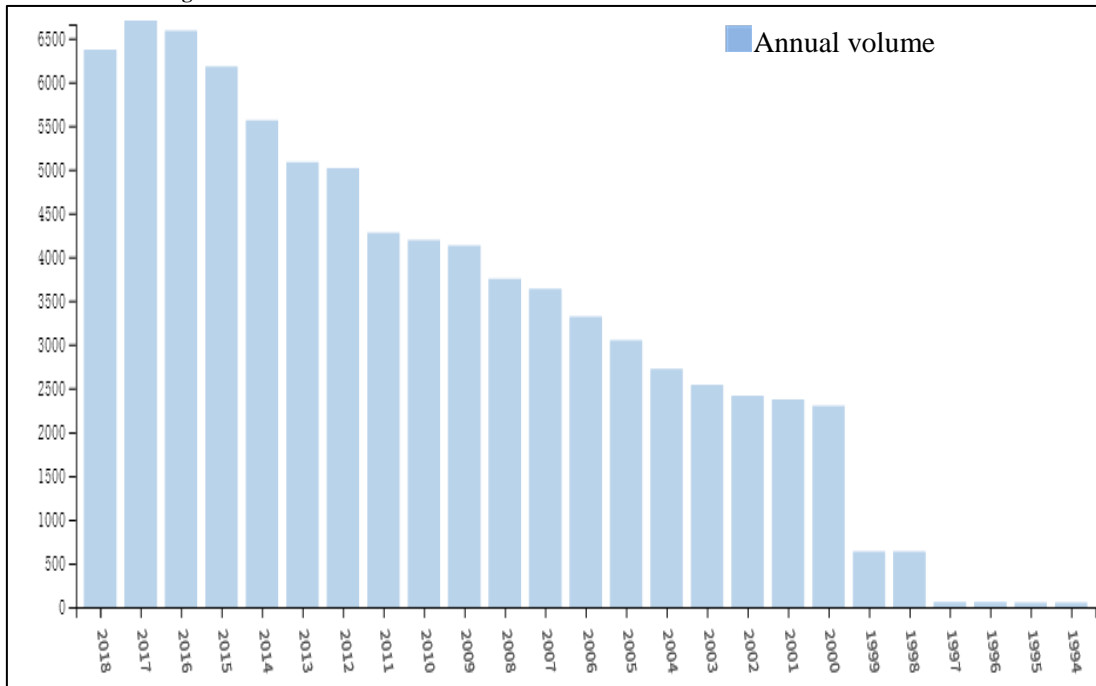
3. Result Analysis

3.1. Publication of Distance Measurement Research Literature

By analyzing the publication of the research literature on distance measurement in Figure 1, it can be seen that:

- The earliest retrieval literature in Web of Science began in 1986, but the research literature on graphene coatings did not appear until 1990.
- Before 1998, there were very few literatures on distance measurement. The number of published papers was less than 100 every year. In 1998, it exceeded 500 for the first time, but the number was still small.
- Before 1999, the total amount of literature was relatively small, and the situation of literature publication did not change much. Until 2000, the research literature of distance measurement began to increase year by year, showing an upward trend.

- With the leap of the science and technology since the 21st century, the publication of research literature on distance measurement has begun to show a surge trend, indicating that the research of distance measurement has become a research hotspot in recent years.
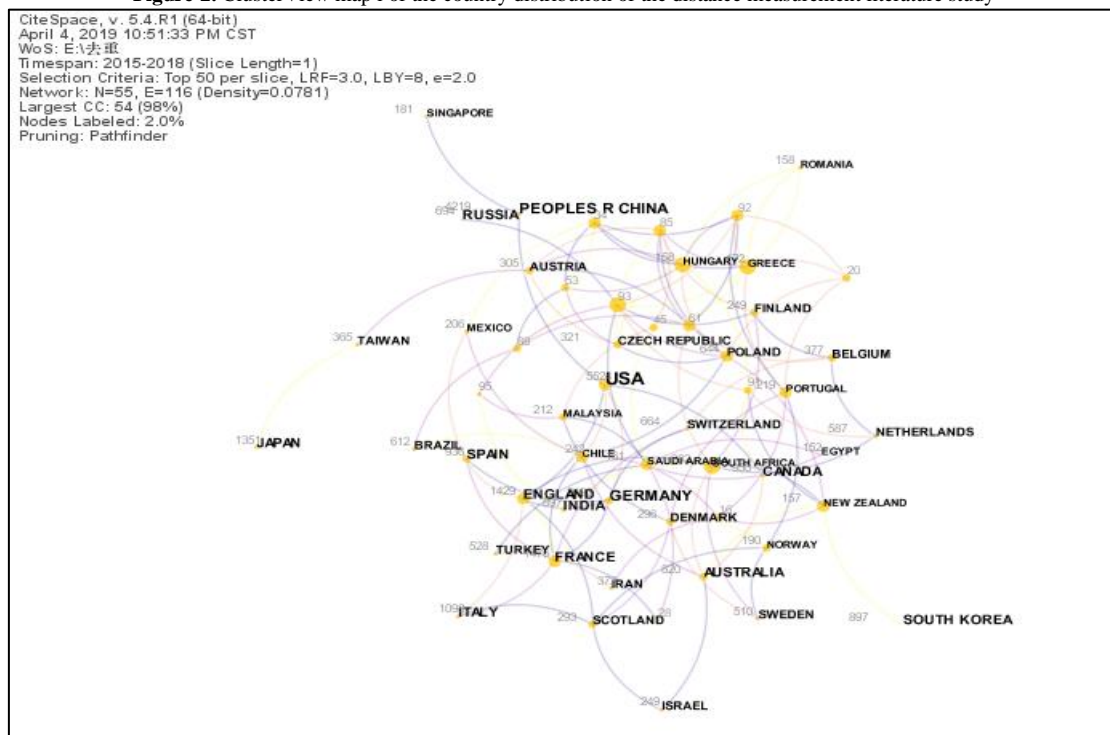
Figure-1. Published literature on distance measurement studies included in Web of Science

