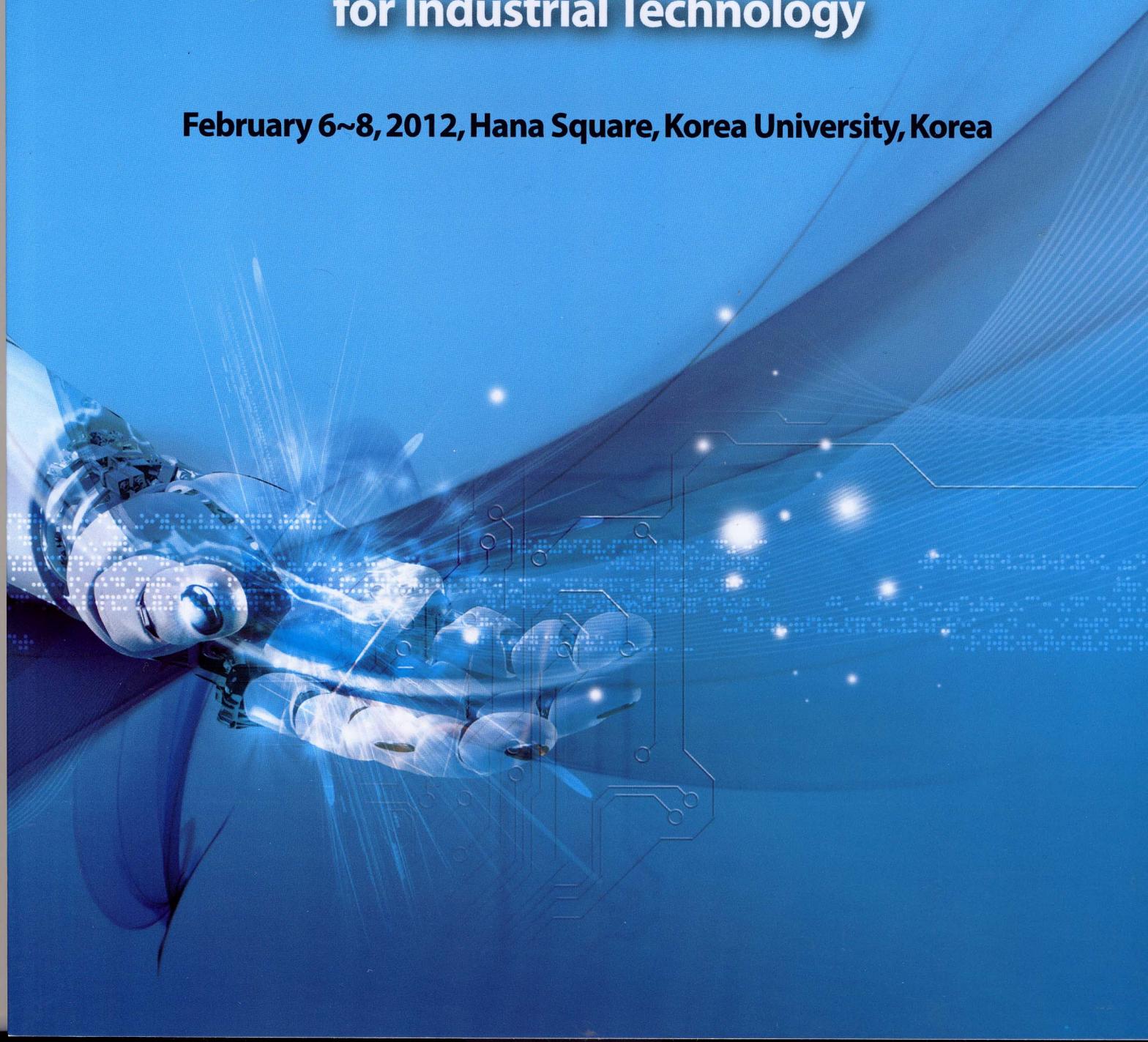


Proceedings of the

FTRA AIM 2012

The 2012 **FTRA** International Conference on
Advanced **I**T, engineering **M**anagement
for Industrial Technology

