FPGA Base Image Registration

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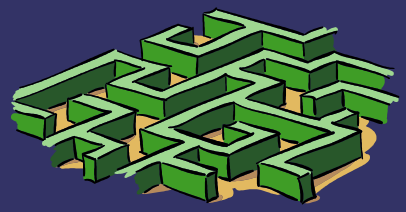
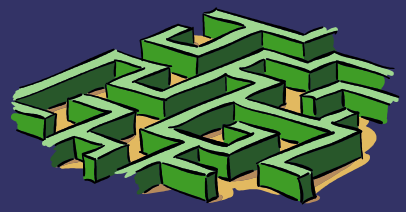
4-30-09



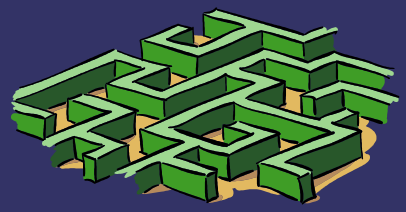
Overview

- Problem Statement
- Theory
- FPGA Discussion
- Hardware
- Software
- Matlab
- Progress
- Conclusion/Questions



Problem Statement

- Hyperspectral Images are translated and rotated relative to each other
- Images need to be aligned with a reference image (possibly middle image)
- Once registered, a hyperspectral cube can be created



Theory

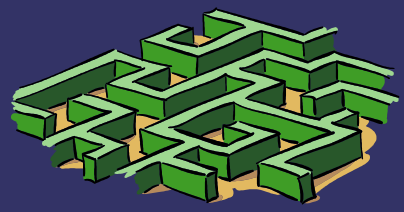
- Fourier Base Image CoRegistration

R = *F{a}*conj(*F{b}*)

normalize R

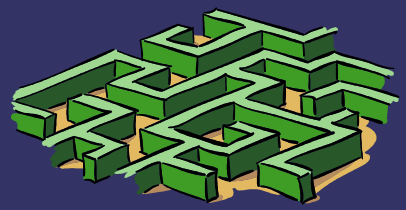
r = *F^-1{R}*

locate peak value in |r|



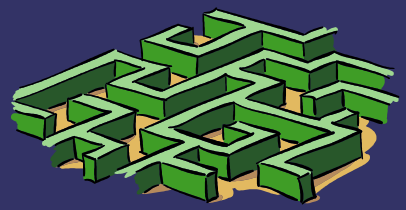
Theory

- Fast Fourier Transform
  - O(N*Log(N)) for 1D
  - Trades complexity for efficiency
  - Removes redundant computation
  - Divide and Conquer
  - Radix-2 or Radix-4
  - Decimation in time or frequency



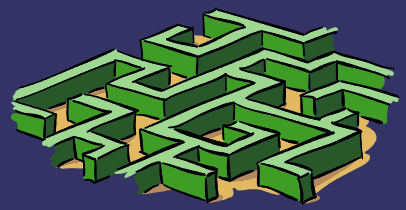
FPGA Discussion

- Field Programmable Gate Array (FPGA
  - Provides SoC solutions
  - Quick prototyping
  - IP reuse
  - Hardware Software Codesign
- Manufacturers
  - Xilinx
  - Actel

