6.111 Final Project Presentation: Wireless EKG Analyzer

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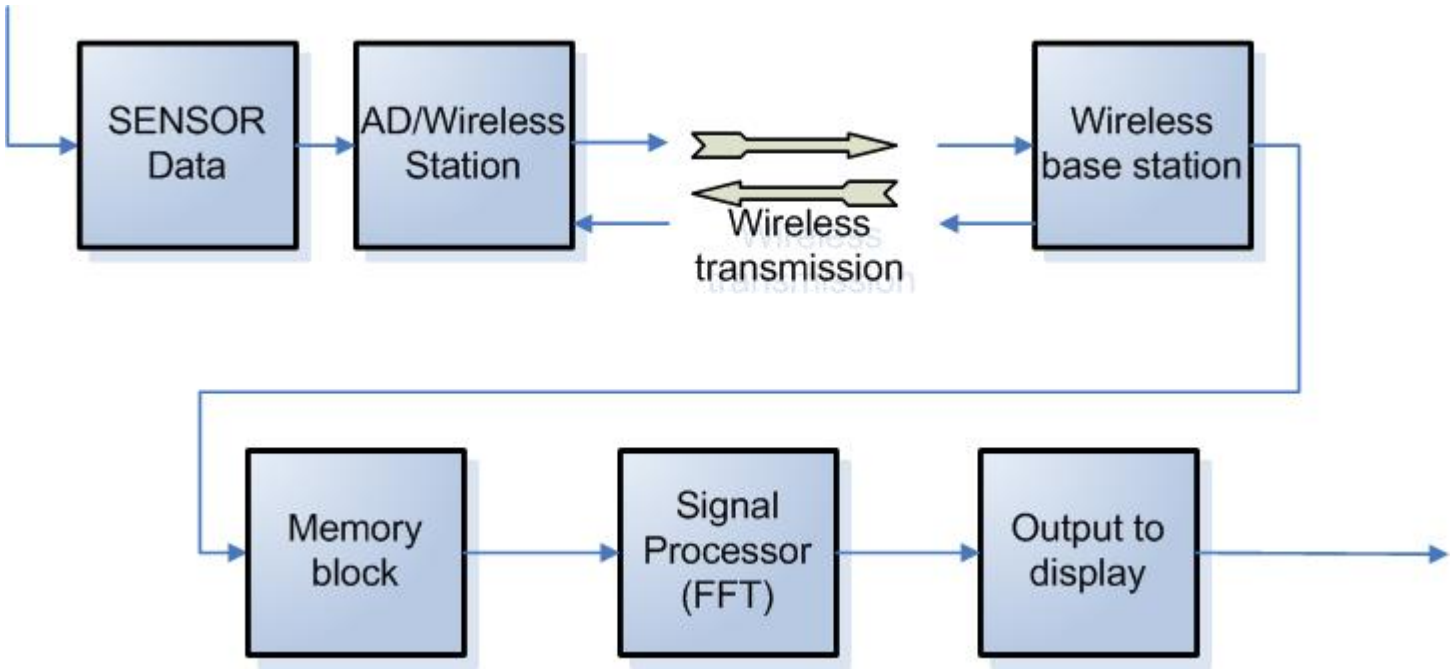
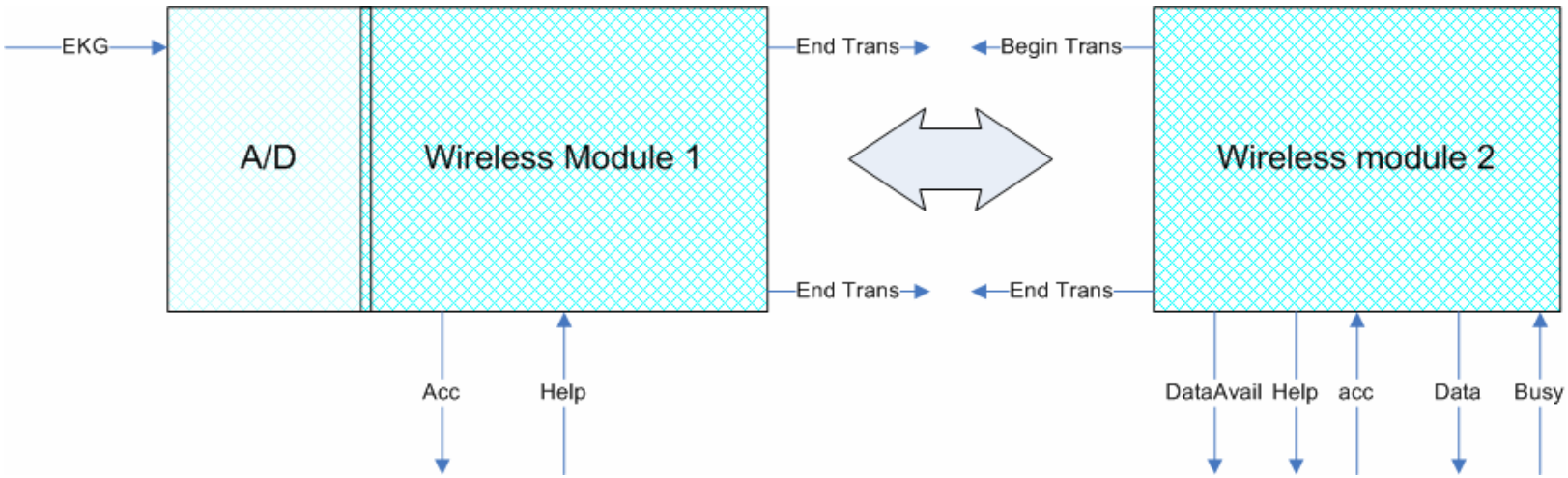
Motivation

