Natural Ecology Sensing System Based on Cloud Technology-The Case Studying for Dan Shui Mangrove Environment

Hsu-Yang Kung

Department of Management Information Systems, National Pingtung University of Science and Technology
kung@mail.npust.edu.tw 886-8-770-3202#7908

ABSTRACT

This study is a first investigation using WSNs for Mangroves protection and observation at Taiwan. In this investigation, this paper proposes a Natural Ecology Sensing System (NESS). NESS can improve the drawbacks of traditional long-term observation method by providing a real-time and networked surveillance system. This paper considers the practical issues of deploying ecological environment sensors in the Mangroves protection area. In additions, feasible solutions are proposed to achieve sustainable energy supply and reliable data delivery with high accuracy. We also evaluate system performance in terms of energy consumption and packet loss rate at different duty cycles, and compare lifetime and data accuracy with different energy supply sources. According to implementation results, the proposed system is efficient and feasible for Mangroves observation, protection, and surveillance. The main contributions of this study are as follows.

INTRODUCTION

Recently, several articles are proposed and used for investigating the Mangroves observation and protection. However, the data collection methodology of these articles adopts field survey. With field survey, researchers have to collect data by themselves in Dan Shiu Mangroves protection area. Therefore, such a method is labor intensive and dangerous, and cannot provide real-time and continuous data collection. To improve above drawbacks, this study designs and implements a Natural Ecology Sensing System (NESS) using Wireless Sensor Networks (WSNs). With the application of WSNs and Internet, researchers can perform long-term observation such as micro-climate and images collection at the remote site. In addition, the system can be used for surveillance of Dan Shiu Mangroves protection area, i.e. real-time invasion detection and alarm.

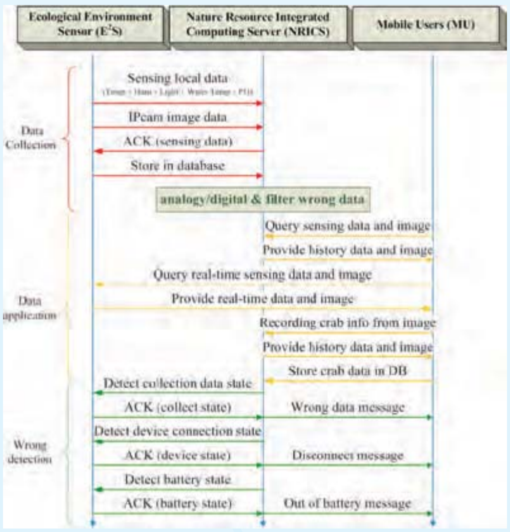

FIGURE 1. NESS SYSTEM OPERATION FLOW

SYSTEM OPERATION FLOW

This section shows the system operation flow of Natural Ecology Sensing System (NESS). As depicted in Fig. 1, the system flow is composed of three stages. Stage one is data collection, stage two is data application, and last stage is for anomaly detection of WSN data.

SYSTEM ARCHITECTURE

Overview of Natural Ecology Sensing System (NESS) Architecture. NESS system architecture includes four parts that are (I) Ecological Environment Sensor (E2S), (II) Nature Resource Integrated Computing Server (NRICS), (III) Mobile User (MU), and Ecological Information Service System (EIS2). As depicted in Fig. 2.

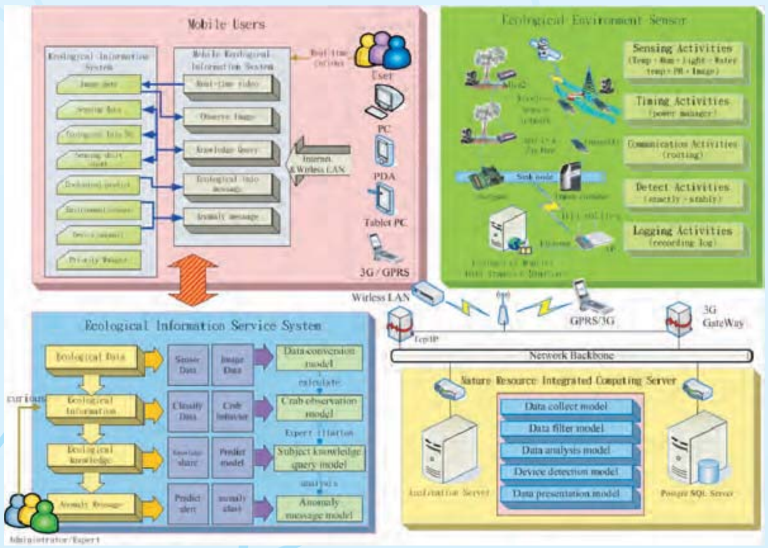

FIGURE 2. NESS SYSTEM ARCHITECTURE

SYSTEM IMPLEMENTATION

This section demonstrates NESS system implementation. Fig. 3 depicts portal interfaces of PC and PDA version, respectively. Users in MU are able to access services in NESS via these interfaces. The system will automatically provision a suitable interface based on users' appliance, when users enter NESS system. In the interface, users can choose query parameters such as observation location, required micro-climate information, images, and presentation types. As Fig. 4 shows, users can view acquired information with a table or line chart.

