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Final Program and Abstracts

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A Short Range Measurement Using RF Signal's Propagation Time Based on Vernier Effect

*Song-il Ko (Tokyo Institute of Technology),
Jumya Takayama (Tokyo Institute of Technology),
Shini Ohyama (Tokyo Institute of Technology)

To get distance data is the preliminary information to complete localization of a moving object in local area. The research for getting a short distance data using RF time of flight (TOF) is very few and could be thought of as a cutting-edge technique. Moreover, it is very difficult to get minutely RF TOF for getting short distance data; that is, very complicated signal processing skills are required for realizing it. In this paper, we present a new methodology of RF short ranging technique based on vernier effect due to the use of heterogeneous operating clocks.

Detecting Sinkhole Attacks in Wireless Sensor Networks

*Charnip Thumrongwittayapak (King Mongkut Institute of Technology Ladkrabang),
Ruttikorn Varakulthipanth (King Mongkut Institute of Technology Ladkrabang)

We present a new approach of robust and lightweight solution for detecting the Sinkhole attack based on Received Signal Strength Indicator (RSSI). The proposed solution needs support of some Extra Monitor (EM) nodes apart from the ordinary nodes. We use values of RSSI from four EM nodes to determine the position of all sensor nodes where the Base Station (BS) is located at origin position (0,0). The simulation results show that the proposed mechanism is lightweight due to the monitor nodes were not loaded with any ordinary nodes or BS. Moreover, the proposed mechanism does not cause the communication overhead.

Reliable Data Transfer using Overhearing for Implicit ACK

*Gyuwon Lee (Kyunghee University),
Eui Nam Huh (Kyunghee University)

Many applications in Wireless Sensor Networks require collecting all data without loss from nodes. End-to-End data retransmission, which is used in the Internet for reliable transport, becomes very inefficient in Wireless Sensor Networks, since wireless communication, and constrained resources pose new challenges. We look at factors affecting reliability, and search for efficient combinations of the possible options. This paper proposes an efficient Overhearing based reliable transfer protocol in Wireless Sensor Networks by calculate Reliability and using implicit Acknowledgement. Finally, it is clarified that the proposed scheme is efficient for reliable data transfer in WSN.

Efficient Range-free Localization Algorithm for Wireless Sensor Network Based on Shortest Path Information

*Jaehun Lee (Yonsei University),
Wooyong Chung (Yonsei University),
Euntae Kim (Yonsei University)

In this paper, we propose an efficient range-free localization algorithm based on shortest path information. The proposed method is a kind of range-free localization algorithm which only uses the proximity information between sensor nodes. In the proposed method, an efficient distance vector based on shortest path information is proposed. The proposed method is applied to various kinds of network topologies. The simulation results demonstrate that the proposed method shows excellent and robust location estimation results.

Design of the Middleware for Wireless Sensor Node Based on IEEE1451.5

*Young-Han Lee (Hanyang University)

Ubiquitous Sensor Network (USN) systems require a mutually well-combinable sensor middleware while maintaining system independence. These middleware are provided differently according to the system characteristics of each producer. Due to these proprietary APIs, Middleware are not applicable for compatibility between varieties of applications and Hardware platforms. This paper suggests the Simple middleware for the Wireless sensor node using a standard API of IEEE1451.5. This middleware can keep the transducer and network module mutually independent and compatible because it uses IEEE1451.5 API between application and hardware platform.

Network-centric Mashup for a Sensor Network that uses

*Kooin Choi (University of Aizu), Junya Tanazono (University of Aizu),
Kensaku Kawaiuchi (University of Tokyo), Kana Itabashi (University of Aizu),
Hitoyuki Fushara (NetOne Systems), Haruu Koseda (NetOne Systems Co., Ltd.)

The present paper describes a mashup and an approach by which to integrate a sensor networking a messaging network. A messaging network is an overlay network that has a rich set of message handling capabilities. The use of a messaging network enables the complexity and maintenance burden of the integrated sensor information systems to be reduced. Mashup refers to the use of different data sources for the purpose of providing value-added information or efficient use of information. The proposed approach generates an SOA-based sensor network design and mashup.
Oral Sessions 2C, Wednesday, August 19

2C02 OS: Sponsored Industrial Session I: Model-Based Design
Organizer(s): Wensi Jin (The MathWorks, Inc.), Yoshito Ohto (Kyoto University)
Chair(s): Hiromichi Ino (MathWorks Japan), Yoshito Ohto (Kyoto University)