February 6~8, 2012, Hana Square, Korea University, Korea



PROGRAM SCHEDULE

February 6, 2012 (Monday)			
open at 09:00	Registration		
09:30- 11:30	Session 1-A Chair: Jaehwa Chung Room: Multimedia Room	Session 1-B Chair: Yi-Ting Mai Room: B-120	Session 1-C Chair: Gyanendra Prasad Joshi Room: B-111
11:30- 13:00	Lunch		
13:00- 14:00	Invited Talk Title : State-of-the-Art Multimedia Forensics by Dr. Hyungjoong Kim , Professor, Korea University, Korea Auditorium / Chair: Jongsung Kim		
14:00- 14:20	Coffee Break		
14:20- 16:20	Session 2-A Chair: Hyung-Ju Cho Room: Multimedia Room	Session 2-B Chair: Min Choi Room: B-120	Session 2-C Chair: Jung-Sik Cho Room: B-111
16:20- 16:40	Coffee Break		

The 2012 FTRA International Conference on Advanced IT, engineering and Management (AIM 2012)

16:40-18:00	<p align="center">Session 3-A Chair: Seung-Ho Lim</p> <p align="center">Room: Multimedia Room</p>	<p align="center">Session 3-B Chair: Mucheol Kim</p> <p align="center">Room: B-120</p>	<p align="center">Session 3-C Chair: Neil Yen</p> <p align="center">Room: B-111</p>
19:00-20:30	<p align="center">Banquet</p> <p align="center">Holiday Inn Hotel</p>		

February 7, 2012 (Tuesday)			
open at 09:00	Registration		
09:30-11:30	<p align="center">Session 4-A Chair: Mucheol Kim</p> <p align="center">Room: Multimedia Room</p>	<p align="center">Session 4-B Chair: Young-Gab Kim</p> <p align="center">Room: B-120</p>	<p align="center">Session 4-C Chair: Pham Thi Thu Thuy</p> <p align="center">Room: B-111</p>
11:30-13:00	Lunch		

The 2012 FTRA International Conference on Advanced IT, engineering and Management (AIM 2012)

13:00-15:00	<p>Session 5-A Chair: Hsun-Chih Kuo</p> <p>Room: Multimedia Room</p>	<p>Session 5-B Chair: Asmatullah Chaudhry</p> <p>Room: B-120</p>	<p>Session 5-C Chair: Sateesh Kumar Peddoju</p> <p>Room: B-111</p>
15:00-15:20	Coffee Break		
15:20-17:40	<p>Session 6-A Chair: Muhammad Tariq Mahmood</p> <p>Room: Multimedia Room</p>	<p>Session 6-B Chair: Jaehwa Chung</p> <p>Room: B-120</p>	<p>Session 6-C Chair: Yang Sun Lee</p> <p>Room: B-111</p>

February 8, 2012 (Wednesday)	
09:30 - 12:00	FTRA Executive Meeting

1. A paper presentation should be made by one of authors of the paper, during a 20 minute time slot (15 minutes for the presentation itself and 5 minutes for Q/A).
2. All speakers of each session should meet the session chair at its room 10 minutes before the session begins.
4. We will prepare Windows 7 laptops running the Adobe Reader and Microsoft Office 2007 for paper presentations. Please prepare your presentation files for being read by those applications.
5. If you have any questions, please feel free to contact the secretary (aim@ftrai.org).

DETAILED SCHEDULE FOR AIM 2012

February 6, 2012 (Monday)

9:30 - 11:30 [Session 1-A](#)

(Room: Multimedia Room)

(Chair: Jaehwa Chung)

- **Rearing Cyber-I from a Perspective of Security**
Jie Wen, Jianhua Ma, Runhe Huang, Qun Jin, Jian Chen, Benxiong Huang
- **Biclique Cryptanalysis on the Full CRYPTON-256 and mCrypton-128**
Junghwan Song, KwanHyung Lee, HwanJin Lee
- **A Study on Protecting Privacy based on Secure Access Control in the Social Network Environments**
Kyong-jin Kim, Seng-phil Hong
- **FakePIN: Dummy-Key Based User Authentication Scheme For Smartphones Resistant to Shoulder-Surfing Attacks**
Siwan Kim, Hyunyi Yi, Gunil Ma, Jeong Hyun Yi
- **A Reputation-based Approach for Anti-spamming in Social Networks**
Bo-Chao Cheng, Guo-Tan Liao, I-Cheng Liang, Huan Chen

9:30 - 11:30 [Session 1-B](#)

(Room: B-120)

(Chair: Yi-Ting Mai)

