



from which the perfect emerges

Wavelet Based Denoising

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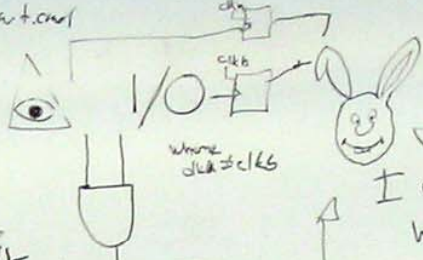
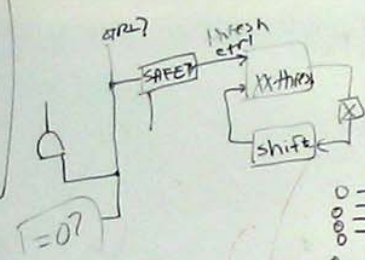
Douglas Duncan

Where we left off

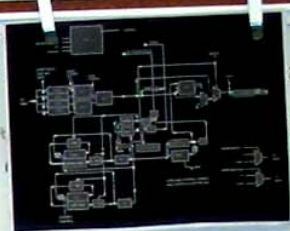
DD 4 LATCHES
LEAR SHIFTER

PLZ KILL ME!

- base case w/resh + cmd
- clipboth.cmd { clipfinal-ps } {
- thresh0.cmd { wothresh-ps } {
- lengthresh.cmd { LargeThresh-ps } {
- thresh0t.cmd { earlyexit-ps } {
- thresh2.cmd { thresh0-ps } {
- smallimg.cmd { smallimage, ps } {



I am the walrus



Decomp. Problem:

Initialization:
 $[0 \rightarrow 255 \quad 0 \rightarrow 255]$
 $[0 \rightarrow 255 \quad 0 \rightarrow 255]$
 inductive step
 if $[-255 \rightarrow 255 \quad -255 \rightarrow 255]$
 then coeff = $[-255 \rightarrow 255 \quad -255 \rightarrow 255]$
 \Rightarrow always have $[-255 \rightarrow 255 \quad -255 \rightarrow 255]$
 on decomp \Rightarrow no

- $D = A + B + C + D$
- $D = A - B + C - D$
- $D = A - B - C + D$
- $D = A + B - C - D$

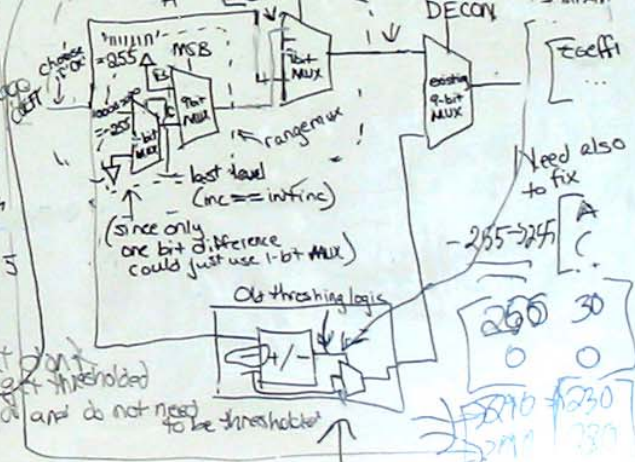
What we need to do to submit this f---ing thing:

- finish testing:
 - fix adder probs
 - run chipboth
 - run chipmiddle
 - run a case w/ initial thresh=0
 - run a 2x2 image
 - run a case w/ a big thresh

Did we truncate to produce cameraman photos or did we actually MSB?

03c 255
204 01111111

chiptest1



scaling $\Rightarrow 260$
 NAND
 means $-255 \rightarrow 0$ & not on last level
 - wrong

Recon

if we didn't expect to get a back upon recon why? b/c these coeffs for - level of r
 \Rightarrow so we should clip the c level w/o int error
 BUT \Rightarrow on the last level clip to 8-b
 $[255 \quad 230]$
 $[255 \quad 220]$

- check that infunc can become whatever we would like
- repartition of labor
- pin outs
- final checks

Special aspects:
 - neg coefficients
 - wavelet coeffs that don't get thresholded
 - neg coefficients that do not need to be thresholded

- KT, holding a cable bottle
 water had some issues turning

Englishly incorrect: "Doug
 ve than you" - Katie
 asked him until the Sabbath
 no matter how we? - Doug
 I guess you can't have everything" - Doug

I wish I was smart like you, but you know, God made me good looking. I guess you can't have everything" - Doug