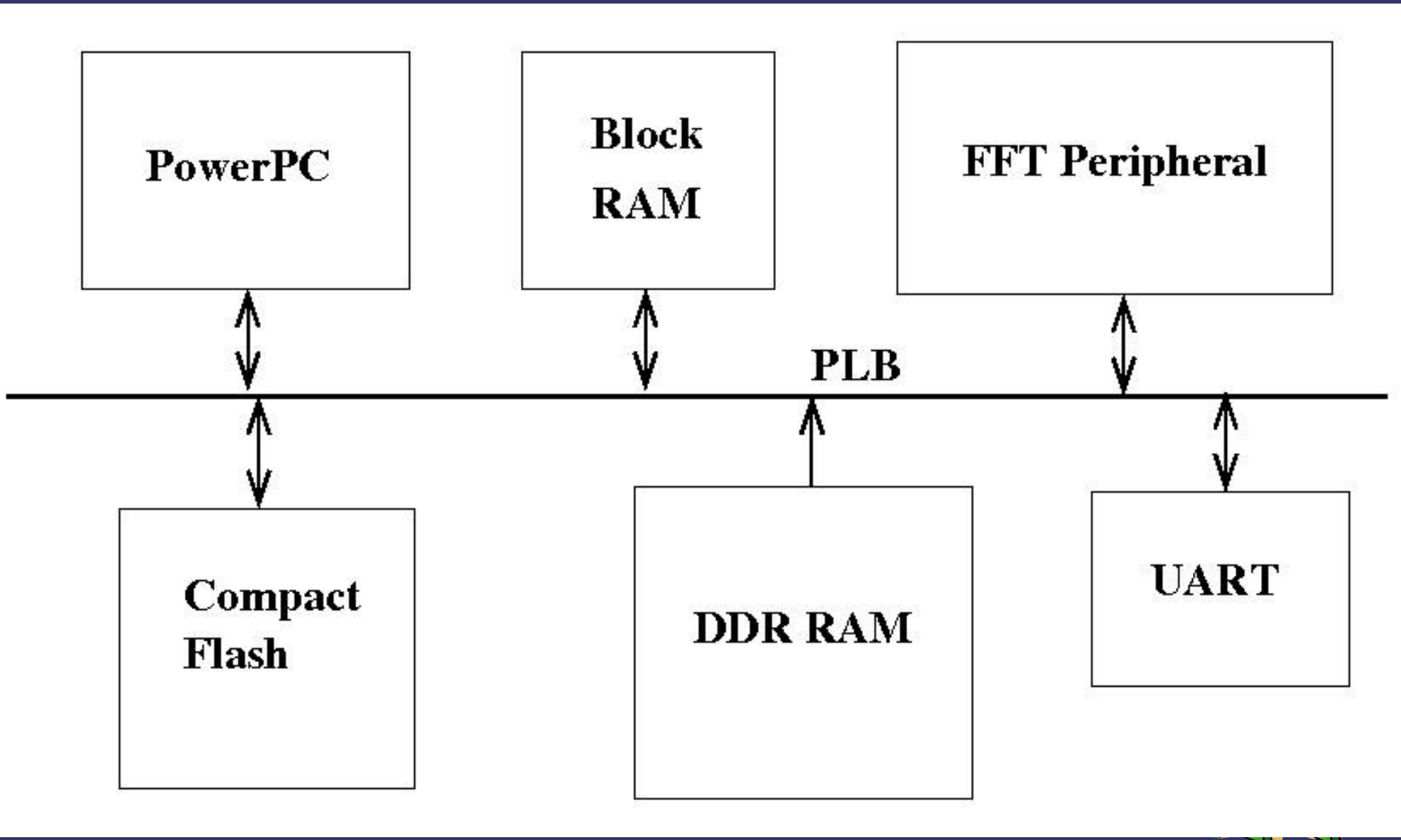


Hardware

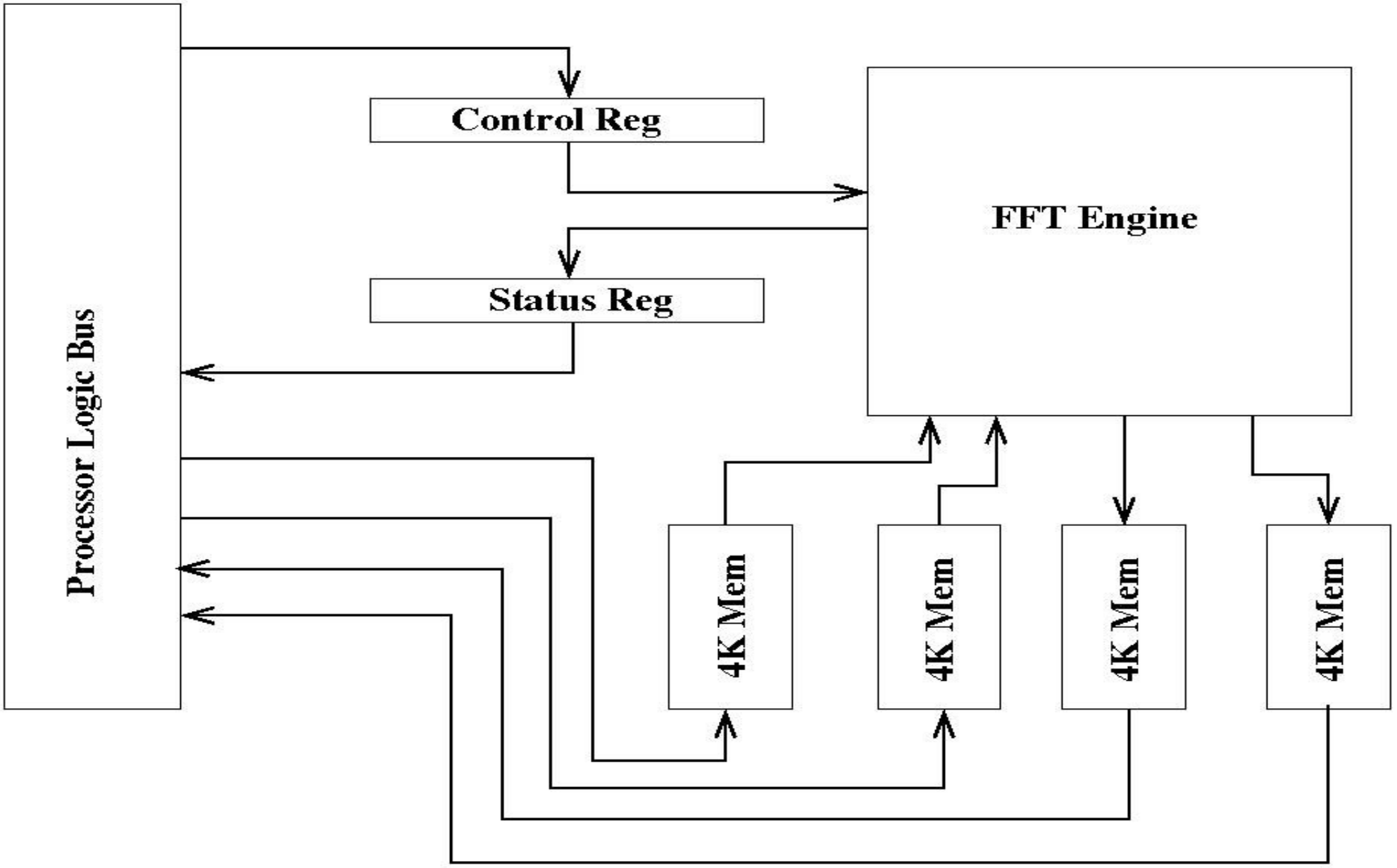
- Necessary HW for registration
  - RAM (lots of it!)
  - Microprocessor (32-bit)
  - Mass Storage (Compact Flash)
  - User IO (UART and STDLIB)
  - FFT peripheral (hardware acceleration)