- **Biorthogonal Wavelet Packet Based Color Image Watermarking Featuring the Human Visual System**
Anuva Chowdhury, Ui Pil Chong
- **Digital Watermarking Based Image Authentication and Restoration Using Error Correction Coding and Integer Wavelet Transform**
Tanveer Ahsan, Uipil Chong
- **A one time password based non-repudiation mechanism for the electronic transaction**
KEUNOK KIM, HEASUK JO, DONGHO WON
- **Two-Factor Authentication Technology on Smartphone**
Junghun Park, Okkyung Choi, Kangseok Kim, Taeshik Shon, Manpyo Hong, Hongjin Yeh
- **Efficient DRM Mechanism for Scalable Contents based on H.264/SVC**
Su-Wan Park, Jong Wook Han, Sang Uk Shin

9:30 - 11:30 [Session 1-C](#)

(Room: B-111)

(Chair: Gyanendra Prasad Joshi)

- **An Effective Clustering Scheme for Load-balancing**
CHIMING HUANG, REI-HENG CHENG, JHIH-SIAN HUANG
- **Routing Advertisement Method for High Density Ad-hoc Network**
Chang-Un Park, Jae-Jo Lee, Dae In Choi, H K kahng
- **Power Range Control for Sensors in Wireless Sensor Networks to Enhance Network Availability**
CHIMING HUANG, REI-HENG CHENG, KUAN-FAN CHEN
- **Motion-Aware Location Service for Geographic Routing in Ad Hoc Networks**
REI-HENG CHENG, CHIMING HUANG, WEI-YU LAI
- **IEEE 802.15.4 MAC Protocol Enrichment Using Multi-Beam Antenna Approach**
MD ASDAQUE HUSSAIN, MD NASRE ALAM, KYUNG SUP KWAK

13:00 - 14:00 [Invited Talk](#)

(Room: Auditorium)

(Chair: Jongsung Kim)

Prof. Hyungjoong Kim
Korea University, Korea

14:20 - 16:20 [Session 2-A](#)

(Room: Multimedia Room)

(Chair: Hyung-Ju Cho)

- **WiSEMobile Service for managing Smart Vineyard**
HYUNJOONG KANG, JUNWOOK LEE, SUNGSOO KANG, DAEHEON PARK
- **Connectivity Maintenance Scheme for Mobile Wireless Sensor Networks**
Sooyoung Moon, Heesuk Seo, Jin Kwak
- **Flow-based Analytic model with Deletion Policies**
UI-JIN JANG, CHENGGGEN QUAN, YONGTAE SHIN, CHANGJIN SUH
- **Decentralized Cognitive Radio Medium Access Control Protocol for Cognitive Radio Wireless Sensor Networks**
Gyanendra Prasad Joshi, Maksudur Rahman Jonayed, Sung Won Kim
- **Multi-signature Based Integrity Checking Scheme For Detecting Modified Applications on Android**
Hyeong-Chan Lee, Jin-Hyuk Jung, Jeong Hyun Yi

14:20 - 16:20 [Session 2-B](#)

(Room: B-120)

(Chair: Min Choi)

- **A study on Visible Light Communication Service employing Transmission Diversity**
Jiang Liu, Mianxiong Dong, Laurence Yang, Sikieng Sok, Shigeru Shimamoto
- **Cluster Authentication Protocol based on VANET in M2M**
You-Boo Jeon, Keun-Ho Lee, Doo-Soon Park, Chang-Sung Jeong
- **Tracking Methods of Movable Node Using Relative Distances**
Shoji Sano, Tomoki Yoshihisa, Tsutomu Terada, Masahiko Tsukamoto
- **A Rule-based Home Energy Management System**
Tomoki Yoshihisa, Naotaka Fujita, Masahiko Tsukamoto
- **A Rechargeable Battery Control System Based on Rules for Exploiting Rechargeable Batteries**
Makito Takahashi, Tomoki Yoshihisa, Naotaka Fujita, Masahiko Tsukamoto
- **Goal-Driven Navigation of Optimized Information Seeking Process Based on Similarity of User Access Behavior Patterns**
JIAN CHEN, QUN JIN

14:20 - 16:20 [Session 2-C](#)

(Room: B-111)

(Chair: Jung-Sik Cho)

