# Exploring the Potential of Traffic Cameras for Ground Validation of Satellite Data

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## ABSTRACT
Time-sensitive applications may greatly benefit from use of non-ideal satellite imagery – for instance those with large swaths of thin clouds being present. One application is the study of river ice, where little data may be available if cloud-free conditions are imposed. There are many cases in which the surface is covered by thin clouds, and only some of the surface is visible. However, since clouds may cause misclassifications, it is critical to have ground based reference for both validation and calibration. Traffic cameras have the potential to be a useful and cost effective means to leverage already existing infrastructure for calibration and validation purposes. As a first

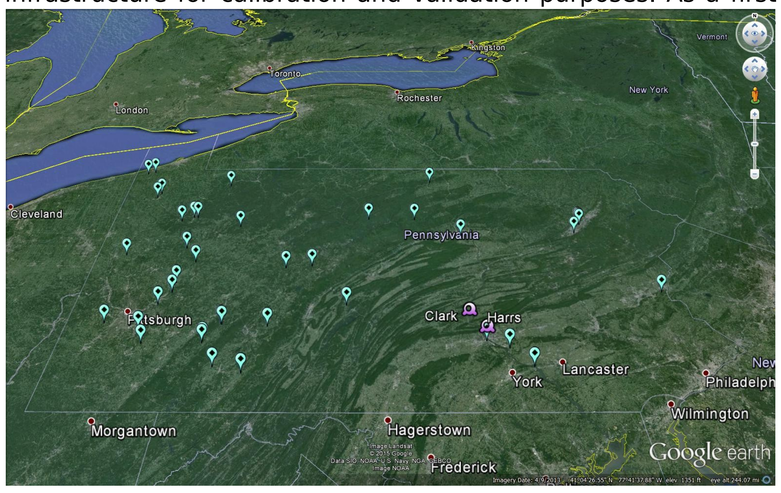


*Figure 1. Observed ice jams that were reported from January 2014- March 2015, and image was created using EarthPoint to visualize recent jam locations in the Susquehanna River Basins, Pennsylvania. Each ice jam is represented by a blue marker, and the two cameras used (Clark and Harrs) are represented by purple markers.*

## INTRODUCTION
Traffic cameras are common in urban areas, and may be accessed through the internet to observe the flow of traffic at various locations. Here, we take advantage of the fact that some of these traffic cameras also have a good view on the river. As a proof of concept of utilizing traffic cameras for environmental monitoring, we developed an algorithm to detect cars. If shown to work, the algorithm can be applied over the river to ascertain if, and how much ice is present. Eventually, traffic cameras may also be used to identify clouds, fog, water


*Figure 2. The following images represent two traffic camera images that were used to validate and calibrate car data.*

## GOAL
Develop a simple algorithm via MATLAB that accurately detects if a car is present in the region of interest.

## MATERIALS AND METHODS
First, we developed an algorithm in MATLAB. The algorithm masks out a region in an image and outputs the histogram of the Red, Green and Blue bands. Figure 3 shows the flow chart of the algorithm logic. To check if the code works as intended, we first tested cars with exaggerated colors as presented below, and examined the Red, Green and Blue color histograms. Test results are shown in Figure 4.

