



Sci-Tech Trend Report on Intelligent City in 2021

IKCEST Intelligent City Sub-platform Team
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IKCEST Sci-Tech Trend Report

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Through bibliometric methods, this report analyzes the paper output and influence of major countries and research institutions in the field of intelligent city science, and the research hotspot direction in the discipline field, and focuses on the research in China to analyze the advantages and disadvantages, so as to grasp the development trend of scientific research in the field of intelligent city from a macro perspective.

1. Research on national and institutional analysis

1.1 main research countries and their influence

As of the search date [February 27, 2022.] The searchers are in the core collection database of WOS (web of Science) of the American Institute of scientific information] The core collection database contains the world's best scientific and technological journals in various disciplines. The papers included can timely reflect the development trends of the scientific frontier and the documents issued by countries and institutions to a certain extent, further reflect the advantageous position of countries and institutions in a certain discipline, and reveal the academic competitiveness of countries and institutions in various disciplines.] 26739 journal papers in the field of "smart city / intelligent city" in all years (1952-2022) were retrieved, and a total of 169 countries have carried out relevant research in this field. It is obvious from the search results that the number of literatures published in this field before 2010

was less than 100, and the number was very small. However, since 2011, the number of papers published in this field has increased rapidly year by year, and rapidly increased to 14 times that in 2010 in 2015, indicating that the global attention to this field has reached an unprecedented level. The average annual number of papers published from 2019 to 2021 has reached more than 4000.

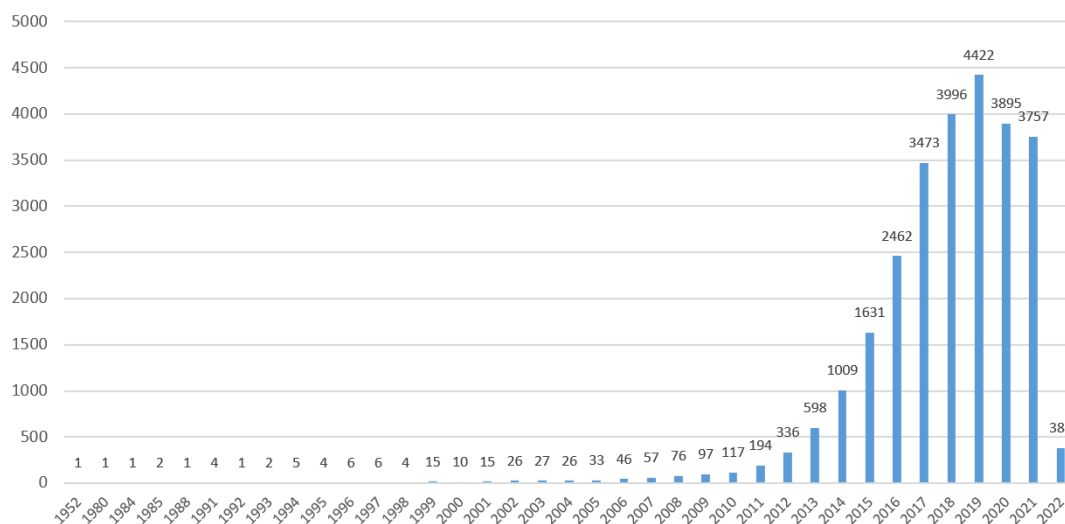


Figure 1 literature published in the field

Focus on the research situation in this field in recent five years (2018-2022). As of the search date, the top 20 countries / regions in the volume of documents are: China, the United States, India, Italy, the United Kingdom, Spain, Australia, South Korea, Canada, Saudi Arabia, Germany, Brazil, Pakistan, France, the Netherlands, Portugal, Japan, Russia, Greece and Poland. China and the United States occupy a leading position in this research field: among them, China ranks first in the world, with a total of 3283 papers participated by China, accounting

for about 21.7% of all papers; The number of papers in the United States has occupied the largest proportion in the world for a long time in history, and now the gap has been gradually opened by China, with a total of 2348 papers, accounting for about 15.5% of all papers. According to this trend, China will continue to occupy the top of the world's smart city research papers for a long time, and the gap between China and the United States will continue to widen.

Table 1 research in the field of smart cities in recent five years
(2018-2022), top 50 countries

Ranking	Country / Region	Number of Published Papers
1	CHINA	3283
2	USA	2348
3	INDIA	1191
4	ITALY	1125
5	UK	1113
6	SPAIN	1110
7	AUSTRALIA	786
8	KOREA	671

9	CANADA	632
10	SAUDI ARABIA	538
11	GERMANY	518
12	BRAZIL	448
13	PAKISTAN	420
14	FRANCE	408
15	NETHERLANDS	392
16	PORTUGAL	332
17	JAPAN	314
18	RUSSIA	309
19	GREECE	297
20	POLAND	293
21	TAIWAN	293
22	SWEDEN	252
23	MALAYSIA	234
24	TURKEY	232
25	IRAN	225
26	SINGAPORE	203
27	FINLAND	196
28	NORWAY	182
29	IRELAND	176
30	EMIRATES	170

31	SWITZERLAND	160
32	BELGIUM	153
33	ROMANIA	149
34	EGYPT	147
35	AUSTRIA	143
36	SCOTLAND	135
37	INDONESIA	133
38	DENMARK	132
39	MEXICO	131
40	AFRICA	109
41	HUNGARY	106
42	REPUBLIC	103
43	MOROCCO	97
44	VIETNAM	93
45	JORDAN	89
46	EMIRATES	83
47	QATAR	76
48	COLOMBIA	73
49	ZEALAND	72
50	TUNISIA	59

Among the top 20 countries, the papers of the United States, China and

Italy are cited frequently

[https://apps.webofknowledge.com/RAMore.do?product=UA&search_mode=GeneralSearch&SID=7CWLJVjyPZOPhDPULgR6&qid=1&ra_mode=more&ra_name=CountryTerritory&colName=&viewType=raMore]The highest citation frequency of papers in the United States is more than 10000 times higher than that in China and more than 25000 times higher than that in Italy; The United States, China, Italy and the United Kingdom have the highest proportion of papers cited, with papers from four countries accounting for 53.8% of 20 countries; The papers of the United States, Italy, Britain, Canada, the Netherlands and Greece were cited more frequently, and the frequency of citations was > 20.0; It shows that these countries have produced a large number of high-level achievements, which have attracted the attention of scientists all over the world.

Although the number of scientific research papers published in Italy is only 65% of that in China, the citation frequency of papers is nearly twice that of China, and the citation frequency of papers is the highest among the top 20 countries, reaching 24.69, indicating that its scientific research efficiency is very high; Although the number of papers published in China is the highest, the citation frequency of papers is relatively lower, the citation rate of papers is relatively lower, and the scientific research efficiency is not high.

Table 2 top 20 countries and their influence in the number of papers on smart city research in wos core collection database

Ranking	Country/Region	Numbers of Published Papers in WoS	Citation Frequency	Proportions of Cited Papers (%)	Citation Frequency per Paper
1	USA	2348	53120	19.35%	22.62
2	CHINA	3283	42650	15.54%	12.99
3	ITALY	1125	27777	10.12%	24.69
4	UK	1113	24062	8.77%	21.62
5	SPAIN	1110	16221	5.91%	14.61
6	AUSTRALIA	786	15450	5.63%	19.66
7	CANADA	632	13915	5.07%	22.02
8	INDIA	1191	12574	4.58%	10.56
9	SOUTH KOREA	671	11541	4.20%	17.2
10	GERMANY	518	8989	3.27%	17.35
11	NETHERLANDS	392	8908	3.25%	22.72
12	FRANCE	408	6877	2.51%	16.86
13	SAUDI ARABIA	538	6203	2.26%	11.53
14	GREECE	297	6136	2.24%	20.66
15	PAKISTAN	420	5671	2.07%	13.5

16	PORTUGAL	332	4606	1.68%	13.87
17	JAPAN	314	3766	1.37%	11.99
18	BRAZIL	448	3725	1.36%	8.31
19	RUSSIA	309	2309	0.84%	7.47
20	POLAND	293	1848	0.67%	6.31

1.2 main research institutions and their influence

This report analyzes the top 25 institutions in the number of articles published by the first author, which are active research institutions. According to the country division of research institutions, China has the largest number of active research institutions, and seven Chinese research institutions have contributed 828 documents. These Chinese research institutions are the Chinese Academy of Sciences, Wuhan University, Hong Kong Polytechnic University, Tsinghua University, University of Electronic Science and technology and Southeast University, indicating that the research output and research level related to smart city of Chinese research institutions are improving year by year, At present, there are seven institutions whose research output is among the top 25 in the world, and they have a high citation rate, indicating that the scientific research efficiency is high.; Followed by the United States, six American research institutions contributed 690 articles. Next came Saudi Arabia, with 328 articles contributed by three research institutions

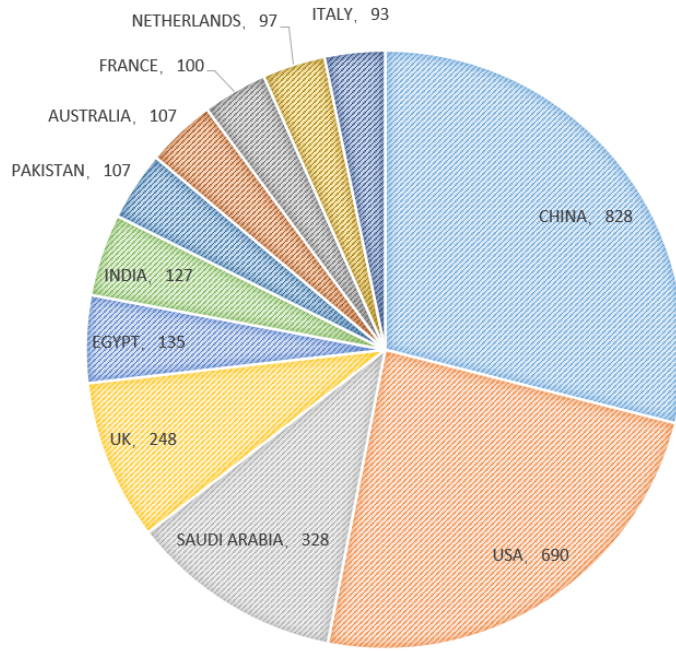


Figure 2 countries of the top 25 institutions of smart city research in was core collection database

Table 3 top 25 research institutions of smart city research in was core collection database

Ranking	Research Institution	Number of Records
1	CHINESE ACADEMY OF SCIENCES	226
2	NATIONAL INSTITUTE OF TECHNOLOGY NIT SYSTEM	157
3	UNIVERSITY OF LONDON	156
4	CHINESE ACAD SCI	141
5	EGYPTIAN KNOWLEDGE BANK EKB	135