3.2. Analysis of the National Distribution of Distance Measurement Research Literature

The NodeTypes of CiteSpace selects Country, to set a reasonable threshold and draws the relevant visual knowledge atlas. According to the analysis of the results of the atlas (figure 2), the line between countries represents the cooperative relationship; the thickness of the line represents the density of cooperation, the more cooperation, the thicker the line. The knowledge network atlas consists of 55 nodes and 115 lines. Each node in the figure represents one country, and it can be clearly seen from the map that the literature is widely distributed all over the world, and 25668 distance measurement research literatures are mainly distributed in 55 countries around the world. In addition, it can be seen that the connection between nodes is generally fine, indicating that there is not a lot of cooperation between countries. at present, the research of distance measurement in each country is relatively independent. However, it has been observed that the central circle of the United States, China, South Africa and Greece is larger, indicating that the cooperation between these countries and other countries is more extensive and in-depth.

Figure-2. ClusterView map i of the country distribution of the distance measurement literature study

Based on the statistical results of the number of articles published in the hot countries of the relevant research literature on distance measurement (Table 1), the largest number of literatures are published in the United States and China, which were 6182 and 4950 respectively, accounting for 24.084% and 19.285% of the total respectively, followed by Germany, France and the United Kingdom. The number of research literatures in the top five countries reached 17162, accounting for 66.861% of the total number of published literatures. The number of published literatures in the top 10 countries accounted for 89.667% of the total.

Table-1. Status of publication of national data on distance measurement studies

Ranking	country	volume（Article）	percent（%）
1	United States	6182	24.084%
2	China	4950	19.285%
3	German	2794	10.885%
4	France	1642	6.397%
5	United Kingdom	1594	6.210%
6	Japan	1527	5.949%
7	Italy	1221	4.757%
8	Canada	1054	4.106%
9	Spain	1027	4.001%
10	Korea	1025	3.993%