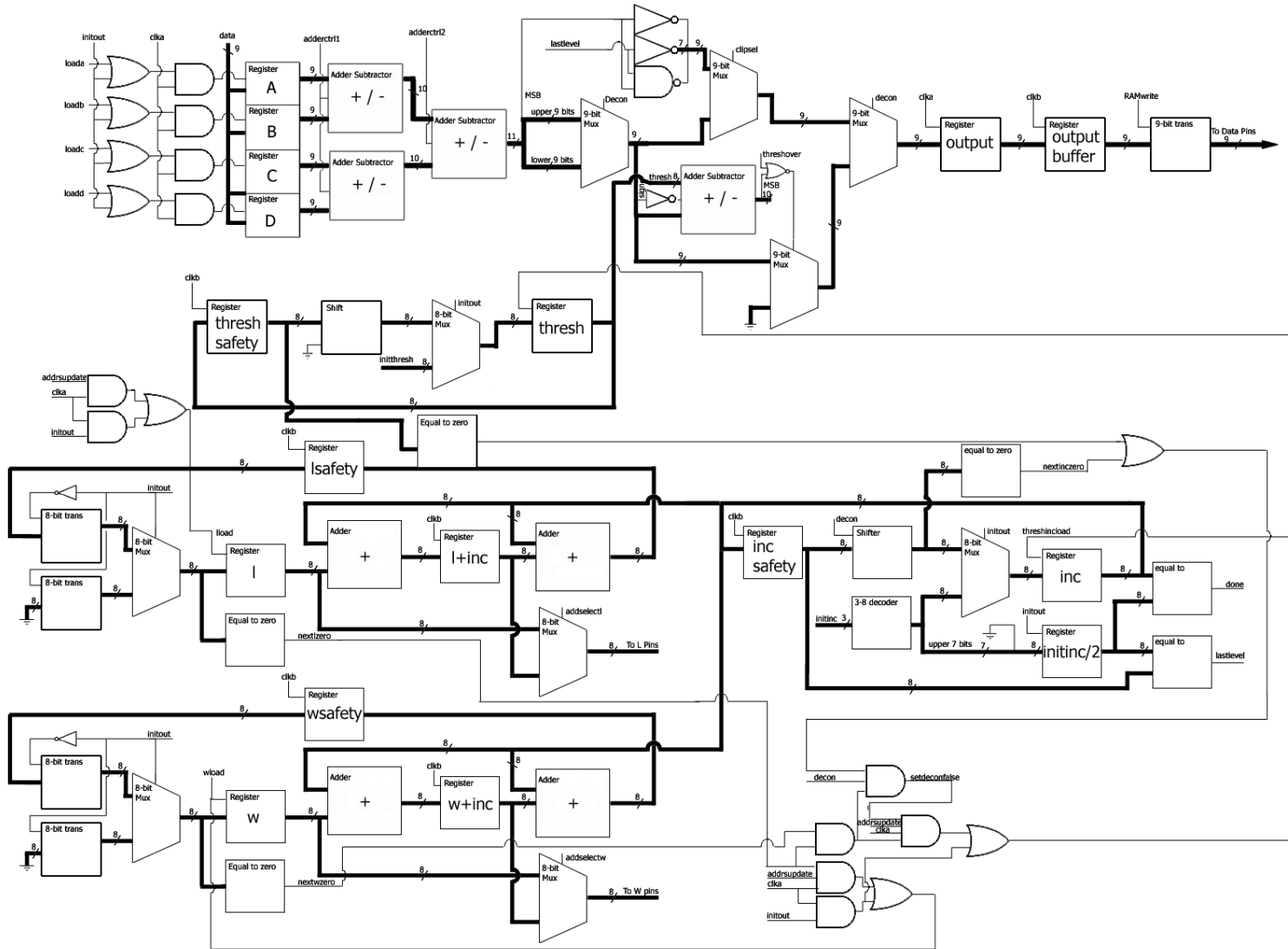
Chrysalis: our vision

- Wavelet denoising of grayscale images
- Compact, portable hardware implementation
- Fast enough to be practical
- Versatility in image sizes and choice of thresholds
- Interface with external RAM

