

Bibliometric Analysis of 2019–2021 Conference Proceedings on Artificial Intelligence and Energy Indexed in Scopus

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Abstract — The article presents a bibliometric analysis of 2019–2021 conference proceedings indexed in Scopus and dealing with the subject of Artificial Intelligence and Energy. The relevance of the subject is considered in the context of the energy transition and the application of artificial intelligence to the rational use of energy resources. A comparative analysis of the publication activity of researchers from Russia, China, India, the United States, and Indonesia on the subject in question is given. Methodology-wise, the emphasis for the purpose of identifying the subject is not on the co-occurrence of keywords but rather on the clustering of documents, which rests on the hypothesis that the titles of research contributions most concisely and fully reveal the content of the research paper and allow the subject matter expert to make a relevant choice of such contributions to facilitate their research. The study made use of two software tools: Carrot2 and Clustering App (CSV Explorer). It is shown that Russian contributions are characterized by the tendency of having engineering issues prevail while insufficient attention is paid to environmental, economic, and social issues of using AI in the energy sector. Studies originating from China and the United States are of the greatest interest in terms of the information presented, both with respect to the relevance of their topics and the cutting-edge nature of their content. Studies from India and Indonesia are more general in nature; of interest are the efforts of these countries to engage in global scientific activities.

Index Terms: bibliometric analysis, artificial intelligence, energy, documents clustering, Carrot2, Clustering App (CSV Explorer).

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<http://dx.doi.org/10.38028/esr.2022.01.0005>

Received May 06, 2022. Revised May 21, 2022.

Accepted June 03, 2022. Available online June 25, 2022.

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I. INTRODUCTION AND OBJECTIVES

The subject of the energy transition is largely related to the efficient and rational use of energy resources. Such a statement of the problem is actively promoted by leading international institutions. Thus, the International Energy Agency supported the policy “National Program for Rational and Efficient Use of Energy” (2007–2017) designed to support the efficient use of energy in energy production, transportation and distribution, storage and consumption, to achieve the highest sustainable development with the available technologies, minimizing the impact on the environment and optimization of energy saving and cost reduction.

Since 2010, there has been an expansion of this program to introduce energy efficiency measures into national public buildings, standardize management systems, develop recommendations and implement energy efficiency measures. The report [1] states that in 2021, global energy intensity – a key measure of the economy’s energy efficiency – is expected to improve by 1.9% after improving by only 0.5% in 2020.

The Russian Federation is characterized by a high level of energy intensity of its GDP [1–3], the current situation requires reducing the specific consumption of fuel, heat, and electricity by increasing their rational use.

The main reasons behind this situation taking place are the wear-and-tear and obsolescence of process equipment and energy equipment, along with high energy losses in buildings and structures.

In this regard, the Ministry of Economic Development of the Russian Federation is working to fulfill the task set by the President of the Russian Federation to reduce the energy intensity of the GDP, including as part of the implementation of a comprehensive plan of measures to improve the energy efficiency of the Russian economy, approved by Order No. 703-r of the Government of the Russian Federation of April 19, 2018.

The report “Energy Efficiency in Russia: Untapped Reserves” [4] presents a comprehensive, practical analysis of energy efficiency in Russia: its potential, benefits, and recommendations for making full use of this resource.

To solve the above tasks, relevant structures are created: the Center for Expert and Analytical Support in the Field of

Energy Saving and Energy Efficiency Improvement of the Ministry of Economic Development of Russia, Department of Competition, Energy Efficiency, and Environment.

The International Energy Agency also emphasizes that energy transitions require innovation in power system planning.

Achieving these goals is possible only on the basis of in-depth data analysis in making both organizational and engineering decisions.

Advances in AI technology make it possible to explore vast amounts of monitoring data, optimize processes, predict anomalies, identify objects, and extract meaning from disparate data sources. Enriching reality with a digital twin, providing verification and trust through distributed ledgers fundamentally changes operational activities.

Leading oil and gas companies are well aware of this, to take one example, there is an opinion voiced by Shell as cited in the article “Digitalization accelerates the energy transition,” and it is clear that digitalization is based on artificial intelligence [5].

A variety of issues related to this matter can be found in the report [6].

The above brief summaries were to define the main objective of this study: how the issues of AI applications in the energy sector are mapped in the proceedings of scientific conferences of 2019–2021.

Materials

The choice of abstract databases for bibliometric analysis is quite subjective, the indexing of conference papers and the forming of queries in the databases differ significantly. The arguments in favor of the choice of Scopus for this author were the following results of queries to the two main abstract databases:

WoS: for Conference Proceedings Citation Index – Science (CPCI-S); 2019–2021; Topic=Energy, one gets **73 560** results as of 2022-02-19. When refined by Countries= RUSSIA the query returns **4 545** results.

Scopus: the query PUBYEAR > 2018 AND SUBJAREA (ener) AND (LIMIT-TO (DOCTYPE, “cp”)) returns **159 249** results. When refined by AFFILCOUNTRY, “Russian Federation” the query returns **14 667** results.

Since one of the goals of this study was to identify possible areas for further research in the field of energy for Russian academic institutions, the significantly higher representation of Russian conference proceedings on energy-related topics in Scopus influenced the choice in favor of this abstract database.

The second selection factor was the classification system used by these abstract databases, while they are comparable to some extent for energy-related topics: WC=Web of Science Categories Energy & Fuels and Scopus SUBJAREA Energy, including: Energy (all); Energy (miscellaneous); Energy and Energy Technologies; Fuel Technologies; Nuclear Energy and Engineering; Renewable Energy Sources, it is harder to compare them

with respect to topics related to Artificial Intelligence.

Scopus has All Science Journal Classification Codes (ASJC) and the code 1702 – Artificial Intelligence, while in WoS a similar result can only be achieved by forming a query with Topic = Artificial Intelligence, which is not a built-in filter in the system.

When analyzing the topics of conference papers, additional keywords are important: Keyword Plus in WoS (Key Words Plus are index terms automatically generated from the titles of cited articles) and Index Keywords (Index Terms) in Scopus (Description: Controlled vocabulary terms assigned to the document). The advantage of the Scopus platform appears to be in the controlled vocabulary of terms (uniform description of entities) and the fact that Index Keywords reflect the content of the document, not the titles of references. And this study aims to work with the content of the conference proceedings themselves, rather than identifying topics from the titles of references.

The reasoning behind choosing conference proceedings over journal articles to form the main query was as follows: of the total 31 058 research contributions written in English and indexed in Scopus for 2019–2021 for SUBJTERMS (1702) AND SUBJAREA (ener), 29 160 are articles from conference proceedings and 1 252 are journal articles. Contributions by Russian authors are 1 585 conference papers and 113 journal articles, respectively. Moreover, 112 articles by Russian authors were published in the International Journal of Engineering Research and Technology, which is no longer indexed by Scopus since 2021, i.e., in a journal with low ranking.

With the above reasons in mind, the final query to Scopus was stated as follows: (SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA(ENER) AND (LIMIT-TO (DOCTYPE, “cp”)) AND (LIMIT-TO (LANGUAGE, “English”))).

Methods

The main data structure used in text analysis is the term-document matrix (TDM), even if the terms are authors’ names or affiliations. The terms can also be bibliographic data, authors’ keywords, and the fields of research to which the papers belong. In turn, one can treat, to take one example, a journal issue as a single document, and use areas of research as terms and analyze trends in the research topics of a given journal.

TDM is the most common form of document vectorization [7], from which one can build a matrix of co-occurrence of terms and conduct further analysis using free software packages. Such software packages can handle the original bibliometric data available from the WoS, Scopus, and The Lens abstract databases directly.

The most common software tools for bibliometric studies are VOSviewer [8], Citespace [9], and Bibliometrix [10]. The Scopus database for 2019–2021 lists 1 927 documents that published with the term VOSviewer mentioned in their titles, abstracts, and keywords, 1 383 documents mention

Citespace, and Bibliometrix is mentioned 274 times.

When solving the problem of analyzing trends in research topics, the major usage of these programs is to analyze the co-occurrence of terms, even if the term is a cited document.

The approach of clustering documents by similarity of their texts using free software is much less common.

For example, the high-quality software Carrot2, which is used as a document clustering engine, appears only 9 times in Scopus-indexed articles for 2019–2021.

