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Tutorial 1

Tutorial Title: Using Information Fusion in Wireless Sensor Networks: State-of-the-art and Challenges

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Duration: 3 hours

Abstract: Ubiquitous computers, networks and information are paving a road towards a smart world in which computational intelligence is distributed throughout the physical environment to provide trustworthy and relevant services to people. This ubiquitous intelligence will change the computing landscape because it will enable new breeds of applications and systems to be developed; the realm of computing possibilities will be significantly extended. By embedding computational intelligence in everyday objects, our workplaces, our homes and even ourselves, many tasks and processes could be simplified, made more efficient, safer and more enjoyable. Ubiquitous computing, or pervasive computing, composes these many wireless devices to create the environments that underpin the smart world.

In this scenario, the fast growth in wireless sensors and actuators have the potential to create a global computing infrastructure that is profoundly changing the way people live and work. People may interact with themselves, the physical world, and information services using a wide range of sensor devices connected together, enabling computing and communication at an unprecedented scale and density. This new infrastructure presents a number of challenges especially when it comes to data-intensive applications: enormous scale, different types of data, data processing and management, varying and intermittent connectivity, location dependence and context awareness, limited bandwidth and power capacity, small device size, and multimedia delivery across different networks.

A possible solution to overcome these challenges is to embed the pervasive environment with information fusion techniques. Briefly, information fusion comprises theories, tools, and algorithms used to process several sources of information generating an output that is, in some sense, better than the individual sources. The proper meaning of “better” depends on the application. In wireless sensor networks, which have a very important role in pervasive computing, “better” has at least two meanings: cheaper and more accurate. Information fusion involves several different areas, such as control, robotics, statistics, computer vision, geosciences and remote sensing, artificial intelligence, and digital image/signal processing.

This tutorial will present a perspective on information fusion to be employed in wireless sensor networks. The goal is to present the different aspects (theories, tools, and algorithms) of information fusion considering a data management perspective.

Motivation, target audience, and interest for the EWSN community

The motivation to present this tutorial comes from the interest in the recent evolution of computing paradigms, starting with mobile computing, and pervasive computing, including the important aspect of information fusion and the different fields that are involved such as distributed computing, networking, and

data management, which are areas of interest to the EWSN community.

The theme of this tutorial will be covered in an introductory/intermediate level. Thus, there is no need of a previous knowledge to understand the main topics to be discussed. Graduate students and other professionals interested in the application of the concept of information fusion to pervasive computing can benefit from this tutorial.

Outline: This tutorial will cover the following topics:

- Introduction to information fusion and wireless sensor networks: Presents an overview of how information fusion can be applied to wireless sensor networks.
- Fundamentals: Discusses common terms and factors that motivate and encourage the practical use of information fusion in WSNs.
- Methods, techniques, and algorithms: Classifies methods, techniques and algorithms based on several criteria, such as the data abstraction level, purpose, parameters, type of data, and mathematical foundation.
- Information fusion classification: Discusses how information fusion can be categorized based on several aspects.
- Architectures and models: Describes architectures and models that have been proposed to serve as guidelines to design information fusion systems considering a data management perspective.
- Case studies: Presents some case studies showing how information fusion can be applied to pervasive computing.
- Research agenda for information fusion in wireless sensor networks: Presents some research topics related to information fusion in wireless sensor networks.
- Conclusions: Presents a discussion about this theme and its importance to wireless sensor networks.

About the authors / presenters:

Eduardo F. Nakamura is an Assistant Professor of Computer Science at the Center of Research and Technological Innovation (FUCAPI), Brazil. Dr. Nakamura holds a PhD in Computer Science from the Federal University of Minas Gerais, Brazil, 2007. His research areas are ad hoc and sensor networks, ubiquitous and autonomic computing, computer networks and distributed systems. In the last 5 years, he has published regularly in international conferences and journals related to sensor networks, and also presented two tutorials (ACM SIGMOD 2008 and IEEE CIT 2008) about the use of information fusion in wireless sensor networks.

Antonio Loureiro is a Professor of Computer Science at the Federal University of Minas Gerais (UFMG), Brazil. Professor Loureiro holds a PhD in Computer Science from the University of British Columbia, Canada, 1995. His main research areas are wireless sensor networks, ubiquitous and autonomic computing, and distributed systems. In the last 10 years he has published over 100 papers in international conferences and journals. Since 1996, when he became a faculty member at UFMG, Professor Loureiro has received six times the Undergraduate Teaching Excellence Award in Computer Science.