6	INDIAN INSTITUTE OF TECHNOLOGY SYSTEM IIT SYSTEM	127
7	STATE UNIVERSITY SYSTEM OF FLORIDA	126
8	UNIVERSITY OF CALIFORNIA SYSTEM	126
9	KING SAUD UNIVERSITY	122
10	WUHAN UNIVERSITY	117
11	HONG KONG POLYTECHNIC UNIVERSITY	108
12	COMSATS UNIVERSITY ISLAMABAD CUI	107
13	UNIVERSITY OF NEW SOUTH WALES SYDNEY	107
14	TSINGHUA UNIVERSITY	106
15	KING SAUD UNIV	104
16	KING ABDULAZIZ UNIVERSITY	102
17	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	100
18	UNIVERSITY OF TEXAS SYSTEM	100
19	DELFT UNIVERSITY OF TECHNOLOGY	97
20	HUAZHONG UNIVERSITY OF SCIENCE TECHNOLOGY	94
21	CONSIGLIO NAZIONALE DELLE RICERCHE CNR	93
22	UNIVERSITY COLLEGE LONDON	92
23	UNIVERSITY SYSTEM OF GEORGIA	91
24	MASSACHUSETTS INSTITUTE OF TECHNOLOGY MIT	90
25	UNIVERSITY OF ELECTRONIC SCIENCE TECHNOLOGY OF CHINA	89

2. Analysis of research hotspots

2.1 main disciplines

Based on the wos platform, smart city research involves a total of 148 discipline fields [the discipline classification system of web of Sciences is a multi-disciplinary system, that is, a paper may belong to multiple disciplines.], However, it is mainly distributed in the following 16 disciplines (the number of papers is more than 1000): Computer Science, engineering, electronic communication, transportation, environmental science and ecology, mathematics, public management, energy and fuel, business economics, science and technology and others, media, automatic control systems, geology, urban research, instrumentation and construction technology.

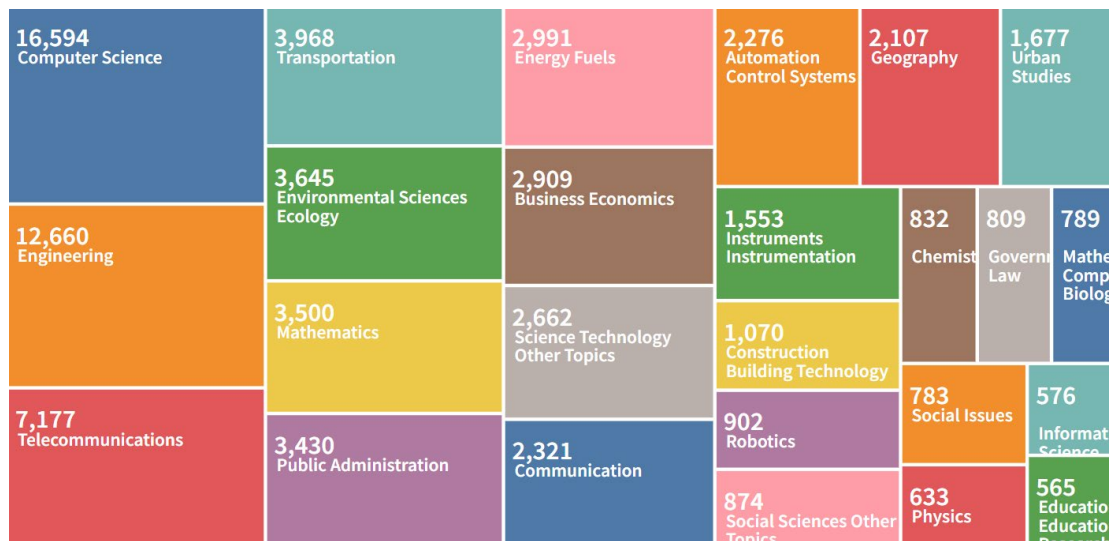


Figure 3 main subject areas

At the same time, this report selects the top 100 highly cited papers in the field of smart city research to analyze their research direction. It is

found that the research direction focuses on seven fields: Computer Science, engineering, electronic communication, environmental science, ecology, public management, geology and energy and fuel.

The classification system of web of Sciences is a multiple classification system, that is, a paper may be long to multiple disciplines, It is mainly distributed in the following 10 disciplines: Computer Science, engineering, electronic communication, mathematics, transportation, environmental science ecology, automatic control systems, media, energy and fuel and public management et. compared with the world, China's research on smart cities has its own characteristics. For example, China's research on smart cities involves less business economics Technology and other, geology and instrumentation. It can be seen from table 4 that most of the papers published in the field of smart cities in China involve the research of computer science and engineering disciplines, especially in the field of computer science, which is more concentrated than the field of global trend disciplines.

Table 4 Discipline Distribution of smart city research in China

Research Direction	Number	
	of	Percentage
	Records	
Computer Science	3,472	21.5277778

Engineering	2,634	16.3318452
Telecommunications	1,560	9.67261905
Mathematics	1,103	6.8390377
Transportation	948	5.87797619
Environmental Sciences Ecology	677	4.19766865
Automation Control Systems	655	4.06125992
Communication	588	3.64583333
Energy Fuels	558	3.45982143
Public Administration	509	3.15600198
Business Economics	487	3.01959325
Science Technology Other Topics	417	2.58556548
Geography	349	2.16393849
Instruments Instrumentation	314	1.9469246
Robotics	259	1.60590278
Construction Building Technology	197	1.22147817
Mathematical Computational Biology	192	1.19047619
Materials Science	177	1.09747024
Remote Sensing	176	1.09126984
Chemistry	159	0.9858631
Physical Sciences Other Topics	148	0.91765873
Physical Geography	147	0.91145833
Physics	137	0.84945437

Social Sciences Other Topics	135	0.83705357
Operations Research Management Science	130	0.80605159

2.2 main journals

The published journals reflect the research direction and count the published journals in the field of intelligent city research. There are 44 journals with more than 50 articles published in the global author publishing period, accounting for 34.9% of the total published articles of 2126 journals. It can be seen that these 44 journals play an important role in the field of intelligent city research.

Table 5 main journals of smart city in wos core collection database

Publication Source	Number
IEEE ACCESS	636
SENSORS BASEL SWITZERLAND	539
SUSTAINABILITY	532
SENSORS	528
SUSTAINABLE CITIES AND SOCIETY	310
IEEE INTERNET OF THINGS JOURNAL	265
ENERGIES	206
IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION	182
SYSTEMS	
FUTURE GENERATION COMPUTER SYSTEMS THE	180

INTERNATIONAL JOURNAL OF ESCIENCE	
APPLIED SCIENCES BASEL	165
CITIES	142
PROCEDIA COMPUTER SCIENCE	137
ISPRS INTERNATIONAL JOURNAL OF GEO INFORMATION	120
SMART CITIES	120
JOURNAL OF CLEANER PRODUCTION	112
URBAN STUDIES	101
APPLIED SCIENCES	99
FUTURE GENERATION COMPUTER SYSTEMS	98
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	96
IEEE COMMUNICATIONS MAGAZINE	94
WIRELESS PERSONAL COMMUNICATIONS	90
ELECTRONICS	88
IOP CONFERENCE SERIES EARTH AND ENVIRONMENTAL SCIENCE	86
ENERGY PROCEDIA	78
JOURNAL OF URBAN TECHNOLOGY	78
WIRELESS COMMUNICATIONS MOBILE COMPUTING	76
IOP CONFERENCE SERIES MATERIALS SCIENCE AND ENGINEERING	74
COMPUTER COMMUNICATIONS	73

IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY	72
INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS	72
PROCEEDINGS OF SPIE	72
IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS	70
TRANSPORTATION RESEARCH RECORD	67
JOURNAL OF AMBIENT INTELLIGENCE AND HUMANIZED COMPUTING	65
EXPERT SYSTEMS WITH APPLICATIONS	63
MULTIMEDIA TOOLS AND APPLICATIONS	63
IEEE SENSORS JOURNAL	62
INTERNATIONAL JOURNAL OF DISTRIBUTED SENSOR NETWORKS	62
IEEE NETWORK	59

3. Summary

This report is released to the world every year to help people understand and master the cutting-edge developments of smart cities. The 2020 smart city science and technology pulsation report analyzes the paper output and influence of major countries and research institutions in the field of smart city research, as well as the research hotspot direction in the discipline field through the literature measurement method. Based on the analysis of the international situation in this report and the research

situation of smart cities in China, we can make international comparison, so as to be familiar with the development trend of scientific research in the field of smart cities and better grasp the development law of smart urbanization.

Bibliometric data can largely reflect the social research heat and research characteristics of smart cities, and reflect the main research participating countries and their research influence. The report found that by the beginning of 2022, a total of 169 countries had invested relevant research efforts in the field of smart cities. From the perspective of chronological development order, the number of research in the field of smart city was very small before 2010. Taking 2011 as the turning point, the number of papers published increased rapidly year by year, and reached a state of rapid growth in 2015, which has been maintained so far. It proves that the global research attention in the field of smart city has experienced a development process from cold to hot, from slow to fast, and has maintained a steady growth until now. According to this trend, it can be predicted that the global attention to the research field of intelligent city will continue to maintain a high growth trend in the near future.

Through the country analysis of the countries that mainly participate in the research in the field of smart cities, it is found that China and the

United States are the largest participating countries and occupy an unshakable leading position in this research field. Historically, the United States has long occupied the top position in the field of smart city research until it has been overtaken by China in recent years. At present, China maintains a high growth rate towards the United States. According to this trend, China will continue to occupy the top of the world's smart city research publications for a long time in the future, and the gap between China and the United States will continue to widen. To a large extent, it can be understood that China's research input and output in the field of smart cities will maintain steady growth, and its advantages over the United States will continue to expand.

Citation rate can largely reflect the recognition and quality of research. According to the calculation of citation frequency, the papers of the United States, China and Italy are cited the most frequently, indicating that the research in the field of smart city in these countries is generally recognized by the international academic community. However, in terms of citation frequency, the papers of the United States, Italy, Britain, Canada, the Netherlands and Greece are cited more frequently, which proves that these countries have produced a large number of high-level achievements and attracted the attention of scholars all over the world. Although the number of papers published in China is the highest, the citation rate of papers is relatively low, and the citation frequency of

papers is relatively low. To a certain extent, it represents that the scientific research efficiency is not high, and the research quality needs to be improved.