If we consider the use of the above software within our main query `SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA(ENER) AND (LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English"))` then we get: **5** documents for VOSviewer, **3** documents for Citespace, **1** document for Bibliometrix, and **0** documents for Carrot2, respectively.

Comparing the occurrence of the terms “document clustering” and bibliometric* within our main query we get: **4** document results returned by `SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA(ener) AND TITLE-ABS-KEY (“document clustering”) AND (LIMIT-TO (DOCTYPE, “cp”) AND (LIMIT-TO (LANGUAGE, “English”))` and **18** document results returned by `SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA(ener) AND TITLE-ABS-KEY(bibliometric*) AND (LIMIT-TO (DOCTYPE, “cp”) AND (LIMIT-TO (LANGUAGE, “English”))`.

One can come up with different examples but the result will be approximately the same: the “document clustering” term is used less often than “bibliometric”.

It is worth noting that for a subject-matter expert, the titles of research papers and their systematization prove more telling of the area of research than when identifying topics by keyword clustering.

Therefore, one of the goals of this paper is to explore and demonstrate the use of software that allows clustering of documents to identify dominant research topics that correspond to our main Scopus query.

Two tools were used in this work: Carrot2 and Clustering App (CSV Explorer). The algorithm Lingo3G used in Carrot2 is proprietary, while the latter package uses Topic Modeling by applying non-negative matrix factorization.

II. ANALYSIS AND RESULTS

Discussion of the results of the analysis of bibliometric data and identification of dominant research topics covers the following: a brief discussion of the features of Russian conference proceedings, identification of countries whose publication activity is comparable with that of Russian authors, a comparative analysis of the main topics dealt with in these countries and Russian conference proceedings as based on document clustering and presented as lists of titles of papers in major clusters.

The main feature of the Russian conference proceedings

that satisfied our main Scopus query is that the vast majority of them were presented at the three types of conferences held in Russia as listed below.

Of these, the vast majority of papers (1 005) are presented at the International Multi Conference on Industrial Engineering and Modern Technologies FarEastCon held in 2019 and 2020 in Russia. At international conference, held in Madrid in 2021, which is the second most important conference, only 14 Russian papers on the subject were published.

- International Multi Conference on Industrial Engineering and Modern Technologies FarEastCon 2020 (https://www.dvfu.ru/schools/engineering/far_east_con/) – 559.
- International Multi Conference on Industrial Engineering and Modern Technologies FarEastCon 2019 – 446.
- 3rd International Conference on Control Systems Mathematical Modeling Automation and Energy Efficiency Summa 2021 (<https://summa.stu.lipetsk.ru/>) – 240.
- International Russian Automation Conference Rusautocon 2020 (<https://rusautocon.org/index-eng.html>) – 194.
- 2021 IEEE Madrid Powertech. Powertech 2021 Conference Proceedings – 14.

The data from this list show that Russian researchers need to develop and promote Russian scientific conferences to the international level; participation in conferences held abroad is fine but expensive.

Moreover, given that the majority of Russian articles are published in the International Journal of Engineering Research and Technology, which does not rank among the best journals, then what was said above about conferences holds to even greater extent for Russian journals where Russian researchers can publish their papers on AI as applied to the energy sector.

When considering the affiliations of the Russian authors of the conference proceedings, it can be seen that the list includes the major leading Russian technical universities and institutes: Russian Academy of Sciences (61 conference proceedings); Lipetsk State Technical University (57); National Research University “Moscow Power Engineering Institute” (53); Komsomolsk-na-Amure State University (52); V. A. Trapeznikov Institute of Control Sciences (51); South Ural State University (51); Far Eastern Federal University (43); Voronezh State Technical University (35); Platov South-Russian State Polytechnic University NPI (34); North-Eastern Federal University (33); Samara National Research University (32); Samara State Technical University (32); Kazan National Research Technical University named after A. N. Tupolev -KAI (32); Peter the Great St. Petersburg Polytechnic University (31); Novosibirsk State Technical University (30); Skolkovo Institute of Science and Technology (29); Kazan State Power Engineering University (28); Ufa

TABLE 1. Distribution of the number of conference proceedings on AI for Energy for 2019–2021 for Russia and the 4 countries by main areas of research.

Country:	Russia		India		China		US		Indonesia	
SUBJECT AREA	N	%	N	%	N	%	N	%	N	%
Computer Science	1577	22.868	6102	25.78	5678	25.032	1689	24.791	819	25.27
Energy	1577	22.868	6102	25.78	5678	25.032	1689	24.791	819	25.27
Engineering	1567	22.723	3805	16.07	4639	20.451	1422	20.872	807	24.9
Decision Sciences	1063	15.415	1695	7.16	1474	6.498	372	5.46	33	1.018
Mathematics	1037	15.038	2699	11.4	3353	14.782	962	14.12	367	11.324
Social Sciences	29	0.421	509	2.15	1121	4.942	323	4.741	117	3.61
Medicine	23	0.334	1332	5.63	286	1.261	72	1.057	83	2.561
Physics and Astronomy	12	0.174	1294	5.47	76	0.335	99	1.453	102	3.147
Environmental Science	6	0.087	43	0.18	33	0.145	62	0.91	11	0.339
Business, Management and Accounting	2	0.029	12	0.05	339	1.495	84	1.233	5	0.154
Materials Science	2	0.029	56	0.24	5	0.022	22	0.323	76	2.345
Chemical Engineering	1	0.015	25	0.11	1	0.004	17	0.25	2	0.062

TABLE 2. Frequency of keywords in conference proceedings for the 5 countries.

Keyword	N	%	N	%	N	%	N	%	N	%
Automation	119	12.332	117	2.075	54	0.869	30	1.174	11	2.326
Energy Efficiency	72	7.461	118	2.093	99	1.594	145	5.675	8	1.691
Neural Networks	63	6.528	176	3.121	155	2.495	56	2.192	33	6.977
Electric Power Transmission Networks	61	6.321	596	10.569	1736	27.946	614	24.031	22	4.651
MATLAB	57	5.907	430	7.625	171	2.753	44	1.722	21	4.44
Decision Making	50	5.181	73	1.295	106	1.706	46	1.8	10	2.114
Controllers	47	4.87	328	5.817	91	1.465	74	2.896	31	6.554
Optimization	45	4.663	135	2.394	110	1.771	43	1.683	15	3.171
Data Handling	43	4.456	71	1.259	105	1.69	26	1.018	15	3.171
Forecasting	40	4.145	239	4.238	223	3.59	92	3.601	34	7.188
Machine Learning	40	4.145	483	8.565	127	2.044	107	4.188	24	5.074
Efficiency	38	3.938	79	1.401	134	2.157	21	0.822	12	2.537
Energy Utilization	38	3.938	110	1.951	174	2.801	55	2.153	10	2.114
Digital Storage	34	3.523	114	2.022	169	2.721	85	3.327	10	2.114
Smart Power Grids	33	3.42	425	7.537	1452	23.374	552	21.605	17	3.594
Renewable Energy Resources	28	2.902	138	2.447	94	1.513	58	2.27	10	2.114
Costs	23	2.383	76	1.348	98	1.578	50	1.957	23	4.863
Learning Systems	21	2.176	273	4.841	176	2.833	93	3.64	33	6.977
Genetic Algorithms	18	1.865	88	1.561	149	2.399	22	0.861	16	3.383
Network Security	18	1.865	128	2.27	133	2.141	69	2.701	13	2.748
Classification (of Information)	17	1.762	204	3.618	103	1.658	20	0.783	26	5.497
Convolutional Neural Networks	16	1.658	255	4.522	117	1.883	31	1.213	21	4.44
Deep Learning	15	1.554	479	8.494	256	4.121	113	4.423	31	6.554
Learning Algorithms	15	1.554	251	4.451	87	1.401	47	1.84	15	3.171
Electric Inverters	14	1.451	253	4.487	93	1.497	62	2.427	12	2.537

TABLE 3. The 15 most frequent keywords that are typical of the conference papers by Russian researchers, but occur much less frequently in Chinese research contributions, and vice versa.

