



IBM Research has made significant advances in various aspects of signal processing and multimedia computing research, both in theory and practice. Some of these are fundamental breakthroughs, such as the development of the Fast Fourier Transform (FFT) algorithm by Jim Cooley, trellis-coded modulation by Gottfried Ungerboeck, constrained coding by Peter Franaszek, arithmetic coding by Jorma Rissanen, as well as quantum information theory and computation by Charles Bennett. Other advances have found practical applications within IBM's speech recognition products, ThinkPad wireless antennas, high-performance digital signal processors, digital media solutions, and devices for processing and analyzing medical signals, to name a few. In addition, IBM Research has been a leading contributor to the development of multimedia standards such as JPEG, MPEG-1, MPEG-2, and MPEG-7.

The key challenge is to design and realize a new generation of information systems in which multimedia signal processing enables a far richer capture, representation, search, retrieval, and experience of real-world activities, leading to greater personal and business productivity. IBM's research deals with the processing of various signals, including audio, video, speech, image, geophysical, sonar, radar, and medical, as well as techniques for correlating these varied signals in practical information systems.

SIGNAL PROCESSING

Fundamental research is directed at exploring new paradigms of signal processing algorithms and designing high-performance digital processors. One such new paradigm is quantum cryptography, in which information is encoded in the quantum states of single photons, and the secrecy is guaranteed by the principles of quantum mechanics rather than by physical or computational barriers. One result of this work is a research prototype for a single-photon detection module, now in use at universities, government, and corporate laboratories working on quantum cryptography and quantum information research. Another focus area is the development of new high-performance robust video compression algorithms characterized by low-power and a very low encoder complexity, to be used in deep space for remote robotic exploration or surveillance, tasks that conventional video encoding schemes cannot properly address. IBM Research has also been deeply involved with the design and manufacture of high-performance digital signal processors as exemplified by two different and customized solutions: the Vector Multimedia eXtensions (VMX) architecture, a media processing unit that is embedded in the Microsoft Xbox 360, and the Cell Broadband Engine™, with its synergistic processor unit optimized for three-dimensional graphics, Digital Signal Processing (DSP), video, and audio applications, that is to be used in the upcoming Sony PlayStation®3.



IBM Research collaborated with The Builder's Association/moti roti to create digital effects for the multimedia performance, "Alladeen." (Photo: Simone Lynn).

MULTIMEDIA INFORMATION SYSTEMS

Digital multimedia content is skyrocketing, fueled by the rapid expansion of broadband Internet connectivity and increasing interest in online multimedia-rich applications. IBM researchers are investigating fundamental issues involved in the automatic extraction of intelligent information from digital multimedia repositories. Through a combination of machine learning, signal processing, pattern recognition, database, and data mining techniques, systems are being created to extract multimodal metadata and to detect concepts that can be used to efficiently access unstructured data at a semantic level. Special attention is directed to the contextual organization of spatio-temporal information obtained from real-time capture systems. Researchers are also exploring pattern discovery techniques for detecting salient trends in multi-dimensional time series, resulting in business alerts and notifications. Another key focus is addressing the media lifecycle from capture to consumption by developing an open framework that facilitates the development of end-to-end systems and solutions.

The IBM Multimedia Search and Retrieval System enables search of immense video and image repositories using system-generated semantic labels. Shown here are the top matches for the automatic semantic labeling of a personal image archive with semantic labels "water" and "nature."