An Integrated system For Regional Environmental Monitoring and Management Based on IoT

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ABSTRACT

Climate change and environmental monitoring and management have received much attention recently, and an integrated information system (IIS) is considered highly valuable. This paper introduces a novel IIS that combines Internet of Things (IoT), Cloud Computing, Geoinformatics [remote sensing (RS), geographical information system (GIS), and global positioning system (GPS)], and e-Science for environmental monitoring and management, with a case study on regional climate change and its ecological effects. Multi-sensors and web services were used to collect data and other information for the perception layer; both public networks and private networks were used to access and transport mass data and other information in the network layer. The key technologies and tools include real-time operational database (RODB); extraction–transformation–loading (ETL); on-line analytical processing (OLAP) and relational OLAP (ROLAP); naming, addressing, and profile server (NAPS); application gateway (AG); application software for different platforms and tasks (APPs); IoT application infrastructure (IoT-AI); GIS and e-Science platforms; and representational state transfer/Java database connectivity (RESTful/JDBC). Application Program Interfaces (APIs) were implemented in the middleware layer of the IIS. The application layer provides the functions of storing, organizing, processing, and sharing of data and other information, as well as the functions of applications in environmental monitoring and management.

Keywords: Iot, Environment, GPS, IIS, GIS.

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1. INTRODUCTION

Environmental issues such as climate change have recieved much attention in recent years and environmental monitoring modelling and management enable us to gain a deeper understanding of natural environmental processes envionmental monitoring and management is a broad area focusing on using scientific and engineering principal to improve environmental conditions .how to effetely monitor, model and manage environmental processes is a critical task for both scientists and engineers.

Environmental infometics has experienced a very rapid development and wide application in monitoring and managing environmental process in the past decade. Environmental infometics involves specific environmental problems related to the application of computer science and system engineering technical management information system, environmental information system, which were design to collect process to exchange data and information since 1980s.automatic data acquisition has been accelerated by a variety of technologies such as remote sensing, geographical information system, and global positioning system soon. From 2000 the proliferation of automatic data acquisition technologies such as radio frequency identification and sensor technologies was introduce to create decision support system and integrated environmental system and also brought vitality to environmental monitoring and management.

The rapid development and wide application of environmental infometics has significantly improved environmental monitoring, management efficiency and effectiveness. however both the DSSs and enterprise information system(EISs)were implemented to help locate and analyse environmental problems rather than to solve any environmental problems in the reality, in the last decade ,internet of things, a concept describing how the internet extends in to peoples everyday life though wireless network of uniquely identifiable objets,is predicted to be able to promote the entire process of environmental ,monitoring, modelling and mana gent as well as to support sustainable decision making. This paper focuses on the IOT application in the new generation of environmental infometics and provides a new paradigm for the environmental monitoring and management in the future.

2. RELATED WORK

Integrated environmental monitoring and management based on IOT is an enduring and active topic, not only for the scientists and engineers, but also for the public and administrators and it covers broad issues and involves many technologies in the computer and information sciences. In this section, existing environmental monitoring and management issues are discussed with a focus on environmental infometics, corresponding EISs and integrated information systems as well as IOT are also reviewed to clarify the essence of this work

2.1 Environmental Informatics

Environmental informatics is an interdisciplinary field involving environmental science, computer science, information science, and industrial information integration engineering (IIIE). It formally started developing in the early 1990s in Europe to integrate and coordinate various informatics technologies and facilitate decision-making to intimately link the territory knowledge with expected social, economic, ecological, and environmental objectives [4], and it can help handle various kinds of environmental problems with more cost-effective and forward-looking solutions. The spectrum of environmental informatics can be classified into five categories: 1) database system (DBS) [3]; 2) GIS; 3) DSS [4]; 4) expert system (ES); and 5) IEIS [5]. In China, Professor Jiulin Sun (academician of the Chinese Academic of Engineering) leads the development of Res-informatics, with topics on mechanism of resources information, development and application of Geo informatics, information integration, information sharing, ES, data bank, visualization, modelling of resource environment, and establishment of simulated research environment of resource sciences [6], [7]. From the late 2000s, IoT represents how the Internet extends into people's everyday lives through a wireless network of uniquely identifiable objects [5] and it is predicted that IoT will promote the entire process of environmental monitoring and management in the near future.

2.2 Integrated Information System

A specific kind of EIS (i.e., DBS, GIS, DSS, and ES) in general has its own merits and limitations. DBS is the basic component of various EISs, but it is limited to spatial analysis and decision making.
The strength of GIS lies in spatial analysis and information visualization, but it falls short of data management and utility modelling. DSSs usually excel in extracting relational knowledge from multidimensional data comparison and organizing the interactions among users and models, but they are vulnerable to decision-makers' experiences and preference [1].

