Applications of Deep Learning to Enhance Environmental Sensing Capabilities of Mobile Devices and Other Image Sensors

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Motivation

- Accurate marine weather "nowcasts" and forecasts are critical to maintain situational awareness and ensure safe navigation.
- **Smartphones** enable multi-modal environmental sensing using built in device sensors and multimedia inputs.
- Availability of sensors varies, but all smartphones have a **camera**.
- **Deep Convolution Neural Networks (DCNNs)** can be used to extract pertinent information from images.

Project Objectives

- Support the development of the WeatherCitizen crowd sourcing platform (see bottom left).
- Demonstrate advanced image based data products and derive Insights from crowd-sourced data.
- Develop real-time quality control routines for crowd-sourced image data by filtering out observations taken indoors; and provide the ability to filter images based on context such as rain or snow.

WeatherCitizen

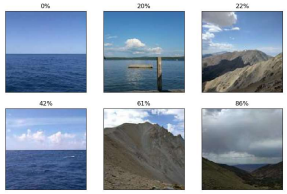
WeatherCitizen is a mobile platform for collecting and distributing crowd-sourced environmental observations. Integrated **DCNNs** facilitate the use of mobile device cameras for such observations.

Try it Now
Download the app and design/deploy your study within minutes using the public WeatherCitizen server.

Current Data Products

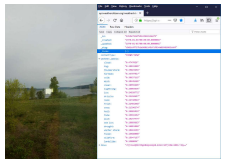
Cloud Cover

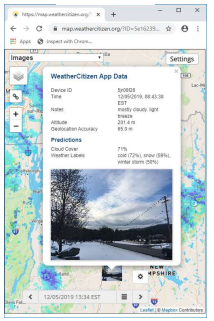
Estimation of percent cloud cover in images. DCNN learns to estimate cloud coverage even in images where sky is a small part of the image or presence of blue or reflective water could be confused with sky.



Weather Labels

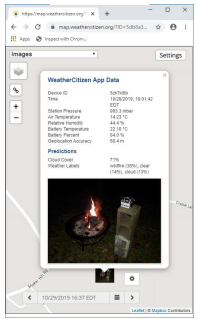
DCNN extracts independent probabilities of roughly two dozen qualitative weather specific labels from image (snow, cloud, rain, tornado, etc.).



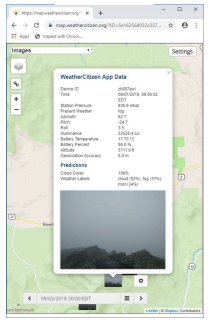


Cold, snow, and evidence of a **winter storm**

71% cloud cover



DCNN has identified potential **wild fire**



Cloud, fog, and **mist**

100% cloud cover

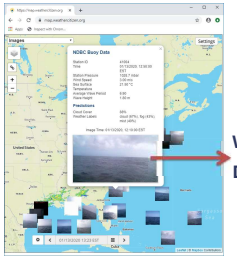
Data Sources

- NOAA National Data Buoy Center (ndbc.noaa.gov)
- Papadopoulos, Dim P., Jasper R. R. Uijlings, Frank Keller and Vittorio Ferrari. "We Don't Need No Bounding-Boxes: Training Object Class Detectors Using Only Human Verification." 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (2016): 854-863
- Onishi, R., Sugiyama, D.: Deep convolutional neural network for cloud coverage estimation from snapshot camera images. SOL Atmos. 13, 235–239 (2017)

Future Work

Sea State

DCNNs are good at recognizing texture clues in images. Using clues like identifying white caps or wave peak/trough can they estimate dominant wave period or height? This would be useful in cases where accelerometer based measurements are not feasible or would require modeling individual water vessel geometry.



Wave Height: 1.8
Dominant Period: 6.9

Cloud Type

DCNNs can estimate cloud cover in images. Can they also be used to identify cloud type? This can be indicative of weather phenomena and can indicate what altitudes the clouds are at.