# Automated Identification of Potholes Using Remotely Sensed Data

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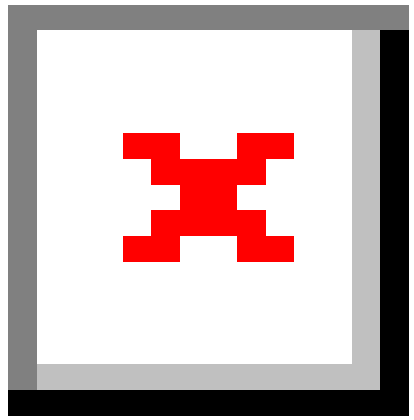
# Introduction

Transportation infrastructure is a key element driving economic growth in developing countries. World-class expressways and highways make transportation efficient. However over time this infrastructure requires maintenance. Potholes or cracks cause safety hazards and present dangerous conditions for motorists. UAV technology can be utilized to remotely capture real time road condition data. This project aims to investigate digital processing alternatives for feature identification.

# Purpose

Evaluate automated identification of roadway damage to increase efficiency of UAV employment using nearest neighbor algorithm to distinguish target features.



# Rationale

Methods must be developed to coordinate UAV flight paths pre-programmed with GPS routes according to roadway infrastructure. This aspect poses no particular issues given the reliability of conventional route programming with GPS enabled UAV units.

This proposal utilizes static images as an alternative methodology to live video for the purpose of increasing automated efficiency. In other words, this proposal intends to eliminate the need for active monitoring by a UAV pilot.

# Background

Potholes present transportation challenges often requiring constant need for repair and maintenance. Proliferation of UAV technology across a variety of applications has emerged as an economical and robust platform with which to increase roadway maintenance efficiency as well as public safety.

The present challenge concerns reliable automated identification of distressed areas of roadway infrastructure. In methods proposed by Lokeshwor Huidrom, et.al:

"pothole, cracks and patches from real life video clips of highways are detected and quantified automatically using various image processing techniques supported by heuristically derived decision logic."

# Hypothesis

Digital still frame images in the visual spectrum captured with UAV's can be processed using the Nearest Neighbor (8 pixel) formula to distinguish between pixel values for the purpose of identifying particular features – in this case areas of roadway in need of maintenance or repair.

