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Super-High Resolution Imaging Using Easy Accessible Resources

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Super-High Resolution Imaging Using Easy Accessible Resources

Jamison Murphy (MS Comp. Sci.)
SYEG 696 Capstone Presentation

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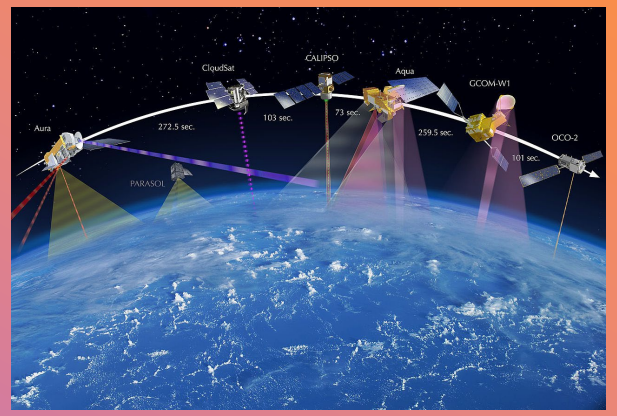
Summary

- **Background**: Satellites, drones, and other aircrafts are used to present aerial coverage views of what's occurring in communities by taking images of them that can been seen on software using graphics
- **Problem**: Many generic systems and hardware for non-governmental and low budget users are not capable of executing software producing super-high resolution images from these aerial and space crafts because of their lack of capability to process large amounts of data
- **Goal**: Produce super high resolution images on systems and hardware that are not using expensive and exclusive to governmental officials
- **Methodology**: Agile software development strategies will be implemented to test and analyze solutions for image resolutions
- **Opportunity**: Images will be a lot clearer and the processing of them will be simplified with low cost as production companies look towards less expensive systems
- **Accomplished**: Super high resolution images were produced at fast speeds, good image clarity, and less complexity using cloud platforms
- **Conclusion**: Image resolutions with super high quality can be obtained on cheap systems and hardware

Background – Aerial & Space Crafts

- Researchers and photographers use satellites, drones, and other aerial crafts to take images of communities and environments for studies and marketing
  - ~ detecting environmental changes over time
  - ~ showcasing the communities for 3D maps
  - ~provides clear observation of a scene during 911 emergency



Background – GPU's

- GPU's (Graphical Processing Units) are hardware that allows computers to process graphics for images, videos, and videogames
- The first official GPU was the GeForce 256 created by NVIDIA
- A typical GPU is expected to process a "minimum of 10 million polygons per second" [1]
- Over recent years of development, they have become "the largest, most complex, and most expensive components" for any technological device [3]
- Since the "flurry of new graphics competitors" popped up in 1993, that number has slimmed down to 3 main producers [2]:

  ~ NVIDIA: $495 – 1,823

  ~ AMD: $259 – 999

  ~ Intel: $???

Background – Cloud Platforms

- Cloud platforms are services that provide servers for working on and storing files to prevent having a significant amount of CPU and RAM usage
- Google Colab is a cloud platform that allows users to upload, create, edit, execute, and store their Python files in Jupyter Notebook format and providing fast online GPU's for large data projects
- Replit is a cloud platform that allows users to upload, create, edit, execute, and store files of any language up to date and provide a gpu
- GPU's available in Colab:

  ~Tesla T4

  ~ Tesla K80

  ~Tesla P4

  ~ Tesla P100

- Colab Cost: Free - $49.99
- Replit Cost: Free

Motivation

- Interest in image processing

- Urge to find ways to do computing tasks a lot more simplified and cheaper

Problem

- Many generic systems and hardware for non-governmental and low budget users are not capable of executing software producing super-high resolution images from these aerial and space crafts because of their lack of capability to process large amounts of data

  ~ Blocked, suspended, or unrecognized processes on CPU's

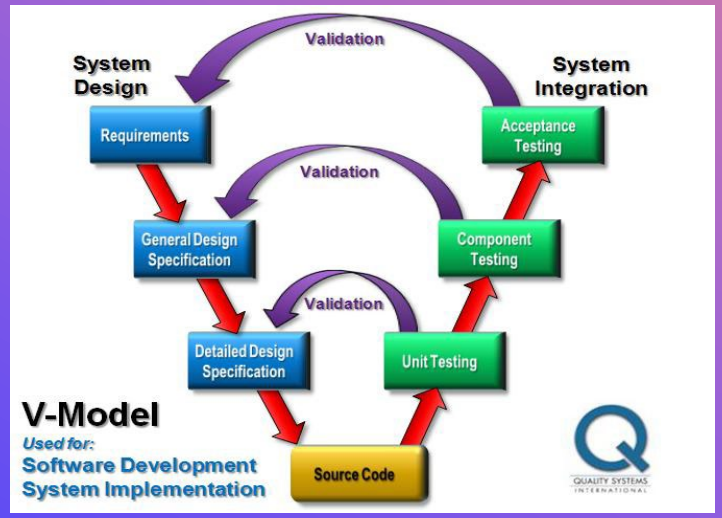
  ~Reduction of image sizes from high dimensions to low dimensions