2C02-1 "Control Design in Model-Based Development and New SICE Benchmark Control Design Problem," *Akira Ohata (Toyota Motor Corporation)
14:20

2C02-2 "Application of MSD to Automotive Control System Engineering," *Atsushi Sawabe (AISIN AW CO., LTD)
15:00

2C02-3 "Development of a High Throughput LDPC Codec with 1Gb/s and OFDM Transmission System Utilizing MBD," *Takashi Masahata (Sumitomo Electric Industries, Ltd.)
15:40

2C02-4 "Bridging the Gap in Engineering Education through Student Competition," *Paul Smith (The MathWorks, Inc.)
16:10

2C03 OS: International Standardization for Robot Technology
Organizer(s): Tetsuo Kotoku (AIST), Yoji Yamada (Nagoya University)
Chair(s): Tetsuo Kotoku (AIST), Yoji Yamada (Nagoya University)

2C03-1 "Survey on ISO Standards for Industrial and Service Robots," *Seungbin Moon (Sejong University), Gurinder S Virk (Massey University)
15:30

2C03-2 "Novel Activity on International Safety Standardization for Personal Care Robots," *Yoji Yamada (Nagoya University), Yasuhiro Ota (Toyota Motor Engineering & Manufacturing North America)
15:50

2C03-3 "Standardization Activities for Service Robots in Korea," *Seungbin Moon (Sejong University), Kwang Ho Park (Korea Agency for Technology and Standards), Soon-Geul Lee (Kyung Hae University), Young-Jo Cho (Electronics and Telecommunication Research Institute), Youngsun Ryu (Korea Institute of Industrial Technology)
16:10

2C03-4 "Collecting Plant Floor Data using Agent Embedded in Controller," *Satoru Hiro (Hitachi Ltd.), Hiromitsu Kato (Hitachi Ltd.), Hiroshi Fuji (Hitachi Industrial Equipment Systems Co., Ltd.), Seiichi Shin (The University of Electro-Communications)
16:30

2C04 OS: Advanced Adaptive and Learning Control -Theory and Applications-
Organizer(s): Ikuro Mizumoto (Kumamoto University), Toru Yamamoto (Hiroshima University)
Chair(s): Ikuro Mizumoto (Kumamoto University), Toru Yamamoto (Hiroshima University)

2C04-1 "A Method of Offset Error Reduction of Simple Adaptive Control Using Neural Networks for MIMO Nonlinear Systems," *Muhammad Yasser (IDS Research Group), Ikuo Mizumoto (Kumamoto University)
15:30

2C04-2 "A Simple Redesign of Adaptive Control for Flexible Arms by Finite Dimensional Controllers," *Yoshishige Miyasato (The Institute of Statistical Mathematics)
15:50

2C04-3 "A Switching Method of PID Controllers Based on Performance Assessment," *Yoshiohiro Ohnishi (Kure National College of Technology)
16:10

2C04-4 "Intelligent IMC-PID Control for Ultrasonic Motor," *Mu Shinglin (Yamaguchi University), Kyana Tanaka (Yamaguchi University), Yoji Nakawa (Yamaguchi University), Takuwa Akashi (Yamaguchi University), Masato Oka (Ube National College of Technology)
16:30

2C04-5 "Power Consumption/Supply Control Using Neural Network for Micro Grids," Kanate Tsunashiki (Science and Technology, Keio University), *Shohei Shimizu (Keio University), Hiromitsu Ohnori (Keio University)
16:50

2C04-6 "A Self-repairing Control System with an Unstable Filter," *Masanori Takashiki (Tokai University)
17:10

2C05 Image Processing
Organizer(s): Byung-Ryong Lee (University of Ulsan)
Chair(s): Byung-Ryong Lee (University of Ulsan), JaeWook Shin (POSTECH), PooGyeon Park (POSTECH)

2C05-1 "Piecewise Linear Motion Blur Identification Using Morphological Filtering in Frequency Domain," *Byunghoon Kang (POSTECH), JaeWook Shin (POSTECH), PooGyeon Park (POSTECH)
15:30

2C05-2 "Image Reconstruction from Point Cloud Data by CIP-Level Set Method," *Hironori Ishimoto (Aran National College of Technology), Ryuzaburo Sugino (Aran National College of Technology), Noboru Morizumi (Aran National College of Technology)
15:50

