Wireless Information Network Group

at the

Worcester Polytechnic Institute

Activity Report

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PREFACE

The Electrical Engineering Department at the Worcester Polytech has a long tradition in radio communications. Perhaps our most prominent alumnus in the radio communication industry is Atwater Kent, one of the pioneers in the radio communication industry. The Electrical Engineering Department building is named after him: the Atwater Kent Laboratory. This building, originally built in 1906, is the first building in the U.S. which was used to host an Electrical Engineering Department.

Currently, a group of our faculty and graduate students have shown considerable interest in various aspects of Wireless Information Networks. The uniqueness of our group lies in the ability to investigate all issues related to wireless indoor communications. Unmatched by any other research group, in the past few years we have contributed in basic research in channel modeling and simulation, spread spectrum communications, adaptive equalization, multiple access methods, network architectures and wireless optical communications. Our group has performed numerous measurements at the Worcester Polytech campus and in particular the Atwater Kent Laboratories. As a result, it is an ideal place for performance evaluation of the new systems. Currently, we intend to expand our group to study multi-media wireless networks. The research work of our group was initially supported by GTE Laboratories and, recently, the main part was supported by the National Science Foundation with some contributions from the Raytheon Company, HP and TI. We are intending to increase our industry sponsored research activities.

PROJECTS

- Frequency domain measurement and modeling indoor radio propagations
- Time domain measurement and modeling of the indoor radio propagations
- Simulation of the indoor radio propagations
- Spread spectrum for wireless offices
- Adaptive equalization of the indoor radio channel
- Multiple access techniques for local wireless networks
- Performance evaluation of wireless office information networks
- Speech and image coding for wireless local communications
- Optical wireless indoor networks
FACILITIES

The lab. is equipped with time and frequency domain measurement systems. The main component of the frequency domain measurement system is a network analyzer (HP 8753B) which outputs a swept frequency signal and analyzes the received signal. The network analyzer is capable to measure up to 3GHz and can be updated to perform measurements up to 6GHz. The signal generated by the network analyzer is used as the input to a 45 dB transmitter RF amplifier. The output of the RF power amplifier is propagated by a dipole antenna. The signal from the receiver dipole antenna is passed through an attenuator and a series of amplifiers with a gain of 60 dB. The output of the amplifiers is returned to the network analyzer to determine the frequency response of the channel. The measured data is then read and stored by the PC controller for further analysis. The network analyzer is equipped with the Fourier transform board which provides the time domain response of the channel.

The time domain measurements are based on a fast digital scope (Tektronix 11402) with 600 MHz bandwidth. A carrier frequency of around 1 GHz is modulated by a train of narrow pulses providing 5nsec resolution for the received signal (the HP8852A pulse generator can generate pulses upto 2nsec width). The pulses are repeated every 500 ns. The modulated carrier is input to the 45 dB amplifier and the output is transmitted with a quarter-wave dipole antenna. The stationary receiver also uses a similar antenna to capture the radio signal. This is followed by a step attenuator and a low-noise high gain (≈60dB) amplifier chain. The signal is then demodulated using an envelope detector whose output is displayed on a digital storage oscilloscope coupled to a AT&T 3000 PVC with a GPIB instrument bus.

In addition, analog and digital spectrum analyzers covering the frequency range of 0-110MHz are available, as well as function generators, frequency synthesizers, analog and digital scopes, as well as standard laboratory instruments. A high quality shielded room for low-level, noise free measurements is also available. Recently, Texas Instruments has donated about 100,000 dollars equipment for DSP design which are used by the members of the group for speech and image coding projects.