Goal

- Produce super high resolution images on systems and hardware that are not expensive and exclusive to governmental officials

Methodology

- Agile software development – the utilization of multiple tests, executions, or “sprints to create and deliver a large software project
- Kanban – an agile software development strategy where multiple tests are being executed on a visual schedule leading up to a delivery



Measurement of Effectveness (MOE)

- Image Clarity~ How clear are the images coming out
- Processing Time~ How long does it take for the images to be fully processed and displayed
- Complexity~ How difficult it is to execute
- Cloud Compatibility~ The ability to run on a cloud platform service

Verification Requirements

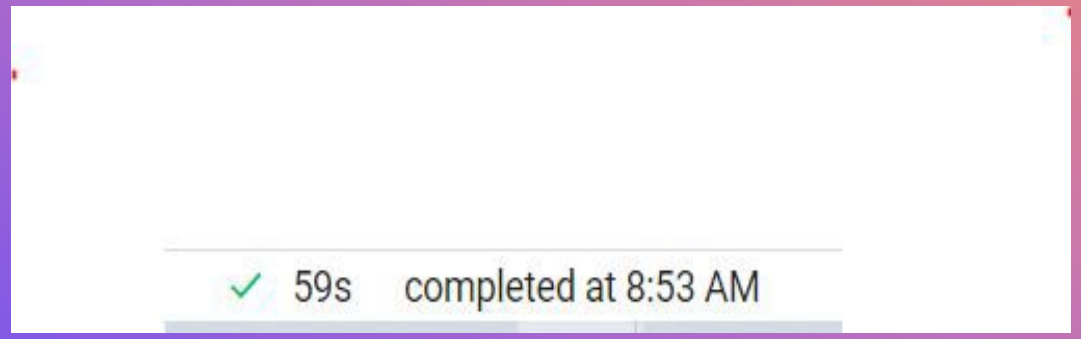
- Image Clarity: Blurriness is reduced and pixel quality enhanced
- Process Time: <10 min of processing output
- Complexity: In between moderate and easy
- Cloud Compatibility: Can execute on Colab or Replit

Verification Requirements

Image Clarity

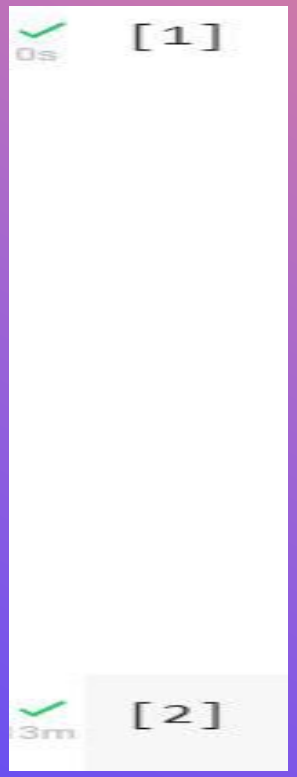
Verification Requirements

Processing Time



Verification Requirements

Complexity



*This is a list of cells or steps that need to be executed in order for the programming process to be completed

Verification Requirements

Cloud Compatibility

```
Downloading and Extracting Packages
ninja-1.10.2          |    7 KB | : 100% 1.0/1 [00:00<00:00, 22.37it/s]
pytorch-0.4.0         | 440.0 MB | : 100% 1.0/1 [01:35<00:00, 95.83s/it]
```

*Shows packages fully installed on platform

Stakeholders

- Non-Governmental Users
  ~Drone Users
  ~Undergraduate Earth Data Scientists/Researchers
  ~ Photographers
  ~Landscapers
- Companies
  ~ Google
  ~Anaconda
  ~ Replit
- Client
  ~ LMU Marketing & Communications

Scope

In-Scope	Out-of-Scope
• Improvement of image resolution from aerial & space coverage • Increased capability of software to process super resolutions • Reduced expenses for advanced hardware to detect images	• Photographers using improved software to improve image resolution of ground-level images • Biologists using improved software for volume-metric imaging • More clarity to 3-D imaging