Keywords (Russia)	N	Keywords (China)	N
Engineering	71	Smart City	558
Industrial Engineering	67	Intelligent Computing	373
Control Systems	60	Data Communication Systems	345
Process Control	53	Internet of Things	328
Electric Drives	51	Power Electronics	295
Electric Power Systems	51	Big Data	290
Modeling	38	Social Networking (online)	265
Electric Network Parameters	35	Green Computing	228
Fuzzy Logic	35	Cloud Computing	224
Sustainable Development	35	Computer Aided Instruction	219
Technological Process	35	Trusted Computing	167
Mathematical Model	33	Ubiquitous Computing	162
Parameter Estimation	29	Data Mining	142
Differential Equations	28	Scheduling	142
Comparative Analysis	27	Electric Load Flow	134

State Petroleum Technological University (27); Bauman Moscow State Technical University (26); Tambov State Technical University (25); Moscow State University of Civil Engineering (25); Southern Federal University (25); Nosov Magnitogorsk State Technical University (25); Pacific National University (22); Kazan Federal University (22); Saint Petersburg National Research University of Information Technologies, Mechanics and Optics University ITMO (22).

As for funding sources, these are the well-known institutions: Russian Foundation for Basic Research (198); Ministry of Education and Science of the Russian Federation (52); Russian Science Foundation (41); Council on grants of the President of the Russian Federation (28). A certain discrepancy may be caused by the different spelling of the sources, for example, Ministry of Education and Science of the Russian Federation (52) and Ministry of Science and Higher Education of the Russian Federation (21). Here the data are given as they appear in the Scopus database. However, the key takeaway remains the same: public funding is the main source of funding for research.

In Russia, engineering disciplines historically have been more developed than social studies, as is reflected in the following list of research topics in Russia and all other countries represented in Scopus:

- Decision Sciences; in Russia – 15.4%, in all countries – 7.4%
- Social Sciences; in Russia – 0.42%, in all countries – 3.45%
- Environmental Science; in Russia – 0.09%, in all countries – 0.77%
- Business, Management and Accounting; in Russia – 0.03%, in all countries – 0.49%

According to Scopus, 2019-2021 conference

proceedings on AI in Energy are mostly from the following countries: India (6,101 conference proceedings); China (5603); United States (1686); Russian Federation (1337); Indonesia (818); Bangladesh (798); Brazil (761); Pakistan (605); United Kingdom (595); Italy (579); United Arab Emirates (557); Romania (494); Germany (491); Canada (481); Turkey (468); Malaysia (457); South Africa (420); Taiwan (406); Japan (349); France (341).

In what follows, a comparative analysis of research topics will be carried out using data on the first five countries: India, China, United States, Russian Federation, and Indonesia.

Above, the data on Russia and the average for all countries were compared; Table 1 gives a comparison with the 4 countries with the highest publication activity for the query in question.

Table 1 shows that while Russian researchers are well-positioned in topics from Computer Science to Mathematics, they are significantly underrepresented in other fields.

Hence, a suggestion can be made to Russian researchers to use the experience from the areas at the top of the list to develop the areas of research presented at the bottom of the list.

Social Sciences, Medicine, Environmental Science, and Business play an increasingly important role in today's world.

Research topics can be described not only by the Subject Areas to which the Scopus platform attributes research papers but also by the keywords assigned to the papers. Such results are presented in Table 2. The table is derived using an inner join for country-specific keyword tables. I.e., keywords occurring in the research papers of all 5 countries are compared.

TABLE 4. The 15 most frequent keywords specific to Russian research papers, but much less common in U.S. papers, and vice versa.

Keywords (Russia)	N	Keywords (US)	N
Engineering	71	Smart City	200
Industrial Engineering	67	Internet of Things	164
Process Control	53	Embedded Systems	105
Electric Drives	51	Intelligent Buildings	97
Electric Power Systems	51	Distributed Energy Resources	94
Modeling	38	Machine Design	92
Monitoring	37	Automobile Drivers	89
Quality Control	36	Social Robots	88
Electric Network Parameters	35	Driver Training	87
Fuzzy Logic	35	Microgrids	87
Technological Process	35	Educational Robots	86
Mathematical Model	33	Multi Agent Systems	83
Parameter Estimation	29	Distribution Systems	79
Differential Equations	28	Motion Tracking	73
Comparative Analysis	27	Vibrations (mechanical)	69

As in Table 1, these data show that Russian research contributions can be attributed more to the engineering sciences.

Interestingly, all countries use MATLAB as the main software product. The query SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA (ene) AND TITLE-ABS-KEY (**matlab**) AND (LIMIT-TO (DOCTYPE, “cp”)) AND (LIMIT-TO (LANGUAGE, “English”)) returns **1 895** results, whereas the query SUBJTERMS (1702) AND PUBYEAR > 2018 AND SUBJAREA (ener) AND TITLE-ABS-KEY (**julia**) AND (LIMIT-TO (DOCTYPE, “cp”)) AND (LIMIT-TO (LANGUAGE, “English”)) yields only **8** conference proceedings.

The Julia programming language is seen as an open-source alternative to MATLAB but its widespread application in engineering tasks will take a long time required to develop and implement a variety of specialized packages that have been created in MATLAB for decades.

To build the above tables, the inner join operator was used, i.e., what is found in the data of all countries was determined and compared.

Using the left join to the Russian data, it is possible to identify keywords that are widely used in the Russian conference proceedings but not found in the proceedings of other countries.

Below is such data for comparison with China and the U.S.

The data in the table highlights the dominance of well-established engineering topics in Russian research papers, while Chinese research papers are dominated by topics that can be described by the following words: Smart City – Intelligent Computing – Internet of Things – Big Data.

Table 4 provides a similar comparison for Russian and American research papers.

The Russian data are only slightly different from Table 3; the American topics, as well as the Chinese ones, reflect more the modern tasks of AI in the energy sector.

The above tables are based on the Scopus data presented in the files named Scopus_exported_refine_values, which

contain generalized bibliometric data on the given query.

A. Clustering documents by subject

In this subsection, bibliometric data contained in exported files with detailed bibliometric information was used for analysis. Given the limited size of the article and its scope, in what follows we focus on studying the description and systematization of research topics using the titles of conference proceedings for description purposes.

By definition, the titles of research papers should briefly but fully reflect its content, and therefore reveal its topics.

Document clustering by its content can be performed by text mining using non-negative matrix factorizations. A lot of research papers are devoted to this issue, e.g., in the study [11] presents key methods for automatically determining semantic features and clusters of documents in a collection of texts based on the factorization of non-negative matrices. Manually grouping text files and assigning labels to the found groups is a time-consuming task and the authors [12] proposed the novel K-means Non-Negative Matrix Factorization (KNMF) system, which after preprocessing the texts uses NMF results for subsequent document clustering.

To show the effectiveness of the above approach a simple clustering was carried out, in which conference proceedings headings were used as texts for the 5 countries considered above. To spare the reader some unnecessary detail, below are examples in which the number of clusters is chosen equal to 5 and 5 most relevant headings are given to characterize each of them. The data were obtained using the Clustering APP listed in the Methods section.

For illustration purposes, only the first cluster of Russian and Indian research papers is examined in more detail. India has the largest number of research papers on the topic in question but its economy is weaker than that of China and the United States, so it was interesting to compare the data on Russia with those on a less-than-advance economy.

As already noted, the titles reflect well the topics of the

articles, and it is easy to find articles themselves, as well as those similar to them in terms of their subject matter. The most of abstract databases provide the latter.

Russian Federation (1 577 titles)

CLUSTER: 1: SYSTEMS; BASED; INFORMATION; MODELING

- Digraph Modeling of Information Security Systems
- Ontology based method of data codification for information exchange
- Assessment of the Conflict Stability of Information Systems Using Mathematical Modeling
- Hierarchical Data Model Choosing in the Information Systems Design in Relational DBMS
- Decision Support for the Windfarms Siting Based on Multi-Attribute Analysis and Aerodynamic Modeling

CLUSTER: 2: POWER; SUPPLY; ELECTRIC; PLANTS

- Challenges in Power Supply of the Arctic
- The Linear Adjustable Power Supply
- Electric Power Quality in the Single-Phase Power Supply Networks of Electronic Means
- Power Supply System with Power Plant on Solid Oxide Fuel Cells
- Distributed Generation in Railroad Power Supply Systems

CLUSTER: 3: CONTROL; PROCESS; AUTOMATIC; AUTOMATED

- Using of Control Actions Shaper for Movement Control Process of Mobile Platform
- Automatic Control System of Electromagnetic Vault Down-Faller
- Dynamic Verification of Process-Oriented Control Software by the Case of Crossroad Control
- A Neural Network-Based Control System Using PID Controller to Control the Deaerator
- Development of the Predictive Control System for Ethylbenzene Dehydration

CLUSTER: 4: NEURAL; NETWORK; USING; NETWORKS

- Development Application for Traffic Classification Using the Neural Network Approach
- Neural Network Approach for Prediction of Pneumonia
- System of diagnosis of acute nazhopharyngitis using artificial neural networks
- Neural Network Decoder of Automatic Process Control System
- Identification of Psoriasis by Images Using Convolutional Neural Networks

CLUSTER: 5: ENERGY; EFFICIENCY; STORAGE; TECHNOLOGIES

- The Energy System of an Autonomous Vehicle with Electric Energy Storages
- Modeling of the Processes of Regulating Energy Efficiency of Technologies and Combining Energy

Resources

- Adsorption Equipment Energy Efficiency Increase
- Improving the Energy Efficiency of the Oil Well Electrical Complex
- Modeling of the Mechanism of Management of Efficiency of Energy Technologies

Based on the keywords of the cluster headings: “systems; information; modeling; power; supply; electric; plants; control; process; automatic; neural; network; energy; efficiency; storage; technologies” and the titles of the most representative research papers in each cluster, we can conclude that Russian research papers largely focus on engineering issues. This is consistent with the results presented in Table 1.

