Cloudiness Estimation for Video Meteor Observations

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1 The Problem

- Meteor triggered video cameras can't estimate cloudiness.
- Knowing cloudiness is required to track shower activity.
- Maybe another All Sky camera can be used for that purpose.

2 The Solution

Automatically process night sky images and print a table with cloudiness percentages for our field of view in the sky.

Existing Solutions

Solutions found before starting the project have issues such as:

- Only taking into account clearly visible clouds, and excluding the high night ones, where the area is just black.
- Too simple procedural solutions - fails in ambiguous situations.
- Covers the whole sky and not given field of view.

New Solution

To solve the above problems, we attempted a machine learning approach. A Convolutional Neural Network (CNN) takes a night sky image as input and outputs a "cloud map", where pixel intensity represents likelihood of that pixel belonging to a cloud.

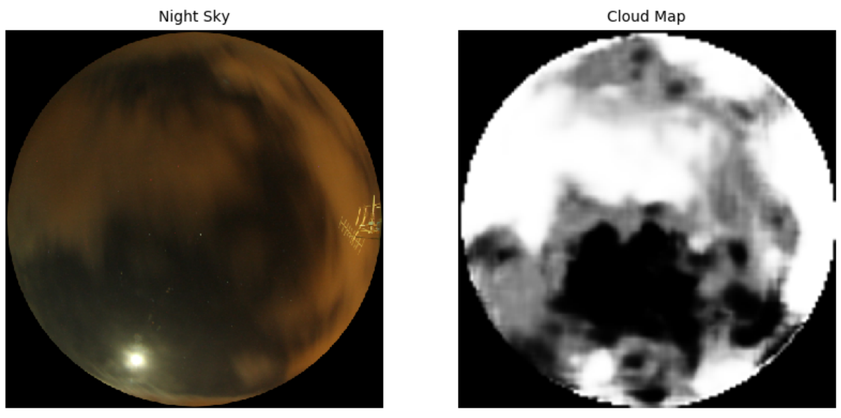

Figure 1: Input and corresponding output of the network.

Data

- Neural networks need labeled data to learn from.
- Only 200 images have been labeled for this solution.
- Partially remedied by synthesizing data. Images are rotated multiple times thanks to their circular nature.

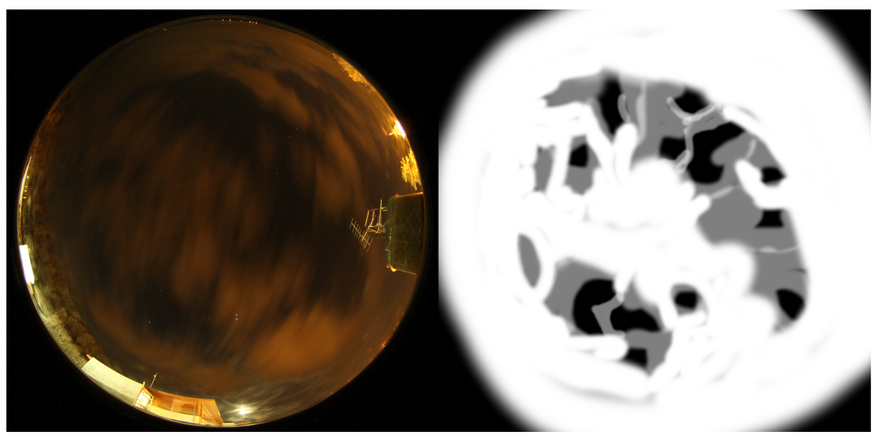

Figure 2: Night sky image and the corresponding label.

Field of View

We're interested in particular area of the sky, our field of view, given with the parameters:

- Azimuth and height of center of view
- Width of view
- Camera rotation from horizon

We calculate pixel positions of field of view by cataloging visible stars and using their pixel positions to help guide converting from azimuth and height to pixel positions for arbitrary coordinates.

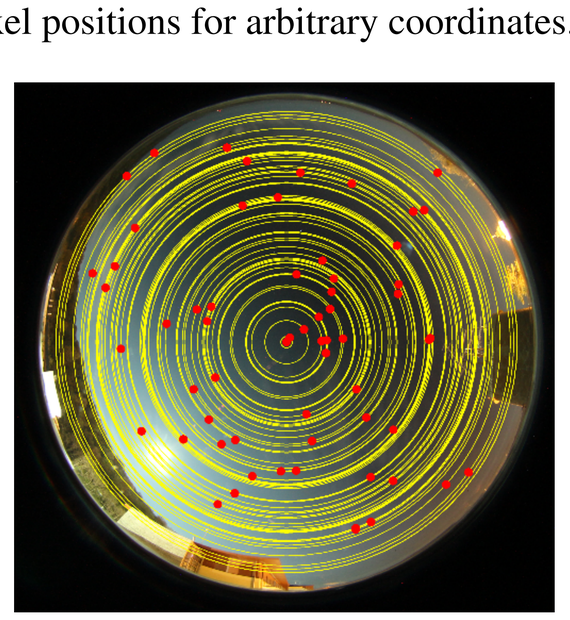

Figure 3: Red dots are the positions of cataloged stars. Yellow concentric circles represent areas of same height, as determined by cataloged stars.

System In Practice

Figure 4: Example 1

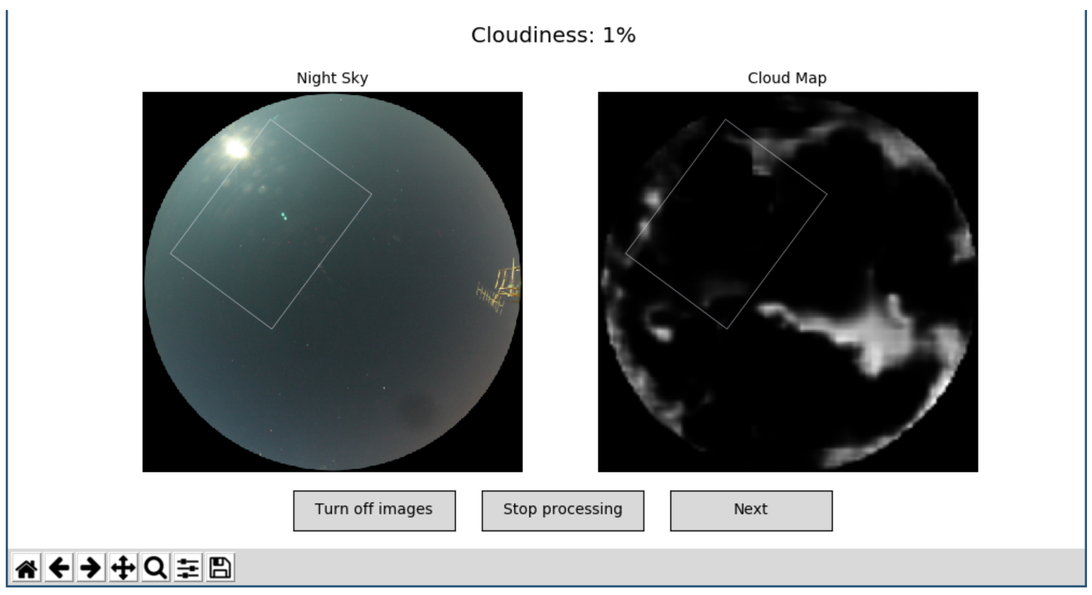

Figure 5: Example 2

3 Future Improvements

- Label more images - the more data the better.
- More complex network. Current network has limited accuracy, but runs on average computers.
- Adapt to different cameras and settings, such as brightness, exposure, etc.