Solutions

- Neural networks are numerous algorithms grouped into layers that are used to detect characteristics in large datasets such as image and video pixels, audio, and physical motion
- Testing a list of software packages with Python and C++ that are neural network compatible

  ~Python(w/ PyTorch)

  ~Python(w/ Tensorflow)

  ~Python(w/ Cognitive Toolkit (CNTK)

  ~Python (w/ Gluon)

  ~C++ (w/ Caffe)

Solution #1 - Python (w/ PyTorch)

- PyTorch is a machine learning package created by the Facebook AI Research team that utilizes torch libraries in Python for handling tasks in computer vision and natural language processing

Solution #2 - Python (w/ Tensorflow)

- Tensorflow is a machine learning and artificial intelligence package created by the Google Brain team that can be used in Python and C++ for a numerous amount of tasks but it specializes in deep neural networks

Solution #3 - Python (w/ CNTK)

- Cognitive Toolkit (CNTK) is a deep learning package for Python and C++ created by the Microsoft Research team that presents neural networks in computational steps which are illustrated through a directed graph

Solution #4 - Python (w/ Gluon)

- Gluon is a package created by Apache that is driven by models and helps deliver the best API services for quick network processing

Solution #5 - C++ (w/ Caffe)

- Caffe is a package created at the University of California, Berkely that specializes in deep learning networks using C++

Solution Architectures – Operational View

Example of a Super Resolution Convolution Neural Network (SRCNN)