Next, here is a brief summary of the content of the articles representing the first cluster. A synopsis of an article, while being smaller than even its abstract, can give the subject matter expert sufficient insight into its topics and allow them to decide whether it is worth reading in its entirety.

Digraph Modeling of Information Security Systems [13]: The article considers a cognitive model of the state of information security system of an average organization. The model is a weighted oriented graph, the vertices of which are standard elements of the information security system of the organization. On the basis of the model the most significant factors affecting the state of information security of the organization are identified.

Ontology-based method of data codification for information exchange [14]: One of the problems of inter-system exchange of data coming from different sources is the ability to identify similar objects. A promising tool that can be used to uncover this complex form of identification is a codification system that allows comparing incoming data from different sources, aggregating different attributes of similar objects and providing qualitative data to end users. This paper describes an experiment in which this model was applied to different object categories - material, financial, and workforce information descriptions.

Assessment of the Conflict Stability of Information Systems Using Mathematical Modeling [15]: The article deals with conceptual, mathematical and computer models of asymmetric conflict interaction of systems, which are typical for the problems of conflict stability of information systems. Within the framework of the mathematical model the analytical relations for assessing the lower bound of the probability of victory of one of the parties to the conflict, which allow abstracting from a particular kind of densities of the distribution of the time of the parties in their possible states, are proposed.

Hierarchical Data Model Choosing in the Information Systems Design in Relational DBMS [16]: Hierarchical data handling is one of the typical tasks in the development of industrial information systems. The performance and operability of the developed application depends on the correct choice of storage structure and hierarchical data

processing mechanisms.

Decision Support for the Windfarms Siting Based on Multi-Attribute Analysis and Aerodynamic Modeling [17]: The article gives an example of multiattribute assessment of wind farm sites based on aerodynamic modeling in the area of the village Ayan, Khabarovsk region. Many economic, technical, environmental and social factors should be taken into account when locating a wind farm. When assessing the economic efficiency of the option of wind farm location it is proposed to use aerodynamic modeling to consider how the topography of the area will affect the wind speed.

India (2 000 of 6 102 titles)

CLUSTER: 1: LEARNING; MACHINE; USING; DEEP

- Machine Learning Based Attrition Prediction
- Analysis of sentiments in political-based tweets using machine learning techniques
- FAB Classification based Leukemia Identification and prediction using Machine Learning
- Scrutinizing Students Performance using Machine learning
- Predicting Fitness and Performance of Diving using Machine Learning Algorithms

CLUSTER: 2: ANALYSIS; DESIGN; PERFORMANCE; ANTENNA

- Bibliometric Analysis of MOOC using Bibliometrix Package of R
- Design and analysis of X band pyramidal horn antenna using FEKO
- Design and Analysis of Proportional Integral Derivative Controller and it's hybrids
- Permutation Algorithm Analysis and Updation
- Derivation of thevenin's and norton's theorems using two-port network analysis

CLUSTER: 3: NETWORK; NEURAL; USING; CONVOLUTIONAL

- Real Time Handwritten Digits Recognition Using Convolutional Neural Network
- Voice recognition-based security system using convolutional neural network
- Leaf Based Trees Identification Using Convolutional Neural Network
- Handwritten Form Recognition Using Artificial Neural Network
- Neural Network Based Driver Warning System

CLUSTER: 4: BASED; SMART; IOT; MANAGEMENT

- IOT Based Smart Waste Management System
- An IoT based Smart Outdoor Parking System
- Smart intimation of mailbox using IoT
- IoT based smart intelligent vehicle systems
- A Study of Smart Farming Based on IOT

CLUSTER: 5: DETECTION; IMAGE; USING; TECHNIQUES

- Sarcasm Detection in Newspaper Headlines
- Cataract Detection using Digital Image Processing
- Motion Detection Using Image Processing
- Survey of skin cancer detection using various image processing techniques
- Detection of Skin Cancer Lesions from Digital Images with Image Processing Techniques

From the keywords of the cluster headings: "learning; machine; deep; analysis; design; performance; network; neural; convolutional; smart; IOT; management; detection; image; techniques" it follows that Indian research papers are more focused on analysis of design and performance of IOT and smart networks using deep machine learning and convolutional neural networks. According to Table 1, the topics of Indian research papers can be classified as Computer Science.

Summaries of the research papers of the first cluster of Indian conference proceedings.

Machine Learning Based Attrition Prediction [18]: The probabilistic estimation is used in this paper to predict personnel attrition based on a human resource database of a company with about 1 500 employees.

Analysis of sentiments in political-based tweets using machine learning techniques [19]: Tweets are useful for analyzing user preferences for different political parties. Users may not only be "for" or "against" a particular political party, but may also have ambiguous opinions about it. This study is an attempt to predict users' opinions about different political parties using machine learning algorithms. People's sentiments about political parties are analyzed using SVM and Naïve Bayes algorithms.

FAB Classification based Leukemia Identification and prediction using Machine Learning [20]: The method proposed by the authors is used to recognize, detect and distribute leukemia based on FAB classification. The shape, textural features, and color of the segmented image are selected by a neural network, classification is performed using a Support Vector Machine, and prediction is performed using a Naïve Bayes classifier. The proposed classifier improved the average classification accuracy to 99.06% and the mean square error is 0.0407.

Scrutinizing Students Performance using Machine learning [21]: To give a unique form to student learning and to apply what they learn to their work; the authors of this article propose using a regression algorithm to strictly assess student learning. They take the dominant attributes as performance data, normalize each element of the performance data by defining a set of models, and then build a model to measure the prophetic value of early student detection in assessing a student's learning ability. If the value is steep, instructors track the prophecy value of early detection to observe students' problems and their explanations in the course.

Predicting Fitness and Performance of Diving using

Machine Learning Algorithms [22]: Lack of data and knowledge exists about which fitness tests can be effective in predicting fitness, performance, and selection of potential divers in national and international competitions. The prediction accuracy using multivariate logistic regression with 6 variables was 52.1%, which was worse than the ordinal forest. The overall accuracy of the final ordinal forest was 70.4%. Balanced accuracy was 68.5% and 82.8% for national and international predictions, respectively.

According to Table 1, studies related to medicine are best represented in Indian studies compared to the other 4 countries, as is reflected in the brief summaries of articles belonging to the first cluster, which is despite the fact that energy was chosen as the subject area for filtering the research papers.

It should be noted that the importance of medical issues in research in various areas is also recognized by the Russian government. Among the target indicators for the fiscal year for research themes funded from the federal budget, there is the following item: Number of medical technologies planned for development within the framework of a scientific theme. This recognizes the importance of the development of medical technologies in research that is essentially not related to medical issues per se.

India's approach to this issue may be useful for Russian researchers.

