Abstract:

Calcium imaging methods

FPGA/CPU/GPU/Other…..

Build a real-time deconvolution in as small a footprint as possible.

In this study we would like to compare the speed and resources

Our target is computational imaging of calcium imaging using a diffuser

Our goal is to compare the latency a low-cost high quality imaging system to be used as a optical system for calcium imaging

Why would we combine the diffuser calculations with the traditional calcium imaging which entail

Background filtering, neural enhancement ,movement compensation and finally calcium trace extraction.

1. Background

Talk about calcium imaging

Talk about diffusers and work done here

As we are talking about diffusers we mention stuff about PSF

There are models that can be used to calibrate

Talk about models and variant and invariant

Notes:

What is multi-row 1D FFT

If we use something other than the FFTW for CPUs or either the GPUFFTW for GPU or the CUFFT the CUDA based FFT, we should make sure that ???

Note: Here we will use the data flow for the CUFFT.

For both CPU and GPU we perform a column order 1-D FFT followed byua 1D-FFT row-order computation

Talk about FPGAs

Talk about CPUs

Talk about GPUs

Talk about overall computational methods

( from paper in Fall)

1. Methods

Diagram

Description automatically generated

1. In theory a lens less system has all the information available at the sensor. However, the problem is ill-posed. Introducing a diffuser gives structure to our point spread function, or random matrix, allowing us to solve an otherwise intractable problem. If we enforce sparsity as a prior, and non-negativity (no negative pixels), minimize for the least squares we are trying to solve the equation below
2. Text

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3. Here in (1) we do not show the regularization term that helps enforce sparsity, instead we want to show the main thrust of how we approach minimization overall
4. Text

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5. Here, the significance of (4) is that we have reduced the problem of computing A which could be a very large matrix to the adjunct of M and C, a much more manageable problem. (C is introduced as a cropping matrix)
6. A screenshot of a computer

   Description automatically generated with low confidence
7. Here there are a few points to note. The first is that the M matrix in (5) has already been decoupled from A, and this is because if we included the cropping effect into A, the matrix would be ill-conditioned. Continuing with (5), we have just expressed the convolution of “Mv” as a product of Fourier and the inverse of that dot product but have expressed the equation as products of matrices.
8. Text

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9. Here we substituted (7) back into (4) to give us (8) and taken the adjunct of (8) to give us (9). At this point (8) and (9) we can implement into code to solve our iteration (10).
10. Text

    Description automatically generated

A picture containing text, gallery, different, clock

Description automatically generated

ADMM

Gradient descent

Algorithm ( from Paper in Fall)

1. System Implementatio

Sh Diagram

Description automatically generatedow figure

Describe steps of our block diagram and show

In our cropped system where we have reduced the size of an image thru don

We will use a fixed point distance of 16 bits, note this can be adjusted empirically as we begin to implement our system in Simulink.

With CPU

With GPU

( Reference paper is in file : IEEE under FPGa folder/ “An Efficient, Model-Based CPU-GPU Heterogeneous FFT Library”, by Ogata, et al. CUDA can help in some areas here.( See reference [11] from Ogata paper above)

For the Cores (CPU and GPU)we see ( from Ogata [5] and [8]))

Memory limitations

Programming limitations that relate to DirectX or OpenGL

With combined CPU and GPU

With FPGA show our diagram

( From Proposal). How we do what we set out to do. Some of this comes from proposal

1. Results

( Running in Simulink)

Figure that shows images between diffused image and FFT of it.( Maybe get this picture with Python)

Estimate with FPGA

In our system we will only compare the 2- dimensional FFTs since they account for the major processing modules in our FISTA deconvolution design.

Estimates with CPU

Estimates with GPU

Estimate with CPU and GPU in tandem.

Do the times meet our system requirements for processing 30 frames a second for a size image that has been downsampled from the original full CMOS array.

1. Discussion and Conclusion

Talk about calcium imaging to be done Other types of processors

A little about optogenetics

1. References