**ENEE439D Spring 2024 Project: Team Notes**

[Your Team Name]

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Proposal link: https://docs.google.com/document/d/1kjRUJkuQmOzlEL2TeuoZacKqCRCYDAKjyjfZMjZp10M/edit?usp=sharing

## **Resources on various tech topics**

[Google Folder on ‘24 Proj Resources](https://drive.google.com/drive/u/1/folders/1YjJz_jIV-QVaqc2i8paO-TJ2HPJcv7Ce)

## **Project Timeline & Deadlines**

**3/11/2024**: Prelim project proposal/dev plan due for feedback

**3/17/2024**: Revised project plan due

**4/22/2024**: Mid-term Milestone report and prelim milestone review slides due at noon   
 (strongly encouraged – share a draft by end of 4/19 for feedback)

**4/23-26/2024 Tues & Friday**: Milestone review presentation

\*\*scroll down to see guidelines on report & presentations

**5/10/2024**: Prelim project report and presentation due for feedback

( The Reading day after the last day of S’24 class; submitting the version you have by 5/10;   
 can further refine and update the slides by 5/16 and report by 5/19 )

**Exam week - tentative time 5/16 or 17/2024**: Final presentation/demo.

**5/19/2024 at 11:59p**: Final submission of project material Due

Slide Deck: <https://docs.google.com/presentation/d/1yPUczZY6Y_JGs06MA0UH2Y3MiU6PfuTbggarlyHtys0/edit?usp=sharing>

## **===== Weekly Updates ====**

### Wk 5/6-10/2024

### Wk 4/29-5/5/2024

### Kyler

Past week progress:

* Exported 2000 masked images and 2000 rgb images from GOES to our drive.
* Created convolutional models to predict cloud movement, trained on different image intervals
  + Very good at producing images
  + Very bad at predicting movement
    - Produces images nearly identical to the input
* Begun work on a U-Net architecture for a frame interpolation model to fill in missing data between images

Issues for group discussions and brainstorms:

* Currently having issues with pooling, upsampling, and concatenation in the model.
  + Dimensions don’t match
* Should have a discussion on increasing the region of interest. I am worried about the amount of relevant frames that any model will be able to produce with our current.

Plan for next week and next milestones:

* Continue work on frame interpolation model
  + Train on multiple time intervals
  + Train on RGB images?
* Look into trajectory prediction models, such as those used for autonomous driving
  + May work better for our interests than optical flow

### Andrew

Past week progress:

* Looked into using Optical Flow from OpenCV on our RGB images
* Optical Flow can detect movement, but it does not seem useful…
* The clouds can move a lot in 15 minutes, leading to inaccuracies in Optical Flow
* Optical Flow based off light, object, and/or camera movement
  + Does not translate well to tracking clouds as too many variables in this situation
* When clouds change shape the Optical Flow vectors do not follow a predictable trend

Issues for group discussions and brainstorms:

* Probably drop Optical Flow as a method for cloud prediction
* Based off the slides Motion and Optical Flow from The University of Washington, it seems that Optical Flow and similar algorithms do not work well with cloud predictions

Plan for next week and next milestones:

* Help with interpolation model

### Wk 4/22-28/2024 (milestone review week)

Past week progress:

* Made progress on an autoregressive model that can take as input a jpg image collection. Started some basic examples of LSTM models that would be better at handling our images’ spatial inputs.

Issues for group discussions and brainstorms:

* Keep working on the different models.

Plan for next week and next milestones:

* Hopefully finalize a complete version of the autoregressive model and start testing its accuracy on our preprocessed data.

### Wk 4/15-21/2024 (preparing for milestone review)

### Wk 4/8-14/2024

### Kyler

Past week progress:

* Creating database scale application of bands for cloud masking
* Attempting to export both original images and processed images as tiff files

Issues for group discussions and brainstorms:

* I can currently extract a tiff from GOES, but not after running the apply scale and offset function. Making the image somewhat useless.
  + Function which returns a copy of the image with altered band parameters according to properties stored in the original image.

Plan for next week and next milestones:

* Fix the masking and exporting algorithm and run it on provided servers.
* Convert tiff files into keras usable format (jpeg or png)
* Begin training a cloud tracking model.
* Begin training a cloud masking/band application model.

**Andrew**

Past week progress:

* Looked at different masks for background subtraction
* select('CMI\_C13').lt(280) seemed to yield the best results
* Combining different masks did not seem to be necessary
* Continuing with only one filter for performance

Issues for group discussions and brainstorms:

* Look into ways of quantifying how “good” the mask is
* Probably get the tracking working first then quantify the filter based off the performance of the mask

Plan for next week and next milestones:

* Help with the mask exporting algorithm
* Begin training a cloud tracking model

### Jonathan

Past week progress:

* Attempting to export both original images and processed images as tiff files
* Working on an autoregressive model that can take as input a jpg image collection.

