

FAST BREAKING PAPERS - 2009

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Ian F. Akyildiz, & Tommaso Melodia talk with *ScienceWatch.com* and answer a few questions about this month's Fast Breaking Paper in the field of Computer Science.



Article Title: A survey on wireless multimedia sensor networks

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SW: Why do you think your paper is highly cited?

Our paper is the first to introduce the concept of "Wireless Multimedia Sensor Network" (WMSN) as a generalization of the notion of "Sensor Network." A multimedia sensor network can be understood as a network of wirelessly interconnected devices that are able to ubiquitously retrieve multimedia content such as video and audio streams, still images, and sensor data from the environment, fostered by the recent availability of low-cost cameras, sensors, and microphones. In addition, our paper systematically outlines the major research challenges of this new field that can potentially have a profound impact on our daily activities.

In our paper, after discussing futuristic applications of WMNSs, we analyze the state of the art in algorithms, protocols, and hardware for wireless multimedia sensor networks, and discuss open research issues in detail. Furthermore, we discuss architectures for WMSNs, along with their advantages and drawbacks. We believe that our paper is and will be an important resource for researchers interested in this field in years to come.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Our paper constitutes certainly a synthesis of knowledge, but it goes beyond that by outlining open research issues and proposing a new research area. We believe that our paper will encourage and inspire many researchers to enter this field, and the high number of citations that the paper has received so far seems to confirm this.

SW: Would you summarize the significance of your paper in layman's terms?

With rapid improvements and miniaturization in hardware, a single device can be equipped with audio and visual information collection modules. By deploying a large-scale network of such devices and by interconnecting them through wireless links, our ability to observe the physical environment can be

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greatly enhanced. For example, multimedia sensors could infer and record potentially relevant activities (thefts, car accidents, traffic violations) and make video/audio streams or reports available for future query. It will be possible to monitor car traffic in big cities or on highways and deploy services that offer traffic routing advice to avoid congestion.

Moreover, multimedia sensors may monitor the flow of vehicular traffic on highways and retrieve aggregate information such as average speed and number of cars. Sensors could also detect violations and transmit video streams to law enforcement agencies to identify the violator, or buffer images and streams in case of accidents for subsequent accident scene analysis.

Another important potential area of application of this technology is advanced health care delivery. Telemedicine sensor networks can be integrated with XG multimedia networks to provide ubiquitous health care services. Patients will carry medical sensors to monitor parameters such as body temperature, blood pressure, pulse oximetry, ECG, breathing activity, while remote medical centers will perform advanced remote monitoring of their patients via video and audio sensors, location sensors, motion or activity sensors, which can also be embedded in a wrist device.

Multimedia sensor networks can also be used to monitor and study the behavior of elderly people as a means to identify the causes of illnesses that affect them. Networks of wearable or video and audio sensors can infer emergency situations and immediately connect elderly patients with remote assistance services or with relatives.



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Tommaso Melodia*

SW: How did you become involved in this research, and were there any problems along the way?

Ian F. Akyildiz: In my research spanning the past several decades, I have always envisioned future directions where technology can be put to better use. My survey on wireless sensor networks is one of the most-cited articles in the field of networking, and I had also published several research papers on the topic of quality of service for multimedia applications.

I believed that the recent improvement in hardware platforms, the need for visual monitoring over simple plain-text data, and a growing social awareness for connectivity would be the primary forces driving multimedia research. Thus, my background and experience in this area led me to pursue the design of WMSNs, which was a challenge given the constrained operation of the devices. This, together with a great team composed by my co-authors Tommaso Melodia and Kaushik Chowdhury, led to this highly successful publication.

One of the main problems was convincing the research community in general about the feasibility of this technology. I wished to stress on the practical and implementable aspect of multimedia sensors over describing a theoretical outline. For this, the protocol design approaches and the existing hardware support needed to mutually supportive.

While writing the article we had to adapt our vision to the existing state of the art, and not merely relying on possible future node architectures. We had to often go back to the drawing board to redesign a protocol or suggest alternate paths, if there was no immediate hardware support. Moreover, this area covers a very diverse range of specializations, from coding theory, systems design, to higher layer protocols. This paper has also been a learning process for me, as I had to refer to several new concepts and ideas, not immediately connected with my current research.

SW: Where do you see your research leading in the future?

Ian F. Akyildiz: Efforts from several research areas will need to converge to develop efficient and flexible WMSNs, and this in turn, will significantly enhance our ability to interact with the physical environment. These include advances in the understanding of energy-constrained wireless communications, and the integration of advanced multimedia processing techniques in the communication process.

Another crucial issue is the development of flexible system architectures and software to allow querying the network to specify the required service (thus providing abstraction from implementation details). At the same time, it is necessary to provide the service in the most efficient way, which may be in contrast with the need for abstraction.

As sensor platforms diversify, ranging from static nodes that have restricted computational ability to sensors on vehicular networks and mobile phones, I envision the need for re-visiting classical multimedia networking. Audio and video data may originate and be communicated over diverse network

architectures between a given source and destination pair, and effectively meeting the performance constraints in such scenarios is a challenge. My research will address all the above factors that are likely influence our multimedia access in the near future.

SW: Do you foresee any social or political implications for your research?

The development of WMSNs has important implications from several perspectives. For example, it may have implications for criminal justice policy and practice. The technology has the potential to enable large-scale, low-cost deployment of unattended smart cameras and other multimedia sensors, which are able to process, correlate and fuse in real-time information from heterogeneous sources.

These systems will enhance the ability of law enforcement and correction officers to observe and monitor locations and events in an unprecedented way, since WMSNs can be enhanced with distributed processing and computer vision techniques that will allow performing sophisticated real-time data analysis to detect weapons, identify suspicious individuals, or infer potentially dangerous activities.

While this technology is likely to raise concerns from civil liberties advocates worried about the creation of a surveillance society, if properly regulated, technology for advanced surveillance can actually even be supportive of privacy interests and not simply a means to create a surveillance society.

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