# Methodology

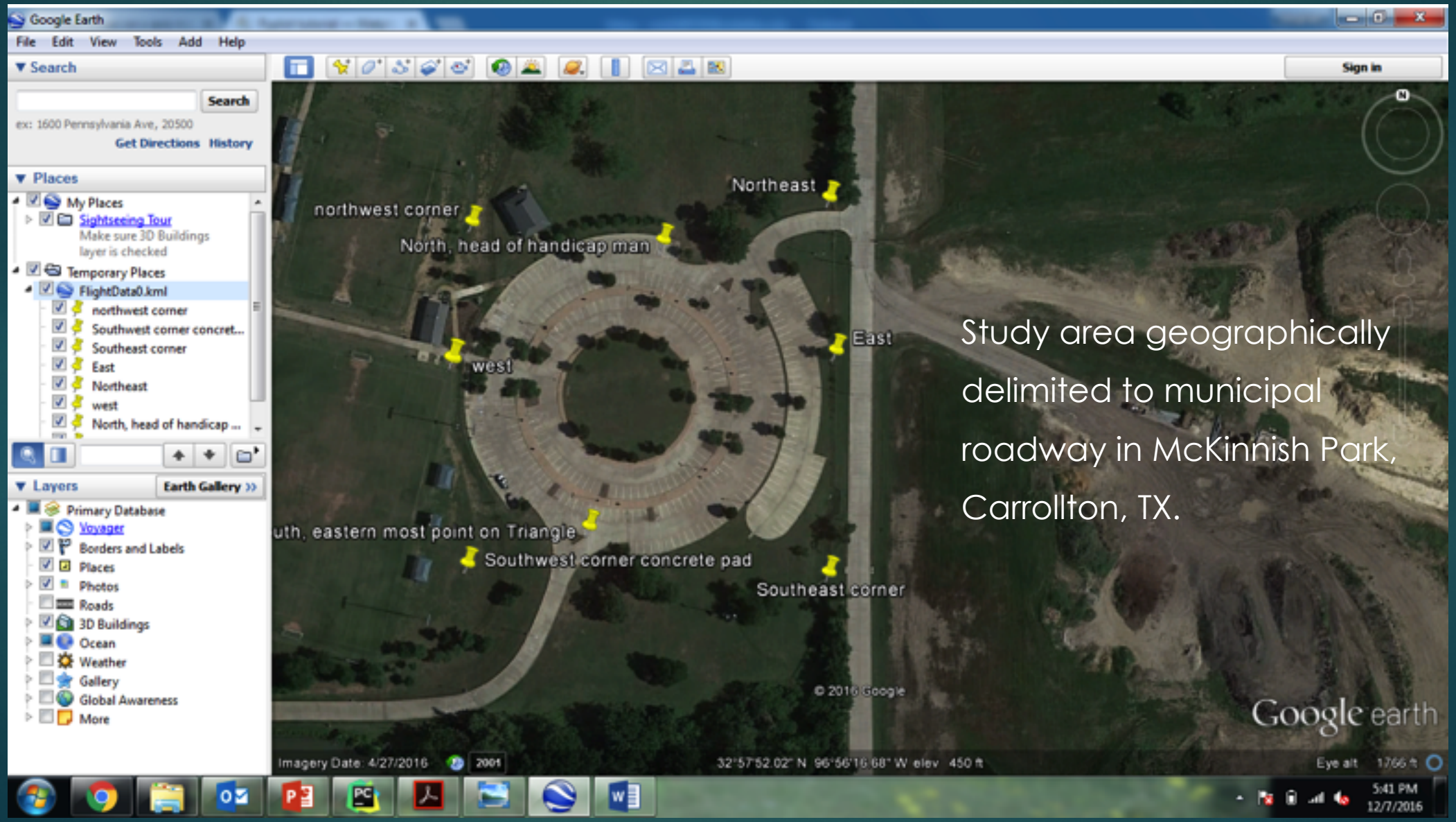
## Image Acquisition

- Acquire digital image of target feature – in this case Google Earth imagery
- Convert radiance data band (BGR) values to digital number format (DN)
- Process data in Python script via OpenCV library

## Statistical Modeling

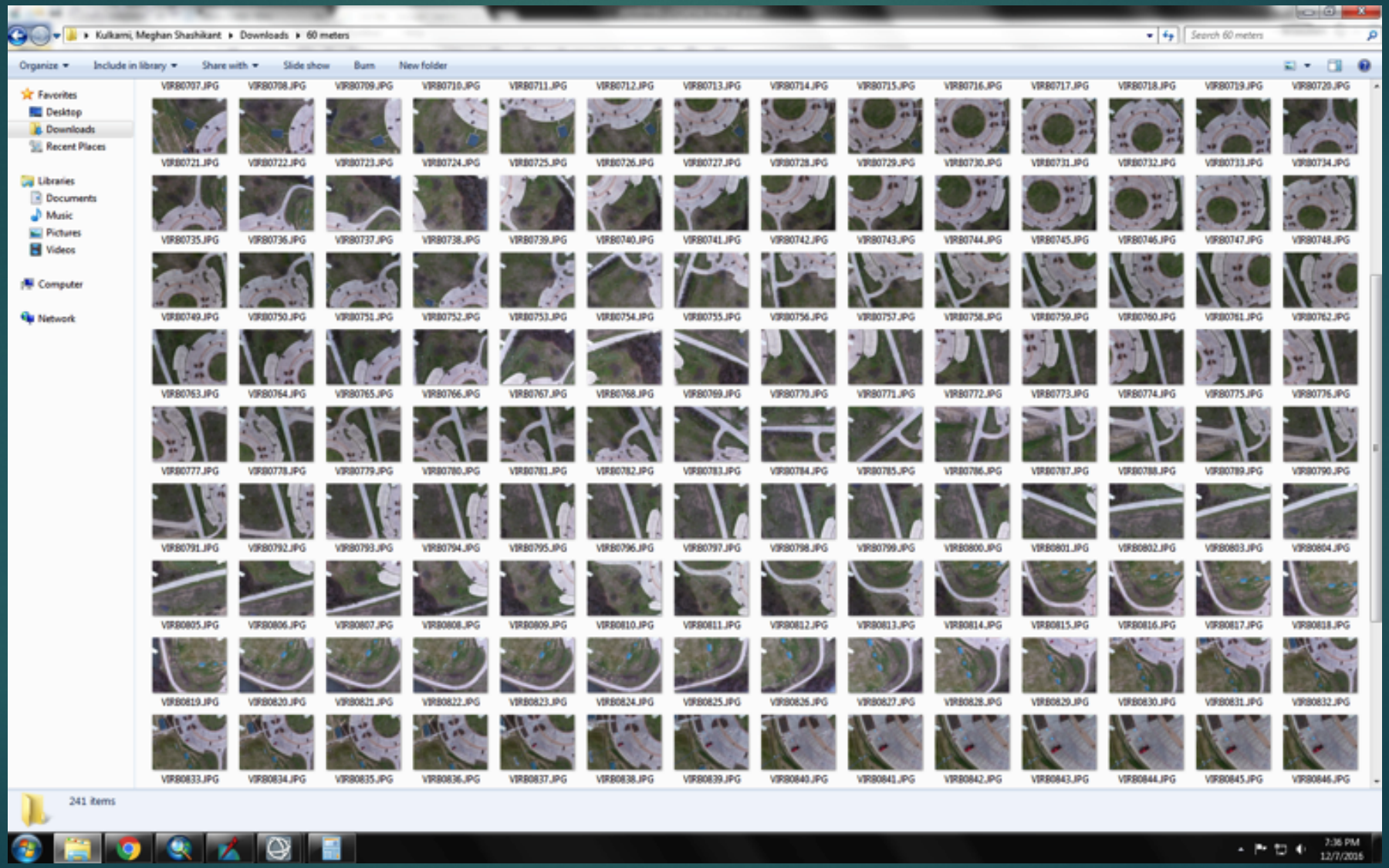
- Generate histogram by plotting BGR DN values
- Analyze histogram for max/min DN values
- Compare/contrast multiple digital image samples

