CONET Newsletter

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Contents

Editorial

Welcome to 2010 and to the seventh issue of the CONET newsletter. CONET is the EU FP7 network of excellence on Cooperating Objects, merging the fields of embedded systems for robotics and control, pervasive computing and wireless sensor networks. CONET focuses on establishing the field of Cooperating Objects within the research and industrial community, thus strengthening the position of Europe in the research landscape.

This issue presents a guest column from Prof. Xing Tao (SIMIT) about the latest Chinese market of Wireless Sensor Networks, the institute he is in (i.e., SIMIT), and two projects that SIMIT undertook. In the “member profile” section, we take the opportunity to present the Communication and Information System Group at University College London (UCL). This issue also presents a lightweighted and efficient file system, Coffee, from Swedish Institute of Computer Science (SICS).

If you are interested in obtaining up-to-date information about the CONET project please visit our website at: http://www.cooperating-objects.eu

We hope you will enjoy this issue ■

An Introduction to *Sensing China* and Shanghai Institute of Micro-System and Information Technology (SIMIT)

By Xing Tao, Shanghai Institute of Micro-system and Information Technology, P.R.China

1. Sensing China: Chinese Strategy towards a green and innovative future

On August 7th, 2009, the Premier of China, Jiabao Wen, visited Wuxi, China and proposed to expedite the development of the Sensing Network Industry and build ***Sensing China*** Center in Wuxi, China.

'We can do it from at least three aspects: (1) to integrate sensor systems with TD technologies in 3G, (2) to accelerate the development of sensor network in the Important National Science and Technology Specific Projects, (3) to accelerate the establishment of ***Sensing China*** Center', Jiabao Wen emphasized.

Figure 1: Jiabao Wen's visit in Wuxi, P.R.China

It was a fascinating and memorable visit, and also indicated the clear plan of the new ***Sensing China*** concept, i.e., to adequately apply new information and communications technologies into every walk of green and innovative life in the future, such as electricity power, energy resources, traffic environment, healthcare and so on.

2. An introduction to Shanghai Institute of Micro-system and Information Technology (SIMIT)

The key wireless sensor networks and communications laboratory of Chinese Academy of Sciences, established in December 2006, is oriented to nationally significant strategies and application needs. It applies itself to wireless sensor networks and broadband wireless mobile communications research including fundamental technologies, application exploration, system integration, system testing and evaluation.

The long-term goals of the lab are (1) to build up a generic collaborative wireless sensor networks framework, (2) to tackle the fundamental mechanism in ubiquitous sensor networks, (3) to enhance national innovation in broadband wireless mobile communications, (4) to become an influential testing and evaluation center, (5) to provide a reliable scientific research platform for international cooperation, (6) to play a leading role in wireless sensor networks and mobile communications research in China, and even in the world.

In details, we would propose sensor network architecture with our own intellectual properties, key transmission technologies, and prototype devices, which could be promoted as options for wireless sensor networks standards. As to broadband wireless mobile communications, we would provide some core technologies for air interface standards, and construct testing platforms and technical evaluation frameworks to support broadband wireless mobile communications research. An international R&D center will be established for the study of national broadband wireless mobile communications.

In terms of Wireless Sensor Networks, currently, the laboratory mainly focuses on the following research fields:

1) Intelligent wireless networking technologies

This research focuses on the randomly deployed and self-organized wireless sensor networking and future multimode mobile networking technology, both of which contain clustering topology protocol, cluster-based dynamic sleeping schedule MAC protocol, wireless sensor networks channel modeling, distributed cellular theory, wireless network planning, etc.

2) High efficiency wireless transmission technologies

This research focuses on the transmission technology to wireless sensor networks and mobile communications in various application environments. For example, wireless sensor networks adaptive transmission technology in the near ground environment, multimode communication scheme adaptive recognition technology, ultra multi-path Rake receiver technology, multi-access and detection technology, channel estimation and equalization technology, adaptive coding and modulation technology, time frequency synchronization and track technology, cross layer optimization and control technology.

3) Wireless collaboration and information sensing technologies

This research focuses on collaborative pattern recognition, information fusion, target tracking and wireless sensing technology in mobile communications. Specifically, it includes the adaptive BSS mixed-target recognition, rough neural network multi-sensor information fusion, multi-target tracking, collaborative information processing and sensing in wireless sensor networks etc.

The laboratory has been acknowledged by the ministry of science and technology as the “international cooperation research center of wireless communication”, the “international science cooperation base”, and the “Shanghai broadband wireless mobile communications R&D center”.