RECENT PUBLICATIONS

General Tutorials:

Channel Characterization

Frequency Domain Channel Modeling and Simulation
Time Domain Modeling and Simulations


Spread Spectrum


Adaptive Equalization


Network Architectures and Multiple Access


Other Related Publications


Grad. students and their projects
1. M. Chase, Spread Spectrum Multiple Access for Indoor Radio Channels. He is currently working in Kodak Inc., Waltham, MA (he is expected to complete his Ph.D. requirements by June 1991).
2. T. A. Sexton, Adaptive Equalization of Indoor Radio Channels. He is currently working at Motorola Inc, Schaumberg, IL (completed his Ph.D. requirements on Aug. 1989).
3. R. Ganesh, Multipath Channel Characterization for Indoor Radio Channels. R. Ganesh was a Research Assistant supported by NSF (he will complete his Ph.D. requirements by June 1991). He is currently an instructor at WPI.
4. K. Zhang, Integrated Voice Data for Wireless Indoor Radio Networks. He was a Research Assistant supported by NSF (completes his Ph.D. requirements in June 1990). He is currently with Motorola Inc.- Cellular Division, Arlington Heights, IL.
5. S. J. Howard, Characterization of the Indoor Radio Propagations in Frequency Domain. He was a Raytheon fellow (completes his Ph.D. requirements by the June 1991). He is currently with Raytheon Equipment Division, Marlboro, MA.
6. A. Falsafi, Spread Spectrum for Indoor Applications. He is currently with the Digital Equipment Corporation, MA (he has started his Ph.D. program).
7. Paul Fay, Channel Simulation for Indoor Radio Channel, M.S. candidate started recently.
8. Y. Q. Wang, Wireless Networks, Ph.D. candidate started recently.
9. S. Wang, Implementation and Analysis of Wireless Optical Indoor Networks. He was originally supported by the Government of China and this year he is full-time M.S. student.

Samples of undergrad. projects
5. B. Silvester and B. Hare, Simulation of the Indoor Radio Channel, expected to complete by June 1991 (supported by NSF).
CALL FOR PAPERS
International Symposium on Personal, Indoor and Mobile Radio Communications

Programme Committee Members:
- Dr A H Aghvami
  King's College London - UK
- Dr F Ananasso
  University di Roma - Italy
- Dr H W Arnold
  Bell Comm Research - USA
- Dr K Feher
  University of California Davis - USA
- Dr D J Goodman
  Rutgers The State University - USA
- Dr S Kato
  NTT Radio Comm Syst Labs - Japan
- Dr A D Kucar
  Bell-Northern Research - Canada
- Dr T Mathiopoulos
  University of Br Columbia - Canada
- Dr P J McLane
  Queen's University - Canada
- Dr K Pahlavan
  Worcester Polytechnic Inst - USA
- Dr R Prasad
  Delft University of Technology - The Netherlands
- Dr R S Swain
  Dr Telecom Research Labs - UK

Local Arrangements:
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King's College - University of London
23rd-24th September 1991

The Symposium is being organized by the COM/SP Chapter of the UK & RI Section of IEEE. Papers describing research, development and new concepts are invited for technical sessions. The following topics are suggested but not limited to:

- state-of-the-art future technology
- experiments, trials and services
- performance studies
- user considerations
- coding and modulation techniques
- spread spectrum techniques
- signal processing applications
- antennas and RF subsystems
- equalization and diversity techniques
- multiple access techniques
- propagation study results
- novel network architectures
- land-mobile satellite communications

Those wishing to offer a contribution should submit three copies of the full typescripts of not more than 5 A4 papers before 1st April 1991 to:

Europe & Middle East Submissions
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Requests for further information should be sent to Dr Aghvami.
The IEEE Workshop on Wireless Local Area Networks at the Worcester Polytechnic Institute Worcester, MA May 9–10, 1991

The workshop is sponsored by the Wireless Information Networks Group at WPI, the IEEE Communications Society and WINDATA Inc., Northboro, MA. It is organized to follow the IEEE 802.11 standardization meeting for Wireless Access Methods and Physical Layer Specifications, for local and wide area networks.

PROGRAM

May 9 : Tutorial: Wireless Office Information Networks
Principles of radio channel modeling and digital communications over fading multipath channels as applied to indoor radio environments. Data rate limitations. Adaptive equalization and diversity combining techniques. Spread spectrum systems for wireless offices. Potentials for wireless optical systems.

May 10 : Invited Lectures:

- LANs: past and future
- FCC Regulations
- View of portable and mobile community
- Indoor radio channel characteristics
- Spread spectrum
- Adaptive antenna arrays
- Adaptive equalization
- User’s panel

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