CAMP CAEN

INTRODUCTION TO WIRELESS COMMUNICATIONS' CAMP

SUMMER 2010

INTRODUCTION:

In the summer of 2010 a CAMP CAEN course was offered at the University of Michigan to high school students The goal of the 'Introduction to wireless communications' camp was to impart to the students the basic concepts of electrical engineering with a focus on wireless communications systems. The course was offered as a new Camp CAEN course. Paul Chowdhry, Dr. Kurt Metzger, Divya Paul, Professor Wayne Stark, and Dr. Chih-Wei Wang comprised the group involved in developing and delivering the

course. The duration of the camp was 06/21/10 through 07/02/10 and it was taught in the EECS showcase lab. There were 9 students enrolled in the course.

COURSE DETAILS:

The material covered each day is listed out below:

Day 1: SINE WAVES AND MATLAB

- Outline of course
- Wireless devices
- Signal received by a discone antenna viewed on a spectrum analyzer
- Sine waves, Complex numbers, Phase shift
- Introduction to MATLAB, Generation of commonly used waveforms
- Frequency, Fourier Series, Frequency mixing
- Plot the spectrum of a signal using FFT in MATLAB

Day 2: BASIC CIRCUIT ELEMENTS

- Charge, Current, Voltage, Resistors, Capacitors, Inductors, Transformers, Diodes (LEDs)
- Lab Safety
- How to use lab equipment
- Experiments to measure voltage, current and resistance using a multimeter
- Built RC, RL, RCL, and diode circuits
- Used Labview's VI to view the Bode plot of the transfer function of the filters
- Demonstration of a filter with feedback using the filter board, microphone and speaker

Day 3: TRANSISTORS AND OPERATIONAL AMPLIFIERS

- History of communications - Demonstration of a simple battery, electroscope and spark gap generator by Professor Kim Winick
- Understanding a transistor
- MOSFET as a switch – built the circuit
- Transistors as amplifiers – built the circuit
- Semiconductor device physics
- CMOS technology
- Op amp as a differential amplifier,comparator
- Op amp circuits with negative feedback - Non-inverting and inverting amplifier – built the circuits
- Active filters – low pass, high pass, bandpass , Sallen-Key filter – built the circuits
- Op amp oscillator, summing circuit – built the circuits

Day 4: DIGITAL SYSTEMS

- Sampling, Sampling theorem, Quantization

- Digital signal processing
- Number Systems
- Fixed point, Floating point representation, Negative numbers, 2's complement, Q notation, subtraction
- Logic gates
- Combinational circuits – Majority voter
- Introduction to Quartus and implementation of the majority voter circuit

Day 5: DIGITAL SYSTEMS

- Full adder and implementation in Quartus
- Ripple carry Add/Subtract and implementation in Quartus
- Latches, Flip flops and counters
- Implementation of a divide by 4 counter in Quartus
- Cross correlation and M- Sequences – implementation in MATLAB and Quartus

Day 6: IQ MODULATION AND C PROGRAMMING

- GPS – Gold code, generation in MATLAB
- IQ modulation – theory and simulation in MATLAB
- Amplitude modulation
- C tutorial using Microsoft Visual Studio – simple programs

Day 7: DSP

- Introduction to DSP
- About the TMS320F28335 microcontroller
- Using Code Composer Studio
- Hello world and blinking LED in DSP
- Sine table waveform generator

Day 8: DSP

- M sequence generator and correlator in C
- Connected the DAC on transmitter side to the ADC on receiver side and sent out an M sequence and performed correlation at receiver
- Connected the DAC of transmitter to the IQ board and connected the IQ board at the receiver to the ADC. Sent out an M sequence to the I input of the IQ board and correlated at the receiver.
- Data is transmitted