- Remote monitoring of vital signs in patients by wireless transmission of useful data
- Analog inputs of system are medical sensors:
  - In our case, EKG: Electrocardiogram: electrical recording of the heart
  - Another possibility, Digital Stethoscope: supervising of breathing patterns

System Architecture



Wireless transmission



- Transmits 10 bit EKG Data from 1 to 2, sampled using on board ADC
- Transmits Help signal (button) from 1 to 2
- Transmits Acc signal (button) from 2 to 1
- Outputs dataavail when data is ready, help when help signal is activated, and 10 bit data to FFT module

FFT – Fast Fourier Transform

- Why? Signal in frequency domain - in order to do spectral analysis
- DFT – equally spaced samples of DTFT
- FFT – for powers of 2 number of samples

$$A_k = \sum_{n=0}^{N-1} W_N^{kn} a_n \qquad \text{where} \qquad W_N = e^{-i\frac{2\pi}{N}}$$

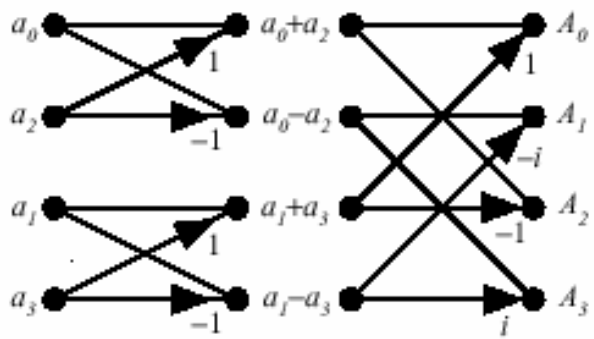
and W_N are the roots of unity in the unit circle

FFT – How it works

- Use divide and conquer
- For 2 points: $A_k = \sum_{n=0}^{1} (-1)^{kn} a_n = (-1)^{k\cdot 0} a_0 + (-1)^{k\cdot 1} a_1 = a_0 + (-1)^k a_1$

$$A_0 = a_0 + a_1$$
$$A_1 = a_0 - a_1$$

- For 4, pre-compute the pairs and add them

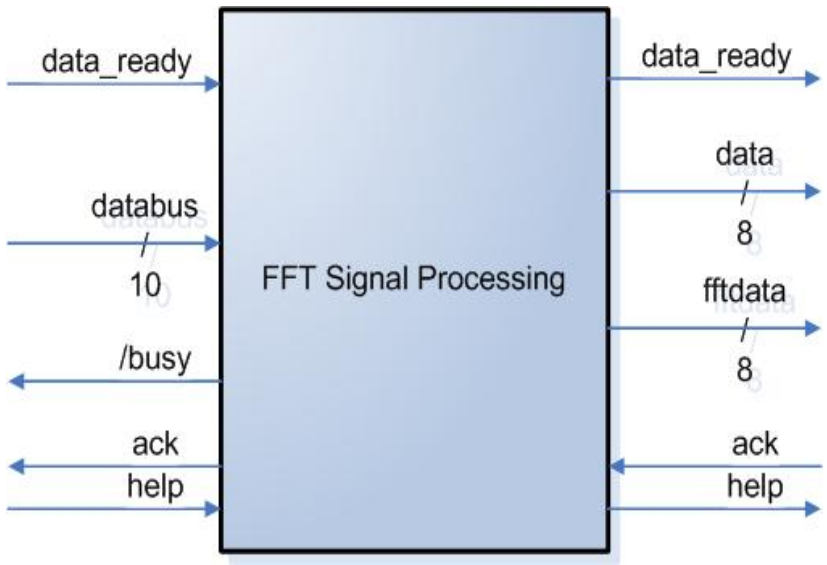


FFT Algorithm

- Use algorithm from “Numerical Analysis” by Burden and Faires
- Basically, two separate loops: one to pre-compute the pairs and add, and one to move to correct coefficient order
- Controlled by a major FSM which stores the data in memory and interfaces with other system components
- Individual FSM for each separate loop that controls the behavior of the algorithm

FFT – Interface with system

- Receives ready signal and 10-bit sample data from wireless base station. Sends a /busy signal to the base station
- Sends a data ready signal to the output display, along with two data buses: one with the input sample, and one with its FFT computed
- Also passes help/acknowledged signals between sensor and display



Display

- Receives and displays Original EKG data and Power spectrum (FFT data)
- Displays using MC6847 low resolution in color EKG data traced scope-like, FFT data refreshed and displayed
- Serial Data transfer accomplish by Data available