- **Development for 3rd Party based Smart Web TV Service Support Platform using Cloud**
Young-Rok Shin, Sang Ho Na, Jun Hyung Lee, Eui-Nam Huh, Ilkwon Cho
- **Concept and Architecture of Open Map Generation based on Cloud Computing and Mashup Approach**
SeungGwan Lee, Daeho Lee, Sanghyuck Ahn, Sungwon Lee
- **A Cloud-based Survey System with a New IPA Discrimination Index**
Hsiang-Chuan Liu, Bai-Cheng Jeng, Yi-Ting Mai, Yu-Du Jheng, Hao-Tung Lin
- **A scalable cloud model applied in a massive delivery email messaging**
Nyirabahizi Assouma, Mauricio Alejandro Gomez Morales, Eui-Nam Huh
- **Highlighting Interested Objects: An Intelligent Search Mechanism based on Social-Like User Modeling**
MARTIN M. WENG, NEIL Y. YEN, HSUAN-PU CHANG

16:40 - 18:00 [Session 3-A](#)

(Room: Multimedia Room)

(Chair: Seung-Ho Lim)

- **A Load-Balancing Scheme for Advanced Metering Infrastructure in Smart Grid**
Jaesung Park, Yujin Lim, Kilhung Lee
- **A Novel Flash-Aware Index Manager for SSD-based Systems**
Rize Jin, Hyung-Ju Cho, Tae-Sun Chung
- **Design Method for Secure Integrated Public Service System using Smart Device in Broadcast Communication Environment**
HyunMi Jang, SengPhil Hong
- **Power Efficient Routing Protocol based on Binary-Tree for Wireless Sensor Networks**
HyeongJun Chang, GwiTae Park

16:40 - 18:00 [Session 3-B](#)

(Room: B-120)

(Chair: Mucheol Kim)

- **An Integrated Load-based Power Saving Scheme in IEEE 802.16e**
Yi-Ting Mai, Chun-Chuan Yang, Jeng-Yueng Chen, Min-Hsien Lin
- **A Simulation Schema of Remote Drive-Directing over Autonomous Vehicles for Experimentation**
Min-Hwan Ok
- **An Extended Neighbor Discovery Protocol for Load Balancing and Topological Stability in Mobile Ad hoc Networks**
DaeWon Lee, YoungHwan Kim, HwaMin Lee

16:40 - 18:00 [Session 3-C](#)

(Room: B-111)

(Chair: Neil Yen)

- **Design of Routing Protocol Supporting Node Mobility over Wireless Body Area Sensor Network**
Dong-Hoon Lee, Yeon-Sang Choi, Jae-Young Pyun
- **Method for Protecting Stored Log Falsification based on WORM**
Dongsoo Kim, Young Ran Hong
- **Security Enhancement of ICT Security Solutions by Common Criteria Certification**
Young Ran Hong, Dongsoo Kim
- **Security Evaluation of Steganography Using Structural Data Created through Editing Software**
Tsuyoshi Toyama, Tsutomu Matsumoto

February 7, 2012 (Tuesday)

9:30 - 11:30 [Session 4-A](#)

(Room: Multimedia Room)

(Chair: Mucheol Kim)

- **Design of Scalable Spatial Index in a Cluster of Servers**
HONG JUN JANG, SOON YOUNG JUNG
- **User Activity Frequency and User Longevity Based Recommendation in Social Network**
A.T.M. Bari, Md. Hossain, Byeong Jeong
- **An effective tool for recommending opinion leaders in SNS**
Byung Joon Park, Seok-Won Hong, Lynn Choi
- **Organizing a User-created Computing Environment in Desktop Grid Systems**
Jaehwa Chung, Joon-Min Gil
- **Computing Semantic Distance Using Ontologies**
WEIJIE LIU, YONGJUN ZHU, WOOJU KIM, HAKJIN KIM
- **T-Grid: A Domain based Trusted Grid Model with Purging of Untrustworthy Transactions**
P. SURESH KUMAR, P. SATEESH KUMAR, S. RAMACHANDRAM

9:30 - 11:30 [Session 4-B](#)

(Room: B-120)

(Chair: Young-Gab Kim)

