Resources, Research, and Utilities

This has been attempted before and there is a plethora of research, tools, resources, and APIs that will help build an application that can successfully detect flooding and measure the depth from a picture.

Research

1. Flood-water Level Estimation From Social Media Images, https://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/IV-2-W5/5/2019/isprs-annals-IV-2-W5-5-2019.pdf
   Description: A Swiss team of researchers utilized deep learning to identify flood depth by training a machine to detect regular objects in a photo and the object submersion level.

2. Real-time Flood Mapping and Water Height Point Extracting Tool http://gis.cas.sc.edu/FloodMapping/
   Description: This is a tool designed to detect flood levels utilizing submitted flood photos and requiring the user to identify a location. The scope of this project is limited to Houston Texas during Hurricane Harvey flooding.

3. Extracting Disaster-related Information from Social Media Data, http://gis.cas.sc.edu/gibd/detecting-disaster-photograph-from-social-media/
   Description: This is the accompanying research for the tool mentioned above.

4. The Floodwater Depth Estimation Tool (FwDET v2.0) for improved remote sensing analysis of coastal flooding, https://nat-hazards-earth-syst-sci.net/19/2053/2019/
   Description: The Floodwater Depth Estimation Tool uses high-resolution DEM (i.e. satellite imagery) to augment current flood depth tools.

5. NAU and ASU researchers use traffic cameras to map urban flooding, https://azdailysun.com/news/nau-and-asu-researchers-use-traffic-cameras-to-map-urban-flooding/article_f165558f-5eb3-5793-b667-2d86eda35a1f.html
   Description: An article about the Flood Aware app developed by researchers in Flagstaff Arizona.

6. Prototyping a Social Media Flooding Photo Screening System Based on Deep Learning and Crowdsourcing, https://scholarcommons.sc.edu/cgi/viewcontent.cgi?article=6207&context=etd
   Description: Masters' Thesis by Huan Ning about using Convolutional Neural

Networks to identify flood photos sourced from various social media platforms.

7. Flood Water Level Estimation from Social Media Using Machine Learning, https://medium.com/ecovisioneth/flood-water-level-estimation-from-social-media-images-b4940c6e99fa
   Description: Similar to the above model, these researchers used social media photos as a data source. However, in this model, the neural networks were trained on annotated photos and classified by submersion on a scale of 0-10 as a proxy for measuring flood depth. The photos were additionally processed using the COCO API.

8. 2018 FloodWarn Training, https://www.weather.gov/media/hgx/Floodwarn/2018_FloodWarn_Training_Galveston.pdf
   Description: Training slides for the National Weather Service with a focus on the Houston Flooding that resulted from Hurricane Harvey.

9. Detecting floodwater on roadways from image data with handcrafted features and deep transfer learning, https://arxiv.org/pdf/1909.00125.pdf
   Description: These researchers also created an image detection model. In this case, they focused their training images on road submersion photos and used a pretty vast array of models with "superpixel-based" methods.

APIs

1. Google Earth Engine, https://developers.google.com/earth-engine
   Description: This API provides access to the Google Earth dataset. It can be used to provide elevation and other contextual information about a local based on latitude and longitude.
2. Google Cloud Vision AI, https://cloud.google.com/vision/
   Description: This is less an API and more a direct call to Google's Vision AI. It can identify a variety of objects and conditions in any photos passed to it.
3. Google Maps Reverse Geocoding API, https://developers.google.com/maps/documentation/geocoding/intro#ReverseGeocoding
   Description: This API will return a mailing address when passed latitude and longitude coordinates.
4. Google Maps Streetview API, https://developers.google.com/maps/documentation/javascript/streetview
   Description: This API will return a Streetview Image when passed either latitude and longitude or mailing address. This is of course based on availability.
5. COCO API, https://github.com/cocodataset/cocoapi, http://cocodataset.org/#overview, http://presentations.cocodataset.org/COCO17-Detect-Overview.pdf
   Description: This API was created in cooperation with Microsoft and a team of researchers. It was trained on a data set of over 300,000 photos to identify and return common objects in a photograph.

Resources

1. USGS Topo Map Library - topoView, https://ngmdb.usgs.gov/topoview/viewer/#4/39.98/-100.06
   Description: This resource provides downloadable topographic maps of the entire United States of America. Topographic maps are another way to estimate the elevation of a given latitude and longitude. This is a backup method as opposed to calling the Google Earth Engine.

