Portable Software-Defined Radio

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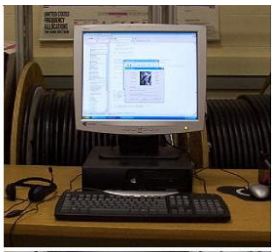
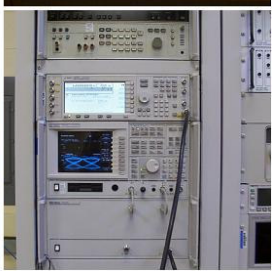




Description of Graphic Image:

The images illustrate the software-defined radio with baseband processing implemented on general-purpose PCs. Left: Host PC of the baseband receiver. The oscilloscope indicates the processing cycles through a serial-port probe. Top-right: Host PC of the baseband transmitter. Bottom-right: Agilent instruments that can be used as the RF front-end.

Project Description and Outcome

Ideas:

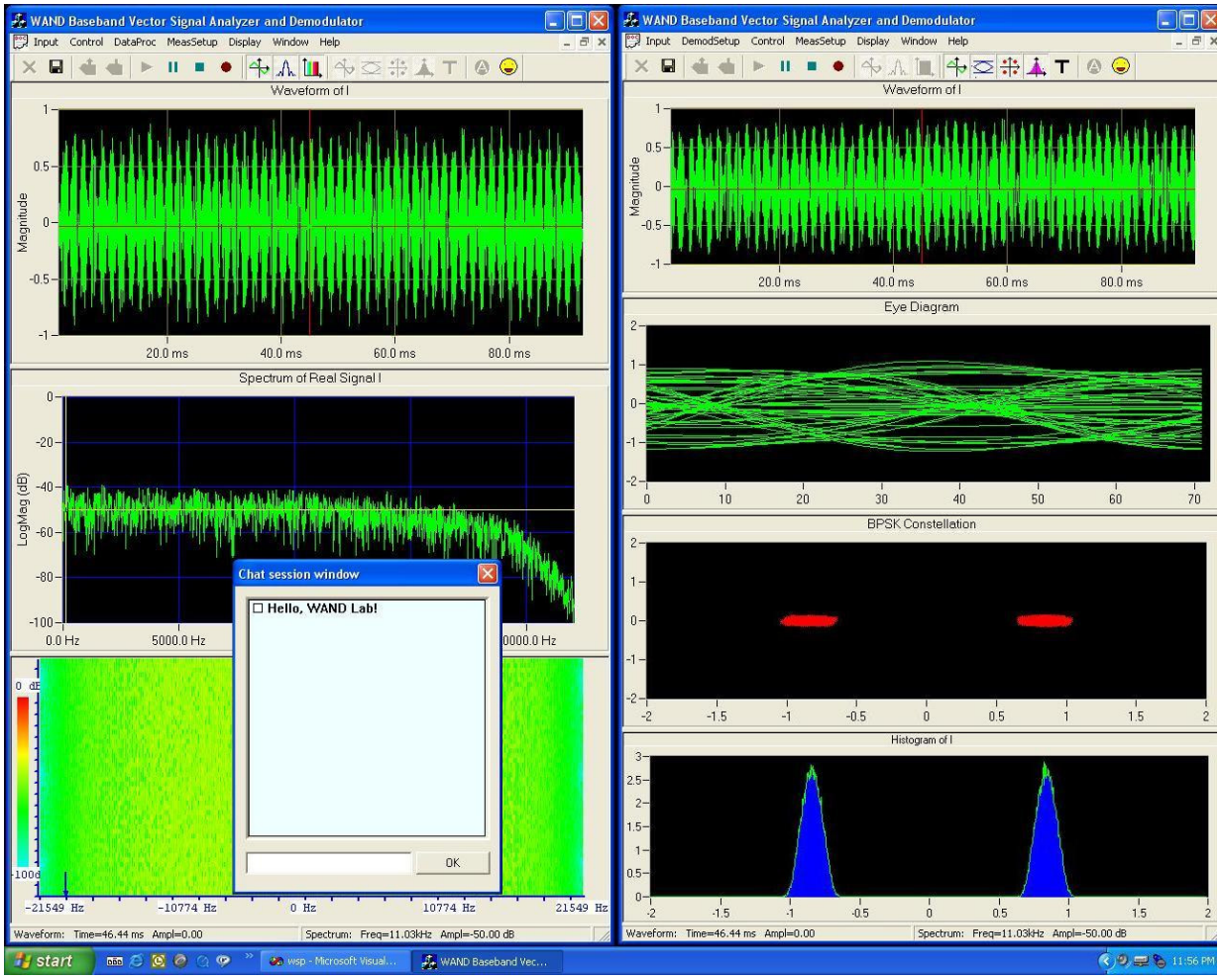
This project is developing a software-defined radio that implements the intensive baseband signal processing on general-purpose processors. As the wireless systems are migrating to new generations with multiple standards, software-defined radio brings flexibility and reconfigurability. It also enables the system to dynamically adapt to changes on the environment, network traffic or user requirements. The software-defined radio in this project is a portable technology that can be easily moved from one host machine to another. All the real-time processing functions are programmed into high-level code rather than code that is specific for a target chip such as a digital signal processor (DSP) or a field-programmable gate array (FPGA). Computationally efficient algorithms for baseband processing, including carrier and timing recovery, digital filtering, coding and modulation, are developed to minimize the consumption of CPU resources.

This project also has a strong emphasis on engineering education, since the software-defined radio can be implemented in any standard computer along with a radio-frequency front-end and an analog-to-digital converter. Without the requirement of wideband digitalization, the computer sound card is programmed as the analog-to-digital converter. Therefore, a standard computer can be readily used as a vector signal analyzer or an analog/digital demodulator.

Tools:

This project is establishing a communications testbed at the Wireless at Notre Dame (WAND) laboratory. The baseband transceiver of the testbed is compiled with C++ on general-purpose PCs running on Windows operating system. For narrowband signals, the stereo sound card is programmed to function as the analog-to-digital converter.

1). This software-defined communication testbed has sophisticated displays that show the frequency analysis of the signals and various stages of data processing in real-time. It also has probes that indicate the resource usage of the code. 2). The software transmitter and receiver provide a platform that new coding, modulation and equalization techniques can be easily implemented and tested. 3). The testbed can demonstrate basic communications through applications such as file transfer, text messaging, voice communication, etc. These demonstrations along with the bit-error-rate measurement capability can depict the performance improvement achieved by new algorithms.



Description of Graphic Image:

This image is a screen print of the receiver user interface. The left half displays the the received signal waveform (I component of the complex signal), spectrum, and spectrogram. The right half displays the signal waveform, eye diagram, constellation, and histogram of the BPSK modulated signal. The “chat box” demonstrates a communication application which receives a message from the transmitter.