This report also analyzes the composition of research institutions participating in smart city research around the world. It is found that China has the most active research institutions, followed by the United States and Saudi Arabia. At the same time, it focuses on the analysis of Chinese research institutions. It is found that the research output and research level of Chinese research institutions related to smart cities are improving year by year, and the scientific research efficiency is improving year by year.

Based on the literature data, the world's smart city research involves a total of 148 discipline fields, mainly focusing on 16 discipline directions. China's smart city research involves 126 disciplines, mainly distributed in 10 disciplines. Compared with the world, China's smart city research has its own characteristics, which is in line with China's national conditions and development stage. It mostly involves the research of computer science and engineering disciplines, especially in the field of computer science, which is more concentrated than the international level. Finally, the report counts the composition of journals in the field of intelligent city research, and explores the community characteristics of the research

direction in this field. Through scientific means, the accurate pulse of cutting-edge development and the timely understanding of macro laws illuminate the way forward for research and provide better basic support for intelligent urbanization.

Appendix: high cited relevant literature summary

1. Internet of Things for Smart Cities

Authors: Zanella, Andrea; Bui, Nicola; Castellani, Angelo; et..

Journal: IEEE INTERNET OF THINGS JOURNAL

Abstract: The Internet of Things (IoT) shall be able to incorporate transparently and seamlessly a large number of different and heterogeneous end systems, while providing open access to selected subsets of data for the development of a plethora of digital services. Building a general architecture for the IoT is hence a very complex task, mainly because of the extremely large variety of devices, link layer technologies, and services that may be involved in such a system. In this paper, we focus specifically to an urban IoT system that, while still being quite a broad category, are characterized by their specific application domain. Urban IoTs, in fact, are designed to support the Smart City vision, which aims at exploiting the most advanced communication technologies to support added-value services for the administration of the city and for the citizens. This paper hence provides a comprehensive survey of the enabling technologies, protocols, and architecture for an urban IoT. Furthermore, the paper will present and discuss the technical solutions and best-practice guidelines adopted in the Padova Smart City project, a proof-of-concept deployment of an IoT island in the city of Padova, Italy, performed in collaboration with the city municipality.

Citation frequency: 2,620

2. Edge Computing: Vision and Challenges

Authors: Shi, Weisong; Cao, Jie; Zhang, Quan, et.

Journal: IEEE INTERNET OF THINGS JOURNAL

Abstract: The proliferation of Internet of Things (IoT) and the success of rich cloud services have pushed the horizon of a new computing paradigm, edge computing, which calls for processing the data at the edge of the network. Edge computing has the potential to address the concerns of response time requirement, battery life constraint, bandwidth cost saving, as well as data safety and privacy. In this paper, we introduce the definition of edge computing, followed by several case studies, ranging from cloud offloading to smart home and city, as well as collaborative edge to materialize the concept of edge computing. Finally, we present several challenges and opportunities in the field of edge computing, and hope this paper will gain attention from the community and inspire more research in this direction.

Citation frequency: 2,337

3. Smart Cities in Europe

Authors: Caragliu, Andrea; Del Bo, Chiara; Nijkamp, Peter

Journal: JOURNAL OF URBAN TECHNOLOGY

Abstract: Urban performance currently depends not only on a city's endowment of hard infrastructure (physical capital), but also, and increasingly so, on the availability and quality of knowledge communication and social infrastructure (human and social capital).

The latter form of capital is decisive for urban competitiveness. Against this background, the concept of the "smart city" has recently been introduced as a strategic device to encompass modern urban production factors in a common framework and, in particular, to highlight the importance of Information and Communication Technologies (ICTs) in the last 20 years for enhancing the competitive profile of a city.

The present paper aims to shed light on the often elusive definition of the concept of the "smart city." We provide a focused and operational definition of this construct and present consistent evidence on the geography of smartcities in the EU27. Our statistical and graphical analyses exploit in depth, for the first time to our knowledge, the most recent version of the Urban Audit data set in order to analyze the factors determining the performance of smartcities. We find that the presence of a creative class, the quality of and dedicated attention to the urban environment, the level of education, and the accessibility to and use of ICTs for public administration are all positively correlated with urban wealth. This result prompts the formulation of a new strategic agenda for European cities that will allow them to achieve sustainable urban development and a better urban landscape.

Citation frequency: 1,321

4. Integration of Cloud computing and Internet of Things: A survey

Authors: Botta, Alessio; de Donato, Walter; Persico, Valerio; et..

Journal: FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL

Abstract: Cloud computing and Internet of Things (IoT) are two very different technologies that are both already part of our life. Their adoption and use are expected to be more and more pervasive, making them important components of the Future Internet. A novel paradigm where Cloud and IoT are merged together is foreseen as disruptive and as an enabler of a large number of application scenarios. In this paper, we focus our attention on the integration of Cloud and IoT, which is what we call the CloudIoT paradigm. Many works in literature have surveyed Cloud and IoT separately and, more precisely, their main properties, features, underlying technologies, and open issues. However, to the best of our knowledge, these works lack a detailed analysis of the new CloudIoT paradigm, which involves completely new applications, challenges, and research issues. To bridge this gap, in this paper we provide a literature survey on the integration of Cloud and IoT. Starting by analyzing the basics of both IoT and Cloud Computing, we discuss their complementarity, detailing what is currently driving to their integration. Thanks to the adoption of the CloudIoT paradigm a number of applications are gaining momentum: we provide an up-to-date picture of CloudIoT applications in literature, with a focus on their specific research challenges. These challenges are then analyzed in details to show where the main body of research is currently heading. We also discuss what is already available in terms of platforms - both proprietary and open source - and projects implementing the CloudIoT paradigm. Finally, we identify open issues and future directions in this field, which we expect to play a leading role in the landscape of the Future Internet. (C) 2015 Elsevier B.V. All rights reserved.

Citation frequency: 1,021

5. Smart Cities: Definitions, Dimensions, Performance, and Initiatives

Authors: Albino, Vito; Berardi, Umberto; Dangelico, Rosa Maria

Journal: JOURNAL OF URBAN TECHNOLOGY

Abstract: As the term "smart city" gains wider and wider currency, there is still confusion about what a smart city is, especially since several similar terms are often used interchangeably. This paper aims to clarify the meaning of the word "smart" in the context of cities through an approach based on an in-depth literature review of relevant studies as well as official documents of international institutions. It also identifies the main dimensions and elements characterizing a smart city. The different metrics of urban smartness are reviewed to show the need for a shared definition of what constitutes a smart city, what are its features, and how it performs in comparison to traditional cities. Furthermore, performance measures and initiatives in a few smart cities are identified.

Citation frequency: 1,015

6. A Survey on Internet of Things: Architecture, Enabling Technologies, Security and Privacy, and Applications

Authors: Lin, Jie; Yu, Wei; Zhang, Nan; et..

Journal: IEEE INTERNET OF THINGS JOURNAL

Abstract: Fog/edge computing has been proposed to be integrated with Internet of Things (IoT) to enable computing services devices deployed at network edge, aiming to improve the user's experience and resilience of the services in case of failures. With the advantage of distributed architecture and close to end-users, fog/edge computing can provide faster response and greater quality of service for IoT applications. Thus, fog/edge computing-based IoT becomes future infrastructure on IoT development. To develop fog/edge computing-based IoT infrastructure, the architecture, enabling techniques, and issues related to IoT should be investigated first, and then the integration of fog/edge computing and IoT should be explored. To this end, this paper conducts a comprehensive overview of IoT with respect to system architecture, enabling technologies, security and privacy issues, and present the integration of fog/edge computing and IoT, and applications. Particularly, this paper first explores the relationship between cyber-physical systems and IoT, both of which play important roles in realizing an intelligent cyber-physical world. Then, existing architectures, enabling technologies, and security and privacy issues in IoT are presented to enhance the understanding of the state of the art IoT development. To investigate the fog/edge computing-based IoT, this paper also investigate the relationship between IoT and fog/edge computing, and discuss issues in fog/edge computing-based IoT. Finally, several applications, including the smart grid, smart transportation, and smart cities, are presented to demonstrate how fog/edge computing-based IoT to be implemented in real-world applications.

Citation frequency: 994

7. Current trends in Smart City initiatives: Some stylised facts

Authors: Neirotti, Paolo; De Marco, Alberto; Cagliano, Anna Corinna; et..

Journal: CITIES

Abstract: The concept of Smart City (SC) as a means to enhance the life quality of citizen has been gaining increasing importance in the agendas of policy makers. However, a shared definition of SC is not available and it is hard to identify common global trends. This paper provides with a comprehensive understanding of the notion of SC through the elaboration of a taxonomy of pertinent application domains, namely: natural resources and energy, transport and mobility, buildings, living, government, and economy and people. It also explores the diffusion of smart initiatives via an empirical study aimed at investigating the ratio of domains covered by a city's best practices to the total of potential domains of smart initiatives and at understanding the role that various economic, urban, demographic, and geographical variables might have in influencing the planning approach to create a smarter city. Results reveal that the evolution patterns of a SC highly depend on its local context factors. In particular, economic development and structural urban variables are likely to influence a city's digital path, the geographical location to affect the SC strategy, and density of populations with its associated congestion problems, might an important component to determine the routes for the SC implementation. This work provides policy makers and city managers with useful guidelines to define and drive their SC strategy and planning actions towards the most appropriate domains of implementation. (C) 2014 Elsevier Ltd. All rights reserved.

Citation frequency: 921

8. Smart cities of the future

Authors: Batty, M.; Axhausen, K. W.; Giannotti, F.; et..

Journal: EUROPEAN PHYSICAL JOURNAL-SPECIAL TOPICS

Abstract: Here we sketch the rudiments of what constitutes a smart city which we define as a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies. We first sketch our vision defining seven goals which concern: developing a new understanding of urban problems; effective and feasible ways to coordinate urban technologies; models and methods for using urban data across spatial and temporal scales; developing new technologies for communication and dissemination; developing new forms of urban governance and organisation; defining critical problems relating to cities, transport, and energy; and identifying risk, uncertainty, and hazards in the smart city. To this, we add six research challenges: to relate the infrastructure of smart cities to their operational functioning and planning through management, control and optimisation; to explore the notion of the city as a laboratory for innovation; to provide portfolios of urban simulation which inform future designs; to develop technologies that ensure equity, fairness and realise a better quality of city life; to develop technologies that ensure informed participation and create shared knowledge for democratic city governance; and to ensure greater and more effective mobility and access to opportunities for urban populations. We begin by defining the state of the art,

explaining the science of smart cities. We define six scenarios based on new cities badging themselves as smart, older cities regenerating themselves as smart, the development of science parks, tech cities, and technopoles focused on high technologies, the development of urban services using contemporary ICT, the use of ICT to develop new urban intelligence functions, and the development of online and mobile forms of participation. Seven project areas are then proposed: Integrated Databases for the Smart City, Sensing, Networking and the Impact of New Social Media, Modelling Network Performance, Mobility and Travel Behaviour, Modelling Urban Land Use, Transport and Economic Interactions, Modelling Urban Transactional Activities in Labour and Housing Markets, Decision Support as Urban Intelligence, Participatory Governance and Planning Structures for the Smart City. Finally we anticipate the paradigm shifts that will occur in this research and define a series of key demonstrators which we believe are important to progressing a science of smart cities.