In the analysis of the atlas generated by CiteSpace visualization software, the nodes with intermediary centrality greater than or equal to 0.1 are defined as the key nodes. The intermediary centrality of a node refers to the number of nodes passing through all the shortest paths in the network, and it is a measure of the size of the connection played by the nodes in the network as a whole. The higher the intermediary centrality of a node, the more it appears on the shortest path in the network, and the greater its influence and importance. Analyzing the knowledge graph of hot countries published in the literature according to the intermediary centrality statistics, the top three are the United Kingdom, Spain, France (Figure 3). It shows that the research between the British islands and the EU member States has a greater impact on each other.
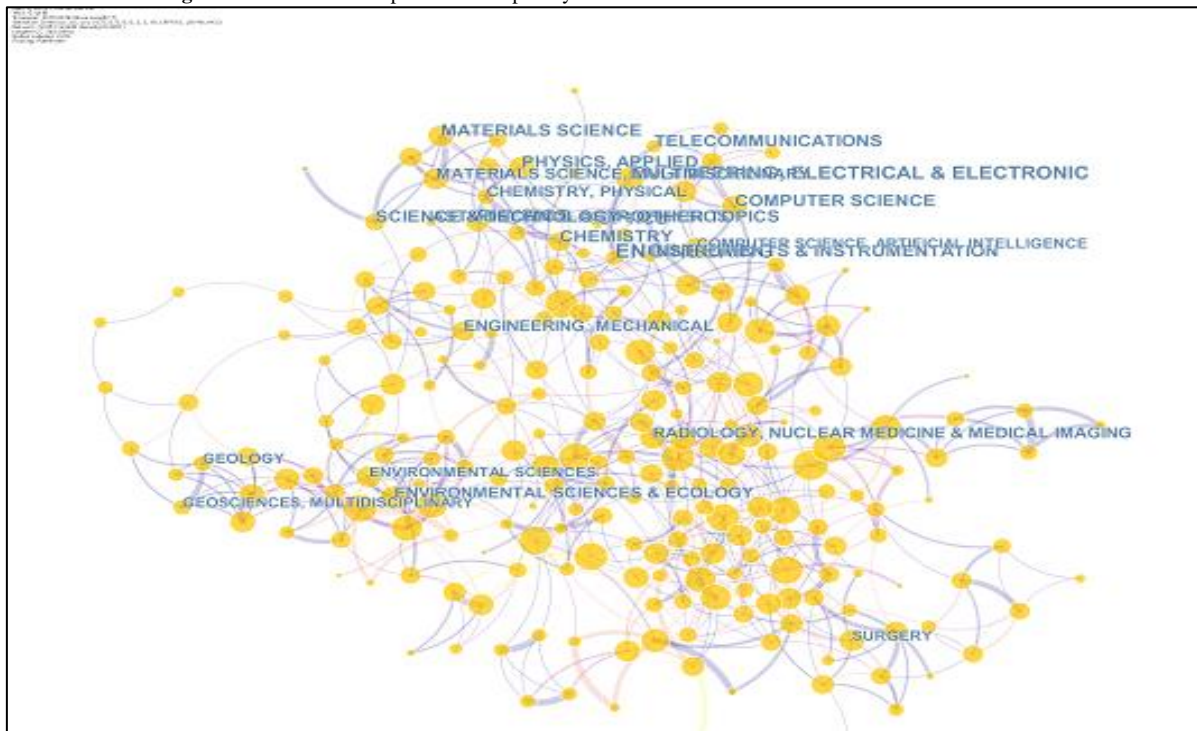
Figure-3. ClusterView map i of the country distribution of the distance measurement literature study

3.3. Subject Distribution of Distance Measurement Research Literature

NodeTypes selects the Category, threshold of (1,1, 10) (2,2,15) (3,3,20) and selects the shortest Pathfinder run data. After the analysis and processing of CiteSpace software, a visual atlas of the distribution of disciplines in the field of distance measurement is drawn, which is composed of 234 nodes and 265 lines (Figure 4). It can be seen that there are many obvious key nodes in the map, and the nodes are connected to each other, each node represents a discipline, and the connection between nodes represents the osmotic relationship between disciplines.

Figure-4. ClusterView map i of the disciplinary distribution of distance measurement literature research

The statistical results of the number of literatures published in various disciplines of distance measurement research literature can be obtained (Table 2). In the distance measurement research literature, the number of published research literatures related to Engineering reached 6812, accounting for 23.77% of the total published literatures and at the heart of it. Followed by published research literatures related to Engineering Electrical & Electronic 3501, published literatures related to Physics 3302, accounting for 13.64% and 12.58% of the total literatures published, respectively. From the number of literatures published, in the related literature research disciplines of distance measurement, Engineering, Engineering Electrical & Electronic, Physics as the core, mainly extended to the field of Chemistry, Computer Science, Optics, Astronomy & Astrophysics, Physics Applied. It shows that distance measurement research in the future development, the application field is very extensive, and the interaction with various disciplines is very strong.

Table-2. Disciplinary distribution of distance measurement research literature

Ranking	Subject	volume（Article）	percent（%）
1	Engineering	6102	23.77%
2	Engineering Electrical & Electronic	3501	13.64%
3	Physics	3302	12.85%
4	Chemistry	1776	6.92%
5	Computer Science	1761	6.91%
6	Optics	1746	6.80%
7	Astronomy & Astrophysics	1614	6.29%
8	Physics Applied	1544	6.02%
9	Materials Science	1320	5.14%

Key nodes play an important role in connecting in the overall network, which has a relatively large influence and importance. The key nodes with intermediary centrality greater than or equal to 0.1 are selected from the map generated by Cite Space visualization software (Table 3), and the mediation centrality is compared and analyzed. The top disciplines are public environmental occupational health engineering, electricity, computer science and behavioral science. Compared with Table 2, not much of the subject literatures are published in these subjects, but the centrality is very high, which indicates that in the trend of academic knowledge diffusion and knowledge sharing in distance measurement research, absorption of the existing technical advantages of distance measurement in other disciplines to carry out the development of the discipline, and use of the new technology to solve the key problems of the discipline play an important role in the extension and penetration of the discipline. Combined with the time zone view generated by the hot subject of distance measurement literature research (Figure 6), conclusion has been drawn that from 2015 to 2018, the basic disciplines of public environmental occupational health engineering, electricity, computer science and behavioral science have been a hot field of distance measurement research, infiltrating and extending from which to other disciplines. It shows that the current research in the development of distance measurement is mainly focused on the research and application of methods, most of the research is at the macro level, and there is still great research value and development potential for further exploration and

improvement of methods. The value and development potential of the disciplines that have been studied in relative depth need to be further excavated.