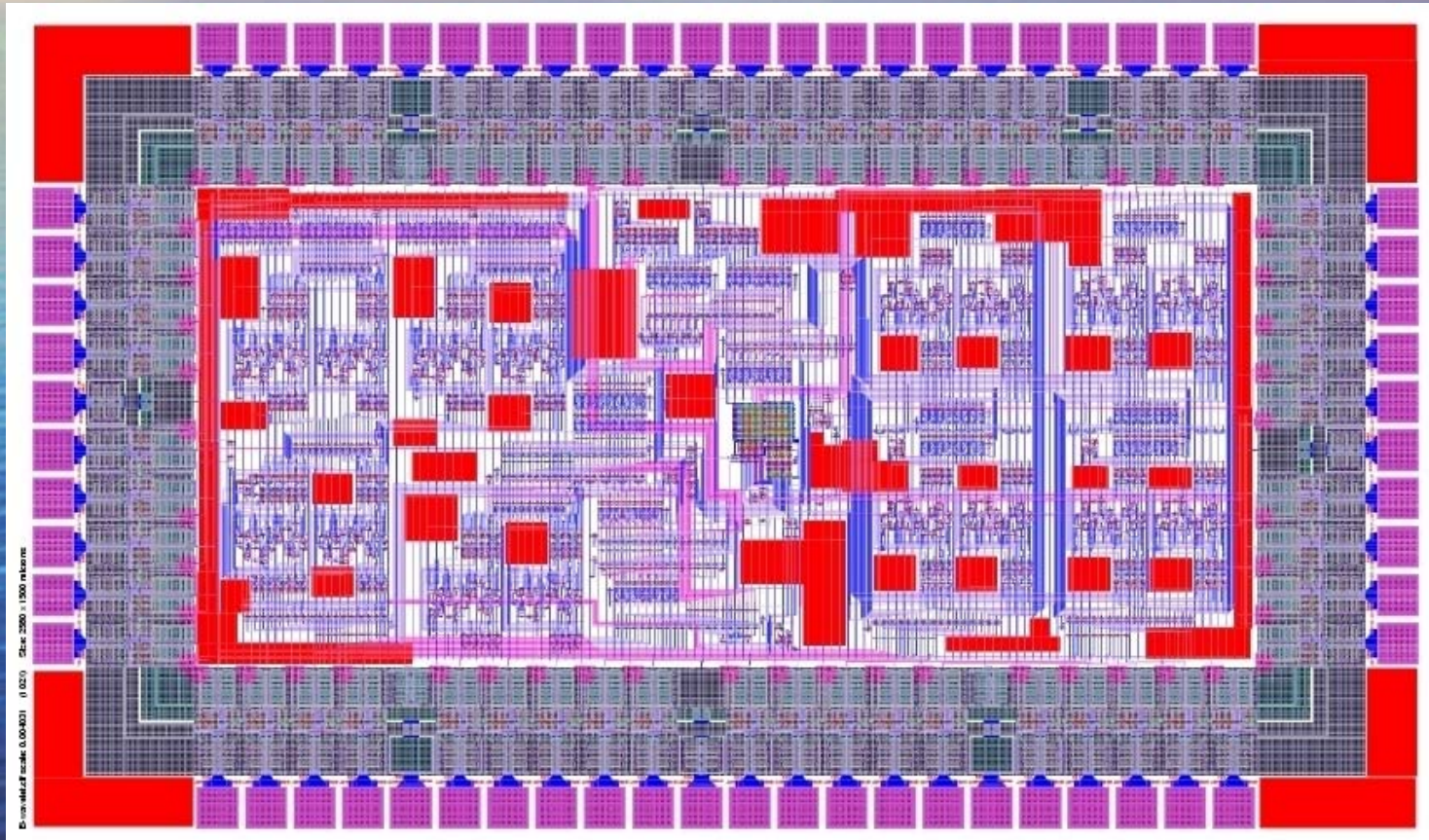
Review of algorithm

- Multilevel wavelet transform
- Threshold small coefficients
- Inverse multilevel wavelet transform
- Clipping