Issues for group discussions and brainstorms:

* Gonna start working on an autoregressive model framework that will take jpg input. Importantly we start making the models and move on from pre-processing alone.

Plan for next week and next milestones:

* Begin training a cloud tracking model.

**Overall team:**

Progress so far:

* Preprocessing exportation process finished, just need to use server to process all GOES satellite imagery into a preprocessed dataset.

Issues with respect to overall project goals & timeline:

* Need to find out how to actually use server to run processing tasks in Colab.
* AJ needs to focus on band and model visualization prediction model, Kyler and Jonathan work on various ML models that take the cloud masks as input (beginning with autoregressive and working way up to CNNs, LSTMs, and LSTMConvolutional models.

Teamwork Plan for next week and next milestones:

* Cloud bank mask model
* Preprocess GOES imagery using UMD server
* Begin autoregressive learning model to fill in missing information between snapshots.

### **W**eek 4/1-4/7

**Kyler**

Past week progress:

* Tested various GOES bands to find the best at differentiating clouds and decided on the best approach for cloud identification.
  + CMI\_C04: Near-IR - Cirrus
    - Able to detect daytime cirrus clouds which other bands tend to miss.
  + CMI\_C16: Infrared - CO2 longwave
    - Able to differentiate clouds by height and see clouds at night.
  + CMI\_C11: Infrared - Cloud-top phase
    - Removes majority of non cloud imagery.
* Begun to try applying the bands to the entire GOES library rather than one image at a time.

Issues for group discussions and brainstorms:

* Is there any way for us to speed up the exporting of our data?
  + I believe I can apply the bands to the GOES library, but I’m not sure that it's helpful if we have to screenshot each time.

Plan for next week and next milestones:

* Continue working with the GOES library, either collecting all the image IDs or applying the bands
* Capture processed images for model training

**Jonathan**

Past week progress:

* Created program that takes user-inputted dates and finds all GOES image IDs

Issues for group discussions and brainstorms:

* How do we efficiently preprocess hundreds of images? Our current process is: Run Image ID retrieval, use image ID to get cloud mask, convert cloud mask from png to jpg, use JPG in google colab program to get clouds only against black background as final data input for our ML model.

Plan for next week and next milestones:

* Begin development of the LMST ML model and also the preprocessing of several datasets.
* Identification of key time frames to use for our data.

**Jonathan**

Past week progress:

* Created program that takes user-inputted dates and finds all GOES image IDs associated with that time frame for input in our Band Application and Background Subtraction program
* Created a background subtraction process to extract the clouds only from the GOES band filtered images
* Decided specific region coordinates for all models
* Standardized the image format (image region of interest and dimensions) for consistent imagery input for ML model input later
  + Addressed issues with the GOES images such as the Google label and options UI that would’ve interfered with the model’s learning through image cropping on Google Colab

Issues for group discussions and brainstorms:

* How do we efficiently preprocess hundreds of images? Our current process is: Run Image ID retrieval, use image ID to get cloud mask, convert cloud mask from png to jpg, use JPG in google colab program to get clouds only against black background as final data input for our ML model.

Plan for next week and next milestones:

* Begin development of the LMST ML model and also the preprocessing of several datasets.
* Identification of key time frames to use for our data.

**Andrew**

Past week progress:

* Specified specific coordinates that we will be using based off most frequent hurricane routes
* Aided in background subtraction process for the GOES band filtered images
  + Found a good value of blue to subtract so that too many clouds aren’t subtracted but we do not pick up too much background
* Looked into images from different times

Issues for group discussions and brainstorms:

* Having issues preprocessing images
* Image files directly from Google Earth API take up a lot of memory and take a long time to import into Google Drive
* Preprocessing by taking screenshots will take long time
  + Plus there may be different aspect ratios depending on the monitor when taking screenshots, so if we go this route we would have to do it all on the same system

Plan for next week and next milestones:

* Capture images for training in a model
* Work on LMST for processing the images

**Overall team:**

Progress so far:

Issues with respect to overall project goals & timeline:

Teamwork Plan for next week and next milestones:

### Wk 3/25-31/2024 (summary due 4/1)

**Kyler**

Past week progress:

* Defined area of interest for study as the the Gulf of mexico
  + Should be easier for background subtraction being over a body of water
  + If we get to tropical storm portion, data will be available in this area
* Obtained license/permissions to use Google Earth Engine API
* Studied earth engine manual and tested some available datasets
  + <https://developers.google.com/earth-engine/guides/objects_methods_overview>
  + <https://developers.google.com/earth-engine/apidocs>
  + <https://developers.google.com/earth-engine/datasets>
    - Sentinel 2
    - Sentinel 5P

Issues for group discussions and brainstorms:

* The interactive map does not seem to work well when multiple image layers are added.
  + Either need a static map or a single image of the entire area of interest
* The best available sentinel data of a cloudless gulf results in a wide range of hues and brightness of the water
  + Not useful as background reference

Plan for next week and next milestones:

* Search for new ways to display earth engine maps
  + Or find an alternative API for background creation
* Create a small scale cloudless background to test the approach
  + Compare to additive cloud mapping approaches
    - Earth engine built in functions

**Jonathan**

Past week progress:

* Created an efficient cloud mask that is able to create a visual contrast between clouds and landmass/water, causing clouds to appear light gray or white and everything else to appear black.
* Obtained license to use Google Earth Engine API
* Tested Sentinel 2 dataset and performed comparative testing on the benefits of GOES dataset vs Sentinel 2 dataset

Issues for group discussions and brainstorms:

* Need to improve on visualization parameters for the cloud mask, right now it is passable but would be nice to improve the contrast to make background subtraction easier.
* Should probably use GOES satellite imagery over sentinel-2 now primarily since we are trying to fill in missing data between satellite snapshots. With sentinel-2 this is impossible since the snapshots are taken days apart, making the “missing information” aspect worthless.

Plan for next week and next milestones:

* Implement background subtraction on the cloud masked images to extract only the cloud shape as input into our ML model
* Find a way to preprocess these extracted clouds into a format suitable for a LMST ML model, one idea that comes to mind is the conversion of the cloud into a polygon object.

**Andrew**

Past week progress:

* Obtained permissions to use Google Earth Engine API
* Tested different code from <https://developers.google.com/earth-engine/guides> to get more familiar with working with the Google Earth Engine API
  + Specifically mainly worked on the Sentinel 2 dataset
  + Later looked at the GOES dataset
* Tried testing primitive background subtraction (unsuccessful)

Issues for group discussions and brainstorms:

* Need see if we can find images instead of using a interactive map object, static map would be fine too

Plan for next week and next milestones:

* Find a way to obtain images from the API
* More background subtraction testing
* Look through dataset of the Gulf of Mexico for different times

**Overall team:**

Progress so far:

* Settled on Google Earth API with GOES imagery from NOAA
* Cloud mask functionality achieved
* Region of focus (Gulf of Mexico) decided

Issues with respect to overall project goals & timeline:

* Need to divide workload into a task force dedicated to preprocessing images only and another task force dedicated to ML model training and testing
* Background subtraction should be complete this week alongside a way to preprocess the clouds

Teamwork Plan for next week and next milestones:

* Background subtraction
* Improve visual clarity of the cloud mask
* Begin the process of preprocessing GOES images into cloud polygons

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## **Preparing for Report & Presentation**

### (for milestone review; and further developing into the final report; Updated 3/2024)

**1. Slides for a 15-minute presentation:**

* Include main motivation and approaches, key results/take-aways and/or issues, and next step plan.
* include at least one block diagram outlining the main data/signal processing pipeline and/or system structure
* Pay attention to the design of the slides:
  + Keep the amount of text to the minimum necessary and in large enough font size
  + Avoid overly long sentences -- keep to 1 line and no more than two per bullet
  + Proper use of figures, graph, and/or table

**2. Prelim. Documentation for project report**

Please refer to [the template/outline of the ECE Capstone Project Report](https://piazza.com/class_profile/get_resource/lr6ko2oji1b4or/lt4t1no265j2cc). Start filling out some sections now with the material and progress you have so far, and further develop in the next several weeks. For some sections on the background and related prior art, you can build and update upon your project proposal.

For References, include IEEE type of reference citation with author name, title, source, month/year, URL or DOI if applicable.

An annotated reference many of you have started at the project planning stage is still useful at this stage, where you include a brief description/summary of a few sentences on what the reference is about. For the final report, your reference section would be a regular list of papers (as you see in technical publications and reports); and you can include an annotated reference as an appendix.

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## **Sample weekly summary:** (for reference; from S’20)

Past week progress:

* *Found 2 papers regarding ENF detection and identification and algorithms to determine if an ENF signal is present in a video.*

*[... give links and citations of the papers here]*

*[put Google doc/slides link if there are detailed results and notes to discuss]*

Issues for group discussions and brainstorms: *Other possible databases for testing?*

* *ENF presence determination from videos for real vs deep fake video.*
* *If present: using face localizer.*

[*Dr. Wu’s notes during the weekly review & discussions*]

1. AMTC frequency tracking module for class internal use.
2. ……

Plan for next week and next milestones:

* *Implement an algorithm for determining if ENF is present in a video, then try estimating ENF in different blocks of a video.*
* *I would also like to check if ENF signals can be used for classification by checking for ENF signals in several different blocks of an image and then comparing this with any present ENF signals on faces found in the image.*