Figure-5. ClusterView map ii of the disciplinary distribution of distance measurement literature research
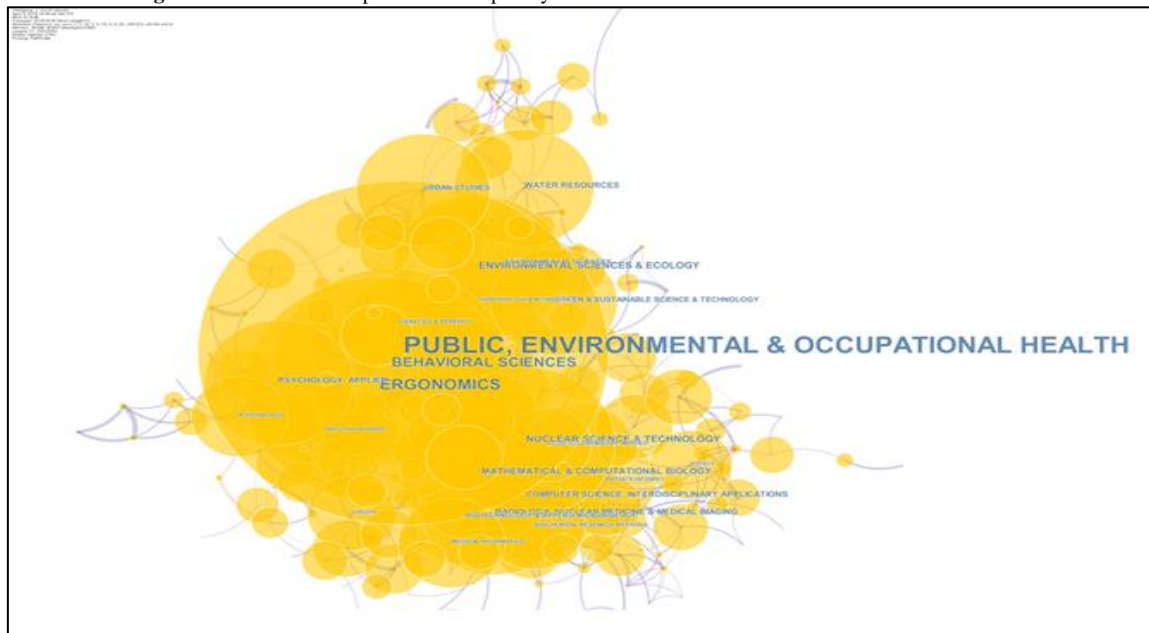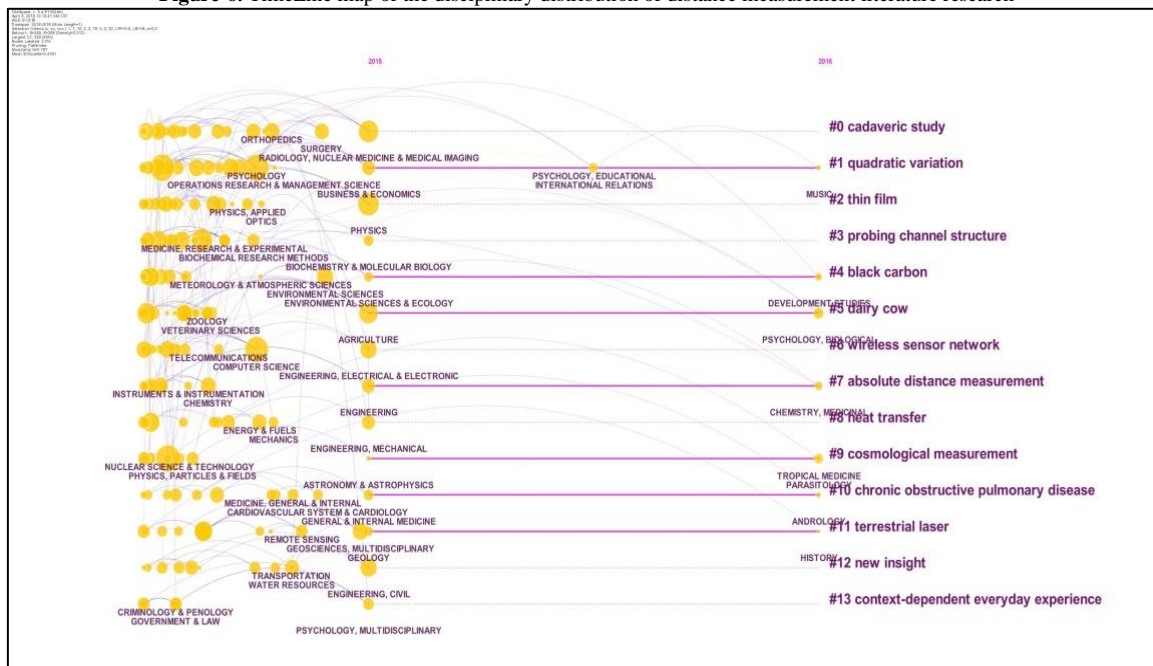