Final logic diagram



Final floorplan

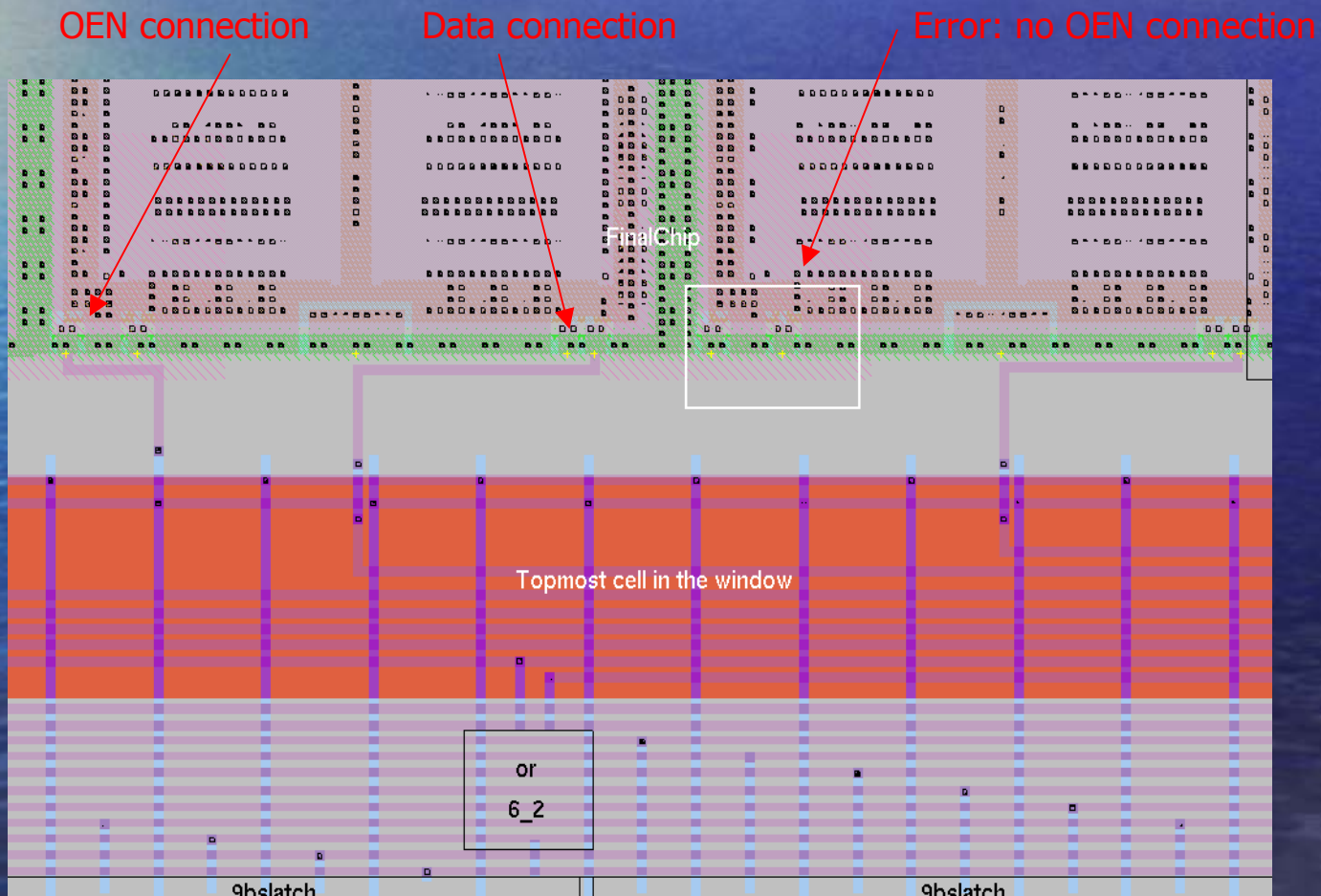


Testing setup

- Omnilab
 - Use our test images from last semester
 - 6 4x4 image tests and 1 2x2 image test
 - This part done with just the chip (no RAM)
- Tektronix
 - Interfacing with the RAM
 - Test a 2x2 image to warm up and then go for 256x256 cameraman image
 - Speed testing

Design errors found

- Floating OEN for Inc2 and Thresh2 pins



Design error details

- Consequence: Inc2 is grounded and Thresh2 is held high
- Cause: Wiring error
 - IRSIM simulation results didn't reflect errors
- Implications:
 - Reduction of image size possibilities to 2x2, 64x64, 128x128 and 256x256
 - Minimum threshold of 4 for image denoising