- **User-privacy and modern smartphones: A Siri(ous) dilemma**
Dimitrios Damopoulos, Georgios Kambourakis, Marios Anagnostopoulos, Stefanos Gritzalis, Jong Hyuk Park
- **Location Privacy Pre-protection through Markov Chain for Wireless Sensor Networks**
Yuan Tian, Biao Song, Eui-nam Huh
- **An Adaptive and Efficient Remote Screen Transmission Protocol for Mobile Thin Client**
Biao Song, Wei Tang, Eui-nam Huh
- **Attack Strategies Construction and Exchange Model in a Collaborative Cloud Computing environment**
Doan Man Nguyen, Jun Young Park, Sang Ho Na, Tian Yuan, Eui-Nam Huh
- **User Model with Life in Cyber-Individual**
Bofeng Zhang, Jianxing Zheng, Jianhua Ma, Yinsheng Li, Guobing Zou

9:30 - 11:30 [Session 4-C](#)

(Room: B-111)

(Chair: Pham Thi Thu Thuy)

- **Efficient Error-tolerant String Search Techniques for Supporting Mobile Applications**
Jongik Kim, Eunseok Lee
- **Modeling and Analysis of Computation Offloading for Energy Conservation on Multi-Interface Smartphone in Mobile Cloud Computing**
Yun Won Chung
- **Resource Provision Technique with Mobility Grouping in Mobile Cloud Computing**
JiSu Park, Byoungwook Kim, HeonChang Yu, EunYoung Lee
- **A Collaborative Processing Scheme for Continuous Nearest Neighbor Monitoring in Mobile Navigation**
Hyung-Ju Cho, Rize Jin, Tae-Sun Chung
- **Hybrid Remote Display Protocol for mobile Thin Client Computing**
Wei Tang, Biao Song, Tien Dung Nguyen, Eui Nam Huh

13:00 - 15:00 [Session 5-A](#)

(Room: Multimedia Room)

(Chair: Hsun-Chih Kuo)

- **Souls of 5.18(May 18th) Gwangju Resistance: Visualization of Human Emotion**
Sungdae Hong, Soochul kim
- **On Utilizing Intra-body Communication for Arm Movement Identification**
Sikieng SOK, Shigeru SHIMAMOTO
- **Hawkeye: Real-time Video Error Detection Using Cloud Computing Platform**
MD. MEHEDI HASAN, KIOK AHN, SM ZAHID ISHRAQUE, OKSAM CHAE
- **Cloud Architecture for Lossless Image Compression by Efficient Bit-plane Similarity Coding**
Mahbub Murshed, SM Zahid Ishraque, Md. Mehedi Hasan, Oksam Chae
- **Testbed Design for Providing Stable Broadcasting Services in Next-Generation D-CATV**
Jong Won Yang, Soo Hyun Kim, Sung Jun Kim

13:00 - 15:00 [Session 5-B](#)

(Room: B-120)

(Chair: Asmatullah Chaudhry)

- **Genetic Programming based Blind Image Deconvolution for Surveillance Systems**
MUHAMMAD TARIQ MAHMOOD, SEONGHWAN JEONG, JONGWOO HAN, YOUNG-KYU CHOI

- **Object Tacking for Video Surveillance: A GHT based Edge Segment Matching Method**
SM Zahid Ishraque, Mahbub Murshed, Taskeed Jabid, Oksam Chae
- **Real-Time Human Detection by Using Cascaded Adaptive Boosting Classifier Based on Histogram of Oriented Gradients Features**
Joo-Hyung Kim, Jeong-Eom Lee, Yong-Guk Kim, Gwi-Tae Park
- **Semi-supervised Local Clustering**
Anh Pham The, Young-Koo Lee, Sungyoung Lee
- **Study on Image Processing of Panorama X-ray using Deviation Improvement Program**
Taegon Kim, Youngpyo Kim, Yangsun Lee, Yongpil Park, Minwoo Cheon

13:00 - 15:00 [Session 5-C](#)

(Room: B-111)

(Chair: Sateesh Kumar Peddoju)

- **Ontology Module Extraction based on the Concept Relations**
Keonsoo Lee, Seheon Song, Minkoo Kim
- **Adaptive Classification of Malicious Web Pages**
Young-Sup Hwang, Jae-Chan Moon, Seong-Je Cho
- **Intelligent Content Based Image Retrieval by Partial Supervised Learning**
Aun Irtaza, Arfan Jaffar, Tae-Sun Choi
- **R2Sim: A Novel Semantic Similarity Measure for Matching between RDF Schemas**
Pham Thi Thu Thuy, Young-Koo Lee, Sungyoung Lee