System Level View

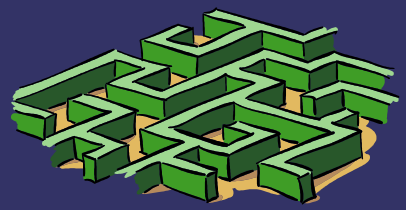


FFT Peripheral

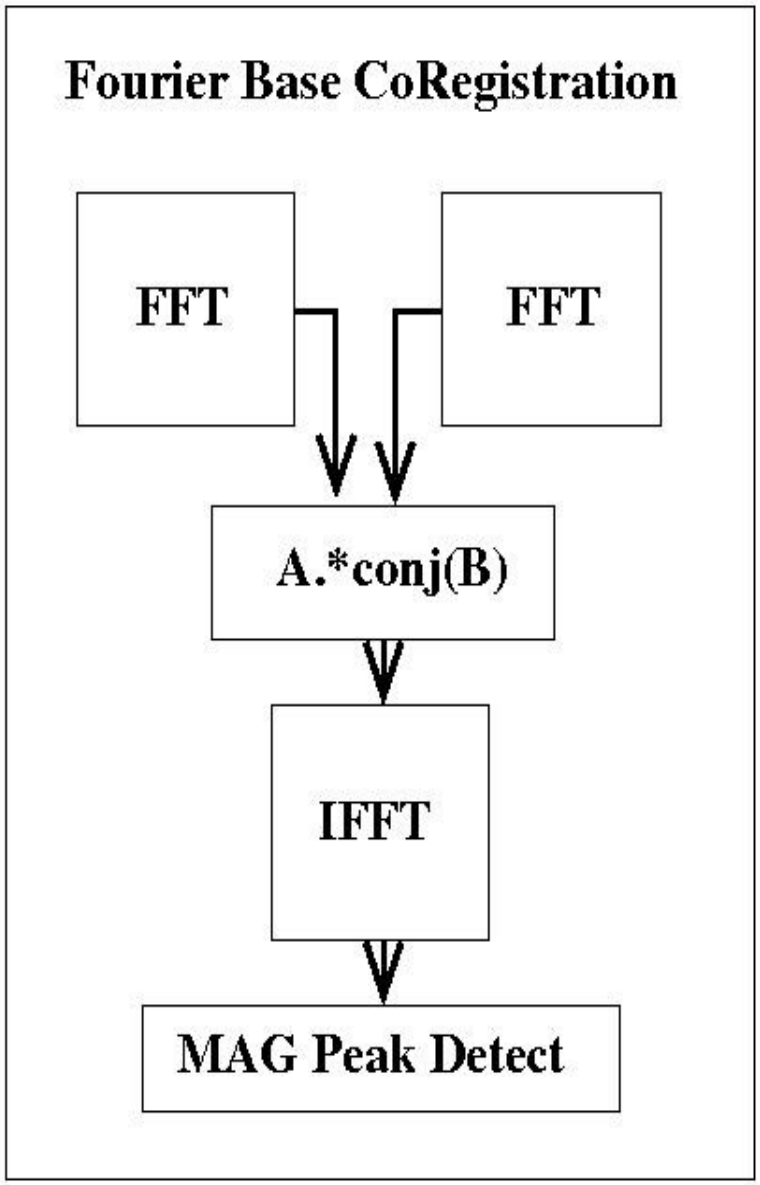


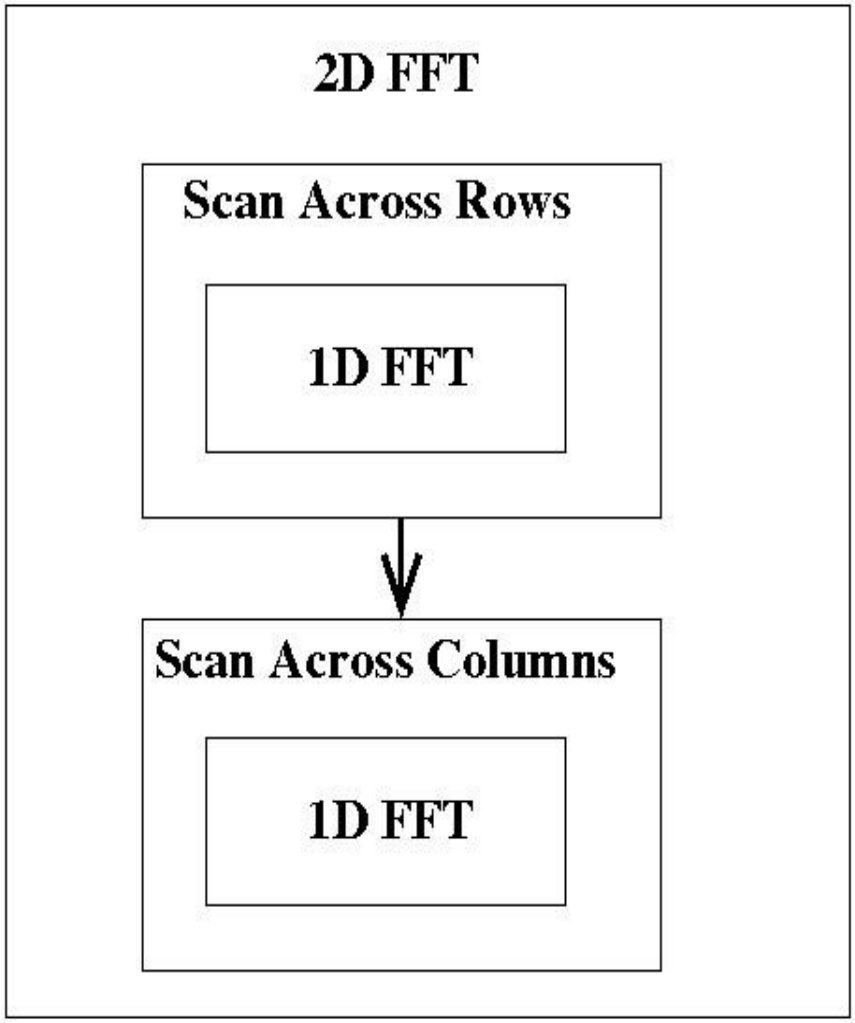
Software

- FFT peripheral Drivers
- UART Drivers (provided :( )
- Compact Flash Drivers (provided sort of...)
- Memory management (malloc and free)
- 2D FFT/IFFT
- Complex computation