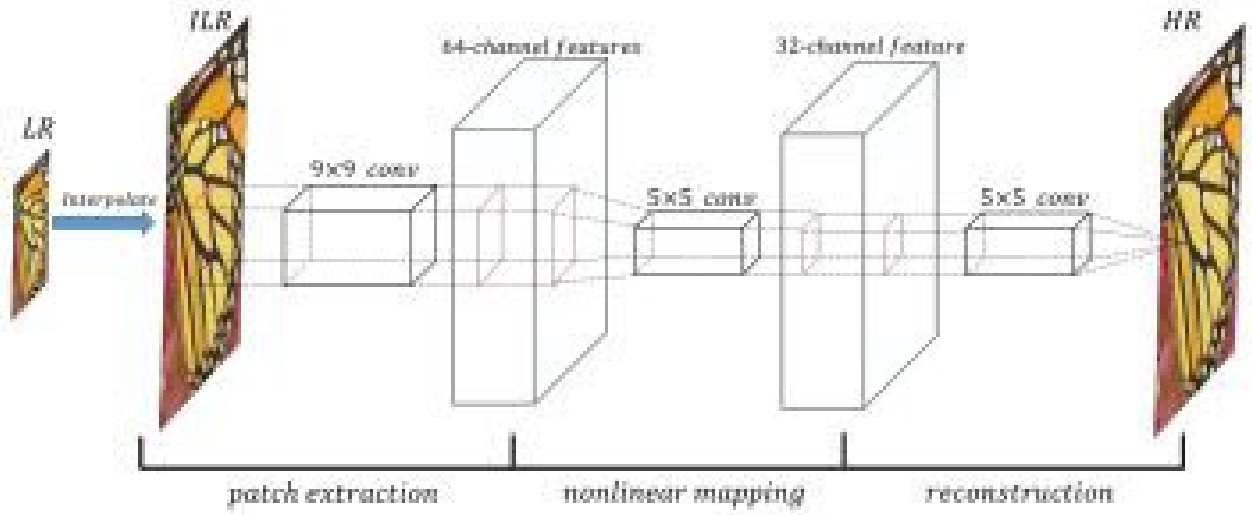
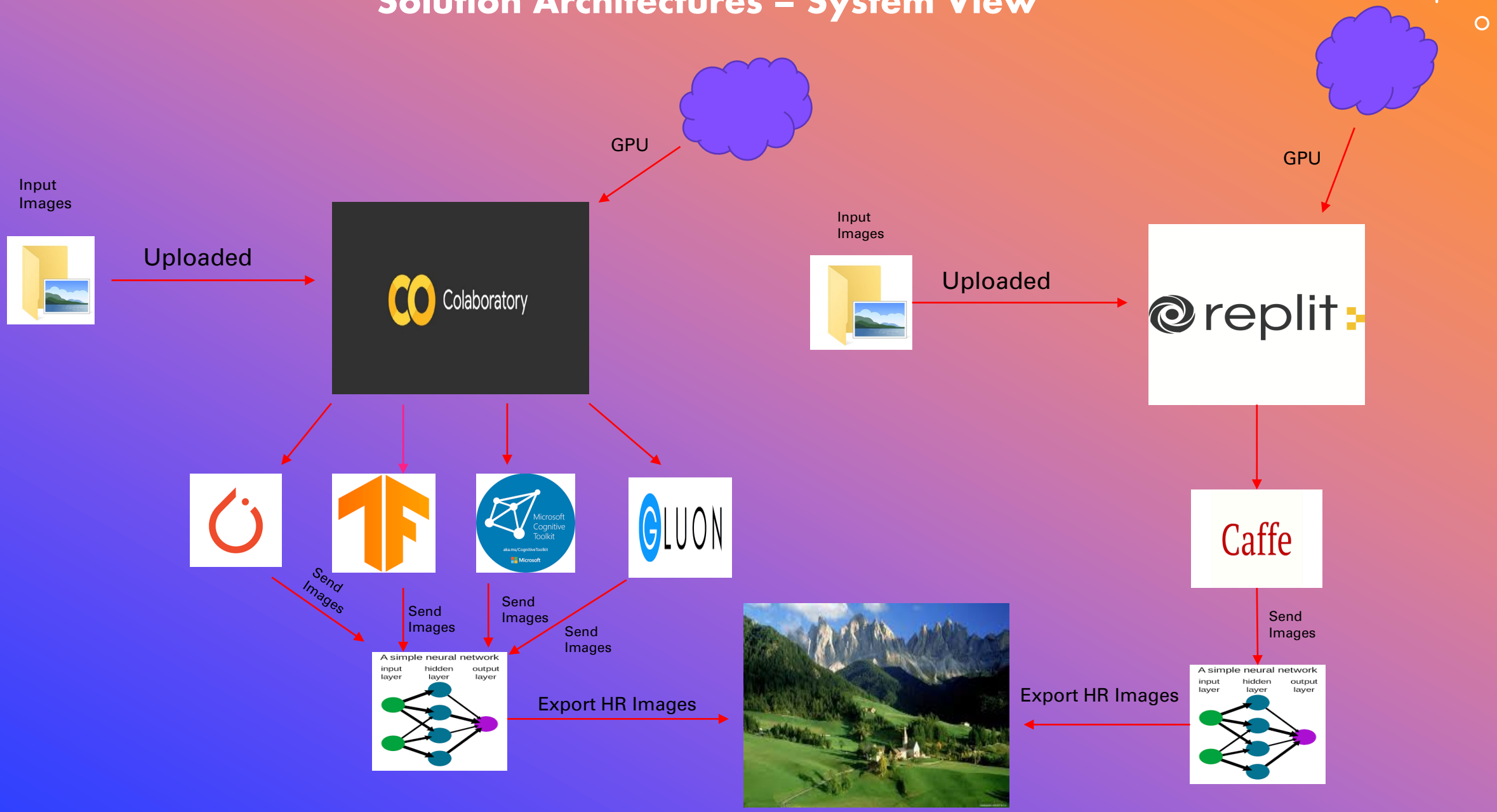