Citation frequency: 817

9. Low Power Wide Area Networks: An Overview

Authors: Raza, Usman; Kulkarni, Parag; Sooriyabandara, Mahesh

Journal: IEEE COMMUNICATIONS SURVEYS AND TUTORIALS

Abstract: Low power wide area (LPWA) networks are attracting a lot of attention primarily because of their ability to offer affordable connectivity to the low-power devices distributed over very large geographical areas. In realizing the vision of the Internet of

Things, LPWA technologies complement and sometimes supersede the conventional cellular and short range wireless technologies in performance for various emerging smart city and machine-to-machine applications. This review paper presents the design goals and the techniques, which different LPWA technologies exploit to offer wide-area coverage to low-power devices at the expense of low data rates. We survey several emerging LPWA technologies and the standardization activities carried out by different standards development organizations (e.g., IEEE, IETF, 3GPP, ETSI) as well as the industrial consortia built around individual LPWA technologies (e.g., LORa Alliance, WEIGHTLESS-SIG, and DASH7 alliance). We further note that LPWA technologies adopt similar approaches, thus sharing similar limitations and challenges. This paper expands on these research challenges and identifies potential directions to address them. While the proprietary LPWA technologies are already hitting the market with large nationwide roll-outs, this paper encourages an active engagement of the research community in solving problems that will shape the connectivity of tens of billions of devices in the next decade.

Citation frequency:756

10. IoT security: Review, blockchain solutions, and open challenges

Authors: Khan, Minhaj Ahmad; Salah, Khaled

Journal: FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE

Abstract: With the advent of smart homes, smart cities, and smart everything, the Internet of Things (IoT) has emerged as an area of incredible impact, potential, and growth, with Cisco Inc. predicting to have 50 billion connected devices by 2020. However, most of these IoT devices are easy to hack and compromise. Typically, these IoT devices are limited in compute, storage, and network capacity, and therefore they are more vulnerable to attacks than other endpoint devices such as smartphones, tablets, or computers.

In this paper, we present and survey major security issues for IoT. We review and categorize popular security issues with regard to the IoT layered architecture, in addition to protocols used for networking, communication, and management. We outline security requirements for IoT along with the existing attacks, threats, and state-of-the-art solutions. Furthermore, we tabulate and map IoT security problems against existing solutions found in the literature. More importantly, we discuss, how blockchain, which is the underlying technology for bitcoin, can be a key enabler to solve many IoT security problems. The paper also identifies open research problems and challenges for IoT security. (C) 2017 Elsevier B.V. All rights reserved.

Citation frequency: 722

11. MES (multi-energy systems): An overview of concepts and evaluation models

Authors: Mancarella, Pierluigi

Journal: ENERGY

Abstract: MES (multi-energy systems) whereby electricity, heat, cooling, fuels, transport, and so on optimally interact with each other at various levels (for instance, within a district, city or region) represent an important opportunity to increase technical, economic and environmental performance relative to "classical" energy systems whose sectors are treated "separately" or "independently". This performance improvement can take place at both the operational and the planning stage. While such systems and in particular systems with distributed generation of multiple energy vectors (DMG (distributed multigeneration)) can be a key option to decarbonize the energy sector, the approaches needed to model and relevant tools to analyze them are often of great complexity. Likewise, it is not straightforward to identify performance metrics that are capable to properly capture costs and benefits that are relating to various types of MES according to different criteria. The aim of this invited paper is thus to provide the reader with a comprehensive and critical overview of the latest models and assessment techniques that are currently available to analyze MES and in particular DMG systems, including for instance concepts such as energy hubs, microgrids, and VPPs (virtual power plants), as well as various approaches and criteria for energy, environmental, and techno-economic assessment. (C) 2013 Elsevier Ltd. All rights reserved.

Citation frequency: 683

12. An Information Framework for Creating a Smart City Through Internet of Things

Authors: Jin, Jiong; Gubbi, Jayavardhana; Marusic, Slaven; et..

Journal: IEEE INTERNET OF THINGS JOURNAL

Abstract: Increasing population density in urban centers demands adequate provision of services and infrastructure to meet the needs of city inhabitants, encompassing residents, workers, and visitors. The utilization of information and communications technologies to achieve this objective presents an opportunity for the development of smart cities, where city management and citizens are given access to a wealth of real-time information about the urban environment upon which to base decisions, actions, and future planning. This paper presents a framework for the realization of smart cities through the Internet of Things (IoT). The framework encompasses the complete urban information system, from the sensory level and networking support structure through to data management and Cloud-based integration of respective systems and services, and forms a transformational part of the existing cyber-physical system. This IoT vision for a smart city is applied to a noise mapping case study to illustrate a new method for existing operations that can be adapted for the enhancement and delivery of important city services.

Citation frequency: 646

13. A Survey on 5G Networks for the Internet of Things: Communication Technologies and Challenges

Authors: Akpakwu, Godfrey Anuga; Silva, Bruno J.; Hancke, Gerhard P.; et..

Journal: IEEE ACCESS

Abstract: The Internet of Things (IoT) is a promising technology which tends to revolutionize and connect the global world via heterogeneous smart devices through seamless connectivity. The current demand for machine-type communications (MTC) has resulted in a variety of communication technologies with diverse service requirements to achieve the modern IoT vision. More recent cellular standards like long-term evolution (LTE) have been introduced for mobile devices but are not well suited for low-power and low data rate devices such as the IoT devices. To address this, there is a number of emerging IoT standards. Fifth generation (5G) mobile network, in particular, aims to address the limitations of previous cellular standards and be a potential key enabler for future IoT. In this paper, the state-of-the-art of the IoT application requirements along with their associated communication technologies are surveyed. In addition, the third generation partnership project cellular-based low-power wide area solutions to support and enable the new service requirements for Massive to Critical IoT use cases are discussed in detail, including extended coverage global system for mobile communications for the Internet of Things, enhanced machine-type communications, and narrowband-Internet of Things. Furthermore, 5G new radio enhancements for new service requirements and enabling technologies for the IoT are introduced. This paper presents a comprehensive review related to emerging and enabling technologies with main focus on 5G mobile networks that is envisaged to support the exponential traffic growth for enabling the IoT. The challenges and open research directions pertinent to the deployment of massive to critical IoT applications are also presented in coming up with an efficient context-aware congestion control mechanism.

Citation frequency: 517

14. LONG-RANGE COMMUNICATIONS IN UNLICENSED BANDS: THE RISING STARS IN THE IOT AND SMART CITYSCENARIOS

Authors: Centenaro, Marco; Vangelista, Lorenzo; Zanella, Andrea; et..

Journal: IEEE WIRELESS COMMUNICATIONS

Abstract: Connectivity is probably the most basic building block of the IoT paradigm. Up to now, the two main approaches to provide data access to things have been based on either multihop mesh networks using short-range communication technologies in the unlicensed spectrum, or long-range legacy cellular technologies, mainly 2G/GSM/GPRS, operating in the corresponding licensed frequency bands. Recently, these reference models have been challenged by a new type of wireless connectivity, characterized by low-rate, long-range transmission technologies in the unlicensed sub-gigahertz frequency bands, used to realize access networks with star topology referred to as low-power WANs (LPWANs). In this article, we introduce this new approach to provide connectivity in the IoT scenario, discussing its advantages over the established paradigms in terms of efficiency, effectiveness, and architectural design, particularly for typical smart city applications.

Citation frequency: 497

15. Smart tourism: foundations and developments

Authors: Gretzel, Ulrike; Sigala, Marianna; Xiang, Zheng; et..

Journal: ELECTRONIC MARKETS

Abstract: Smart tourism is a new buzzword applied to describe the increasing reliance of tourism destinations, their industries and their tourists on emerging forms of ICT that allow for massive amounts of data to be transformed into value propositions. However, it remains ill-defined as a concept, which hinders its theoretical development. The paper defines smart tourism, sheds light on current smart tourism trends, and then lays out its technological and business foundations. This is followed by a brief discussion on the prospects and drawbacks of smart tourism. The paper further draws attention to the great need for research to inform smart tourism development and management.

Citation frequency: 496

16. Sensing as a service model for smart cities supported by Internet of Things

Authors: Perera, Charith; Zaslavsky, Arkady; Christen, Peter; et..

Journal : TRANSACTIONS ON EMERGING TELECOMMUNICATIONS TECHNOLOGIES

Abstract: The world population is growing at a rapid pace. Towns and cities are accommodating half of the world's population thereby creating tremendous pressure on every aspect of urban living. Cities are known to have large concentration of resources and facilities. Such environments attract people from rural areas. However,

unprecedented attraction has now become an overwhelming issue for city governance and politics. The enormous pressure towards efficient city management has triggered various Smart City initiatives by both government and private sector businesses to invest in information and communication technologies to find sustainable solutions to the growing issues. The Internet of Things (IoT) has also gained significant attention over the past decade. IoT envisions to connect billions of sensors to the Internet and expects to use them for efficient and effective resource management in Smart Cities. Today, infrastructure, platforms and software applications are offered as services using cloud technologies. In this paper, we explore the concept of sensing as a service and how it fits with the IoT. Our objective is to investigate the concept of sensing as a service model in technological, economical and social perspectives and identify the major open challenges and issues. Copyright (c) 2013 John Wiley & Sons, Ltd.

Citation frequency: 495

17. Smartmentality: The Smart City as Disciplinary Strategy

Authors: Vanolo, Alberto

Journal: URBAN STUDIES

Abstract: The paper analyses the concept of the smart city in critical perspective, focusing on the power/knowledge implications for the contemporary city. On the one hand, smart city policies support new ways of imagining, organising and managing the city and its flows; on the other, they impress a new moral order on the city by introducing

specific technical parameters in order to distinguish between the 'good' and 'bad' city. The smart city discourse may therefore be a powerful tool for the production of docile subjects and mechanisms of political legitimisation. The paper is largely based on theoretical reflections and uses smart city politics in Italy as a case study. The paper analyses how the smart city discourse proposed by the European Union has been reclassified to produce new visions of the 'good city' and the role of private actors and citizens in the management of urban development.