15:20 - 17:40 [Session 6-A](#)

(Room: Multimedia Room)

(Chair: Muhammad Tariq Mahmood)

- **A New Signed Fuzzy Measure Based Choquet Integral and Its Application to the Reading Achievement TEST**
HSIANG-CHUAN LIU, BEN-CHANG SHIA, CHIA-CHEN LEE, FENGMING CHANG, YEN-KUEI YU
- **Design of Image Contents System for Real-time Emotion Retrieval**
Jae-Khun Chang, Seung-Taek Ryoo
- **Regularly Frequent Pattern Mining in Incremental Transactional Databases**
MD. MAMUNUR RASHID, BYEONG-SOO JEONG, HO-JIN CHOI
- **Facial Expression Recognition using Local Transitional Pattern Variance**
Taskeed Jabid, SM Zahid Ishraque, Oksam Chae
- **Parameter Optimization for Local Structure-Based Fingerprint Alignment**
Heemin Park, Jae Won Lee, Jong Woo Lee
- **A Novel Composition Forecasting Model Based on Choquet Integral with Respect to H-measure**

HSIANG-CHUAN LIU, YU-TING CHENG, SHANG-LING OU, YIH-CHANG OU, YEN-KUEI YU, HSUN-CHIH KUO

15:20 - 17:40 [Session 6-B](#)

(Room: B-120)

(Chair: Jaehwa Chung)

- **An Adaptively Emerging Mechanism for Selection of Ambient Services**
Yishui ZHU, Qun JIN
- **Performance Evaluation of User Authentication System in U-City Environment**
Jae-Soo Jang, Chang-Jin Suh, Hyung-Min Lim
- **Grouping Mechanism for Wireless Mesh Networks to Future Internet Services**
Madhusudan Singh, Sang Gon Lee, Dhananjany Singh
- **A Safe Exit Approach to Continuous Nearest Neighbor Monitoring in Road Networks**
Hyung-Ju Cho, Tae-Sun Chung
- **Dynamic Access Control Policies on RBAC in Ubiquitous Environment**
Young-Gab Kim, Sungdeok Cha
- **Intelligent Human Activity Recognition in Videos: Using Hybrid Features and Artificial Neural Network**
Javed Ullah, M. Arfan Jaffar, Asmatullah Chaudhry, Jin Young Kim

15:20 - 17:40 [Session 6-C](#)

(Room: B-111)

(Chair: Yang Sun Lee)

- **Smart TV recommender systems for multiple users using social network**
SOO-CHEOL KIM, CHAN-SOO PARK, SUNG KWON KIM
- **An Efficient Sensor-based Dynamic Control Middleware for Cyber Physical System**
Sang Oh Park, Young-Sik Jeong
- **Intelligent Multi-hop Clustering Algorithm for Prolonging the lifetime of WSNs**
Mucheol Kim, Sunhong Kim, Jiwan Seo, Sangyong Han
- **Abnormal Traffic Detection System for 3G WCDMA Mobile Network**
Jung-Sik Cho, Dongwan Kang, Sekwon Kim, JooHyoun Oh, Cheateae Im
- **Revisit: Cryptanalysis of GOST**
Jongsung Kim

Decentralized Cognitive Radio Medium Access Control Protocol for Cognitive Radio Wireless Sensor Networks

GYANENDRA PRASAD JOSHI¹, MAKSUDUR RAHMAN JONAYED² AND SUNG WON KIM³

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Abstract

Cognitive radio wireless sensor networks enable opportunistic spectrum access. In this paper, we propose a MAC protocol for cognitive radio wireless sensor networks. In the proposed protocol, secondary users recognize spectrum opportunities and transmit data, based on the licensed users' arrival prediction in the channel. Nodes estimate the number of active sensors and adjust the sleep cycle to conserve energy. The proposed protocol does not need dedicated common control channel. We evaluate energy consumption and goodput through simulation. The results show that the proposed protocol utilizes white spaces efficiently and conserve energy with a small cost of per packet delay.

Keywords: Cognitive radio, wireless sensor networks.

1. Introduction

The wireless applications that utilize the resource are experiencing drastic growth in the past few years. Due to the fixed radio spectrum allocation system, some licensed radio spectrum resources are underutilized, while, some unlicensed bands the sensor networks use are becoming overcrowded.