In addition, the laboratory is very active in research collaboration and academic exchanges with many famous research institutions and universities nationally and worldwide, such as the “Joint Laboratory for Trustworthy Wireless Sensor Network”, the “Joint Laboratory for WSN Application in 2010 Expo”, the “Wireless Communication Research Center, Joint laboratory with Nokia”, and the “joint laboratory with Quebec”.

3. Demonstration of Two Projects in China

As the 1st co-editing unit, SIMIT participated in the formulation of regional standards on the safety of urban track, which was come into force on 1 Sep. 2007. As a subediting unit, SIMIT participated in the formulation of national standards on the safety of urban track transportation. With the cooperation with the American company Tyco, it has become the general contractor for Shanghai railway technology and security.

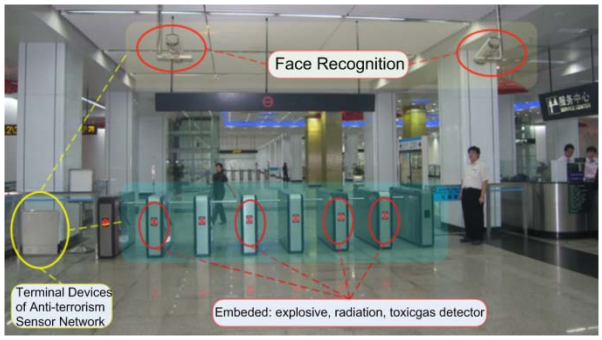

Figure 2: The anti-terrorism sensor network system at the subway stop of Yaohua Road has been started.

Agriculture-oriented applications are applied to vegetable production in greenhouse. The network is formed by various sensors and actuators with the functions of measuring soil moisture, soil composition, pH, temperature, air humidity, air pressure and so on. With these data, we can regulate the greenhouse according to the best conditions for crop growth so as to improve the crop output and increase the economic efficiency. ■

Figure 3: Greenhouse Environmental Monitoring

Member Profile: University College London (UCL), UK

By Yang Yang, University College London, U.K.

University College London (UCL) was founded in 1826, the original University of London; it is the third oldest university in England, the first university in England to admit students of any race, class or religion (1826), and the first to welcome women on equal terms with men (1878).

59 Nobel laureates have passed through UCL. Specifically in Electronic and Electrical Engineering, staff and students, past and present, have contributed to a number of important scientific advances, including the invention of the telephone (Alexander Graham Bell), the invention of the thermionic valve (Sir John Ambrose Fleming), and the development of fiber optics (Charles K. Kao).

Figure 4: A Summertime View of the UCL Main Building

Apart from a member of CONET, we are also involved in several other research projects which can be seen as the natural complement to the CONET project.

1) Efficient and Reliable Wireless Communication Algorithms for Active Flow Control and Skin Friction Drag Reduction, collaboration with Airbus, 2007-2008.

As an important part of an aircraft's "nervous system", advanced wireless sensor/actuator network technologies will be used to realise active flow control and efficient reduction of skin friction drag during flight. This research project aims to develop feasible medium access control (MAC) and routing algorithms with performance guarantees in transmission delay, throughput and energy efficiency. New algorithms can guarantee timely delivery of sufficient sensed data over multi-hop wireless paths and, therefore, can be used to support distributed and centralised control approaches.

2) Static Sensor Networks for Surveillance and Monitoring Applications, collaboration with SELEX Galileo, 2007-2011.

Static sensor networks can be used to improve autonomous surveillance and monitoring of rural and urban environments. Such networks usually consist of a large number of sensor nodes and operate in hostile environments, such as battlefield and toxic regions, so the exact sensor locations have to be controlled by optimised sensor deployment strategies to avoid coverage holes, which potentially degrade sensing performance. This project is focused on sensor deployment, heterogeneous data collection and fusion under information uncertainties and communication constraints, while obeying monitoring and tracking mission requirements.

3) Data Fusion and Sensor Web Enablement (SWE) Technologies for Supporting Different Wireless Sensor Network Applications, collaboration with British Telecom, 2007-2011.

Considerable business benefits will be realised by developing and deploying intelligent sensor networks. In the OGC's (Open Geospatial Consortium) Sensor Web Enablement (SWE) activities, members are defining, testing, and documenting a consistent framework of open standards for exploiting web-connected virtual sensors and sensor systems of any type in the physical world. Excessive data collected from data rich environments may be unrelated, irrelevant or difficult to place in time and space and therefore meaningless or impossible to analyse. So the challenge is to corroborate the data captured from several isolated sensors. Moreover, it is imperative that sensors work in unison to correlate data and to identify distinct behavioural patterns (i.e. feature detection). This research project is being performed in conjunction with the research work on past, present and future Sensor Networks Group projects at British Telecom. Specifically, this research will focus on the role of networked sensing with a particular emphasis on data capture methods in data rich environments. We will also examine the trade-off between data analysis versus network performance requirements.