Figure-6. TimeLine map of the disciplinary distribution of distance measurement literature research

3.4. Distribution of Hot-Spot Mechanisms in Distance Measurement Research

Node Types selects institution, to set a reasonable threshold, and the visual atlas of mechanism cooperation for distance measurement research can be generated by Cite Space software. The resulting atlas is very similar to the map of national partnerships engaged in distance measurement-related research (Figure 7), and the analysis shows that the institutions involved in distance measurement-related research are also widely distributed around the world. However, the mutual cooperation between institutions is not strong. Most of the cooperative relations between institutions are between the National Academy of Sciences and colleges and universities, and there is a form of cooperation between enterprises and colleges and universities at the same time. Colleges and universities and scientific research institutes play an important role in the research of the whole distance measurement method, and promote the development process in the field of distance measurement research. This paper is from the distance measurement of the published literature, the results of the analysis of colleges, universities and scientific research institutes in the volume and influence of the absolute advantage. From the current cooperation of distance measurement research institutions, the institutions engaged in distance measurement research are relatively extensive, not only including academic research institutions (colleges and universities, scientific research institutes), but also involving enterprises, the government and some individuals.

Figure-7. Cluster View map of the organization distribution of the distance measurement literature study

3.5. Analysis of Funded Status from the Graphene Coatings Research Fund for Distance Measurement
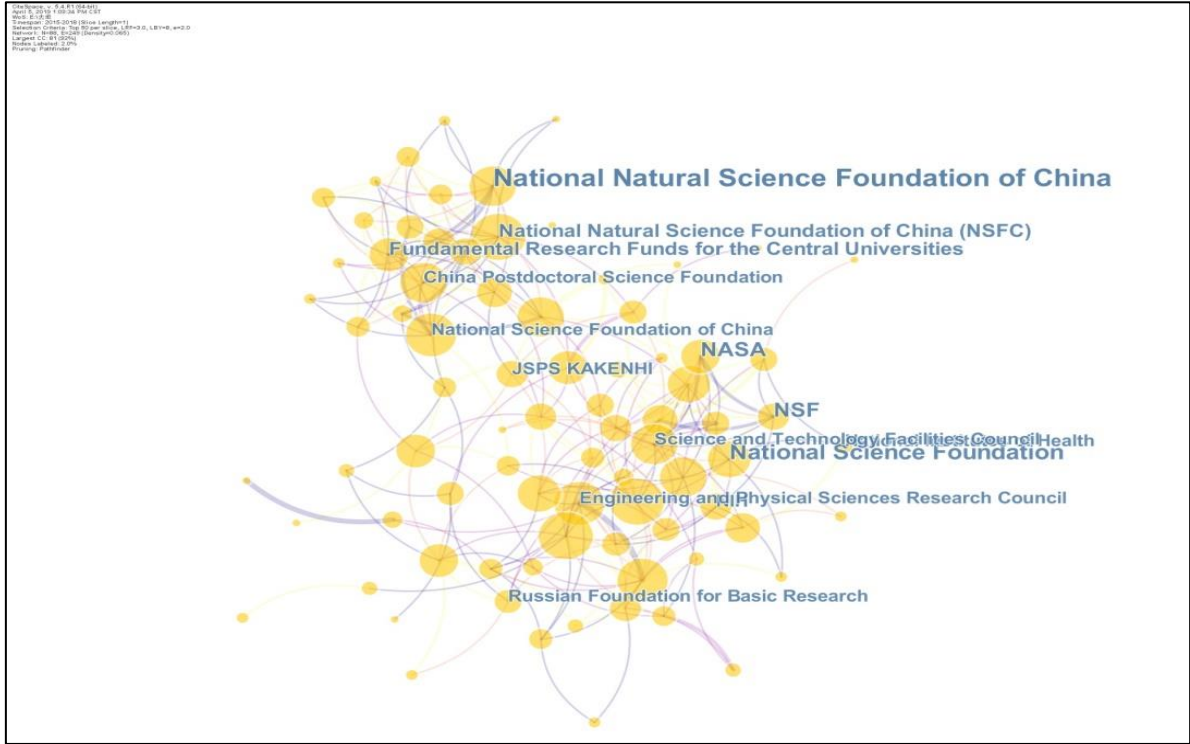
NodeTypes selects grant, to set a reasonable threshold and selects the shortest Pathfinder, to draw a visual analysis map of the funding status of the Distance Measurement Research Fund. Because of the results of CiteSpace software analysis and statistics, the abbreviation and the full name of the English fund are identified as two different funds. The abbreviation and the whole process of the same fund are combined and counted in the statistical analysis. The status of global funding for distance measurement research is shown in Table 3. The largest amount of funding is obviously China, which accounts for four of the top 10 projects in the world, and the number is far ahead, indicating that China has attached great importance to research in the field of distance measurement research in recent years. It also shows that distance measurement research may cause great influence in the future national development.