Citation frequency: 492

18. Making Bertha Drive-An Autonomous Journey on a Historic Route

Authors: Ziegler, J; Bender, P; (...); Zeeb, E

Journal: IEEE INTELLIGENT TRANSPORTATION SYSTEMS MAGAZINE

Abstract: 125 years after Bertha Benz completed the first overland journey in automotive history, the Mercedes Benz S-Class S 500 INTELLIGENT DRIVE followed the same route from Mannheim to Pforzheim, Germany, in fully autonomous manner. The autonomous vehicle was equipped with close-to-production sensor hardware and relied solely on vision and radar sensors in combination with accurate digital maps to obtain a comprehensive understanding of complex traffic situations. The historic Bertha Benz Memorial Route is particularly challenging for autonomous driving. The course taken by the autonomous vehicle had a length of 103 km and covered rural roads, 23 small villages and major cities (e.g. downtown Mannheim and Heidelberg). The route posed a

large variety of difficult traffic scenarios including intersections with and without traffic lights, roundabouts, and narrow passages with oncoming traffic. This paper gives an overview of the autonomous vehicle and presents details on vision and radar-based perception, digital road maps and video-based self-localization, as well as motion planning in complex urban scenarios.

Citation frequency : 452

19. Multi-sensor fusion in body sensor networks: State-of-the-art and research challenges

Authors: Gravina, R; Alinia, P;Ghasemzadeh, H ; Fortino, G

Journal: INFORMATION FUSION

Abstract: Body Sensor Networks (BSNs) have emerged as a revolutionary technology in many application domains in health-care, fitness, smart cities, and many other compelling Internet of Things (IoT) applications. Most commercially available systems assume that a single device monitors a plethora of user information. In reality, BSN technology is transitioning to multi-device synchronous measurement environments; fusion of the data from multiple, potentially heterogeneous, sensor sources is therefore becoming a fundamental yet non-trivial task that directly impacts application performance. Nevertheless, only recently researchers have started developing technical solutions for effective fusion of BSN data. To the best of our knowledge, the community is currently lacking a comprehensive review of the state-of-the-art techniques on multi-sensor fusion

in the area of BSN. This survey discusses clear motivations and advantages of multi-sensor data fusion and particularly focuses on physical activity recognition, aiming at providing a systematic categorization and common comparison framework of the literature, by identifying distinctive properties and parameters affecting data fusion design choices at different levels (data, feature, and decision). The survey also covers data fusion in the domains of emotion recognition and general-health and introduce relevant directions and challenges of future research on multi-sensor fusion in the BSN domain.

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Citation frequency: 448

20. Smart Specialization, Regional Growth and Applications to European Union Cohesion Policy

Authors: McCann, P; Ortega-Argiles, R

Journal: REGIONAL STUDIES

Abstract: McCann P. and Ortega-Argiles R. Smart specialization, regional growth and applications to European Union Cohesion policy, Regional Studies. The aim of this paper is to achieve two objectives. Firstly, it examines the smart specialization concept and explains the challenges involved in applying this originally sectoral concept to an explicitly spatial and regional setting. Secondly, it explains the ways in which this might be achieved so as to make the concept suitable as a building block of a reformed European Union cohesion policy.

Citation frequency: 439

21. A Survey on the Edge Computing for the Internet of Things

Authors: Yu, W; Liang, F ; He, XF ; Hatcher, WG ; Lu, C ; Lin, J ; Yang, XY

Journal: IEEE ACCESS

Abstract: The Internet of Things (IoT) now permeates our daily lives, providing important measurement and collection tools to inform our every decision. Millions of sensors and devices are continuously producing data and exchanging important messages via complex networks supporting machine-to-machine communications and monitoring and controlling critical smart-world infrastructures. As a strategy to mitigate the escalation in resource congestion, edge computing has emerged as a new paradigm to solve IoT and localized computing needs. Compared with the well-known cloud computing, edge computing will migrate data computation or storage to the network "edge," near the end users. Thus, a number of computation nodes distributed across the network can offload the computational stress away from the centralized data center, and can significantly reduce the latency in message exchange. In addition, the distributed structure can balance network traffic and avoid the traffic peaks in IoT networks, reducing the transmission latency between edge/cloudlet servers and end users, as well as reducing response times for real-time IoT applications in comparison with traditional cloud services. Furthermore, by transferring computation and communication overhead from nodes with limited battery supply to nodes with significant power resources, the system can extend the lifetime of the individual nodes. In this paper, we conduct a comprehensive survey,

analyzing how edge computing improves the performance of IoT networks. We categorize edge computing into different groups based on architecture, and study their performance by comparing network latency, bandwidth occupation, energy consumption, and overhead. In addition, we consider security issues in edge computing, evaluating the availability, integrity, and the confidentiality of security strategies of each group, and propose a framework for security evaluation of IoT networks with edge computing. Finally, we compare the performance of various IoT applications (smart city, smart grid, smart transportation, and so on) in edge computing and traditional cloud computing architectures.

Citation frequency: 438

22. Governing the smart city: a review of the literature on smart urban governance

Authors: Meijer, A; Bolivar, MPR

Journal: INTERNATIONAL REVIEW OF ADMINISTRATIVE SCIENCES

Abstract: Academic attention to smart cities and their governance is growing rapidly, but the fragmentation in approaches makes for a confusing debate. This article brings some structure to the debate by analyzing a corpus of 51 publications and mapping their variation. The analysis shows that publications differ in their emphasis on (1) smart technology, smart people or smart collaboration as the defining features of smart cities, (2) a transformative or incremental perspective on changes in urban governance, (3) better outcomes or a more open process as the legitimacy claim for smart city governance. We argue for a comprehensive perspective: smart city governance is about crafting new

forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes. Research into smart city governance could benefit from previous studies into success and failure factors for e-government and build upon sophisticated theories of socio-technical change. This article highlights that smart city governance is not a technological issue: we should study smart city governance as a complex process of institutional change and acknowledge the political nature of appealing visions of socio-technical

Citation frequency: 434

23. Smart sustainable cities of the future: An extensive interdisciplinary literature review

Authors: Bibri, SE ; Krogstie, J

Journal: SUSTAINABLE CITIES AND SOCIETY

Abstract: In recent years, the concept of smart sustainable cities has come to the fore. And it is rapidly gaining momentum and worldwide attention as a promising response to the challenge of urban sustainability. This pertains particularly to ecologically and technologically advanced nations. This paper provides a comprehensive overview of the field of smart (and) sustainable cities in terms of its underlying foundations and assumptions, state-of-the art research and development, research opportunities and horizons, emerging scientific and technological trends, and future planning practices. As to the design strategy, the paper reviews existing sustainable city models and smart city approaches. Their strengths and weaknesses are discussed with particular emphasis being placed on the extent to which the former contributes to the goals of sustainable

development and whether the latter incorporates these goals. To identify the related challenges, those models and approaches are evaluated and compared against each other in line with the notion of sustainability. The gaps in the research within the field of smart sustainable cities are identified in accordance with and beyond the research being proposed. As a result, an integrated approach is proposed based on an applied theoretical perspective to align the existing problems and solutions identification for future practices in the area of smart sustainable urban planning and development. As to the findings, the paper shows that critical issues remain unsettled, less explored, largely ignored, and theoretically underdeveloped for applied purposes concerning existing models of sustainable urban form as to their contribution to sustainability, among other things. It also reveals that numerous research opportunities are available and can be realized in the realm of smart sustainable cities. Our perspective on the topic in this regard is to develop a theoretically and practically convincing model of smart sustainable city or a framework for strategic smart sustainable urban development. This model or framework aims to address the key limitations, uncertainties, paradoxes, and fallacies pertaining to existing models of sustainable urban form with support of ICT of the new wave of computing and the underlying big data and context-aware computing technologies and their advanced applications. We conclude that the applied theoretical inquiry into smart sustainable cities of the future is deemed of high pertinence and importance given that the research in the field is still in its early stages, and that the subject matter draws upon contemporary and influential theories with practical applications. The comprehensive overview of and critique on existing work on smart (and)

sustainable cities provide a valuable and seminal reference for researchers and practitioners in related research communities and the necessary material to inform these communities of the latest developments in the area of smart sustainable urban planning and development. In addition, the proposed holistic approach is believed to be the first of its kind. That is, it has not been, to the best of one's knowledge, investigated or produced elsewhere. (C) 2017 Elsevier Ltd. All rights reserved.

Citation frequency: 425

24. What are the differences between sustainable and smart cities?

Authors: Ahvenniemi, H; Huovila, A; Pinto-Seppa, I; Airaksinen, M

Journal: CITIES

Abstract: City assessment tools can be used as support for decision making in urban development as they provide assessment methodologies for cities to show the progress towards defined targets. In the 21st century, there has been a shift from sustainability assessment to smart city goals. We analyze 16 sets of city assessment frameworks (eight smart city and eight urban sustainability assessment frameworks) comprising 958 indicators altogether by dividing the indicators under three impact categories and 12 sectors. The following main observations derive from the analyses: as expected, there is a much stronger focus on modern technologies and "smartness" in the smart city frameworks compared to urban sustainability frameworks. Another observation is that as urban sustainability frameworks contain a large number of indicators measuring

environmental sustainability, smart city frameworks lack environmental indicators while highlighting social and economic aspects. A general goal of smart cities is to improve sustainability with help of technologies. Thus, we recommend the use of a more accurate term "smart sustainable cities" instead of smart cities. However, the current large gap between smart city and sustainable city frameworks suggest that there is a need for developing smart city frameworks further or re-defining the smart city concept. We recommend that the assessment of smart city performance should not only use output indicators that measure the efficiency of deployment of smart solutions but also impact indicators that measure the contribution towards the ultimate goals such as environmental, economic or social sustainability. (C) 2016 Elsevier Ltd. All rights reserved.

Citation frequency: 412

25. The role of big data in smart city

Authors: Hashem, IAT; Chang, V; Anuar, NB; et..

Journal: INTERNATIONAL JOURNAL OF INFORMATION MANAGEMENT

Abstract: The expansion of big data and the evolution of Internet of Things (IoT) technologies have played an important role in the feasibility of smart city initiatives. Big data offer the potential for cities to obtain valuable insights from a large amount of data collected through various sources, and the IoT allows the integration of sensors, radio-frequency identification, and Bluetooth in the real-world environment using highly networked services. The combination of the IoT and big data is an unexplored research

area that has brought new and interesting challenges for achieving the goal of future smart cities. These new challenges focus primarily on problems related to business and technology that enable cities to actualize the vision, principles, and requirements of the applications of smart cities by realizing the main smart environment characteristics. In this paper, we describe the state-of-the-art communication technologies and smart based applications used within the context of smart cities. The visions of big data analytics to support smart cities are discussed by focusing on how big data can fundamentally change urban populations at different levels. Moreover, a future business model of big data for smart cities is proposed, and the business and technological research challenges are identified. This study can serve as a benchmark for researchers and industries for the future progress and development of smart cities in the context of big data. (C) 2016 Elsevier Ltd. All rights reserved.