China (2 000 of 5 678 titles)

CLUSTER: 1: ALGORITHM BASED IMPROVED IMAGE

- Improved Design of des Algorithm Based on Symmetric Encryption Algorithm
- A Novel Feature Selection Algorithm Based on Artificial Bee Colony Algorithm and Genetic Algorithm
- Design of a Gearbox Based on Genetic Algorithm
- A Multi-population Whale Optimization Algorithm Based on Orthogonal Learning
- Multi-exposure image fusion based on improved pyramid algorithm

CLUSTER: 2: POWER CONTROL DC GRID

- Power Grid Model Data Governance System Based on Dcloud*
- Architecture Design and Evaluation of Hybrid AC/DC Power Grids Based on Power Electronic Transformer
- Analysis of DC line fault characteristics with the UHVDC hierarchical integration into AC power grid
- Optimal control of reactive power and voltage in active distribution network based on source-grid-load interaction
- Short-circuit Current Characteristics of Distributed Power and Fault Location Method after Distributed Power is Connected

CLUSTER: 3: NETWORK NEURAL DISTRIBUTION CONVOLUTIONAL

- BP Neural Network Based Fault Prediction of Distribution Network during Typhoon Disaster
- A Spiking Neural Network for Tooth Chromaticity Detection
- Research of Computer Network Security Evaluation Based on Backpropagation Neural Network
- Research on Distribution Network Topology Reconfiguration Based on LSTM Neural Network
- Fault classification model of distribution network based on rough neural network and decision tree

CLUSTER: 4: RESEARCH BASED TECHNOLOGY DATA

- Research on polygraph technology based on ballistocardiogram signal
- Research on Archives Information Management System Based on Computer Big Data
- Research on the Model of CVT Operation Performance Based on the PHM System
- Application and Research of Computer Mega Data Based on Structure in E-learning
- Research on the control of user privacy data disclosure based on blockchain Technology

CLUSTER: 5: METHOD DETECTION BASED FAULT

- Detection method of phishing email based on persuasion principle
- Edge Detection Method Based on Hysteresis Connection and Prediction
- Study on the Limited Space Detection Method Based on Ultrasonic Diffraction Time Difference Method
- Chip defect detection based on deep learning method
- A Pavement Disease Detection Method based on the Improved Mask R-CNN

Judging by the list of titles of research papers, China is focusing a lot of attention on algorithms and their application to optimize grid management and fault monitoring. This is in line with China's strategy to take a key position in AI research, and the energy sector is no exception.

United States (1 689 titles)

CLUSTER: 1: POWER DISTRIBUTION SYSTEMS USING

- Power Displacement Analysis for Power Systems - A Commodity Model
- A review on impact analysis of electric vehicle charging on power distribution systems
- Adversarial examples on power systems state estimation
- Online Voltage Optimization of the Power Distribution System
- Transient Stability Analysis of Power Systems via Occupation Measures

CLUSTER: 2: LEARNING DEEP MACHINE USING

- Hemp disease detection and classification using machine learning and deep learning
- SwFLOW A dataflow deep learning framework on sunway taihulight supercomputer
- Microwave glucose concentration classification by machine learning
- Grape Leaf Disease Detection and Classification Using Machine Learning
- Survey of Machine Learning and Deep Learning Techniques for Travel Demand Forecasting

CLUSTER: 3: ENERGY DISTRIBUTED STORAGE MANAGEMENT

- Energy distribution in EV energy network under energy shortage
- Sharing Mobile and Stationary Energy Storage Resources in Transactive Energy Communities
- A Distributed Energy Management Approach for Residential Demand Response
- Technical_ financial_ and environmental effects of distributed energy resources on multi carrier energy networks
- Control and Dispatch of Distributed Energy Resources with Improved Frequency Regulation using Fully Active Hybrid Energy Storage System

CLUSTER: 4: SMART DATA GRID CITIES

- Big Data Analysis for Retrofit Projects in Smart Cities
- A LoRa-based Smart Streetlighting System for Smart Cities
- IMirror A Smart Mirror for Stress Detection in the IoMT Framework for Advancements in Smart Cities
- Data integration platform for smart and connected cities
- Making Smart Transportation Work in Smart Cities

CLUSTER: 5: BASED CONTROL TIME MODEL

- Modelica-based control of a delta robot
- Time-varying optimization-based consensus control for microgrid's secondary control
- Real Time Analysis of a Multi-Agent Based Distributed Control Strategy for Islanded AC Microgrids
- Phasor based control with the distributed_ extensible grid control platform
- Optimal control of a multirotor unmanned aerial vehicle based on a multiphysical model

The US also pays a lot of attention to machine learning for energy systems but much of this research focuses on renewable energy sources, such as distributed energy storage, intelligent transportation systems, and smart cities.

The Chinese and U.S. experience shows that Russian researchers pay insufficient attention to distributed systems other than energy systems. This may be due to the fact that the issues of energy transition in our country are only at the initial phase and less attention is paid to smart cities and smart alternative energy systems, due to less developed

infrastructure compared to China and the United States.

Indonesia (819 titles)**CLUSTER: 1: USING DETECTION METHOD LEARNING**

- Asphalt Pavement Pothole Detection using Deep learning method based on YOLO Neural Network
- Detection of Kinship through Microexpression Using Colour Features and Extreme Learning Machine
- Using Metadata in Detection Spam Email with Pornography Content
- Face Movement Detection Using Template Matching
- Feature selection algorithm for intrusion detection using cuckoo search algorithm

CLUSTER: 2: POWER STUDY PLANT ENERGY

- Economic analysis of renewable energy power plant in Sumatra_ Indonesia
- Improving loss of load probability through biomass power plant integration: A case study in Tanjung Balai Karimun
- Power Quality Enhancement on Hybrid Power Plants Using Shunt Passive Power Filter and Detuned Reactor
- Steady State Model of Wind Power Plant for Load Flow Study
- Achieving new and renewable energy target: A case study of java-bali power system_ Indonesia

CLUSTER: 3: BASED MONITORING DESIGN SMART

- Design and implementation of Intelligent Aquaponics Monitoring System based on IoT
- IoT-based smart gallery to promote museum in ambon
- Design of Algorithm Control for Monitoring System and Control Bridge Based Internet of Things (IoT)
- Designing of a Smart Collar for Dairy Cow Behavior Monitoring with Application Monitoring in Microservices and Internet of Things-Based Systems
- Surveillance Monitoring System based on Internet of Things

CLUSTER: 4: NETWORK NEURAL CONVOLUTIONAL ARTIFICIAL

- The Implementation of Neural Network Algorithm to Predict the Eligibility of Prospective Assistants
- Deep Convolutional Neural Network for Melanoma Image Classification
- Jaya-Neural Network for Server Room Temperature Forecasting Through Sensor Network
- Convolutional Neural Network for Automatic Pneumonia Detection in Chest Radiography
- Modeling vertical roller mill raw meal residue by implementing neural network

CLUSTER: 5: CONTROL ROBOT FUZZY LOGIC

- Fuzzy Logic-Based Wet Scrubber to Control Air Pollutant
- A New kicker system of wheeled soccer robot ersow using fuzzy logic method