4) WIDAGATE: Wireless Data Acquisition in Gas Turbine Engine Testing, collaboration with Rolls-Royce and SELEX, 2008-2011.

This project aims to develop the capability required for deploying large-scale wireless sensor networks for data gathering during gas turbine engine testing. Currently, engine testing, requiring measurements of thousands of spatio-temporal parameter values, uses wired sensors connected via a cabling harness to remote condition-monitoring units. Such data acquisition requires many kilometres of wiring, involves long and expensive setup and instrumentation times and hinders efficient time-to-market. We aim to mitigate these limitations by adopting wireless sensors. We will develop and integrate practical technologies to resolve the challenges of deploying wireless sensors for data gathering in the harsh, dynamic and inaccessible environment of gas turbines involving high-speed rotations, rapid airflows, high temperatures and large amplitude vibrations.

5) Cognitive and Intelligent Wireless Networks*, collaboration with Toshiba, 2008-2011.*

This research project is focused on the development of future intelligent self-configuring wireless networks. We will apply cognitive radio, machine learning, and biological inspired techniques to enable wireless networks have the capability of learning, reasoning, analysing and adjusting system parameters across different network layers, thus achieving network self-organisation and optimal system performance.

Finally, we are proud of being a member of CONET, and will continue the excellent reputation of UCL in it. ■

Coffee: A Small and Efficient File System for Sensor Networks

By SICS

1. Motivations

Wireless sensor networks measure physical parameters such as temperature, humidity, noise or vibrations. In most of the early deployments of wireless sensor networks the sensor nodes sent the measured data directly towards the sink for processing. Recently, there has been a growing interested in storage-centric sensor networks where the sensor nodes store data before transmitting them, often in batches. This paradigm is called storage-centric networking[1]. Storage-centric networking is in many cases more energy efficient than its communication-centric counterpart. Furthermore, in many scenarios it is the only possibility, e.g. when mobile sensor node are only sporadically in contact with a collection station. An efficient file system that provides storage abstractions makes storage-centric sensor networking applications more portable and simpler to develop since the focus can be on the higher level design, instead of on the low level flash memory management.

Towards this end, the Coffee File System[2] has been developed as part of a research project at SICS to explore whether flash file systems for sensor devices needed to be as complex as they currently were. The most popular design method

[1] L. Luo, C. Huand, T. Abdelzaher, and J. Stankovic, *EnviroStore: A cooperative storage system for disconnected operation in sensor networks*, in Proc. of the 26th Int. Conf. on Computer Communications (INFOCOM), 2007.

[2] Tsiftes, Nicolas and Dunkels, Adam and He, Zhitao and Voigt, Thiemo (2009) *Enabling Large-Scale Storage in Sensor Networks with the Coffee File System.* In: The 8th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), 13-16 Apr 2009, San Francisco, California, USA.

for flash file systems, log structuring, had become prevalent also in sensor networks. The problem is that such file systems must store extensive meta-data to maintain an acceptable performance. Typically, their RAM footprint grows linearly with the file size. This is an issue when sensor nodes must use multiple large files. Furthermore, previous designs are in general device-specific, which limits their usability in heterogeneous sensor networks.

2. Design

Coffee implements a set of generic file system operations using considerably less program memory and RAM than earlier file systems for sensor networks. The small size stems from its novel design of the stored file structure. Instead of storing all changes to the file system in a spanning log structure as log-structured file systems do, Coffee distinguishes between file appends and file modifications. All files are originally stored in append-only segments that are pre-allocated with a certain size, but able to grow dynamically. In order to handle modifications efficiently, Coffee introduces the concept of micro logs. Essentially, micro logs are small files that contain information about the most recent modifications of a regular file. Micro logs are stored as regular files, but are inaccessible to users of the file system.

Unlike the traditional log-structure method, micro logs do not require any metadata in RAM. Another advantage is that each micro log can be tuned for the expected access pattern for an individual file. Coffee's programming interface allows each file to be configured for the optimal log record size and log size. The log record size configuration is limited to storage devices that allow random access writes. Consider a routing table with fixed size entries or a packet queue where we know the maximum packet size. Conventional log structures perform poorly in these cases since the log record size is constant.