Citation frequency: 411

26. Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities

Authors: Silva, BN; Khan, M ; Han, K

Journal: SUSTAINABLE CITIES AND SOCIETY

Abstract: Smart city is an application of Internet of Things (IoT) notion. Unceasing growth of population and urbanization have intensified innovative ways to handle urbanization with minimal impact on environment, citizen lifestyles, and governance.

Initial integration of information communication technology (ICT) into city operations have

promoted telicity, information city, and digital city concepts. Later, the conception of IoT has founded the smart cities, which support the city operations intelligently with minimal human interaction. Smart city emerged as a solution to address the challenges arise with exponential growth of urbanization and population. However, smart city concept is still evolving and not mainstreamed throughout the globe due to technological, economical, and governing barriers. Therefore, this paper aims to deliver the essence of smart cities. The paper presents a brief overview of smart cities, followed by the features and characteristics, generic architecture, composition, and real-world implementations of smart cities. Finally, we present some challenges and opportunities identified through extensive literature survey on smart cities.

Citation frequency: 396

27. Sustainable-smart-resilient-low carbon-eco-knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization

Authors: de Jong, Martin; Joss, Simon; Schraven, Daan; et..

Journal: JOURNAL OF CLEANER PRODUCTION

Abstract: Over the last couple of decades, metropolitan areas around the world have been engaged in a multitude of initiatives aimed at upgrading urban infrastructure and services, with a view to creating better environmental, social and economic conditions and enhancing cities' attractiveness and competitiveness. Reflecting these developments, many new categories of 'cities' have entered the policy discourse: 'sustainable cities'; 'green cities'; 'digital cities'; 'smart cities'; intelligent cities'; 'information cities'; 'knowledge

cities'; 'resilient cities'; 'eco cities': 'low carbon cities'; 'liveable cities'; and even combinations, such as 'low carbon eco cities' and 'ubiquitous eco cities'. In practice, these terms often appear to be used interchangeably by policy makers, planners and developers. However, the question arises whether these categories nevertheless each embody distinct conceptual perspectives, which would have implications for how they are understood theoretically and applied in policy. In response, this article investigates, through a comprehensive bibliometric analysis, how the twelve most frequent city categories are conceptualised individually and in relation to one another in the academic literature. We hypothesize that, notwithstanding some degree of overlap and cross-fertilization, in their essence the observed categories each harbor particular conceptual perspectives that render them distinctive. This is borne out by the findings, which demonstrate robustly for the first time the conceptual differences and interrelationships among twelve dominant city categories. The 'sustainable city' is the most frequently occurring category and, in a map of keyword co-occurrences, by far the largest and most interconnected node, linked closely to the 'eco city' and 'green city' concepts. Recently, the more narrow concepts of 'low carbon city' and 'smart city' have been on the rise, judging by their frequency of occurrence in academic journals; the latter in particular appears to have become an increasingly dominant category of urban modernization policy. On their part, 'resilient city' and 'knowledge city' represent distinct concepts, albeit with comparatively low frequency. Overall, the findings point to the need for rigor and nuance in the use of these terms, not least if one wishes to comprehend their implications for urban development and regeneration policy and practice. (C) 2015

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Citation frequency: 387

28. Real-Time Urban Monitoring Using Cell Phones: A Case Study in Rome

Authors: Calabrese, F; Colonna, M; Lovisolo, P; et..

Journal: IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS

Abstract: This paper describes a new real-time urban monitoring system. The system uses the Localizing and Handling Network Event Systems (LoCHNESs) platform developed by Telecom Italia for the real-time evaluation of urban dynamics based on the anonymous monitoring of mobile cellular networks. In addition, data are supplemented based on the instantaneous positioning of buses and taxis to provide information about urban mobility in real time, ranging from traffic conditions to the movements of pedestrians throughout the city. This system was exhibited at the Tenth International Architecture Exhibition of the Venice Biennale. It marks the unprecedented monitoring of a large urban area, which covered most of the city of Rome, in real time using a variety of sensing systems and will hopefully open the way to a new paradigm of understanding and optimizing urban dynamics.

Citation frequency: 387

29. Internet of Things and Big Data Analytics for Smart and Connected Communities

Authors: Sun, YC.; Song, HB; Jara, AJ ; Bie, RF

Journal: IEEE ACCESS

Abstract: This paper promotes the concept of smart and connected communities SCC, which is evolving from the concept of smart cities. SCC are envisioned to address synergistically the needs of remembering the past (preservation and revitalization), the needs of living in the present (livability), and the needs of planning for the future (attainability). Therefore, the vision of SCC is to improve livability, preservation, revitalization, and attainability of a community. The goal of building SCC for a community is to live in the present, plan for the future, and remember the past. We argue that Internet of Things (IoT) has the potential to provide a ubiquitous network of connected devices and smart sensors for SCC, and big data analytics has the potential to enable the move from IoT to real-time control desired for SCC. We highlight mobile crowdsensing and cyber-physical cloud computing as two most important IoT technologies in promoting SCC. As a case study, we present TreSight, which integrates IoT and big data analytics for smart tourism and sustainable cultural heritage in the city of Trento, Italy.

Citation frequency: 385

30. On-demand high-capacity ride-sharing via dynamic trip-vehicle assignment

Authors: Alonso-Mora, J ; Samaranayake, S ; Wallar, A ; Frazzoli, E ; Rus, D

Journal: PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA

Abstract: Ride-sharing services are transforming urban mobility by providing timely and convenient transportation to anybody, anywhere, and anytime. These services present

enormous potential for positive societal impacts with respect to pollution, energy consumption, congestion, etc. Current mathematical models, however, do not fully address the potential of ride-sharing. Recently, a large-scale study highlighted some of the benefits of car pooling but was limited to static routes with two riders per vehicle (optimally) or three (with heuristics). We present a more general mathematical model for real-time high-capacity ride-sharing that (i) scales to large numbers of passengers and trips and (ii) dynamically generates optimal routes with respect to online demand and vehicle locations. The algorithm starts from a greedy assignment and improves it through a constrained optimization, quickly returning solutions of good quality and converging to the optimal assignment over time. We quantify experimentally the tradeoff between fleet size, capacity, waiting time, travel delay, and operational costs for low-to-medium-capacity vehicles, such as taxis and van shuttles. The algorithm is validated with similar to 3 million rides extracted from the New York City taxicab public dataset. Our experimental study considers ride-sharing with rider capacity of up to 10 simultaneous passengers per vehicle. The algorithm applies to fleets of autonomous vehicles and also incorporates rebalancing of idling vehicles to areas of high demand. This framework is general and can be used for many real-time multivehicle, multitask assignment problems.

Citation frequency: 383

31. Modelling the smart city performance

Authors: Lombardi, P; Giordano, S; Farouh, H; Yousef, W

Journal : INNOVATION-THE EUROPEAN JOURNAL OF SOCIAL SCIENCE

RESEARCH

Abstract: This paper aims to offer a profound analysis of the interrelations between smart city components connecting the cornerstones of the triple helix. The triple helix model has emerged as a reference framework for the analysis of knowledge-based innovation systems, and relates the multiple and reciprocal relationships between the three main agencies in the process of knowledge creation and capitalization: university, industry and government. This analysis of the triple helix will be augmented using the Analytic Network Process to model, cluster and begin measuring the performance of smart cities. The model obtained allows interactions and feedbacks within and between clusters, providing a process to derive ratio scales priorities from elements. This offers a more truthful and realistic representation for supporting policy-making. The application of this model is still to be developed, but a full list of indicators, available at urban level, has been identified and selected from literature review.

Citation frequency: 375

32. Large-scale physical activity data reveal worldwide activity inequality

Authors: Althoff, T; Sosic, R; Hicks, JLet.

Journal: NATURE

Abstract: To be able to curb the global pandemic of physical inactivity(1-7) and the associated 5.3 million deaths per year(2), we need to understand the basic principles that govern physical activity. However, there is a lack of large-scale measurements of physical activity patterns across free-living populations worldwide(1,6). Here we leverage

the wide usage of smartphones with built-in accelerometry to measure physical activity at the global scale. We study a dataset consisting of 68 million days of physical activity for 717,527 people, giving us a window into activity in 111 countries across the globe. We find inequality in how activity is distributed within countries and that this inequality is a better predictor of obesity prevalence in the population than average activity volume. Reduced activity in females contributes to a large portion of the observed activity inequality. Aspects of the built environment, such as the walkability of a city, are associated with a smaller gender gap in activity and lower activity inequality. In more walkable cities, activity is greater throughout the day and throughout the week, across age, gender, and body mass index (BMI) groups, with the greatest increases in activity found for females. Our findings have implications for global public health policy and urban planning and highlight the role of activity inequality and the built environment in improving physical activity and health.

Citation frequency: 369

33. SmartSantander: IoT experimentation over a smart city testbed

Authors: Sanchez, L; Munoz, L ; Galache, JA et..

Journal: COMPUTER NETWORKS

Abstract: This paper describes the deployment and experimentation architecture of the Internet of Things experimentation facility being deployed at Santander city. The facility is implemented within the SmartSantander project, one of the projects of the Future Internet

Research and Experimentation initiative of the European Commission and represents a unique in the world city-scale experimental research facility. Additionally, this facility supports typical applications and services of a smart city. Tangible results are expected to influence the definition and specification of Future Internet architecture design from viewpoints of Internet of Things and Internet of Services. The facility comprises a large number of Internet of Things devices deployed in several urban scenarios which will be federated into a single testbed. In this paper the deployment being carried out at the main location, namely Santander city, is described. Besides presenting the current deployment, in this article the main insights in terms of the architectural design of a large-scale IoT testbed are presented as well. Furthermore, solutions adopted for implementation of the different components addressing the required testbed functionalities are also sketched out. The IoT experimentation facility described in this paper is conceived to provide a suitable platform for large scale experimentation and evaluation of IoT concepts under real-life conditions. (C) 2013 Elsevier B.V. All rights reserved.