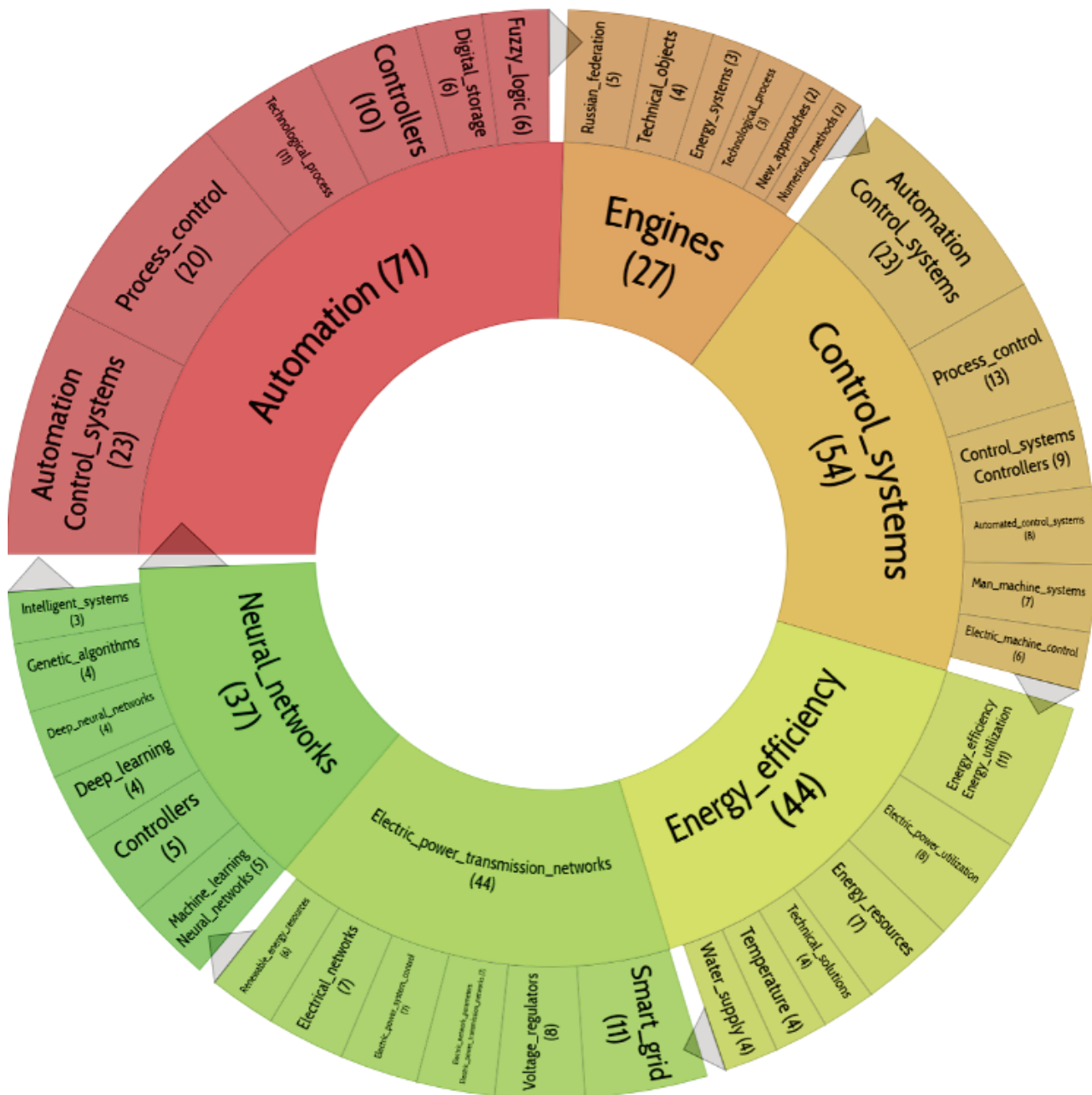


Fig. 1. Circles diagram representing the clustering of Russian conference proceedings by the Lingo3 algorithm.

- Simulation Analysis of Formation Control Design of Leader-Follower Robot Using Fuzzy Logic Controller
- Water Distribution Control Using Arduino with Fuzzy Logic Algorithm Method: A Prototype Design
- Performance Comparison of Fuzzy Logic and Neural Network Design for Mobile Robot Navigation

Scientific research in Indonesia is actively developing. Obviously, it does not have the same resources as China and the United States or even India, but Indonesian scientists are working hard to embark on the new challenges of AI and energy, which is evident from the titles of research papers and the fact that they have more conference proceedings than the United Kingdom (595) and Italy (579).

The analysis presented above, as well as the software

chosen to back it, are rather illustrative in nature, allowing to quickly showcase possibilities of document clustering for bibliometric studies.

For a more detailed analysis of document clustering features, it is advisable, at least briefly, to demonstrate the capabilities of the Carrot2 software.

This software has a long history of development, includes various algorithms for clustering and graphical representation of data, the ability to work with different data sources, including embedding in search engines and working with indexes of these systems. A detailed analysis of the capabilities of this program is beyond the scope of this study. We will give an example of only using its demo version, dealing with the Lingo3 algorithm, and one



Fig. 2. Circles diagram displaying the clustering of conference proceedings by Indian researchers using the Lingo3 algorithm.

format for presenting the results as Circles, or multi-level pie charts in the carrot2 terminology. To avoid the issues of preprocessing textual data, the clustering proximity estimation was performed only by index keywords. For the rest of the parameters we used their default values. In order to avoid treating index keywords as separate words, we performed the simplest preprocessing using regular expressions to replace spaces in them with underscores, which can be seen in the graphs below.

The next section is a comparison of data for the five previously selected countries.

Figure 1 shows the results of clustering Russian conference proceedings by index keywords. The clustering is performed on the documents, so by knowing the DOI,

we can get the title of the documents and other fields from the original tables.

Automation, Control systems, Energy efficiency, Engines, Electric power transmission networks and Neural networks – are the labels of the first-level clusters.

Examples of Russian research papers on the best represented topic being Automation Control_Systems as selected according to the number of their citations.

Development of Information Measuring Complex of Distributed Pulse Control System [23], 3 citations: The article synthesizes the law of temperature field distribution in an isotropic rod on the basis of impulse transition functions - the Green's function. The mathematical modeling of the obtained law was conducted on a hybrid supercomputer



Designing a Method for Constructing Distributed Open ACS Based on the ESP-NOW Wireless Protocol [24], 2 citations: The paper proposes a new approach to the implementation of open distributed automatic control systems, based on the use of cheap Espressif computational nodes exchanging data over the ESP-NOW wireless protocol. The proposed solution allows the use of distributed automatic control systems (ACS) to control complex mechatronic objects, such as industrial manipulators, and allows the placement of computing

Determining the Hazard Quotient of Destructive Actions of Automated Process Control Systems Information Security Violator [25], cited once: The aim of the work was to formalize the assessment of potentially realizable violations of information security, which can lead to a breach in the functioning of multi-level distributed automated process control systems. The results of calculations using the proposed method of modeling threats and violators of information security in the design of information security systems of automated control systems of technological processes are presented.

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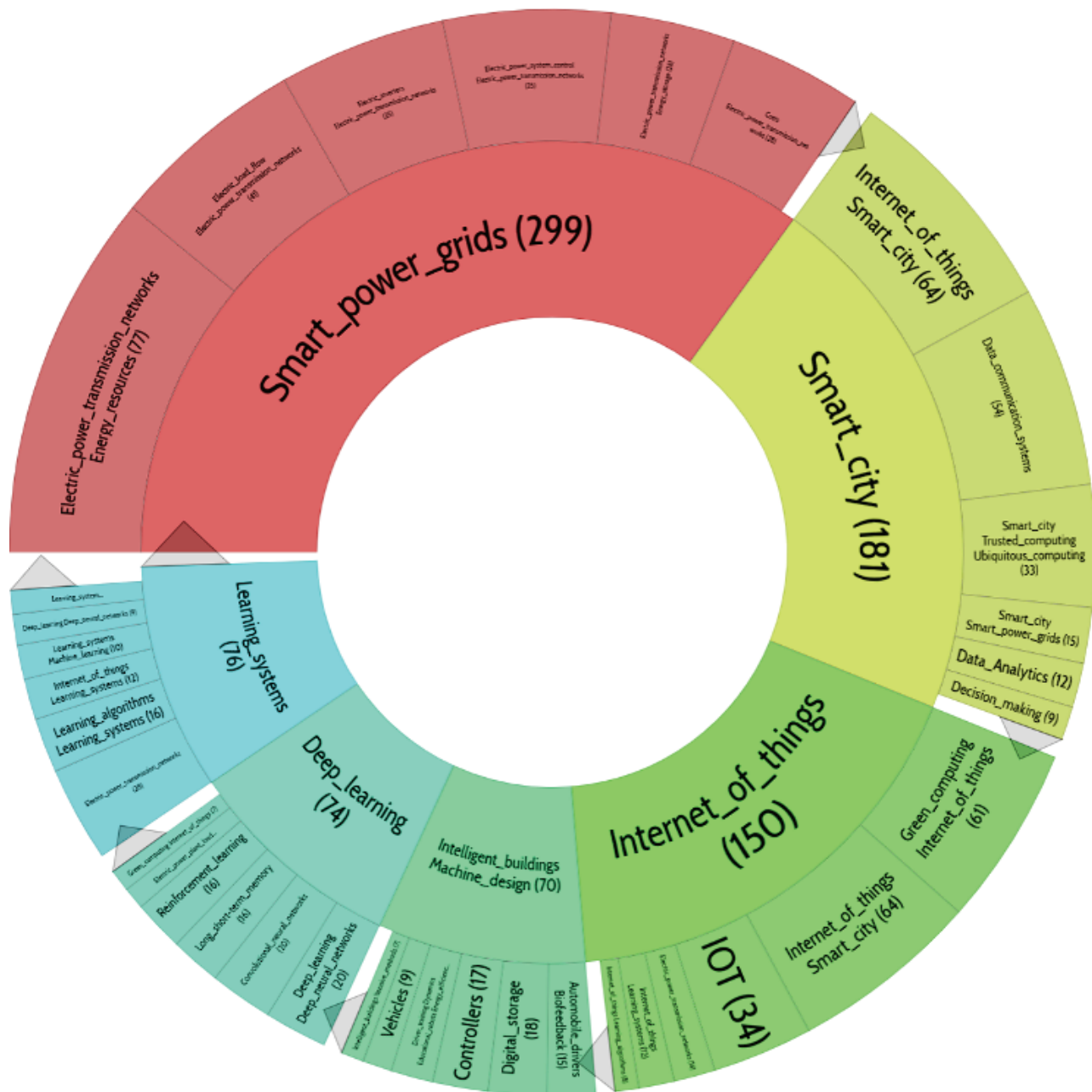


Fig. 4. Circles diagram showing the clustering of conference proceedings by US researchers using the Lingo3 algorithm.

experimental data on the operation of hot water system on solar collectors. The control problems associated with frequent switching of the circulation pump, also stray circulation of the coolant and imbalance of parallel connected collectors were revealed. Justified changes in the design of the control system to solve the identified problems.