2C05-3 "Image Enlargement with Back Projection of Lost High-Frequency Components," *Hidemi Ono (Kyushu Institute of Technology), Hiroshi Maeda (Kyushu Institute of Technology), Hiroki Fukushima (Kyushu Institute of Technology), Norikazu Ikoma (Kyushu Institute of Technology)
16:10

2C05-4 "Image Watermarking Using Adaptive Tabu Search," *Petcharin Artameeyaran (Vongchavali University)
16:30

2C05-5 "Medical Image Compression and DIOCM-Format Image Archive," *Pyamas Suasang (Rangsit University), Kechai Dijhan (Rangsit University), Surapan Yimmin (King Mongkut’s University of Technology Thonburi Thonburi)
16:50

2C05-6 "Real-time Forming Error Inspection System Using Computer Vision for Small-sized Tubing," *Hyung-Sok Kim (University of Ulsan), Eredesuren Narambadar (University of Ulsan), Sheikh Ahaan Ahamed (University of Ulsan), Yong-Hwan Ba (Andong National University), Byung-Ryong Lee (University of Ulsan)
17:10

2C06 Networked Sensing System
Organizer(s): Hidetsu Hori (Nagoya Institute of Technology), Hideko Itawaka (Kanazawa Institute of Technology)
Chair(s): Hidetsu Hori (Nagoya Institute of Technology), Hideko Itawaka (Kanazawa Institute of Technology)

2C06-1 "A Short Range Measurement Using RF Signal’s Propagation Time Based on Vernier Effect," *Sang-Il Ko (Tokyo Institute of Technology), Jumya Takayama (Tokyo Institute of Technology), Shingo Oyama (Tokyo Institute of Technology)
15:30

2C06-2 "Efficient Range-free Localization Algorithm for Wireless Sensor Network Based on Shortest Path Information," *Jaehoon Lee (Yonsei University), Wonjong Chung (Yonsei University), Eunhui Kim (Yonsei University)
15:50

2C06-3 "Detecting Sinkhole Attacks in Wireless Sensor Networks," *Chanthip Tumrongviditayapak (King Mongkut Institute of Technology Lad), Ruttikorn Varakuljaruparb (King Mongkut Institute of Technology Lad)
16:10

2C06-4 "Design of the Middleware for Wireless Sensor Node Based on IEEE1451.5," *Young-Han Lee (Hanyang University)
16:30

2C06-5 "Reliable Data Transfer using Overhearing for Implicit ACK," *Ge-won Lee (KyungHee University), Eui-Nam Huh (KyungHee University)
16:50

2C06-6 "Network-centric Mashup for a Sensor Network that uses," *Yeong Choi (University of Aizu), Junya Terazono (University of Aizu), Kenji Kawauchi (University of Tokyo), Kana Itabashi (University of Aizu), Hideyuki Fukuhara (NetOne Systems), Isamu Koseda (Net One Systems Co., Ltd.)
17:10
Reliable Data Transfer using Overhearing for Implicit ACK
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Abstract: Many applications in Wireless Sensor Networks require collecting all data without loss from nodes. End-to-End data retransmission, which is used in the Internet for reliable transport, becomes very inefficient in Wireless Sensor Networks, since wireless communication, and constrained resources pose new challenges. We look at factors affecting reliability, and search for efficient combinations of the possible options. This paper proposes an efficient Overhearing based reliable transfer protocol in Wireless Sensor Networks by calculate Reliability and using implicit Acknowledgement. Finally, it is clarified that the proposed scheme is efficient for reliable data transfer in WSN.

Keywords: WSN, Data Transmission, Reliability, Acknowledgement, Overhearing, Delegation

1. INTRODUCTION

Explosive growth for ubiquitous society(u-society) is fueling the development of Wireless Sensor Networks(WSNs). Internationally, there are several movements trending toward u-society. Objects build ‘Information Network’ through smart, self-regulation information gathering also recognizes and control current information states in u-society based on WSN. In order to guarantee future society, numerous researches have done based on Wireless Sensor Network. These dynamic and adaptive distributed systems have applications ranging from monitoring wild-life habitats, inventory management, data collection, and military and space applications[1].