Table-3. Relevant research grants for distance measurement studies

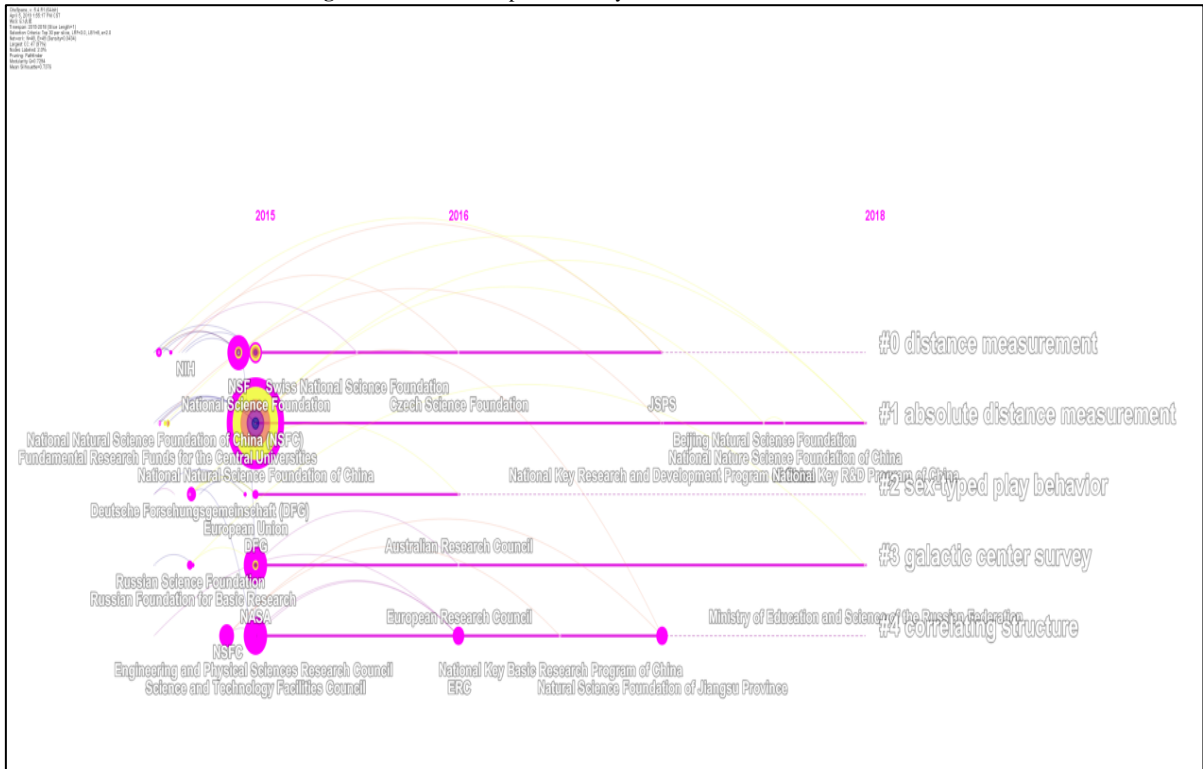| Ranking	grant	country	Number of grants
1	National Natural Science Foundation of China	China	1864
2	Natural Science Foundation	China	655
3	National Science Foundation	United States	434
4	National Aeronautics and Space Administration	United States	357
5	Fundamental Research Funds for the Central Universities	China	318
6	National Nature Science Foundation of China	China	212
7	National Institutes of Health	United States	165
8	National Institutes of Health	United States	162
9	European Union	European Union	153
10	Science and Technology Facilities Council	United Kingdom	140

The graphene coating-related research-funded cluster diagram (Figure. 8), generated by CiteSpace software, contains 88 nodes and 249 connections, resulting in 88 clusters and 81 large clusters. The graphene coating-related research-funded cluster diagram (Figure 8), generated by CiteSpace software, contains 88 nodes and 249 connections, resulting in 88 clusters and 81 large clusters. From the funding projects represented by 88 nodes, the number of funded projects related to distance measurement research is very large in the global scope. At present, the research investment in this area is huge and the research is hot. The number of as many as 88 clusters is generated, which also shows that the relevant research involves a wide range of project categories and a wide range of fields.