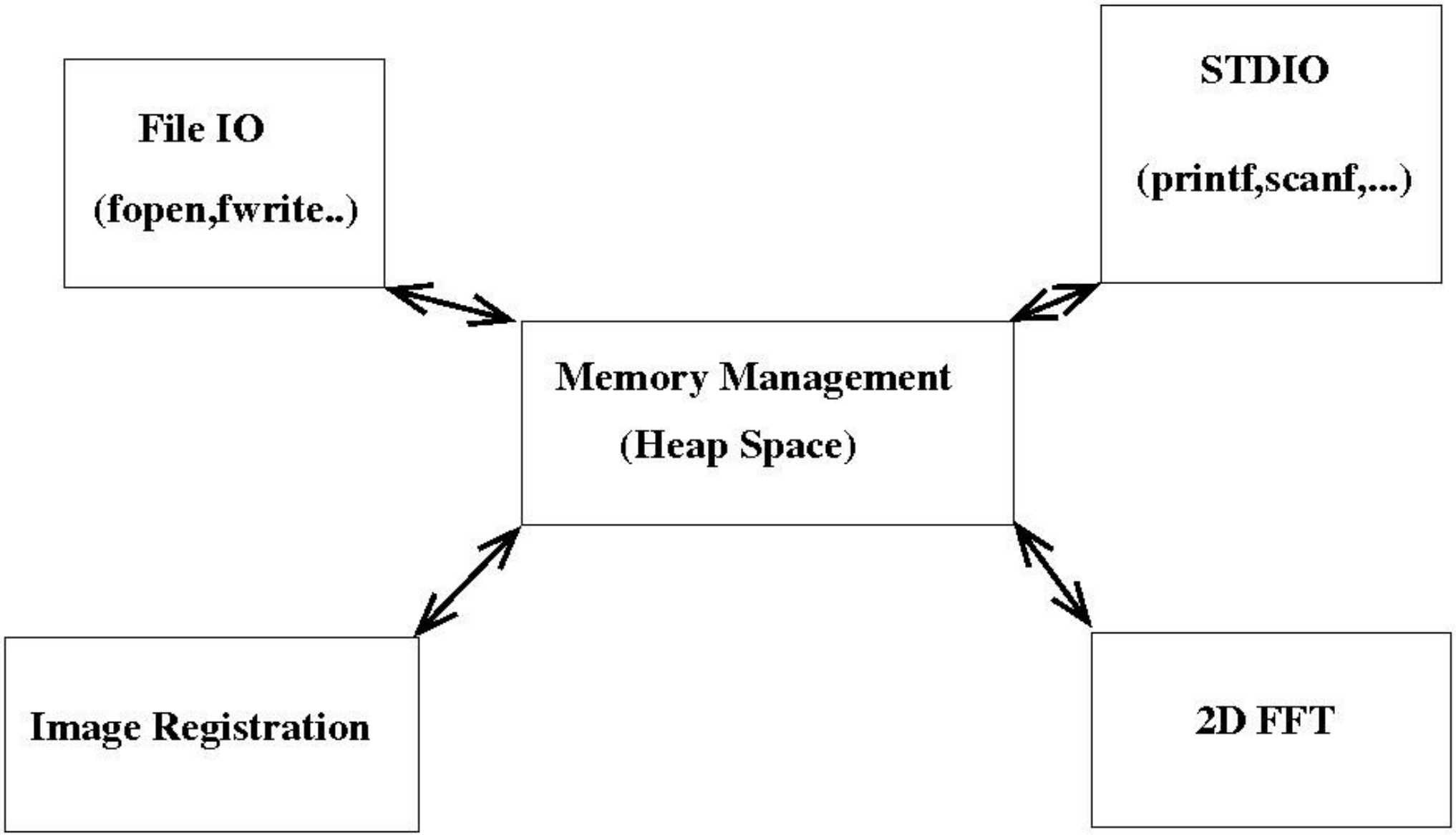


Software Architecture continued...





Software Architecture

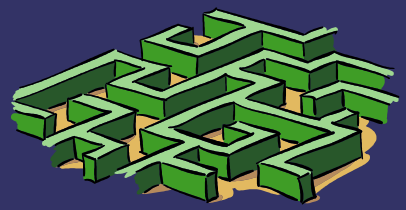


Matlab

- Reads in Image from file into a matrix.
- Writes images into a .bin file for FPGA compatibility.
- Translation of Image by known amount for simulation.
- Simulation of Image Registration computations.
- View 2-D FFT computations from FPGA.

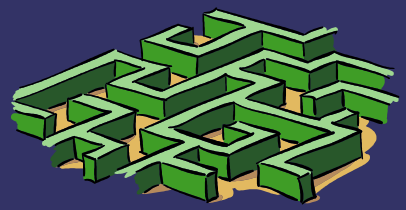
Progress

- FFT peripheral implemented and tested
- 2D FFT software implemented
- Translational registration
- Interaction with Compact Flash
  - Read and Write
- Serial User interface implemented
- Matlab code written and tested



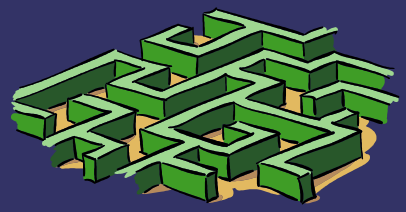
Problems

- Xilinx
  - Compact Flash operation quirky
  - STDIO operation quirky scanf :(
- Fixed-Point
  - Scaling factors
  - Overflow vs. loss of precision



Conclusion

- 1D FFT works!
- 2D FFT works when scaling is correct
- Matlab code correctly reorientates images and provides translational coordinates
- Images are usually easily transferable between FPGA board and PC
- User interaction is adequate



Questions??