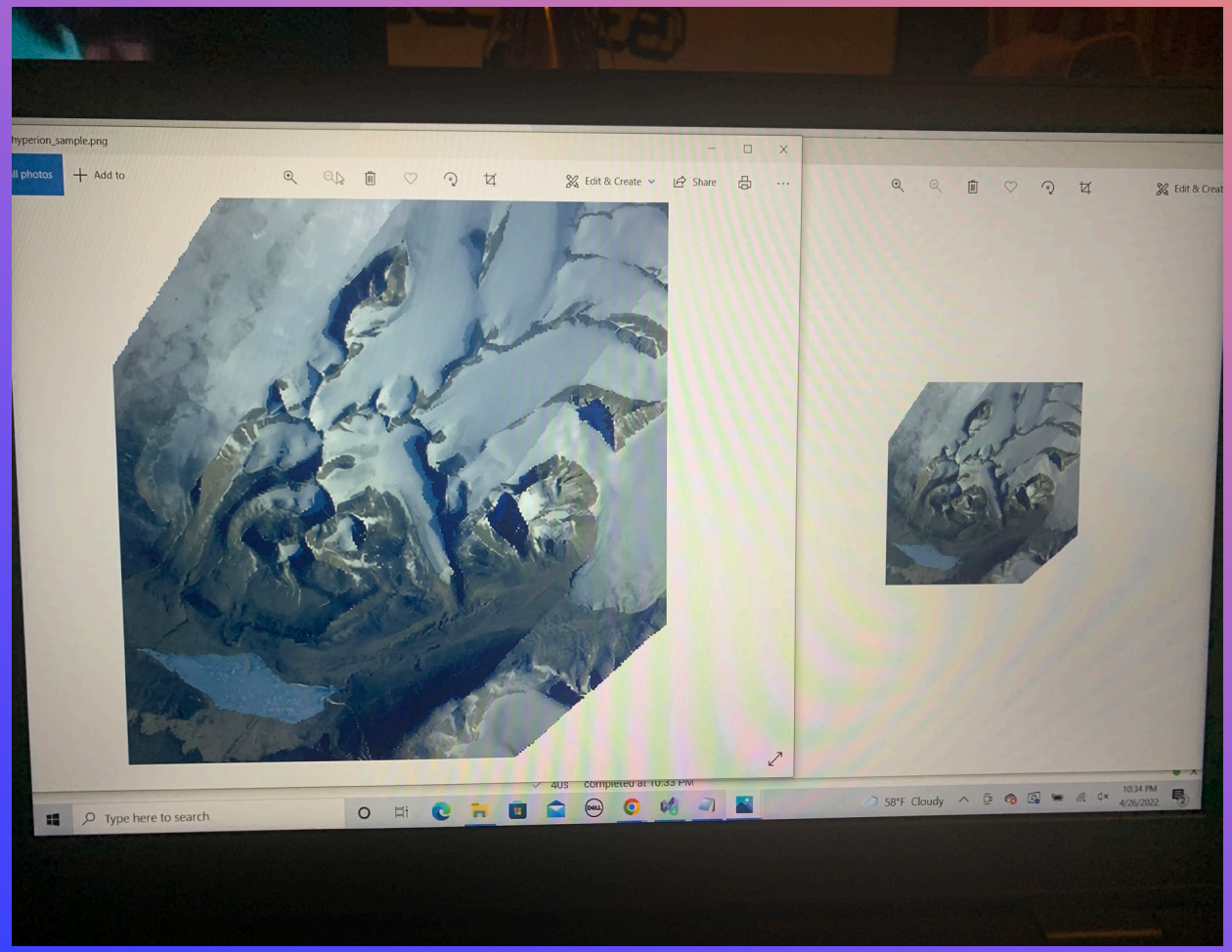
Figure 2: Sketch of the SRCNN architecture.

[4]

Solution Architectures – System View



Demonstrations



Solutions Analysis

Suggested Languages	Image Clarity	Processing Time	Complexity	Cloud Compatibility
Python (w/ PyTorch)	Good	0.26 min/att	Easy	Yes
Python (w/ Tensorflow)	Ok	0.47 min/att	Moderate	Yes
Python (w/ CNTK)	N/A	N/A	N/A	No
Python (w/ Gluon)	N/A	N/A	Hard	Yes
C++ (w/ Caffe)	N/A	N/A	Hard	Yes

Ranges

- Image Clarity: Poor < Ok < Decent < Good < Great
- Complexity: Hard < Moderate < Easy