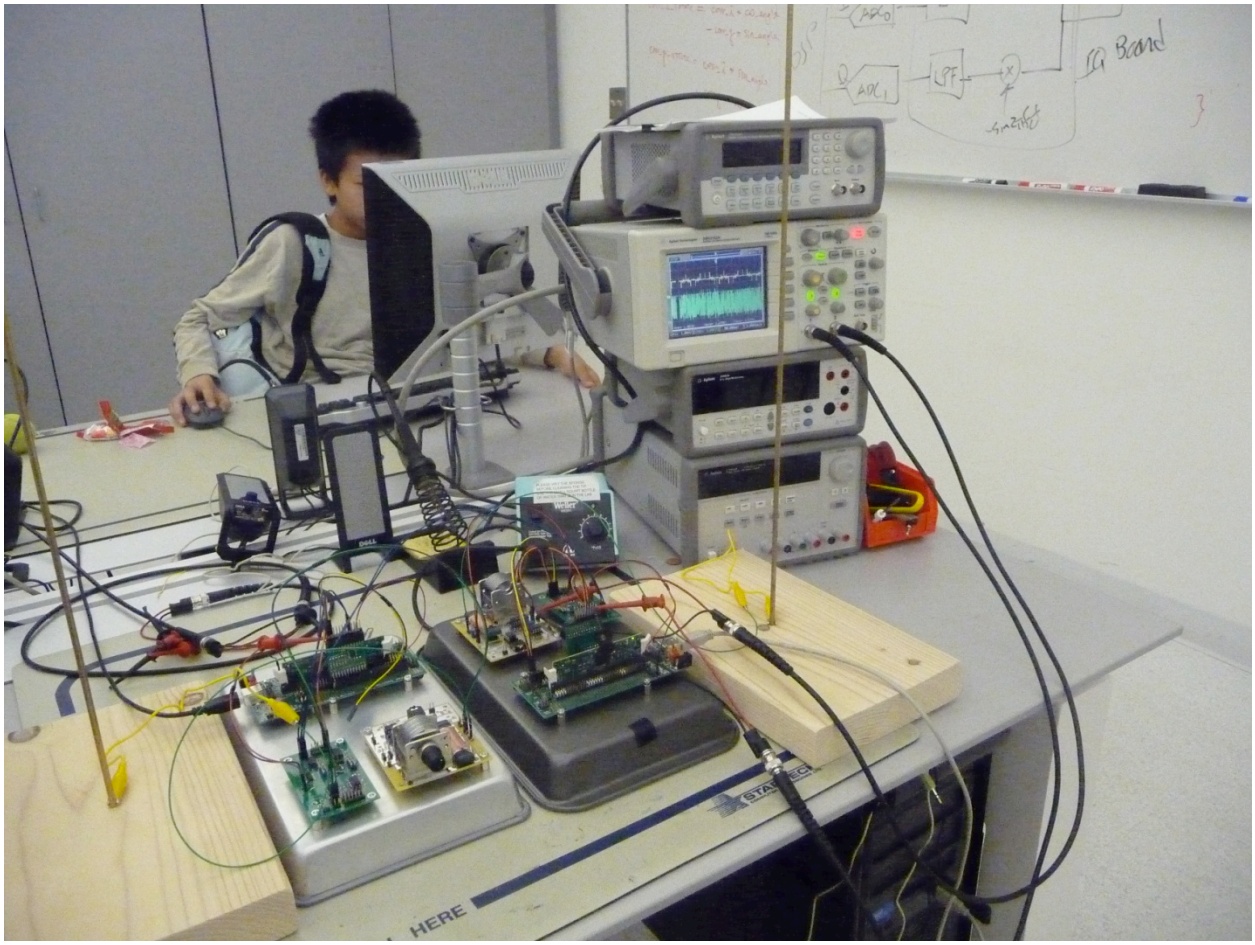
Day 9: DSP

- Transmit M sequences wirelessly (clock synchronization of the boards removed) and phase rotation is corrected at the receiver

- Transmit 2 M sequences wirelessly and perform correlation at the receiver to identify the transmitted sequence

Day 10: DSP

- Wireless transmission of a text message
- Demonstration of wireless transmission to the parents



CONCLUSION:

The students gained significant knowledge in the two weeks of attending the camp. They learned basic wireless communications concepts and applied it in the circuits they built and the simulations they performed. In addition, they learned C programming language, how to use C with Code Composer Studio to program a DSP, and MATLAB. The students were given the opportunity to apply all the theory they were taught and this helped to reinforce concepts.