Esses are excellent in knowledge management but almost all of them are limited in knowledge acquisition. Fortunately, IISs, which involve multiple types of technologies and tools of information and computer sciences, provide a good solution to the complex tasks in environmental monitoring and management.

IIS is an array of multiple information sets linked together in an organized way [9], [10]. IISs and tools have been widely used in practicing environmental monitoring and management including ecosystem assessment and resources Management. The core technologies of IIS and typical application cases have been discussed in literature [11]–[13].

Studies on environmental sustainability incorporating the information systems have been initiated for improving environmental and economic performance [14]. There are numerous studies on the applications of IISs in different areas within the framework of IIIE [15], [16], which is a set of foundational concepts and techniques that facilitate the industrial information integration process and comprise methods for solving complex problems when developing IISs [17], [18].

The applications of IIIE have covered areas such as business analytics [19], supply chain management [20], resources and environment management public health service, integrated medical supply.

2.3 *Internet of Things*

The IoT refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. The term "Internet of Things" was first used by Kevin Ashton in 1999 and became popular through the Auto-ID Center and related market analysis publications ,RFID tags, sensors, actuators, and mobile phones are often seen as prerequisites for the IoT Key technologies of IoT include RFID technology, sensor network and detection technology, Internet technology, intelligent computing technology, and so on; however, technical challenges must be tackled before these systems can be widely applied .The concept of IoT has been proposed more than

10 years, and it is not just staying at the concept level but is becoming a reality with the rapid development and wide application of wireless

Sensor network (WSN) and cloud computing. Ongoing investments and specific work have been initiated to solve challenging research problems, to develop the necessary hardware and software, and to deploy the infrastructure required .The combination of the Internet and the emerging technologies such as near-field communications, real-time localization, and embedded sensors could help us transform everyday objects into smart objects that can understand and react to their environment .Furthermore, some technologies that have been widely used in resource management and environmental science are technical components of IoTs, such as RS, GIS, GPS, and so on. In IoT systems, multi-sensor data fusion issues such as node signal processing, WSN localization, anti-collision, and information- aggregation are often formulated as optimization subjects, data fusion of multi-sensor for IoT precise measurement

Based on improved PSO algorithms have been discussed .The combination of sensors, Wi-Fi, 3G, RFID, near field communication (NFC), and Bluetooth will allow significantly improved measurement and monitoring methods of vital functions of health (temperature, blood pressure, heart rate, cholesterol levels, blood glucose, etc.) .Fueled by the recent adaptation of a variety of enabling wireless technologies such as RFID tags and embedded sensor and actuator nodes, the IoT has stepped out of its infancy and is the next revolutionary technology in transforming the Internet into a fully integrated Future Internet] A naming, addressing, and profile server (NAPS) as a middleware to bridge different platforms in IoTs sensory environments has been presented for widely used standards and protocols. A software framework architecture for mobile devices that aims to facilitate the development process of embedded RFID applications and the integration process of business applications and Electronic Product Code (EPC) Network instances has been introduced to provide a common communication interface to abstract different devices and reading protocols as well as functions to process and distribute data .Application fields of IoT include smart product management, waste management, intelligent shopping, urban planning, continuous care, sustainable urban environment, smart meters, emergency response, smart events, home automation, and so on. IoT technologies can be suitably applied to environmental monitoring applications with the ability of sensing, in a distributed and self-managing fashion, as well as to seamlessly integrate such heterogeneous data into global applications

3. SYSTEM ARCHITECTURE

The explosion of information technologies in the last decade has laid the foundation for integrative information architecture of the IIS for environmental monitoring and management, a novel IIS for regional environmental monitoring and management based on the framework of IoT has been developed in this work, and Fig presents the architecture of this IIS in detail. The architecture of the IIS for regional environmental monitoring and management based on IoT contains four layers: Perception layer, network layer, middleware layer, and application layer.