Citation frequency:365

34. Random Access for Machine-to-Machine Communication in LTE-Advanced Networks:

Issues and Approaches

Authors: Hasan, M; Hossain, E ; Niyato, D

Journal: IEEE COMMUNICATIONS MAGAZINE

Abstract: Machine-to-machine communication, a promising technology for the smart city concept, enables ubiquitous connectivity between one or more autonomous devices

without or with minimal human interaction. M2M communication is the key technology to support data transfer among sensors and actuators to facilitate various smart city applications (e. g., smart metering, surveillance and security, infrastructure management, city automation, and eHealth). To support massive numbers of machine type communication (MTC) devices, one of the challenging issues is to provide an efficient way for multiple access in the network and to minimize network overload. In this article, we review the M2M communication techniques in Long Term Evolution-Advanced cellular networks and outline the major research issues. Also, we review the different random access overload control mechanisms to avoid congestion caused by random channel access of MTC devices. To this end, we propose a reinforcement learning-based eNB selection algorithm that allows the MTC devices to choose the eNBs (or base stations) to transmit packets in a self-organizing fashion.

Citation frequency: 362

35. Smart city policies: A spatial approach

Authors: Angelidou, M

Journal: CITIES

Abstract: This paper reviews the factors which differentiate policies for the development of smart cities, in an effort to provide a clear view of the strategic choices that come forth when mapping out such a strategy. The paper commences with a review and categorization of four strategic choices with a spatial reference, on the basis of the recent

smart city literature and experience. The advantages and disadvantages of each strategic choice are presented. In the second part of the paper, the previous choices are illustrated through smart city strategy cases from all over the world. The third part of the paper includes recommendations for the development of smart cities based on the combined conclusions of the previous parts. The paper closes with a discussion of the insights that were provided and recommendations for future research areas. (C) 2014 Elsevier Ltd. All rights reserved.

Citation frequency: 359

36. Urban planning and building smart cities based on the Internet of Things using Big Data analytics

Authors: Rathore, M. Mazhar; Ahmad, Awais; Paul, Anand; Rho, Seungmin

Journal: COMPUTER NETWORKS

Abstract: The rapid growth in the population density in urban cities demands that services and an infrastructure be provided to meet the needs of city inhabitants. Thus, there has been an increase in the request for embedded devices, such as sensors, actuators, and smartphones, leading to considerable business potential for the new era of the Internet of Things (IoT), in which all devices are capable of interconnecting and communicating with each other over the Internet. Thus, Internet technologies provide a way of integrating and sharing a common communication medium. With this knowledge, in this paper, we propose a combined IoT-based system for smart city development and urban planning using Big Data analytics. We propose a complete system consisting of

various types of sensor deployment, including smart home sensors, vehicular networking, weather and water sensors, smart parking sensors, and surveillance objects. A four-tier architecture is proposed that includes 1) Bottom tier-1, which is responsible for IoT sources and data generation and collection, 2) Intermediate tier-1, which is responsible for all types of communication between, for instance, sensors, relays, base stations, and the Internet, 3) Intermediate tier 2, which is responsible for data management and processing using a Hadoop framework, and 4) Top tier, which is responsible for application and usage of the data analysis and the results generated. The system implementation consists of various steps that begin with data generation and move to collection, aggregation, filtration, classification, preprocessing, computing and decision making. The proposed system is implemented using Hadoop with Spark, voltDB, Storm or S4 for real time processing of the IoT data to generate results to establish the smart city. For urban planning or city future development, the offline historical data are analyzed with Hadoop using MapReduce programming. IoT datasets generated by smart homes, smart parking weather, pollution, and vehicle data sets are used for analysis and evaluation. This type of system with full functionality does not currently exist. Similarly, the results demonstrate that the proposed system is more scalable and efficient than existing systems. Moreover, system efficiency is measured in terms of throughput and processing time. (C) 2016 Elsevier B.V. All rights reserved.

Citation frequency: 354

37. Literature review of Industry 4.0 and related technologies

Authors: Oztemel, E ; Gursev, S

Journal: JOURNAL OF INTELLIGENT MANUFACTURING

Abstract: Manufacturing industry profoundly impact economic and societal progress. As being a commonly accepted term for research centers and universities, the Industry 4.0 initiative has received a splendid attention of the business and research community. Although the idea is not new and was on the agenda of academic research in many years with different perceptions, the term "Industry 4.0" is just launched and well accepted to some extent not only in academic life but also in the industrial society as well. While academic research focuses on understanding and defining the concept and trying to develop related systems, business models and respective methodologies, industry, on the other hand, focuses its attention on the change of industrial machine suits and intelligent products as well as potential customers on this progress. It is therefore important for the companies to primarily understand the features and content of the Industry 4.0 for potential transformation from machine dominant manufacturing to digital manufacturing. In order to achieve a successful transformation, they should clearly review their positions and respective potentials against basic requirements set forward for Industry 4.0 standard. This will allow them to generate a well-defined road map. There has been several approaches and discussions going on along this line, a several road maps are already proposed. Some of those are reviewed in this paper. However, the literature clearly indicates the lack of respective assessment methodologies. Since the implementation and applications of related theorems and definitions outlined for the 4th

industrial revolution is not mature enough for most of the real life implementations, a systematic approach for making respective assessments and evaluations seems to be urgently required for those who are intending to speed this transformation up. It is now main responsibility of the research community to develop technological infrastructure with physical systems, management models, business models as well as some well-defined Industry 4.0 scenarios in order to make the life for the practitioners easy. It is estimated by the experts that the Industry 4.0 and related progress along this line will have an enormous effect on social life. As outlined in the introduction, some social transformation is also expected. It is assumed that the robots will be more dominant in manufacturing, implanted technologies, cooperating and coordinating machines, self-decision-making systems, autonomous problem solvers, learning machines, 3D printing etc. will dominate the production process. Wearable internet, big data analysis, sensor based life, smart city implementations or similar applications will be the main concern of the community. This social transformation will naturally trigger the manufacturing society to improve their manufacturing suits to cope with the customer requirements and sustain competitive advantage. A summary of the potential progress along this line is reviewed in introduction of the paper. It is so obvious that the future manufacturing systems will have a different vision composed of products, intelligence, communications and information network. This will bring about new business models to be dominant in industrial life. Another important issue to take into account is that the time span of this so-called revolution will be so short triggering a continuous transformation process to yield some new industrial areas to emerge.

This clearly puts a big pressure on manufacturers to learn, understand, design and implement the transformation process.

Since the main motivation for finding the best way to follow this transformation, a comprehensive literature review will generate a remarkable support. This paper presents such a review for highlighting the progress and aims to help improve the awareness on the best experiences. It is intended to provide a clear idea for those wishing to generate a road map for digitizing the respective manufacturing suits. By presenting this review it is also intended to provide a hands-on library of Industry 4.0 to both academics as well as industrial practitioners. The top 100 headings, abstracts and key words (i.e. a total of 619 publications of any kind) for each search term were independently analyzed in order to ensure the reliability of the review process. Note that, this exhaustive literature review provides a concrete definition of Industry 4.0 and defines its six design principles such as interoperability, virtualization, local, real-time talent, service orientation and modularity. It seems that these principles have taken the attention of the scientists to carry out more variety of research on the subject and to develop implementable and appropriate scenarios. A comprehensive taxonomy of Industry 4.0 can also be developed through analyzing the results of this review.

Citation frequency: 342

38. Deep Learning in Mobile and Wireless Networking: A Survey

Authors: Zhang, CY; Zhang, CY; Haddadi, H;

Journal: IEEE COMMUNICATIONS SURVEYS AND TUTORIALS

Abstract: The rapid uptake of mobile devices and the rising popularity of mobile applications and services pose unprecedented demands on mobile and wireless networking infrastructure. Upcoming 5G systems are evolving to support exploding mobile traffic volumes, real-time extraction of fine-grained analytics, and agile management of network resources, so as to maximize user experience. Fulfilling these tasks is challenging, as mobile environments are increasingly complex, heterogeneous, and evolving. One potential solution is to resort to advanced machine learning techniques, in order to help manage the rise in data volumes and algorithm-driven applications. The recent success of deep learning underpins new and powerful tools that tackle problems in this space. In this paper, we bridge the gap between deep learning and mobile and wireless networking research, by presenting a comprehensive survey of the crossovers between the two areas. We first briefly introduce essential background and state-of-the-art in deep learning techniques with potential applications to networking. We then discuss several techniques and platforms that facilitate the efficient deployment of deep learning onto mobile systems. Subsequently, we provide an encyclopedic review of mobile and wireless networking research based on deep learning, which we categorize by different domains. Drawing from our experience, we discuss how to tailor deep learning to mobile environments. We complete this survey by pinpointing current challenges and open future directions for research.

Citation frequency: 342

39. UAV-Enabled Intelligent Transportation Systems for the Smart City: Applications and Challenges

Authors: Menouar, H; Guvenc, I; Tuncer, A

Journal: IEEE COMMUNICATIONS MAGAZINE

Abstract: There could be no smart city without a reliable and efficient transportation system. This necessity makes the ITS a key component of any smart city concept. While legacy ITS technologies are deployed worldwide in smart cities, enabling the next generation of ITS relies on effective integration of connected and autonomous vehicles, the two technologies that are under wide field testing in many cities around the world. Even though these two emerging technologies are crucial in enabling fully automated transportation systems, there is still a significant need to automate other road and transportation components. To this end, due to their mobility, autonomous operation, and communication/processing capabilities, UAVs are envisaged in many ITS application domains. This article describes the possible ITS applications that can use UAVs, and highlights the potential and challenges for UAV-enabled ITS for next-generation smart cities.

Citation frequency:342

40. Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco

Authors: Lee, JH; Hancock, MG; Hu, MC

Journal: TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE

Abstract: This study aims to shed light on the process of building an effective smart city by integrating various practical perspectives with a consideration of smart city characteristics taken from the literature. We developed a framework for conducting case studies examining how smart cities were being implemented in San Francisco and Seoul Metropolitan City. The study's empirical results suggest that effective, sustainable smart cities emerge as a result of dynamic processes in which public and private sector actors coordinate their activities and resources on an open innovation platform. The different yet complementary linkages formed by these actors must further be aligned with respect to their developmental stage and embedded cultural and social capabilities. Our findings point to eight 'stylized facts', based on both quantitative and qualitative empirical results that underlie the facilitation of an effective smart city. In elaborating these facts, the paper offers useful insights to managers seeking to improve the delivery of smart city developmental projects. (C) 2013 Elsevier Inc. All rights reserved..

Citation frequency: 322

41. Critical interventions into the corporate smart city

Authors: Hollands, RG

Journal: CAMBRIDGE JOURNAL OF REGIONS ECONOMY AND SOCIETY

Abstract: Driven by the profit motive of global high-technology companies, in collusion with the trend towards city governance being wedded to a competitive form of 'urban

entrepreneurialism', has left little room for ordinary people to participate in the smart city. The article seeks to make a two-fold critical intervention into the dominance of this corporate smart city model. It does this by first looking at how we currently understand the smart city and critiques the growing trend towards corporate and entrepreneurial governance versions. A second form of intervention concerns considering smartness from different perspectives emanating from small-scale and fledgling examples of participatory and citizen-based types of smart initiatives.