FIGURE 4. INFORMATION PRESENTATION FOR PC AND PDA VERSION

Conclusion

This study designs and implements a four-tier system, Natural Ecology Sensing System (NESS), which consist of Ecological Environment Sensor (E2S), Nature Resource Integrated Computing Server (NRICS), Mobile Users (MU), and Ecological Information Service System (EIS2). NESS can solve drawbacks of using field survey for Mangroves protection and observation. With application of WSNs and the proposed system, users can efficiently perform data collection, real-time surveillance, and ecology and biology information acquirement. The main contributions of this study are as follows.

(1)This study is a first investigation with the application of WSNs and Internet to enhance Mangroves protection and observation of Taiwan, and provisions a portal website for real-time surveillance and information query.

(2)Practical sensor deployment issues in Mangroves are considered in this study, and two solutions to overcome these issues are proposed.

(3)We evaluate two system performance metrics in terms of energy consumption and packet loss rate and observe suitable setting parameters in the proposed system.

REFERENCES

[1]Bhaskaran, K. Chebrolu, N. Madabhushi, D. Y. Gokhale, P. K. Valiveti and D. Jain, "Implications of Link Range and (In) Stability on Sensor Network Architecture," The First ACM International Workshop on Wireless Network Testbeds, Experimental evaluation and CHaracterization, conjunction, 65 - 72, September. 2006.

[2]Gilman, J. Polastre, R. Szewczyk, D. Culler, N. Turner, K. Tu, S. Burgess, T. Dawson, P. Buonadonna, D. Gay and W. Hong, "A Macroscope in Redwoods," ACM SenSys, San Diego, 51-63, November, 2005.

[3]Danshuei River Mangrove Nature Reserve. [online] http://conservation.forest.gov.tw/ct.asp?xItem=22277&ctNode=725&mp=11 Accessed Aug 2008.

[4]Polastre, R. Szewczyk, and D. Culler, Enabling ultra-low power wireless research. IEEE SPOTS, 2005.

[5]Kirk, J. K. Hart and R. Ong, "Environmental sensor networks," IEEE Journal on Computer, 37(8): 50-56, 2004.

[6]Lee. C. L. P., The Life History Study of Helice subquadrata in Sin-jhuang-zih Mangrove Forest, 2007.

[7]Lindsey, J. M. Mair, and H. M. Guzman, "An assessment of metal contamination in mangrove sediments and leaves from Punta Mala Bay, Pacific Panama," Marine Pollution Bulletin 50, 547-552, 2005.

[8][Mica Motes and Gateway Specifications. [Online] http://www.xbow.com/Products/wproductsoverview.aspx Accessed Aug 2008.

[9]Mielke, S. M. Brennan, M. C. Smith, D. C. Torney, A. B. Maccabe, and J. F. Karlin, "Independent Sensor Networks," IEEE Instrumentation & Measurement Magazine, 8(2): 33- 37, June. 2005.

[10]Murat, K. Y. Chow and C. S. Wan, "INSIGHT: Internet-Sensor Integration for Habitat Monitoring," IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks, 553-558, 2006. [11]Prabal, J. Hui, J. Jeong, S. Kim, C. Sharp, J. Taneja, G. Tolle, K. Whitehouse, and D. Culler, "Trio: Enabling Sustainable and Scalable Outdoor Wireless Sensor Network Deployments," Information Processing in Sensor Networks, 407 – 415, April 2006.

[12]Rachel, K. Smettem, M. Kranz and K. Mayer, "Field Testing a Wireless Sensor Network for Reactive Environmental Monitoring," Intelligent Sensors, Sensor Networks and Information Processing Conference, 7-12, Dec 2004.

[13]Vijay, S. Ganeriwal, and M. Srivastava., "Emerging Techniques for Long Lived Wireless Sensor Networks," IEEE Communications Magazine, 44(4):108-114, April. 2006.

[14]Wireless Gateway Appliance Software. [online] http://wsnsolution.bandwavetech.com/download/tmote-connect-datasheet.pdf Accessed Aug 2008.

[15]Wireless Distributed System. [online] http://www.pafree.net/media/TB-046.pdf Accessed Aug 2008.

[16]Yan, J. Jo and Y. Kim, "Energy-Efficient Multi-Hop Communication Scheme In Clustered Sensor Networks," International Journal of Innovative Computing, Information and Control, Volume 4, Number 7, July 2008.

[17]Yoshitsugu, H. C., H. Mineno and T. Mizuno, "An Energy-Aware Routing Scheme With Node Relay Willingness In Wireless Sensor Networks," International Journal of Innovative Computing, Information and Control, Volume 3, Number 3, June 2007.

[18]Yu F.J., A Survey on the Composition and Distribution of Mangroves in Kaohsiung and Pingdong Area, 2005.

[19]Zhi, R. Yu and S. Mei, "A Robust Power-aware Routing Algorithm for Wireless Sensor Networks," Military Communications Conference, 1 - 7, Oct. 2006.M. Mahmoud and P. Shi, Methodologies for Control of Jump Time-delay Systems, Kluwer Academic Publishers, Boston, 2003.