Figure-8. ClusterView map of the funded distribution of the distance measurement literature study

From the visual TimeLine knowledge atlas generated by CiteSpace software (Figure 9), it is clear that most of the fund projects are launched in 2015, and the top 10 funding funds have been invested since 2015. Continued investment has also been maintained over the next few years, with some new funding projects continuing to increase in 2016 and starting in 2017 with a marked decrease or even no increase in new funding projects.

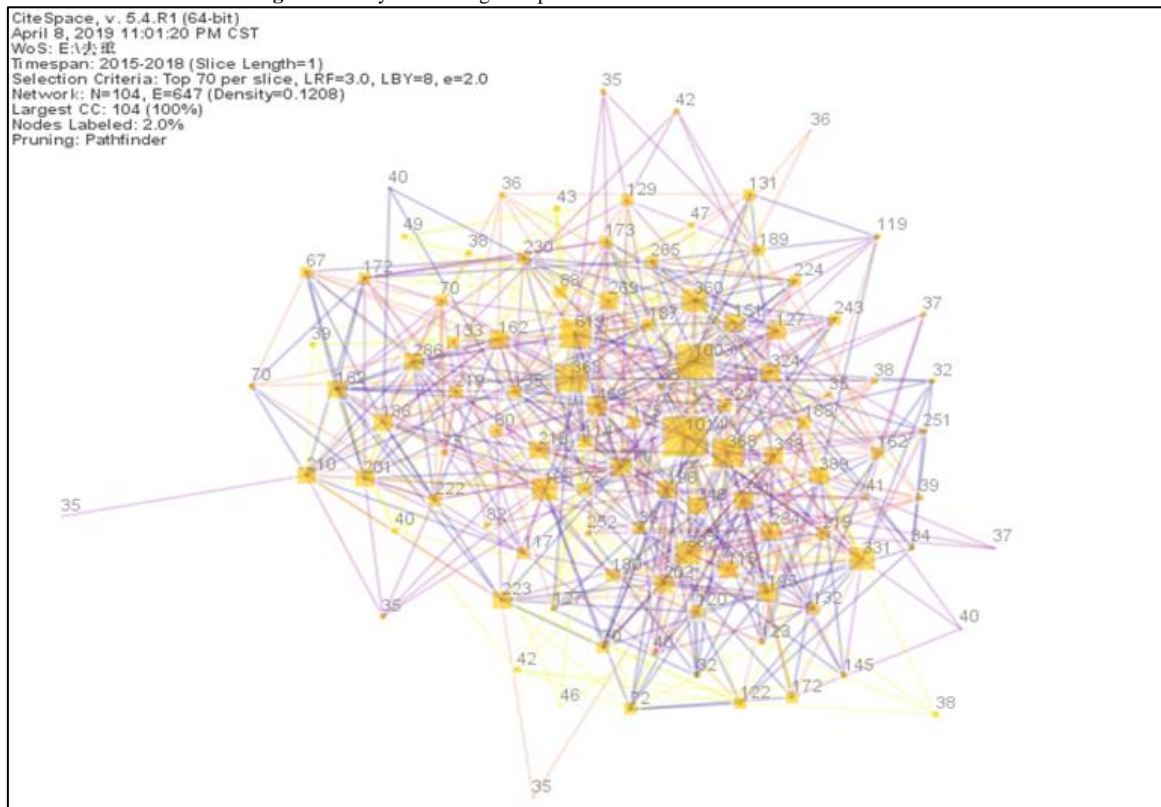**Figure-9.** TimeLine map of the study related to distance measurement

3.6. Research on Keyword Strength and Frontier Analysis of Distance Measurement

NodeTypes selects keyword, to set the relevant threshold and selects the shortest Pathfinder to draw a visual network atlas (Figure 10). The visualization is a keyword strength network analysis atlas which classifies the research direction of a large number of literatures, which is composed of 104 nodes and 647 lines. Through the cluster analysis diagram generated by the co-occurrence network, the combined network structure of the knowledge frontier and knowledge base in the field of distance measurement research can be presented, and the research hotspots and their development changes in the research process can be found.

Figure-10. Keyword strength map of distance measurement literature research

The strength distribution of keywords can be obtained from the results of the operation of CiteSpace software (Table 4). By analyzing the literature with high strength keywords, the hot spots in the field of distance measurement research can be obtained. However, due to the impact of keyword types, journal types, influencing factors and other factors in scientific research literature, there will be a certain deviation in the analysis only according to the frequency of occurrence.