Many applications in WSNs require collecting all data to be transmitted without loss. For example, structure monitoring needs the entire data from all measuring points to build a model and analyze it[2]. Moreover, applications assured delivery of high-priority events to sinks, such as life-care data, reliable control and management of sensor network structure, and remotely programming/re-tasking sensor nodes over-the-air[3]. Consequently, reliable data transmission is an important design criterion for the development of sensor networking protocols involving data dissemination. But sensor networks are composed of low power sensor nodes capable of sensing particular physical phenomena in their vicinity and communicating among themselves using wireless transceivers. We must consider reliable transport protocol must not only lightweight and energy-efficient for lifespan of sensor fields but also capable of isolating applications from the unreliable nature of WSNs in an efficient and robust manner for mission critical area. These two trade-off problems are special regard research part in WSN.

In this paper, we propose a reliable data transfer using path reliability based on RSSI signal and Channel error rate. Selective acknowledgement mechanism is executed by comparing current path reliability and base reliability. In this scheme, overhearing problems are used as advantage for implicit acknowledgement mechanism. Furthermore, delegate acknowledgement mechanism helps more efficient energy consumption. Contribution of this paper is the reliable data transfer considering energy-efficiency and less overhead.

2. RELATED WORK

2.1 Overhearing Problems
Due to the broadcast nature of the wireless channel many nodes in the vicinity of a sender node overhear its packet transmissions even if those are not the intended recipients of these transmissions [4]. This redundant reception results in unnecessary expenditure of battery energy of the recipients. Turning off neighboring radios during a certain point-to-point wireless transmission can mitigate this cost[4,6].

Fig. 1 Overhearing Problems

2.2 ACK/NACK Message
ACK/NACK message is most basic method for guarantee reliability on networks. Main idea is using Acknowledgment message between sender and receiver. If data transfer succeed, send ACK message. But if data transfer failed, send NACK(Negative ACK) message for notice some data is missing and request re-transfer. In high error rate environment, like WSNs, ACK/NACK method increase unnecessary traffic which causes packet overhead on network. ACK/NACK Message is definitely good method for reliable transmission if it is modified to compatible with Wireless Sensor Network which has limited resource and power.

2.3 PSFQ Protocol
PSFQ is one of protocols that ensure reliability on WSN. The key idea that underpins the design of PSFQ is to distribute data from a source node by pacing data at a relatively slow speed (pump-slowly), but allowing nodes that experience data loss to fetch (i.e., recover) any missing segments from their local immediate neighbors aggressively (fetch quickly) [3]. Packets that are lost are detected when a higher sequence number than expected is received at a node triggering the fetch operation.

PSFQ is good for fast recovery. But if packet lost in middle node, buffer must standby until missing packet re-transmission done. This causes buffer overflow and increase data transmission time.

3. PROPOSED MECHANISM

In this paper, we describe the ROIA (Reliable Data Transfer using Overhearing for Implicit ACK) mechanism that we assume for the high-reliability application. Path-Reliability for ROIA based on Channel error rate and RSSI (Radio Signal Strength Indicator) which is a measurement of the power presents in a received RF signal. Selective acknowledgement mechanism will be executed by comparing current path reliability and base reliability. In this scheme, overhearing problems are used as advantage for implicit acknowledgement mechanism. Furthermore, delegate acknowledgement mechanism helps more efficient energy consumption.

Challenges to achieving reliability on WSN in this paper can be divided to four main following phases: Reliability Calculation Phase, Data Transfer Phase, Implicit ACK Phase and Delegation Phase.

We assume that sensor nodes are deployed as an optimized form. Sensor deployment method considers the energy-efficiency and so minimizes the number of sensor node. Since ROIA scheme stores and calculates reliability using neighbor node information, this is limitation due to stored information that related to neighbor nodes.

3.1 Reliability

There are many algorithms proposed and implemented for increase reliability in WSN. To our knowledge, there has been few works on the design of reliable transport protocols using path-reliability for sensor networks. Primary research focused on influence of limited channel error rate. We propose each Path-Reliability using RSSI and Channel Error Rate (CER), even if one node has a lot of neighbor nodes and multipath.

After sensor node deployment, each nodes send sensed RSSI that represent the signal strength of neighbor node, and receive RSSI which represent the signal strength of its own. RSSI are basically negative forms, therefore quantizing steps are required as follows:

\[
\text{RSSI}_{\text{quan}} = 1 - \frac{\text{RSSI}}{\text{MaxRSSI}} \quad (1)
\]

Using these values, a node computes the reliability required for determination selective ACK or Implicit ACK as:

\[
(1 - \text{ErrorRate}) \times \sum \text{CurrentPathRSSI}_{\text{quan}} \quad (2)
\]

3.2 Data Transfer

When a node successfully exchanges RSSI and compute reliability using received RSSI, determine computed reliability as a base reliability. If transfer failed, request ACK until node sets the base reliability.