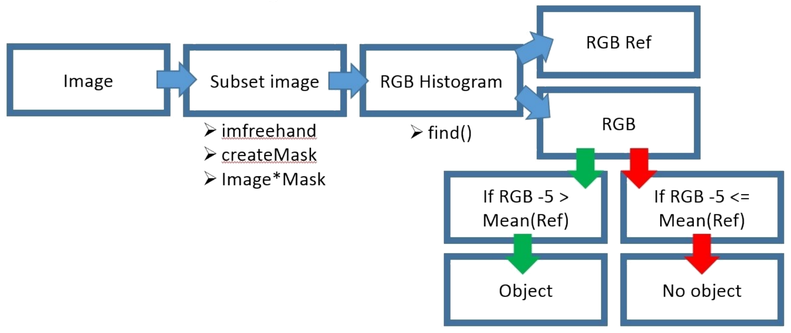


*Figure 3. Algorithm flow chart.*

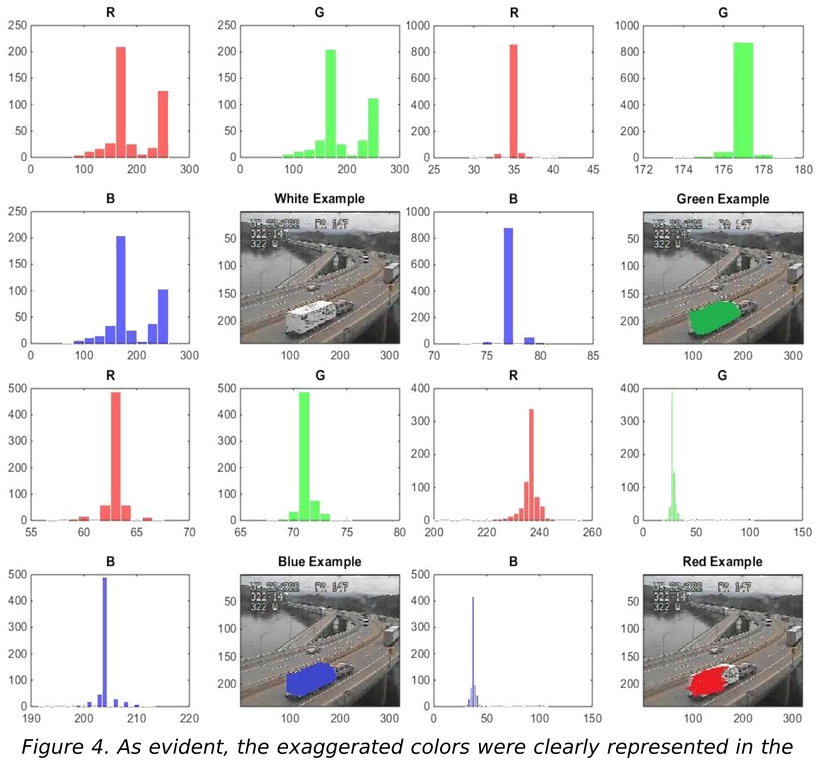


*Figure 4. As evident, the exaggerated colors were clearly represented in the histograms, and by using this concept we were able to create a code that based color off of the histogram data and displayed the color of cars in multiple traffic camera images. (x-axis= amount of color present, y-axis= counts)*

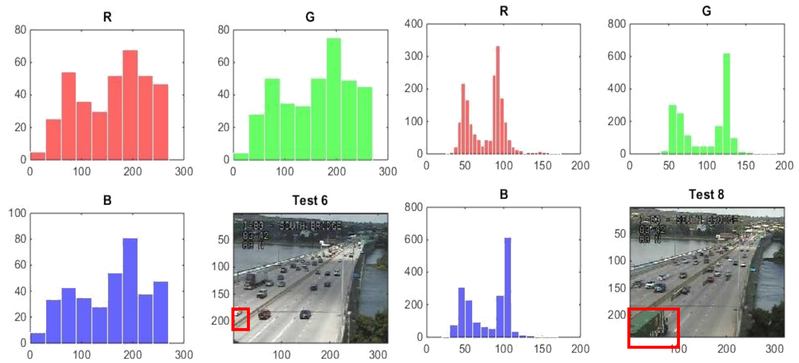


*Figure 5. Two examples of traffic camera images that were tested and validated. The left image was tested for the white truck in the bottom left corner, and the right image was tested for the green truck also in the bottom left corner, both which were identified correctly by both the histograms and algorithm.*

## OBSERVATIONS
As presented by the exaggerated colors, it is evident that the histograms accurately represented the given information. However, when we were initially given the exaggerated colored trucks, the colors were not completely filled in as presented above. This allowed for a sense of reality that allowed us to get exposed to how the histograms would actually work. By not having completely filled in colors, the histograms began to present unusually high levels of colors such as blue and green for the red truck example. This allowed us to understand that when we were actually observing the traffic cameras that the histograms would not be ideal, and would instead be a mixed representation of both the colored car/truck and the road. Thus, this exercise strengthened our ability to observe the colored vehicles.

## RESULTS

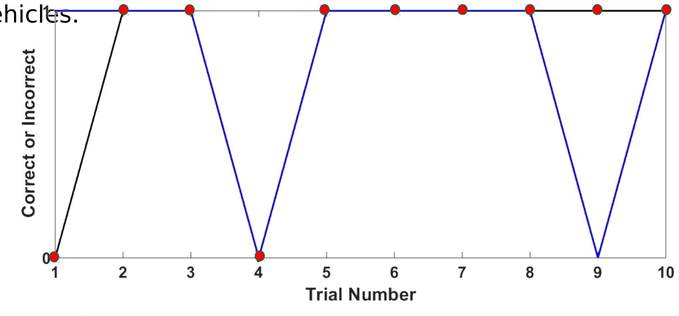


*Figure 6. The blue line represents the detections of the algorithm and the black line (with red dots) is the reference 'true' result. Here, 1 represents an object and 0 represents bare road.*

## INFERENCES/CONCLUSIONS
As presented by the information above, it is evident that the code created for both validation and calibration has a strong success rate (80%), when dealing with figures in traffic camera images such as cars. This information is quite valuable, as it suggests that it can be successfully applied over the river to search for ice.

## ACKNOWLEDGEMENTS:
This research was supported by NOAA CREST (NOAA CREST–Cooperative Agreement No: NA11SEC4810004) and funded by The Pinkerton Foundation. Special thanks to Kathy Ammari, Simon Kraatz, Dr. Reza Khanbilvardi, Dr. Shakila Merchant, and Dr. Emiko Morimoto for aiding us in the creation of this project.

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