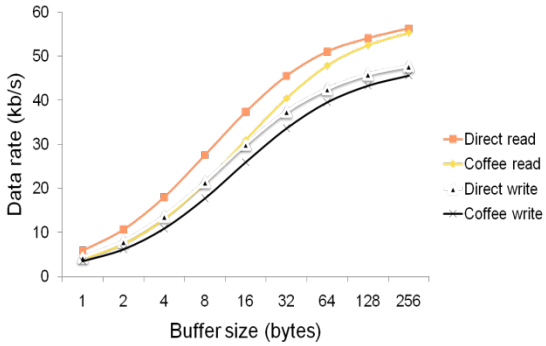

Figure 5: Performance and Memory Footprint

The figure above shows Coffee's performance: Coffee's performance overhead of sequential writes compared to direct flash access is negligible. Small buffers cause a higher processor execution cost per byte. The figure is plotted on a lin-log scale.

Coffee's memory footprint is very low compared to previous solutions. The static RAM footprint of Coffee is constantly smaller than 200 bytes. The Coffee code is around 5 KB and hence occupies approximately 10% of the total code ROM on a Tmote Sky whereas previous file system such as Matchbox had a ROM footprint of around 20 KB.[3]

3. Availability

Coffee is part of the Contiki operating system. It was initially designed for the Tmote Sky platform that features an ST M25P80 external flash module of 1MB that is accessed through a 75MHz serial peripheral interface (SPI) bus. We are also porting Coffee to SD cards. Furthermore, the COOJA/MSPSim simulator also emulates the Tmote Sky's external flash so that applications that use Coffee to access the external flash can be simulated in detail. Researchers outside SICS are currently porting Coffee among others to the Atmel Raven's EEPROM and to micro SD cards.

The Coffee source code is available as part of the Contiki operating system at:

http://www.sics.se/contiki/ ■

[3] H. Dai, Michael N., and R. Han. *Elf: an efficient log-structured flash file system for micro sensor nodes*. In Proceedings of ACM SenSys'04, Baltimore, MD, USA, November 2004.

Announcements

2010 5th International Symposium on Wireless Pervasive Computing (ISWPC)

05 May - 07 May 2010, Modena, Italy

ⓘ http://www.iswpc.org/2010/

Important dates:
Abstract Submission Deadline: 25 Jan 2010
Acceptance Notification: Mar 1, 2010
Final Paper Submission Deadline: 25 Mar 2010

2010 International Symposium on Computer, Communication, Control and Automation (3CA)

May 5-7, 2010 Tainan,Taiwan

ⓘ http://www.ieee3ca.org

Important dates:
Invited Session Proposals Due: January 15, 2010
Paper Submission Due: February 1, 2010
Notification of Acceptance: March 1, 2010
Camera-Ready Paper Due: March 31, 2010

2010 2nd International Workshop on Security and Communication Networks (IWSCN)

26 May - 28 May 2010 Karlstad, Sweden

ⓘ http://www.cs.kau.se/iwscn2010/

Important dates:
Paper submission deadline: February 19, 2010
Paper acceptance or rejection: April 6, 2010
Camera ready submission deadline and registration: April 30, 2010

2010 IEEE 18th International Workshop on Quality of Service (IWQoS)

16 Jun - 18 Jun 2010, Beijing, China

ⓘ http://www.ieee-iwqos.org

Important dates:
Paper submission deadline: Feb. 8, 2010
Notification of accept: April 5, 2010
Camera-ready papers: April 23, 2010

2010 IEEE 11th International Workshop on Signal Processing Advances in Wireless Communications (SPAWC 2010)

20 Jun - 23 Jun 2010, Marrakech, Morocco

ⓘ http://www.spawc2010.org

Important dates:
Submission deadline: February 1, 2010
Notification of acceptance: March 30, 2010
Final paper due: April 10, 2010

2010 6th International Conference on Wireless Communications, Networking and Mobile Computing (WiCOM)

23 Sep - 25 Sep 2010, Chengdu City, China

ⓘ http://www.wicom-meeting.org/2010/

Important dates:
Paper submission due: February 28, 2010
Acceptance notification: May 04, 2010

2010 6th Workshop on Hot Topics in Embedded Networked Sensors (CFP HotEmNets)

June 28-29, 2010, Killarney, Ireland

ⓘ http://www.hotemnets2010.org

Important dates:
Papers Due: February 22, 2010
Notification: April 15, 2010
Camera Ready: May 10, 2010

Latest News

- **CONET** workshop @ CPS Week 2010. This workshop is organized by **CONET** and takes place on April 12, 2010.
- The **CPS Week 2010** brings together five leading conferences – **HSCC**, **ICCPS**, **IPSN**, **LCTES**, and **RTAS** – as well as several workshops and tutorials on various aspects on the research and development of cyber-physical systems.

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