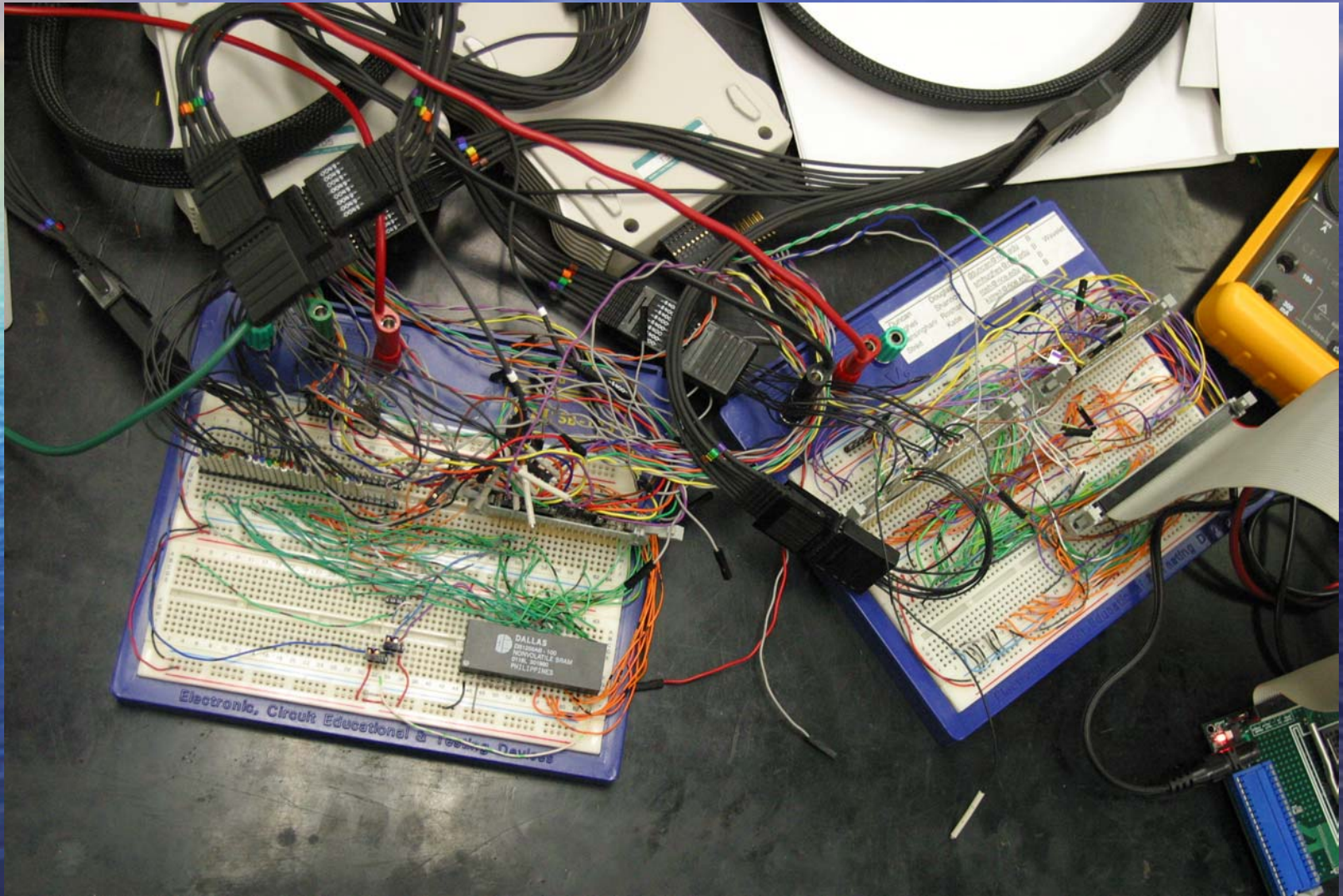
Omnilab testing results

- Despite design errors, we verified our ability to:
 - Initialize values for inc and thresh
 - Calculate correct RAM addresses for data
 - Assert RAM write and read enables when appropriate
 - Calculate wavelet transform coefficients including negative coefficients
 - Threshold when appropriate
 - Threshold ONLY when appropriate
 - Switch from deconstruction to reconstruction mode
 - Reconstruct pixel values from wavelet coefficients
 - Determine that we are done processing and stop

RAM challenges

- Hard to load an image into RAM
 - 256x256 image requires a command file 195,000 cycles long!
- Complicated wiring to interface between chip and RAM
- Running the chip on RAM requires a large command file
 - For a 256x256 image, this file must be 481,000 cycles long!
- Hard to get final data out of RAM for analysis
 - For 256x256 image, need to read out 65KB of data!

RAM Interface



RAM solutions

- Wrote Java program to convert data from Matlab into command file format for us
- Wrote additional Java program to generate command file for supplying inputs for chip with RAM testing
- Saved data out of Tektronix into file
- Wrote yet another Java program to parse this file into a Matlab-readable format

Another error

- While coefficients and addresses are both correct, they are not matching up.
- Reconstructed pixels get put back in the wrong order.
- Design error that is difficult to detect in cycle-by-cycle testing
- Probably fixable using external logic

Performance

- Mostly correct functionality for image denoising
 - Coefficients calculated correctly but stored in incorrect locations
 - Limited versatility in sizes and thresholds due to design errors
- Yield: 4 devices that work according to design

Speed testing results

- Maximum speed: 10 MHz
- Time for 256x256 image calculation:
0.10 seconds

Conclusions

- Still to do
 - Fix RAM interface
 - Full testing with RAM image
- Massively difficult project
- Testing results not perfect, but show promise

Any questions?