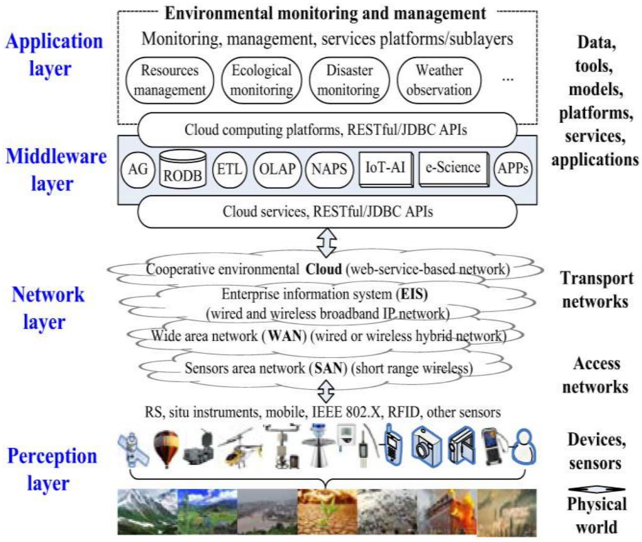

Fig.1: Overall architecture of the IIS based on IoT

3.1 Perception Layer

The perception layer is mainly used for collecting data and other information of detailed factors of physical world (targets or tasks) in environmental monitoring and management, usually including real-time datasets, models/methods, knowledge, and others. The real-time data collection based on IoT is related to multi-sensors, including RS platforms (i.e., satellites, balloons, aircrafts, and radar), situ instruments (i.e., situ observation instruments for meteorological, hydrological, and ecological factors), mobile (i.e., 2G, 3G, and LTE), IEEE 802.X (i.e., WiFi, Bluetooth, and ZigBee), RFID, and other sensors.

3.2 Network Layer

The network layer performs basic functions of data and information transmission as well as the interconnection of systems and platforms. The network layer mainly consists of access networks and transport networks. Access networks are Short-range wireless networks, usually consist of Sensors Area Network (SAN), 2G, 3G, Wi-Fi, and ZigBee are common components to support the connection of things (i.e., sensors, devices, and users) in environmental monitoring and management. In transport networks, various Wide Area Networks (WANs) of Wired or wireless hybrid network are usually subsystems of EIS with wired and wireless broadband IP network, and EISs could be connected to the cooperative environmental cloud with Web service-based.

3.3 Middleware Layer

The middleware layer is a set of sub-layers for the management of data, software/tools, models and platforms, and interposed between the network layer and the application layer. Real-time operational database (RODB) is used for efficiently Managing massive data generated by sensors and devices, and it is also used for storing and management of models, knowledge, and other information in Global network.

3.4 Application Layer

The application layer of the IIS based on IoT mainly consisted of application support platforms, cloud computing platform, and e-Science platforms. The application layer provides the functions of storing, organizing, processing, and sharing the environment data and other information obtained from sensors, devices, and Web services, as well as the functions of taking professional applications in environmental monitoring and management, such as resources management, pollution monitoring (i.e., solid waste, noise, air quality, etc.) ecological monitoring, disaster monitoring and prediction, weather observation and forecasting.

4. EXPERIMENT RESULT

The evidences of climate with trends of meteorological Elements (i.e., annual precipitation, mean annual air Temperature, and mean annual humidity) in Xinjiang-based on in situ observations from 1962 to 2011 are The results showed the following.

1) There is an apparent increasing trend of air temperature in the last five decades is 7.07C (1962-1971), 7.15C (1972-1981), 7.49C (1982-2001), and 8.31C (2002-20 11); and the mean annual air temperature have increased By 1.24 C in the past 50 years at a rate of 0.25C/decade.

2) There is a visible increasing trend of precipitation in xinjiang from 1962 to 2011; the mean annual precipitation in the last 5 decades is 199.13mm (1962-1971), 1118.03mm (1972-1981); 128.66mm (1982-1991), 144.01mm (1992-2001),
And 148.08mm (2002-2011), and the annual precipitation has increased by 29.45mm in the last 50 years at a rate of 5.89mm /decade.

3)The decade trend of relative humidity in xinjiang is stable from 1962 to 2011 and the mean annual relative humidity in the past 5 decades is 51%(1962-1971), 52% 1972 to 1981 52%(1982-1991),53%(1992-2001), and 52%(2002-2011).

Compared with the obviously increasing trends of precipitation and air temperature, the trend of mean annual relative humidity in the past 5 decades is not.

5. **CONCLUSION**

This paper introduces a novel IIS for regional environmental monitoring and management based on IOT for improving the efficiency of complex tasks, the proposed IIS combines IOT cloud computing, geo informatics and e-science for environmental and management with a case study of regional climate change and its ecological responses, which is one of the most hot topics in the scientific world. The result showed that it is greatly benefited from such an IIS,not only in the data collection supported by IOT but also in web services and application based on cloud computing an e-science platforms and the effectiveness of monitoring process and decision making can be obviously improved. The interactive system Introduced in this work is valuable for in the precipitation, transformation, processing, management and sharing of multisource information in environmental monitoring and management, and it also provides new paradigm for the future work, especially in the era of big data and IOT.

