RFMS: Real-time Flood Monitoring System with Wireless Sensor Networks

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Abstract

In this paper, we present RFMS, the Real-time Flood Monitoring System with wireless sensor networks, which is deployed in two volcanic islands Ulleung-do and Dok-do located in the East Sea near to the Korean Peninsula and developed for flood monitoring. RFMS measures river and weather conditions through wireless sensor nodes equipped with different sensors. Measured information is employed for early-warning via diverse types of services such as SMS (Short Message Service) and a web service.

1. Introduction

Ulleung-do, a volcanic island located in the middle of the East Sea, has an area of 72,558,826 m^2 and a population of about 10 thousand. It is prone to rapid fluctuations in weather and also located in the middle of the seasonal typhoon path. The annual precipitation amounts to 1500 millimeters and specially the typhoon Nabi caused extensive damage of approximately half a billion dollars during 5 days in 2005 [1]. Moreover, Dok-do, which has an area of 187,453 m^2 and is located to the southeast of Ulleung-do, has always suffered from problems anchoring at the pier due to insufficient real-time weather information. Therefore, a flood monitoring system to cover all the rivers in Ulleung-do and an anchoring support system are required for inhabitants and tourists to prevent threats from flooding.

RFMS is designed for early forecasting of flooding in the whole Ulleung-do. Sensor nodes equipped with water level and flow velocity sensors are deployed in the upstream and downstream region of 14 rivers and they are configured for multi-hop based wireless networks. In addition, wave height sensors and rainfall sensors are deployed in major areas of Ulleung-do and Dok-do. Web-enabled surveillance cameras are also installed to guarantee reliability of the monitoring system. The collected information is shared with related public offices and represented through the web service (http://211.46.3.33:4001/) and SMS in real-time. Our system monitoring flooding and anchoring information of the whole area in Ulleung-do and Dok-do is currently installed and operating.

In the rest of this paper, we describe the system architecture and characteristics of RFMS, and then conclude our work.

2. System Architecture

RFMS is installed around whole 14 rivers of Ulleung-do. It basically has a structure one sensor network per river. Figure 1 and 2 show a typical architecture and actual deployment of RFMS. The system is divided into sensor networks and back-end networks.

Each sensor network has one or two sensor nodes and one base station. Two sensor nodes are deployed basically in the upstream and downstream area of a river in order to estimate the difference between them. The sensor node is controlled by an Atmel ATmega 128L 8-bit processor running at 8MHz and it is supplied with a 3.7V (7.6 Ah) battery. It utilizes a Chipcon CC1100 RF transceiver radio operating at 447MHz for communications and two connectors for supporting multiple sensors: a water level sensor, a flow velocity sensor, and a rainfall sensor. Moreover, the following software components are included. A CSMA/CA MAC protocol is used for wireless communications and the monitoring application is implemented upon the ANTS-EOS [2]. ANTS-EOS is a sensor network operating system based on a multi-threaded architecture to support concurrent operation of multiple tasks and flexible sensor device drivers for the sensors used in RFMS.

A base station contains a gateway and a base node. The base node is same as a sensor node. The gateway

* This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government (MOST) (No. R0A-2007-000-10038-0). This work was supported by the National Information Society Agency (NIA).

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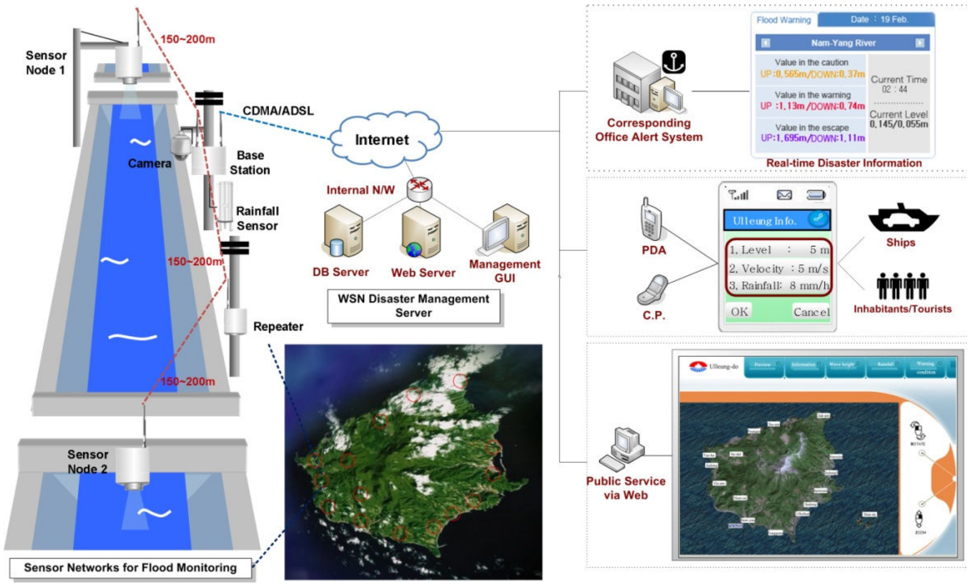
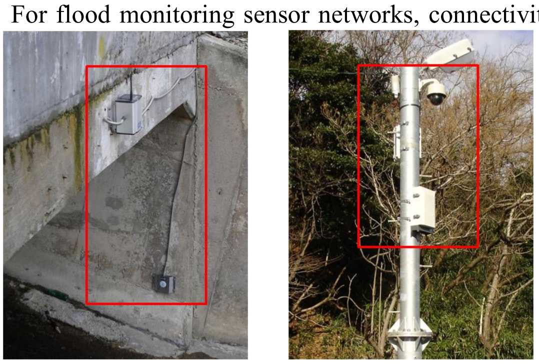


Figure 1. RFMS Overview in Ulleung-do

running on embedded Linux is controlled by a Samsung S3C2410 ARM processor. It equips a wave height sensor and facilitates a CDMA module and an Ethernet port for connection to the Internet. A wave height sensor device driver and applications to communicate with the back-end server and the base node are implemented as a software component. A telegraph pole supplies a stable line power to the base station attached around. The installed base station collects packets from sensor nodes, and then transfers them to the back-end server via CDMA/ADSL. Besides, a web-enabled surveillance camera is used to watch the current status of actual environment.

Back-end networks are essential to verify measured data delivered from sensor nodes in real-time and cope with the amount of data. Data from each river is stored in the database designed to distinguish the measured data by rivers and sensor nodes. The GUI-based web service providing 3D model, data graph, and other representation materials for better readability for users, and SMS are provided by using received data in real-time.

For flood monitoring sensor networks, connectivity between sensor networks and back-end networks should be maintained even in the worst conditions and real-time communications be supported to provide the current status of rivers quickly since rapid changes can be caused by a sudden heavy rain. RFMS provides two-way communications not only for reporting flood information, but for management requests from administrators.



a) Sensor Node b) Base Station

Figure 2. Deployment of RFMS

3. Conclusion

RFMS, a flood monitoring sensor network system supporting reliable networks and real-time communications, is presented. Our system is designed to forecast flooding, thereby effectively preventing casualties from natural disaster. It was initially deployed at the end of November 2007 and improved in spring 2008. Packaging was strengthened with coating and moisture proofing to stand against unfavorable weather. As it is operational now, we expect our flood forecasting system to properly operate and play a crucial role in the rainy spell in summer 2008.

4. References

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