Cognitive radio came up with the idea of open spectrum access that allows unlicensed users to utilize these underutilized spectrum bands opportunistically.

The cognitive radio wireless sensors (CRWS) are the battery-operated devices. When CRWS network is deployed in an ad hoc fashion, they may be inactive for long periods and whenever something is detected, they have to be active suddenly. These characteristics of cognitive radio sensor networks and applications motivate a MAC protocol that is different from traditional cognitive radio MAC protocols.

The main two additional responsibilities of the CRWS-MAC protocols are to protect incumbent licensed users, also called primary users, of the channels from the interference of the cognitive users, and to conserve energy. In this paper, we present decentralized cognitive radio MAC protocol for CRWS networks.

2 System model and assumptions

We consider CRWS devices are the intelligent devices with the cognition capacity that can observe, orient, plan, learn, decide and act as mention in the [1]. Each CRWS device is equipped with control transceiver and data transceiver.

When a secondary sensor (SS) node wakes up, it waits for a certain predefined time in a randomly selected channel.

If it does not hear any activity from any SS node, it considers itself is the first SS node in the network. The SS node divides time into k equal slots of fixed duration ' τ '. Each slot is dedicated to one channel called default slot for the channel and $t \times k$ is the incumbent's maximum tolerable time, as in Figure 1.

The control transceiver of the SS node hops into all the channels. It senses and sends beacon into all channels at the corresponding time slots, if it do not sense incumbent licensed user's signal on the channel. After beaconing, it broadcast available channels list, other SS nodes in the network then respond sending their available channel set. The SS nodes record their own and neighbors' channel information in the channel status table. If a channel occupied already by the incumbent licensed user, then the SS node skips that channel. After sending beacon in all the channels, the SS nodes know default slot for the channel and available channel sets of the neighbor SS nodes.

All the SS nodes in the network tune their control transceiver in the channel's default slot. At the beginning of each default slot, SS nodes compete to send beacon that is carrying their local time. This is similar to the timer synchronization function (TSF), in the IEEE 802.11 [2].

At the system level, it follows two kinds of sensing – fast sensing and fine sensing and from the logical view, the proposed approach use cooperative sensing to learn network-wide spectral opportunities.

3. Protocol description

The SS nodes record the sensing results in a table called channel status table and make a preferred channel list of the available channels according to the availability for the SUs using historical prediction method [3]. Same channel can be in different rank in different SS nodes as per geographical location and time.

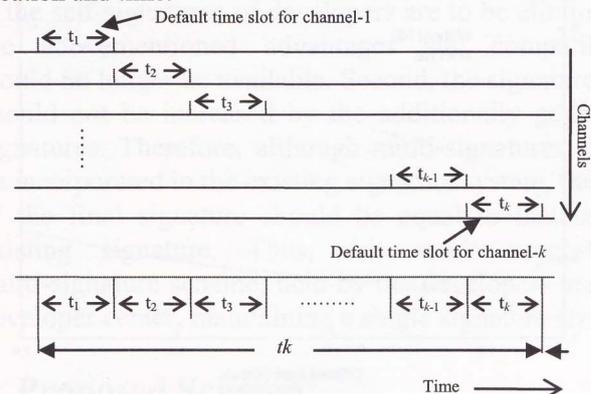


Figure 1. Default timeslots of the channels.

The SS nodes select the highest ranked common channel between sender and receiver for data communication. Then, the data transceiver of the sender SS node and the receiver SS node hop into the negotiated channel and starts data transfer.

After knowing the default slot of the channels, all the SS nodes tune their control transceiver into the channel's default slot. Contention winner node sends channel negotiation message (CNM) with the preferred channel list. Receiver node selects a common channel and sends back CNM-ACK with the selected channel. When, the sender SS node receives the CNM-ACK, it sends CNM-RES.

If PU's activity sensed on the channel, they skip the default time and wait for the next default time.

After the communication pairs select a common channel for data transfer, nodes send data in the selected channel by sending RTS/CTS as in the 802.11 DCF fashion. If the SS node finds that the incumbent licensed user reclaimed the selected channel, it immediately stops sending packets and buffers packet until the SS node successfully negotiates for the next data channel.