Modernization of Setting for Symmetrical Optimum [27], cited once: The paper proposes a symmetric tuning for the calculation of a closed-loop automatic control system, which is obtained by analyzing the frequency characteristics of the tuning for the symmetric optimum.

Thus, the above examples of research papers align well with the major themes presented in Fig. 1, all of which are

of an unmistakably engineering nature.

Relying on citations of research papers, it is possible to give examples of the most cited Russian research contributions related to all sections presented in the Fig. 1.

The below data are in the following format: research contribution title, citation, number of citations, key term describing the cluster to which the contribution belongs, a summary of the contribution.

Algorithm of Current Protection Based on Three Instantaneous-Value Samples [28], 19 citations, key term – Electric_network_parameters: In this work the authors have proposed a method of discretization of instantaneous values of currents and voltages, which allows extracting from instantaneous values of currents, containing periodic

and aperiodic components, only sinusoidal information, necessary for the correct operation of digital relay protection and automation. The method made it possible to realize protections that fix faults by means of analog devices only for a few periods of current changes.

An Object-Oriented Design of Expert System Software for Evaluating the Maintenance of Lined Equipment [29], 16 citations, key term – `Computer_software`: The article describes the actuality of solving the problem of automating the process of assessing the state of critical embedded equipment. An object software model of the expert system for assessing the state of critical built-in equipment has been developed. This system allows to produce recommendations for managing the modes of operation of critical built-in equipment.

A Study on Cost-Effectiveness of Energy Supply Based on the Energy Hub Concept [30], 13 citations, key term – `Electric_power_transmission_networks`: The article discusses the principles of building a simulation model of an integrated multi-energy system based on the concept of an energy node. The proposed approach is applicable to the study of the problems of integrated power systems with multiple carriers, taking into account their properties and operation features.

A Guide to Solar Power Forecasting using ARMA Models [31], 11 citations, key term – `Electric_power_transmission_networks`: This paper describes a step-by-step methodology for predicting the power output of a photovoltaic solar generator using hourly autoregressive moving average (ARMA) models. The resulting model is suitable for incorporation into more complex operation and planning models, and shows relatively good accuracy. It is a good predictive tool for sample generation for stochastic energy optimization models.

Predicting cyber-attacks on industrial systems using the Kalman filter [32], 10 citations, key term – `Sustainable_development`: This paper proposes to use a Kalman filter to solve the problem of predicting the time series describing the gasoil heating loop process. The limitations of this approach are described, as well as the advantages over other prediction models.

The above examples show that the most cited Russian research papers are also related to solving engineering problems of control and automation of power systems using modern methods of analysis and modeling.

Environmental, social, and economic issues are not prevalent in these studies.

Figures 2–4 present diagrams illustrating the clustering of the conference proceedings of the other four countries. In order not to inflate the size of this article, each illustration will be followed by several titles of research articles reflecting the content of the first-level clusters.

The list below shows the titles of the Indian papers belonging to the Deep Learning cluster:

- Performance dependency of facial emotion recognition system on dropout and learning rate;
- An Improved Multifocus Image Fusion Algorithm Using Deep Learning and Adaptive Fuzzy Filter;
- Artificial intelligence based efficient phenotyping for agronomics;
- Weed Detection in Agricultural fields using Deep Learning Process;
- Artificial intelligence-based identification of total knee arthroplasty implants;
- Survey on Automatic Script Identification Techniques;
- Automated Food image Classification using Deep Learning approach;
- Analysis and forecasting of Time-Series data using S-ARIMA, CNN and LSTM.

It is clear that the research is general in nature and does not necessarily relate to energy. Moreover, in 1 793 records with 4 fields (title, abstract, author keywords, and index keywords), the term “Energy” appears only 377 times. However, Scopus attributes all of the records to the field of Energy research. Note: according to Scopus restrictions, data export is limited to 2 thousand data entries, not all records have the index keywords field filled in, so the analysis considered only 1 793 records (out of the total 2 000) that had the index keywords field filled in.

Thus, research on AI is most often general in nature. If one tries to find research papers on AI applications in the energy sector, one would need additional metadata filtering of research papers on specific energy systems, such as smart grids. But then it would be a completely different bibliometric study, such as “Applications of AI in Smart Grids.”

In the Chinese conference proceedings, the main cluster of documents is described by two terms and is more specific than in the case of the Indian research papers. It is described as Power Transmission Networks AND Smart Power System. This topic is directly related to the energy sector, so the Chinese papers on the topic under consideration will be of more interest.

Typical titles of Chinese conference proceedings for this cluster include the following:

- Transmission line electrification spanning construction technology;
- Component Importance Indices of Transmission Systems Based on The Impact-increment Based State Enumeration Method;
- Analysis of Half-Wavelength Transmission Lines System State in Operation;
- Time Difference Method to Calculate the Optimal Differential Point of Half-wavelength AC Transmission Line Differential Protection;
- Fault Diagnosis of Transmission Line – A Phasor Domain Approach;
- Study on charged detection method of porcelain insulator in single asymmetric transmission line;
- Dynamic Modeling and Simulation of the Large-scale Regional Integrated Electricity and Natural Gas System;