In conclusion, this paper provides a prototype IIS for environmental monitoring and management with a case study on regional climate change and its ecological response in china, and the result showed the water resources availability is the decisive factor with regard to the primary production of the terrestrial echo system in the area. The integrated approach introduced in this work would serve as paradigm for resours environmental monitoring and management in the near future.

REFERENCES

[1] E. Welbourne, L. Battle, G. Cole, K. Gould, K. Rector, S. Raymer et al.,“Building the Internet of things using RFID: The RFID ecosystem experience,”IEEE Internet Comput. vol. 13, no. 3, pp. 48–55, May–Jun. 2009.
[2] N. Niu, L. Xu, and Z. Bi, “Enterprise information systems architecture analysis and evaluation,” IEEE Trans. Ind. Informat., vol. 9, no. 4,pp. 2147–2154, Nov. 2013.
[3] M. Haklay, From Environmental Information Systems to EnvironmentalInformatics: Evolution and Meaning. London, U.K.: Centre for Advanced Spatial Analysis, Univ. College London, 1999.
[4] L. Xu, Z. Li, S. Li, and F. Tang, “A decision support system for product design in concurrent engineering,” Decis. Support Syst., vol. 42, no. 4, pp. 2029–2042, 2007.
[5] N. M. Avouris and B. Page, in Environmental Informatics: Methodology and Applications of Environmental Information Processing, B. Page, Ed.New York, NY, USA: Springer, 1995.
[6] J. Sun, “A summary on the management of information science on natural resources,” Resour. Sci., vol. 9, no. 4, pp. 74–80, 1988.
[7] J. Sun, the Spring Up of Res-Informatics and the Regional Sustainable Development Research, in the Research Corpus of Natural Resources Explore Forty Years. Beijing, China: Chinese Science and Technology Press, 1996.
[8] C. Lynch, “Big data: How do your data grow?,” Nature, vol. 455, no. 7209,pp. 28–29, 2008.
[9] H. Reuter, U. Middelhoff, F. Graef, R. Verhoeven, T. Batz, M. Weis, andB. Breckling, “Information system for monitoring environmental impacts of genetically modified organisms,” Environ. Sci. Pollut. Res., vol. 17, no. 8,pp. 1479–1490, 2010.
[10] Y. Lin, X. Duan, C. Zhao, and L. Xu, Systems Science: Methodological Approaches. Boca Raton, FL, USA: CRC Press, 2012.
[11] H. Panetto and H. J. Cecil, “Information systems for enterprise integration, interoperability and networking: Theory and applications,” Enterp. Inf.Syst., vol. 7, no. 1, pp. 1–6, 2013.
[12] S. Fang, L. Xu, H. Pei, Y. Liu, Z. Liu, Y. Zhu et al., “An integrated approach to snowmelt flood forecasting in water resource management,” IEEE Trans.Ind. Informat., vol. 10, no. 1, pp. 548–558, Apr. 2013.
[13] R. Yuan, Z. Li, X. Guan, and L. Xu, “An SVM-based machine learning method for accurate Internet traffic classification,” Inf. Syst. Front., vol. 12,no. 2, pp. 149–156, 2010.
[14] N. P. Melville, “Information systems innovation for environmental sustainability,”MIS Quart., vol. 34, no. 1, pp. 1–21, 2010.
[15] L. Xu, “Enterprise systems: State-of-the-art and future trends,” IEEE Trans.Ind. Informat, vol. 7, no. 4, pp. 630–640, Nov. 2011.
[16] H. Hassan, J. Martinez-Rubio, A. Perles, J. Capella, C. Dominguez, and. Albaladejo, “Smartphone-based industrial informatics projects andlaboratories,”IEEETrans. Ind.Informat.vol.9, no. 1, pp.557–566, Feb.2013.
[17] J. Ulmer, J. Belaud, and J. Le Lann, “A pivotal-based approach for enterprise business process and IS integration,” Enterp. Inf. Syst., vol. 7, no. 1, pp. 61–78, 2013.
[18] X. Gao, L. Xu, X. Wang, Y. Li, M. Yang, and Y. Liu, “Workflow process modelling and resource allocation based on polychromatic sets theory,” Enterp. Inf. Syst., vol. 7, no. 2, pp. 198–226, 2013.
[19] L. Duan and L. Xu, “Business intelligence for enterprise systems: A survey,” IEEE Trans. Ind. Informat., vol. 8, no. 3, pp. 679–687, Aug. 2012.
[20] L. Xu, “Information architecture for supply chain quality management,” Int. J. Prod. Res., vol. 49, no. 1, pp. 183–198, 2011.