After synchronization, a SS node that has residual battery power more than a threshold, waits for random time and sends a signal, claiming cluster head to its vicinity for number of SS nodes estimation. Other SS nodes suppress their cluster head-claiming message after they receive the message from the neighbor. After that, SS nodes estimate the number of active SS nodes. Because of space limitation, we cannot describe the details of the node estimation method here. The control transceiver enters into sleep state according to the number of SS nodes estimated. If the number of active SS nodes estimated is large, the active state of the control transceiver is large and vice versa. If any incumbent user is detected, the SS nodes update their CST and enter into the sleep state and wake up in the next default slot.

4. Performance evaluation

We simulate the proposed protocol in ns-2 [4]. The SS nodes are deploy to a 100m × 120m area. The transmit, receive, idle, and sleep powers are set to 24mW, 15 mW, 15mW and 5 μW respectively. We use the constant bit rate (CBR) traffic with varying offered load and the packet size is 512 bytes. Each simulation is run for around 300 seconds.

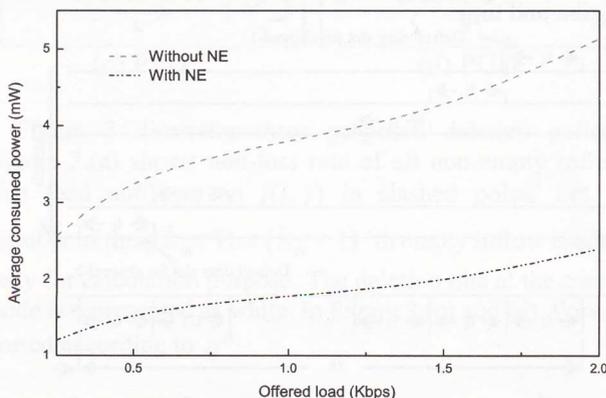


Figure 2. Average consumed power in different offered load.

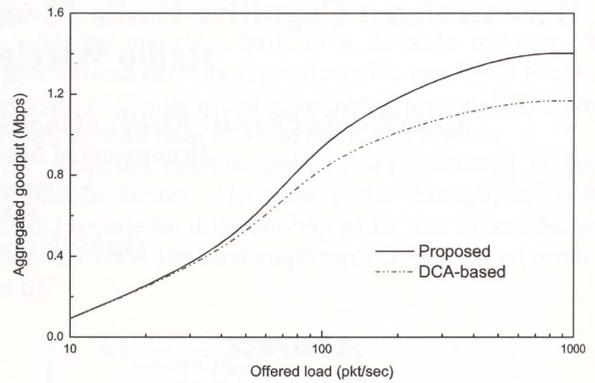


Figure 3. Aggregated goodput.

Figure 2 shows average consumed power in 10 SS nodes and four channels scenario. In the 'without node estimation (NE)' approach, control transceivers of the SS nodes enter into the doze state if PU is detected in the channel. However, in the 'with NE' approach, control transceivers of the SS nodes enter into the doze state according to the SS nodes density. Therefore, the SS nodes conserve more energy. Although, in the 'with NE' approach, nodes have to wait for cluster head selection and node estimation before channel negotiation. It has more overhead than the 'without NE', still it conserve more energy than the without node estimation.

Figure 3 shows the aggregated goodput of the network in 6 SS nodes. We select DCA-based MAC protocol [5] to compare aggregated goodput with our approach. It is a common control channel based MAC protocol. Because the selected channel for data communication in the proposed protocol is less prone to claim by PUs, it achieves better aggregated goodput.

5. Conclusions

We proposed decentralized MAC protocol for CRWSN. The proposed NE based approach achieves higher energy conservation with small cost of delay and adequate aggregated goodput. Since, energy conservation is very important in wireless sensor network, the proposed protocol's achievement is remarkable.

References

- [1] J. Mitola III and Jr. G. Q. Maguire, "Cognitive radios: Making software radios more personal," *IEEE Personal Communications*, vol. 6, no. 4, 1999, pp. 13–18.
- [2] *IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specs.*, TG 802.11, 2003.
- [3] G.P. Joshi, S.W. Kim, "An Efficient MAC Protocol for Throughput Enhancement in Dense RFID System," *ISWPC2009*, pp.1–5.
- [4] The network simulator – ns-2. Internet: <http://www.isi.edu/nsnam/ns/>. Accessed 17 June 2009.
- [5] H. Nan, T.-I. Hyon and S.-J. Yoo, "Distributed coordinated spectrum sharing MAC protocol for cognitive radio," *DySPAN2007*, pp. 240–249.