Citation frequency:319

42. Predicting Taxi-Passenger Demand Using Streaming Data

Authors: Moreira-Matias, L ; Gama, J ; Ferreira, Met.

Journal: IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS

Abstract: Informed driving is increasingly becoming a key feature for increasing the sustainability of taxi companies. The sensors that are installed in each vehicle are providing new opportunities for automatically discovering knowledge, which, in return, delivers information for real-time decision making. Intelligent transportation systems for taxi dispatching and for finding time-saving routes are already exploring these sensing data. This paper introduces a novel methodology for predicting the spatial distribution of taxi-passengers for a short-term time horizon using streaming data. First, the information was aggregated into a histogram time series. Then, three time-series forecasting techniques were combined to originate a prediction. Experimental tests were conducted using the online data that are transmitted by 441 vehicles of a fleet running in the city of

Porto, Portugal. The results demonstrated that the proposed framework can provide effective insight into the spatiotemporal distribution of taxi-passenger demand for a 30-min horizon.

Citation frequency: 318

43. State-of-the-art, challenges, and open issues in the integration of Internet of things and cloud computing

Authors: Diaz, M; Martin, C; Rubio, B

Journal: JOURNAL OF NETWORK AND COMPUTER APPLICATIONS

Abstract: The Internet of Things (IoT) is a paradigm based on the Internet that comprises many interconnected technologies like RFID (Radio Frequency Identification) and WSN (Wireless Sensor and Actor Networks) in order to exchange information. The current needs for better control, monitoring and management in many areas, and the ongoing research in this field, have originated the appearance and creation of multiple systems like smart-home, smart-city and smart-grid. However, the limitations of associated devices in the IoT in terms of storage, network and computing, and the requirements of complex analysis, scalability, and data access, require a technology like Cloud Computing to supplement this field. Moreover, the IoT can generate large amounts of varied data and quickly when there are millions of things feeding data to Cloud Computing. The latter is a clear example of Big Data, that Cloud Computing needs to take into account. This paper presents a survey of integration components: Cloud platforms, Cloud infrastructures and IoT Middleware. In addition, some integration proposals and

data analytics techniques are surveyed as well as different challenges and open research issues are pointed out. (C) 2016 Elsevier Ltd. All rights reserved.

Citation frequency:317

44. A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning

Authors: Durand, CP; Andalib, M ; Dunton, GF; Wolch, J; Pentz, MA

Journal: OBESITY REVIEWS

Abstract: P>Smart growth is an approach to urban planning that provides a framework for making community development decisions. Despite its growing use, it is not known whether smart growth can impact physical activity. This review utilizes existing built environment research on factors that have been used in smart growth planning to determine whether they are associated with physical activity or body mass. Searching the MEDLINE, Psycinfo and Web-of-Knowledge databases, 204 articles were identified for descriptive review, and 44 for a more in-depth review of studies that evaluated four or more smart growth planning principles. Five smart growth factors (diverse housing types, mixed land use, housing density, compact development patterns and levels of open space) were associated with increased levels of physical activity, primarily walking. Associations with other forms of physical activity were less common. Results varied by gender and method of environmental assessment. Body mass was largely unaffected. This review suggests that several features of the built environment associated with smart growth planning may promote important forms of physical activity. Future smart growth

community planning could focus more directly on health, and future research should explore whether combinations or a critical mass of smart growth features is associated with better population health outcomes.

Citation frequency:314

45. Towards fog-driven IoT eHealth: Promises and challenges of IoT in medicine and healthcare

Authors: Farahani, B; Firouzi, F; Chang, V; Badaroglu, Met..

Journal: FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE

Abstract: Internet of Things (IoT) offers a seamless platform to connect people and objects to one another for enriching and making our lives easier. This vision carries us from compute-based centralized schemes to a more distributed environment offering a vast amount of applications such as smart wearables, smart home, smart mobility, and smart cities. In this paper we discuss applicability of IoT in healthcare and medicine by presenting a holistic architecture of IoT eHealth ecosystem. Healthcare is becoming increasingly difficult to manage due to insufficient and less effective healthcare services to meet the increasing demands of rising aging population with chronic diseases. We propose that this requires a transition from the clinic-centric treatment to patient-centric healthcare where each agent such as hospital, patient, and services are seamlessly connected to each other. This patient-centric IoT eHealth ecosystem needs a multi-layer

architecture: (1) device, (2) fog computing and (3) cloud to empower handling of complex data in terms of its variety, speed, and latency. This fog-driven IoT architecture is followed by various case examples of services and applications that are implemented on those layers. Those examples range from mobile health, assisted living, e-medicine, implants, early warning systems, to population monitoring in smart cities. We then finally address the challenges of IoT eHealth such as data management, scalability, regulations, interoperability, device-network-human interfaces, security, and privacy. (C) 2017 Elsevier B.V. All rights reserved.

Citation frequency: 312

46. Everything You Wanted to Know About Smart Cities The Internet of Things is the backbone

Authors: Mohanty, SP (Mohanty, Saraju P.); Choppali, U (Choppali, Uma); Kougianos, E (Kougianos, Elias)

Journal: IEEE CONSUMER ELECTRONICS MAGAZINE

Citation frequency: 308

47. Smart cities: A conjuncture of four forces

Authors: Angelidou, M (Angelidou, Margarita)

Journal: CITIES

Abstract: Despite the ongoing discussion of the recent years, there is no agreed definition of a 'smart city', while strategic planning in this field is still largely unexplored.

Inspired by this, the purpose of this paper was to identify the forces shaping the smart city conception and, by doing so, to begin replacing the currently abstract image of what it means to be one. The paper commences by dividing the recent history of smart cities into two large sections - urban futures and the knowledge and innovation economy. The urban futures strand shows that technology has always played an important role in forward-looking visions about the city of the future. The knowledge and innovation economy strand shows that recent technological advancements have introduced a whole new level of knowledge management and innovation capabilities in the urban context. The paper proceeds to explicate the current technology push and demand pull for smart city solutions. On one hand, technology advances rapidly and creates a booming market of smart city products and solutions around it. On the other hand, there is demand on the side of cities that seek to address the problems of efficiency and sustainability, making the ground fertile for a smart city product economy. The research route of this paper eventually allows the identification of the underlying - and often forgotten - principles of what it means to be 'smart' in an urban context and yields conclusions about strategic planning for the development of smart cities today. (C) 2015 Elsevier Ltd. All rights reserved.

Citation frequency: 304

48. Forecasting energy consumption of multi-family residential buildings using support vector regression: Investigating the impact of temporal and spatial monitoring

granularity on performance accuracy

Authors: Jain, RK (Jain, Rishree K.); Smith, KM (Smith, Kevin M.); Culligan, PJ (Culligan, Patricia J.); Taylor, JE (Taylor, John E.)

Journal: APPLIED ENERGY

Abstract: Buildings are the dominant source of energy consumption and environmental emissions in urban areas. Therefore, the ability to forecast and characterize building energy consumption is vital to implementing urban energy management and efficiency initiatives required to curb emissions. Advances in smart metering technology have enabled researchers to develop "sensor based" approaches to forecast building energy consumption that necessitate less input data than traditional methods. Sensor-based forecasting utilizes machine learning techniques to infer the complex relationships between consumption and influencing variables (e.g., weather, time of day, previous consumption). While sensor-based forecasting has been studied extensively for commercial buildings, there is a paucity of research applying this data-driven approach to the multi-family residential sector. In this paper, we build a sensor-based forecasting model using Support Vector Regression (SVR), a commonly used machine learning technique, and apply it to an empirical data-set from a multi-family residential building in New York City. We expand our study to examine the impact of temporal (i.e., daily, hourly, 10 min intervals) and spatial (i.e., whole building, by floor, by unit) granularity have on the predictive power of our single-step model. Results indicate that sensor based forecasting models can be extended to multi-family residential buildings and that the optimal monitoring granularity occurs at the by floor level in hourly intervals. In addition to

implications for the development of residential energy forecasting models, our results have practical significance for the deployment and installation of advanced smart metering devices. Ultimately, accurate and cost effective wide-scale energy prediction is a vital step towards next-generation energy efficiency initiatives, which will require not only consideration of the methods, but the scales for which data can be distilled into meaningful information. (C) 2014 Elsevier Ltd. All rights reserved.

Citation frequency: 304

49. Big IoT Data Analytics: Architecture, Opportunities, and Open Research Challenges

Authors: Marjani, M (Marjani, Mohsen); Nasaruddin, F (Nasaruddin, Fariza); Gani, A (Gani, Abdullah); Karim, A (Karim, Ahmad); Hashem, IAT (Hashem, Ibrahim Abaker Targio); Siddiqa, A (Siddiqa, Aisha); Yaqoob, I (Yaqoob, Ibrar)

Journal: IEEE ACCESS

Abstract: Voluminous amounts of data have been produced, since the past decade as the miniaturization of Internet of things (IoT) devices increases. However, such data are not useful without analytic power. Numerous big data, IoT, and analytics solutions have enabled people to obtain valuable insight into large data generated by IoT devices. However, these solutions are still in their infancy, and the domain lacks a comprehensive survey. This paper investigates the state-of-the-art research efforts directed toward big IoT data analytics. The relationship between big data analytics and IoT is explained. Moreover, this paper adds value by proposing a new architecture for big IoT data

analytics. Furthermore, big IoT data analytic types, methods, and technologies for big data mining are discussed. Numerous notable use cases are also presented. Several opportunities brought by data analytics in IoT paradigm are then discussed. Finally, open research challenges, such as privacy, big data mining, visualization, and integration, are presented as future research directions.

Citation frequency: 298

50. The actually existing smart city

Authors: Shelton, T (Shelton, Taylor); Zook, M (Zook, Matthew); Wiig, A (Wiig, Alan)

Journal: CAMBRIDGE JOURNAL OF REGIONS ECONOMY AND SOCIETY

Abstract: This paper grounds the critique of the 'smart city' in its historical and geographical context. Adapting Brenner and Theodore's notion of 'actually existing neoliberalism', we suggest a greater attention be paid to the 'actually existing smart city', rather than the exceptional or paradigmatic smart cities of Songdo, Masdar and Living PlanIT Valley. Through a closer analysis of cases in Louisville and Philadelphia, we demonstrate the utility of understanding the material effects of these policies in actual cities around the world, with a particular focus on how and from where these policies have arisen, and how they have unevenly impacted the places that have adopted them.

Citation frequency: 294