Software Technologies for Wireless Communication and Multimedia MIT2000-10

Progress Report: July 1, 2000—December 31, 2000

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Project Overview

This project is developing flexible and adaptive communications and computation systems that adapt easily to user and application requirements, which may not be know at design time, as well as to dynamically changing communication channel conditions.

Progress Through December 2000

We have developed a prototype API for an adaptable physical layer in a wireless communication system. The physical layer uses this API to provide information (e.g., power consumption, latency, available bandwidth, and bit error rate of one or more channels) to applications. Applications use the API to request changes in the physical layer (e.g., a lower bit error rate or reduced power consumption). A controller module uses a set of high level rules to determine how best to fulfill such an application request (e.g., by increasing the amount of forward error correction, changing the modulation format, using a different channel, or some combination of these actions).

We have developed physical layer algorithms for digital communication over dynamically changing channels. For transmission, a digital modulation technique, direct waveform synthesis, uses a precomputed table of samples to map discrete data for transmission into segments of a digitally modulated waveform. This technique is twenty times faster than conventional modulation techniques and can be implemented in either hardware or software.

For reception, we have developed new algorithms for channel separation and detection. Channel separation isolates a desired narrow-band signal from a wideband input signal. Typically, it requires processing proportional to the bandwidth of the input signal. Our approach uses a frequency shifting filter, with processing proportional to the bandwidth of the output signal, and random subsampling of the input signal, with processing proportional to the required output signal quality. Using this approach, wideband receivers can be scaled to wider input bandwidths. Detection recovers the original transmitted data from the channel waveform. Our approach uses a multi-threshold detector that provides a more effective balance between computation and the output confidence levels needed for efficient overall system performance. This detector is five to ten times more efficient than the full matched filter detector, depending on the required output quality and input noise levels.

Research Plan for the Next Six Months

We will continue work on “radioactive network” protocols, which controllers for adaptable physical layers in a transmitter and receiver can use to negotiate and coordinate the kinds of changes in transmission format.

We will take the technologies we have developed for high bandwidth wireless LANs and apply them to low power environments. In particular, we will construct a wireless communications infrastructure for patient monitoring in a hospital operating room. A physician’s ability to treat a patient is influenced strongly by the amount and quality of information available about the state of the patient. Current operating rooms are crowded with cables and devices, making it difficult to add new devices for collecting additional information. We seek to reduce operating room clutter by using a wireless network to connect small, low power sensors attached to (or near) the patient and processors that analyze signals from the sensors, integrate information, and present it to medical personnel. By separating sensors from information analysis and by using an integrated network, we anticipate that it will become much easier to add new sensors and processing capabilities that use data obtained from multiple sensors.