Table-4. Keyword strength rankings for distance measurement literature research

Keywords	Year	Strength	Begin	End
mechanism	2015	19.3107	2016	2018
image	2015	19.2671	2015	2016
scale	2015	18.1064	2016	2018
optimization	2015	17.1039	2016	2018
digital sky survey	2015	3.3794	2015	2016

Through the analysis of the keyword intensity, it can be found that the higher the intensity of the keyword, the more frequent the keyword appears in the field of distance measurement, and the more times the keyword is used. As can be seen from the statistical table, the key word with the highest strength is mechanism, which shows that the research of distance measurement mostly uses mechanical knowledge and distance measurement technology is widely used in the field of mechanical industry and precision instruments. For example, Zhang Duo designs the absolute distance measurement scheme, builds the optical interference system, and obtains the beat frequency signal, then collects and processes the beat frequency signal under different measured distances, and establishes the linear relationship between the laser beat frequency and the measured distance. Zhang Jiatian et al realize that the proximity sensor can detect the displacement of the metal object close to the sensor without contact with the target. The system uses C8051F310 as the main controller and realizes the non-contact distance measurement by connecting the proximity sensor [7]. The second key word in intensity is image, which indicates that the knowledge of image processing is also widely used in the study of distance measurement. For example, by establishing an image acquisition related system, Zhang Kunping et al., use professional programming procedures to detect the edges of the collected images, substituting the difference of the edge line pixels into the formula for evaluating the measurement distance to prove that the correlation processing technology of digital image is accurate in distance measurement [8].

From the point of view of keyword intensity, distance measurement research can break through various limitations and achieve fuller and wider application.

4. Conclusion

Cite Space bibliometric method and other software are used to analyze the sci-tech periodicals and related literature of distance measurement collected by Web of Science from 2015 to 2018. the results show that:

4.1. Research of Number of Published Literatures

After 2000 years of distance measurement research, the publication of relevant literature began to show an explosive growth trend, which reaches an average of 6000 articles per year in 2015-2018 and shows a steady growth trend. It shows that the research of distance measurement has become a hot research in recent years.

Source: https://cloud.tencent.com/developer/news/360442

4.2. Research of Hot-Spot National Distribution of Literature Sources

From the point of view of the distribution of literature countries, the countries engaged in distance measurement related research are widely distributed, with the United States, China, Germany and France ranked in the top four. China has a high quantity of publishes literature, yet has a big lack of influence, cannot occupy the dominant position in the related domain.

4.3. Research of Discipline Distribution

From the point of view of the distribution of research disciplines, distance measurement is mainly used in the field of engineering material chemistry, followed by the field of electrical and electronic engineering. At present, the main research on distance measurement is still focused on the research and application of the method.

4.4. Distribution of Hot Research Institutions and Funding Status

In terms of research institutions and fund funding, China and the United States are the largest funding supporters. The research field of distance measurement in the world is very extensive.

4.5. Analysis of Key Words Intensity and Frontier

According to the analysis of keyword intensity, the intensity of mechanism is the highest, reaching 19.3107. With the progress of science and technology, these existing knowledge systems provide researchers with literature reference and promote the development of distance measurement technology.

To sum up, the research work of distance measurement at home and abroad is in full swing, and the research and application of distance measurement in our country also maintain a good momentum of development. Although the current influence is lacking, the overall development is in sound condition. However, if influence in the international arena tends to be further expanded, the frontiers of field development and research hotspots must be targeted, starting to move toward deeper research and actively strengthening cooperation and exchanges with world-class institutions. Only in this way can we maintain the sustained and rapid development in the field of distance measurement research in our country.

Acknowledgement

References

[1]   Barrau, F.-E., 2014. "Distance measurement using narrowband ZigBee devices." In *Wireless and Optical Communication Conference (WOCC)*.

[2]   Sato, P., 2014. "Ultrasonic precise distance measurement and movement detection installed in sensor network." In *Ultrasonics Symposium (IUS), IEEE International*.

[3]   Yang, W.-W., 2019. "A new measurement method and device for braking distance of road roller." *Construction Mechanization,* vol. 40, pp. 61-62.

[4]   Zhang, 2018. *Research on linear frequency modulation absolute distance measurement system for semiconductor lasers*. Xi'an University of Technology, p. 11.

[5]   Zhao, L., 2017. "A machine learning method based on universal distance measurement for image classification and clustering." *Electronic Measurement Technology,* vol. 40, pp. 136-140.

[6]   Haselich, P., 2014. "Confidence-based pedestrian tracking in unstructured environments using 3D laser distance measurements." In *Intelligent Robots and Systems*.

[7]   Zhang, W.-Y., 2012. "Non-contact distance measurement system." *Electronic Measurement Technology,* vol. 35, pp. 10-13.

[8]   Zhang, 2016. "Application of digital image processing in distance measurement." *Digital Technology and Application,* p. 84.