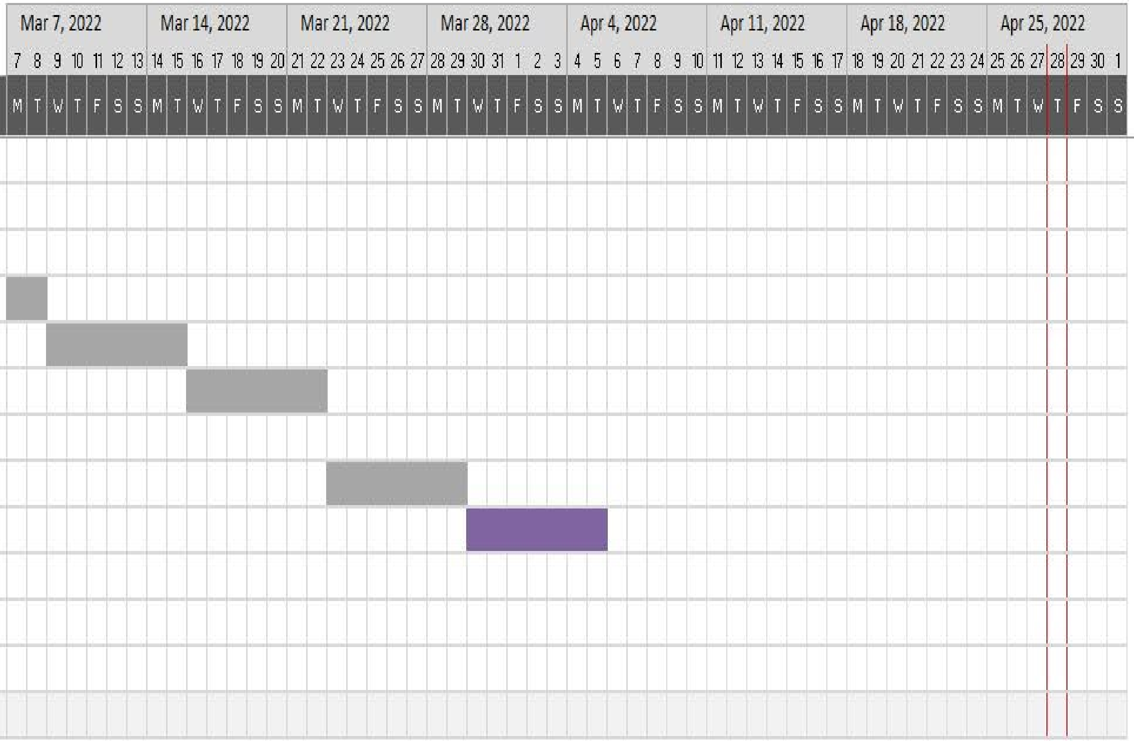
Recommended Solution

- Python (w/ PyTorch) is the best choice for super high resolution images because it has good image quality, the fastest speed, easy to use, and cloud compatibility

Recommendations

- When running PyTorch, try to keep dimensions of lower resolution images between 128 x 128 and 256 x 256
- To get the fastest processing speed on Colab, check to see if your GPU is Tesla P100
- Use image format .jpg or .png for input

Scheduling



Super-High Resolution Imaging Using DeepSUM

▶ Watch How to Make a Gantt Chart in Excel

SYEG 689 Capstone

Jamison Murphy

Project Start: Tue, 1/18/2022

Today: Thu, 4/28/2022

Display Week: 8

TASK	ASSIGNED TO	PROGRESS	START	END
Designing & Execution				
Install and test all neural network packages/modules from libraries w/ sample data		100%	2/15/22	2/22/22
Test solutions #1 & 2 w/ client-given data. Evaluate and analyze results		100%	2/23/22	3/1/22
Test solution #3 w/ client-given data. Evaluate and analyze results		100%	3/2/22	3/8/22
Test solution #4 w/ client-given data. Everyone and analyze results		100%	3/9/22	3/15/22
Test solution #5 w/ client-given data. Everyone and analyze resluts		100%	3/16/22	3/22/22
Implementation				
Decision made on determining the best solution		100%	3/23/22	3/29/22
Attempt at world record		0%	3/30/22	4/5/22

Insert new rows ABOVE this one

SIMPLE GANTT CHART by Vertex42.com

Conclusions/Lessons Learned

- Image resolutions with super high quality can be obtained on cheap systems and hardware

~Simplicity and cloud compatibility is the best going forward with reduced instruction set computers (RISC) such as PC's

~What is highly promoted in software packages might not be the most efficient and in a good quality

Future Opportunities

- Images will be a lot clearer and the processing of them will be simplified with low cost as production companies look towards less expensive systems

~Less expensive equipment to detect laser- scanned images in the biological and medical fields and get very good results

~Less expensive equipment in photo editing for earth data scientists and photographers

Accomplished

- Super high resolution images were produced at fast speeds, good image clarity, and less complexity using cloud platforms

Listed Sources

- [1] Pc, Xotic. “History of GPUs.” *XOTIC PC*, https://xoticpc.com/blogs/news/history-of-gpus.
- [2] Singer, Graham. “The History of the Modern Graphics Processor.” *TechSpot*, TechSpot, 25 Nov. 2021, https://www.techspot.com/article/650-history-of-the-gpu/.
- [3] Evanson, Nick. “History of the Modern Graphics Processor, Part 5.” *TechSpot*, TechSpot, 23 Feb. 2021, https://www.techspot.com/article/2176-history-of-the-gpu-part-5/.
- [4] Yang, Wenming, et al. “Deep Learning for Single Image Super-Resolution: A Brief Review.” *IEEE Transactions on Multimedia*, vol. 21, no. 12, 2019, pp. 3106–3121., https://doi.org/10.1109/tmm.2019.2919431.