2. USGS TNM Elevation Map, https://viewer.nationalmap.gov/theme/elevation/
   Description: This is similar to the USGS Topo Library mentioned above. However, it provides satellite maps for download instead. There is a variety of imagery to include DEM and LiDAR where available. Similar to the Topo Library you will need to download the imagery and process it locally.

3. AAA Digest of Motor Laws, https://drivinglaws.aaa.com/tag/bumper-height/#:~:text=The%20height%20of%20a%20bumper,30%20inches%20from%20the%20ground
   Description: This is a resource for finding the legally required heights of safety devices on vehicles. These heights can be used a proxy when gauging flood depth. When a certain vehicle component is visible above the water then the depth is below that level. Of note, these regulations are not national standards but rather state laws.

4. qGIS, https://www.qgis.org/en/site/
   Description:

5. Reading EXIF on HEIC files, https://stackoverflow.com/questions/54395735/how-to-work-with-heic-image-file-types-in-python
   Description: HEIC is the default file type for all current iPhones. Many available libraries have not updated to be able to extract EXIF(EXchangeable Image File format) data from this newer file type. This article provides a technique for extracting EXIF data, particularly latitude and longitude from HEIC files.

6. ITSC Flood Dataset, https://www.dropbox.com/sh/grxeep1k9a0yziq/AAByrZYB-jGQoTvb0Yp22fJFa
   Description: This is a library of flood photos that can be used to train neural networks to detect flooding.

7. Very Deep Convolutional Networks for Large-Scale Image Recognition

   https://arxiv.org/abs/1409.1556

   Description: Original description of the VGG16 model published in 2015.

8. VGG16 – Convolutional Network for Classification and Detection, https://neurohive.io/en/popular-networks/vgg16/

   Description: Background on the now classic VGG16 model, including tips that the original success required weeks of training on high end hardware and that even saving just the model weights results in large files (500M).

9. Step by step VGG16 implementation in Keras for beginners, https://towardsdatascience.com/step-by-step-vgg16-implementation-in-keras-for-beginners-a833c686ae6c

   Description: Starter code for implementing a VGG16 model.

10. How to Configure Image Data Augmentation in Keras, https://machinelearningmastery.com/how-to-configure-image-data-augmentation-when-training-deep-learning-neural-networks/

    Description: A common technique for working with a small data set is to augment it with transformed versions of the image. One method is to make permanent versions, and another is to do it 'on the fly' during training. This article describes the 'on the fly' method in keras using the ImageDataGenerator class.

11. EU Flood Dataset, https://github.com/cvjena/eu-flood-dataset

    Description: This is a downloadable library of over 3,500 flood photos from a particular flood in the Czech Republic that researchers used to train a flood prediction model.

Libraries

NOTE: This section refers to Python libraries/packages that we either used for this project or ones that we considered to be useful for follow on attempts.

1. OpenCV, https://docs.opencv.org/master/d0/de3/tutorial_py_intro.html

   Description: This is a machine learning library that is particularly built for learning on image data.

2. EXIF Read, https://pypi.org/project/ExifRead/

   Description: This library pulls EXIF data from JPEG and TIFF images.

3. Flask, https://flask.palletsprojects.com/en/1.1.x/

   Description: This library provides methods to detect micro patterns in web applications.

4. Python Wrapper for Google Streetview, https://rrwen.github.io/google_streetview/
   Description: This is a python wrapper to facilitate the use of the Google Streetview API.

5. Floodwater Depth Estimation Tool, https://github.com/csdms-contrib/fwdet
   Description: A functioning example of an image flood estimation tool.

6. Flood Level Estimation Tool, https://github.com/Rabbit1010/Flood-Level-Estimation
   Description: Another example of a functioning tool.

7. Keras, https://www.tensorflow.org/guide/keras
   Description: Keras has a Python wrapper for TensorFlow. It simplifies the code creation and execution of TensorFlow.

8. VGG-16 model for Keras, https://gist.github.com/baraldilorenzo/07d7802847aaad0a35d3
   Description: Another example of starter code for VGG-16, this one showing how to load model weights from a previously trained model.

9. Google Vision API, https://github.com/cemsaz/google-vision-api-multi-thread
   Description: A tool that runs images through Google Vision and returns the top 5 labels for each image.