Set Base Reliability Procedure is shown in Figure 3.

/* Set Base Reliability Procedure */

// After Get A-B Reliability $R_{A,B}$ with Channel error rate $E_c$ and $m_y\text{RSSI}_{\text{quanB-A}}$
If(get_myRSSIB-A signal from neighbors)

\{ Calculate Reliability $R_{A,B}$;
Set A-B Base Reliability $BR_{A,B}$;
$R_{A,B} = BR_{A,B}$;
\}
Else
ReqACK();

Fig. 3 Set Base Reliability

If data of node A transfers to B, A must compare current path $R_{A,B}$ with the base reliability $BR_{A,B}$ based on selective ACK transmission method as shown in Figure 4.

/* Selective ACK algorithm for Data Dissemination */

// if node A has data to transfer :
// Compare path A-B Reliability $R_{A,B}$ to Base Reliability $BR_{A,B}$
IRR($R_{A,B} > BR_{A,B}$) // only Implicit ACK
Else // $R_{A,B} \leq BR_{A,B}$
ReqACK(); // Direct ACK

Fig. 4 Selective ACK algorithm
3.3 Implicit ACK

Sensor node uses radio channel for communication, and there is some solution for prevention of collision which is caused by overhearing problems in ieee 802.15.4 protocol.

Overhearing problems are used as advantage for implicit acknowledgement mechanism in this scheme. Figure 5 shows the Implicit ACK mechanism. The selective ACK method, we determined that if current path reliability was better than the base reliability, then there is no ACK request but only confirms data transmission achievement with implicit ACK.

3.4 Delegation

When node A transfers data to B using the selective ACK algorithm and implicit ACK, node B initiates delegation process. If A requests direct ACK since path-reliability is poor, B must decide the return ACK immediately or delegate ACK. If current path reliability is better than the base reliability, data dissemination will be succeeded even though none ACK requests. B compares next path reliability for delegation determination. In case of one node got the direct ACK request from a former node and the next path reliability is higher than the base reliability, the node delegates direct ACK to the next node.

4. PERFORMANCE EVALUATION

The simulations are done on a uniform topology consisting of 0–100 nodes deployed in a square area of 100m x 100m. We applied an energy model, the network interface and an error model basically included in NS-2.

We compare ROIA to generic ACK protocol and PSFQ protocol that is suitable for the reliable transmission.

The first simulation shows the total number of transmission when the number of nodes increases. In this case, the maximum number of re-transmission is not limited. Figure 7 shows highest total number of transmission since PSFQ use hop-by-hop recovery when ACK and ROIA transfer relatively lower than PSFQ. This shows ROIA performance is better than ACK and PSFQ schemes on reliable transmission view.

This results shows ROIA transmission reliability is similar with ACK mechanism.

The second simulation is for total number of transmission when number of nodes settled in 10 until 60 min. Again the adaptive nature of our algorithm is highlighted vis-à-vis the other methods. Figure 8 shows also similar reliable performance with ACK mechanism, better than PSFQ mechanism.

Fig. 7 Performance comparison with PSFQ, ACK (Node)

Fig. 8 Performance Comparison with PSFQ, ACK (Time)

Here we present the simulation results for the energy-efficiency. In Figure 9 we simulate the total
energy consumed to CBR packet for 3 different error rates. We set the each error rate 0%, 30%, and 50%.

We can easily see the ROIA is more 40% energy-efficient than ACK mechanism.

![Energy efficiency comparison with ACK](image)

Fig. 9 Energy efficiency comparison with ACK

From above results, we can figure out that ROIA shows the much better performance both data dissemination and energy-efficiency in a reliable manner.

5. CONCLUSION

We have presented ROIA, an efficient Reliability based reliable transfer protocol in WSNs by introducing implicit and selective acknowledgement. Compute Reliability using RSSI and Channel Error rate. Selective acknowledgement mechanism is executed by comparing current path reliability and base reliability. We also use overhearing problems as advantage for implicit acknowledgement mechanism. Furthermore, the delegation mechanism helps more efficient energy consumption.

It is clarified that the proposed scheme is efficient for reliable data transfer in WSN. Contribution of this paper is the reliable data transfer considering energy efficiency and less overhead.

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REFERENCES