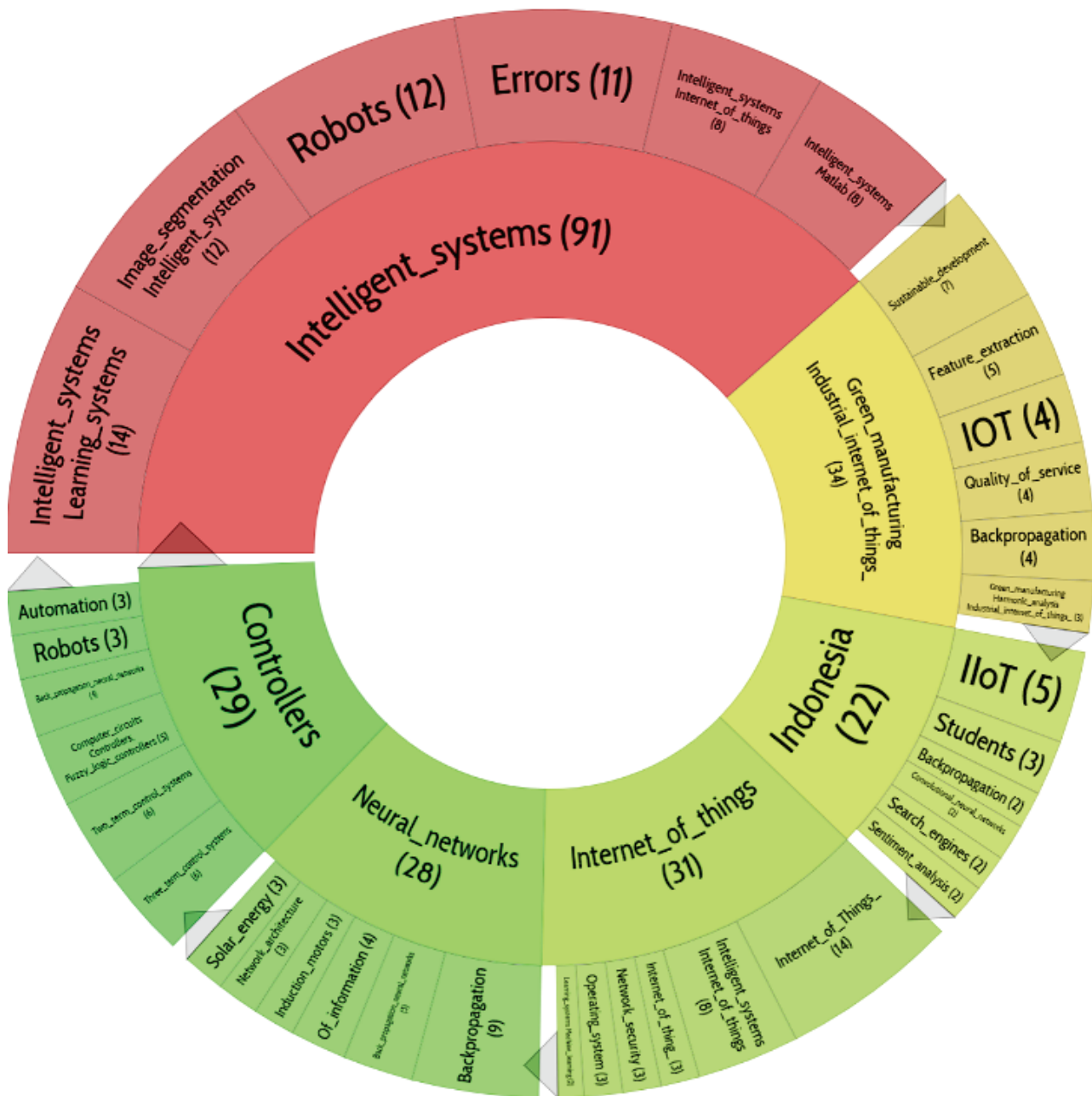


Fig. 5. Circles diagram showing the clustering of conference proceedings by researchers from Indonesia using the Lingo3 algorithm.

- Research on the Integral Metrological Performance of Evaluation Method of Smart Electricity Meters;
- Research on Non-Intrusive Load Monitoring Based on Random Forest Algorithm;
- The Problem Analysis and Solution Suggestion in the Process of City Information Model Construction.

The titles of the Chinese conference proceedings are also more specific and relevant to the energy sector.

In the U.S., Smart power grid, Smart city, Internet of things are clearly dominant.

Typical conference proceedings headlines for the Smart power grid cluster include the following:

- Anomaly detection of transactive energy systems with

competitive markets;

- Evolving distribution utility rate structures to accommodate emerging technologies;
- Moving Towards Distribution System Operators: Current Work and Future Directions;
- Transactive Energy Versus Demand Response in Cutting Wholesale Electricity Prices;
- Quantitative evaluation of reliability improvement: Case study on a self-healing distribution system;
- Development of HELICS-based high-performance cyber-physical co-simulation framework for distributed energy resources applications;
- Quantifying technical diversity benefits of wind as a

distributed energy resource;

- A transactive grid with microgrids using blockchain for the energy internet;
- Defining a use case for the ADMS test bed: Fault location, isolation, and service restoration with distributed energy resources;
- An integrated transmission-distribution modeling for phasor-domain dynamic analysis in real-time;
- A Value-of-Service based Model for Resilient Distribution System Restoration with Microgrids;
- A universal multiple inverter control architecture with droop for unbalanced distribution grid;
- Analysis of Hybrid Smart Grid Communication Network Designs for Distributed Energy Resources Coordination;
- Control and Dispatch of Distributed Energy Resources with Improved Frequency Regulation using Fully Active Hybrid Energy Storage System;
- Toward a service-oriented broker architecture for the distribution grid;
- An intelligent energy router for managing behind-the-meter resources and assets;
- Transactive Energy Management with Blockchain Smart Contracts for P2P Multi-Settlement Markets;
- Network Configurations for IoT Services in Smart Grid.

In all of the above titles of research papers, the topic of AI smart grids and IoT is clearly visible. The U.S. research papers, like the Chinese ones, are more specific than the Indian ones and are of greater interest for further study.

As in the case of the Indian papers, the Indonesian conference proceedings are more general in nature, which is reflected in the title of the main cluster: Intelligent Systems.

Below are some examples of the titles of research papers related to this cluster:

- Exploring challenges of online learning activity in politeknik elektronika negeri surabaya at the beginning of covid-19 outbreak;
- Pedestrian crossing decision prediction based on behavioral feature using deep learning;
- CNN Based Autoencoder Application in Breast Cancer Image Retrieval;
- Determination of learning media in elementary school using multi-objective optimization on the basis of ratio analysis method;
- Student Behavior Analysis to Detect Learning Styles in Moodle Learning Management System;
- Deep Convolutional Neural Network for Melanoma Image Classification;
- Transfer Learning for Recognizing Face in Disguise;
- Violence Classification Using Support Vector Machine and Deep Transfer Learning Feature Extraction;
- A Deep Auto Encoder Semi Convolution Neural Network for Yearly Rainfall Prediction.

Indonesian contributions, like the Indian ones, are of

less interest to Russian researchers. Rather, of interest is the experience of these countries in occupying their niche in current scientific research. For example, both India and Indonesia make great efforts to participate in international conferences, while for Russian researchers it is more typical to participate in international conferences organized and held in Russia. But this is the topic of a dedicated study, which is beyond the scope of this article.

III. CONCLUSION

1. The majority of Russian AI and energy-related conference proceedings indexed in Scopus are presented at conferences organized in Russia; in addition, one conference, the "International Multiconference on Industrial Engineering and Advanced Technologies" (FarEastCon2019 and FarEastCon2020), held in 2019-2020, predominates.

It should be noted that the absolute majority of articles on the topic in question have been published in only one journal, the International Journal of Engineering Research and Technology, which since 2021 is no longer indexed in Scopus.

Thus, it is necessary to further promote journals and conferences held in Russia, where our authors could present the results of their research on current topics such as AI and energy. Participation in prestigious international conferences is good, but expensive. Without developing domestic international-level publication resources, it will be difficult to foster the results of Russian research in the field of AI and energy.

2. Different methods of analysis of bibliometric data of conference proceedings: Subject Area, Index Keywords, Titles, give a similar result: engineering topics prevail in Russian research. The main areas of research can be described by the following words: systems; information; modeling; energy; power supply; power plants; control; process; automation; neural; networks; energy efficiency; technology. The social, environmental, economic and business aspects of AI in the energy sector are very poorly presented. These areas are untapped potential for Russian research.

3. China and the United States are of the greatest interest for AI and energy research.

The works of researchers from these countries are more specific than those of researchers from India and Indonesia.

China focuses on algorithms and their applications to optimize grid control and fault monitoring (most typical terms: Power Transmission Networks AND Smart Power System). This is in line with China's strategy to take a key position in AI research, and the energy sector is no exception.

Machine learning for energy systems has also received a lot of attention in the U.S., yet much of this research has focused on renewable energy sources such as distributed energy storage, intelligent transportation systems, and smart cities (dominated by such topics as Smart power

grid, Smart city, and Internet of things).

The Chinese and U.S. experience shows that Russian researchers pay insufficient attention to distributed systems other than power systems. The reason may be that energy transition issues in this country are only at the initial stage, and less attention is paid to smart cities and smart alternative energy systems due to less developed infrastructure, if compared to China and the U.S.

4. India's and Indonesia's research papers are more general in nature and are not always related to the field of energy.

Of more interest is the approach of these countries to take their place in modern scientific research. These countries apply great efforts to participate in international conferences and try to establish their own journals and hold conferences on relevant topics, despite lacking the economic resources of China and the United States, and engineering capabilities of Russia.

The article demonstrates the effectiveness of using titles of research papers to describe topics by clustering documents but the Russian conferences proceedings are presented by a limited number of research papers indexed in Scopus. For a more complete study of the selected topics and for expanding the scope of sources of the analyzed research papers, it seems expedient to conduct a similar study using abstract databases other than Scopus, such as, for example, Dimensions, which indexes such notable sources as preprints.org, arXiv.org, EarthArXiv.org, engrXiv.org, OSF Preprints, Research Square, and other preprint services, and journals not indexed by Scopus and WoS, such as Energy Systems Research and Actual Problems of Oil and Gas.

ACKNOWLEDGMENT

The research findings were obtained as part of the project carried out under the state assignment to the Oil and Gas Research Institute of the Russian Academy of Sciences (OGRI RAS), # 122022800270-0.

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