# Methodology – Image Acquisition

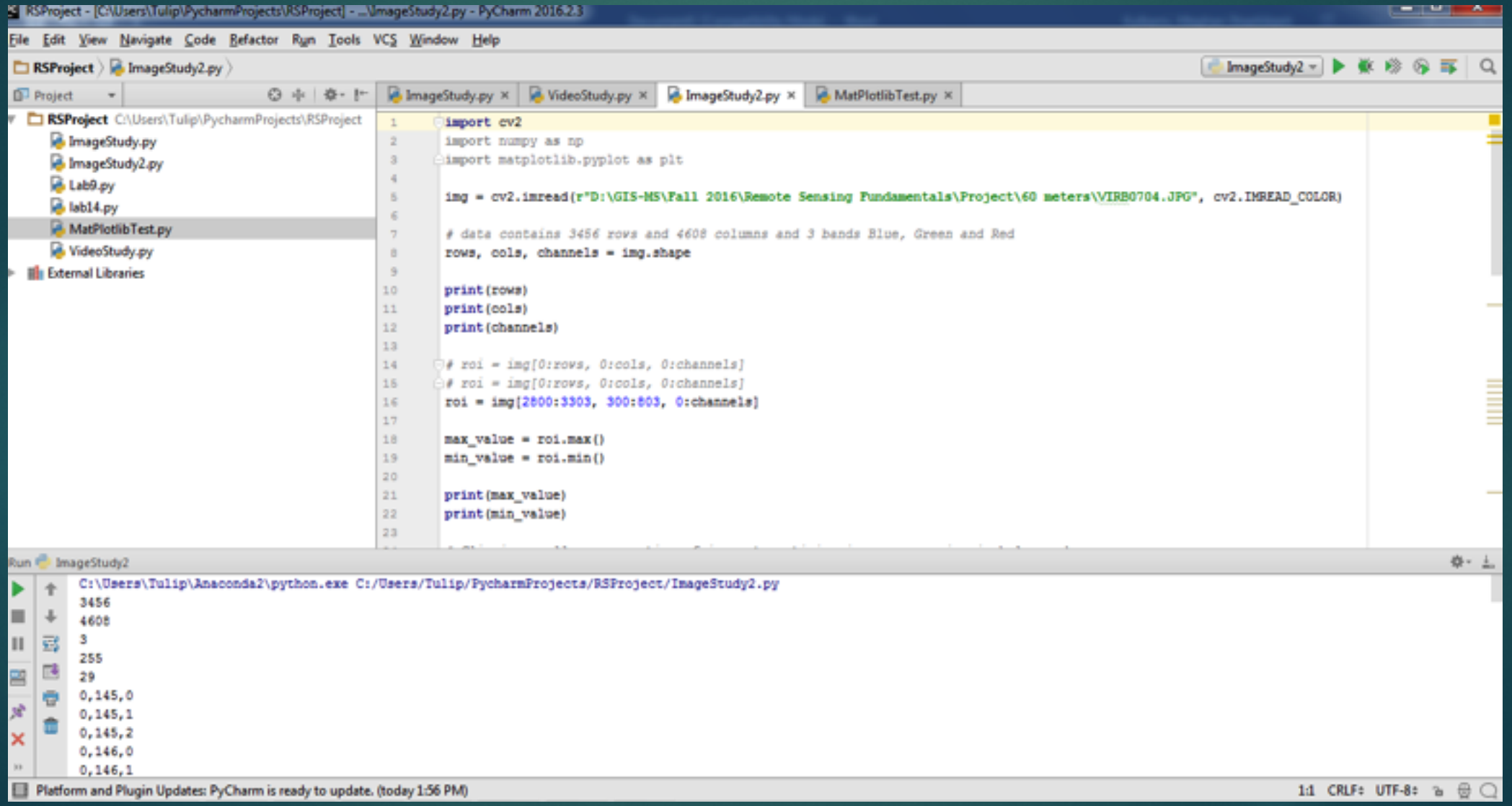



Study area geographically delimited to municipal roadway in McKinnish Park, Carrollton, TX.

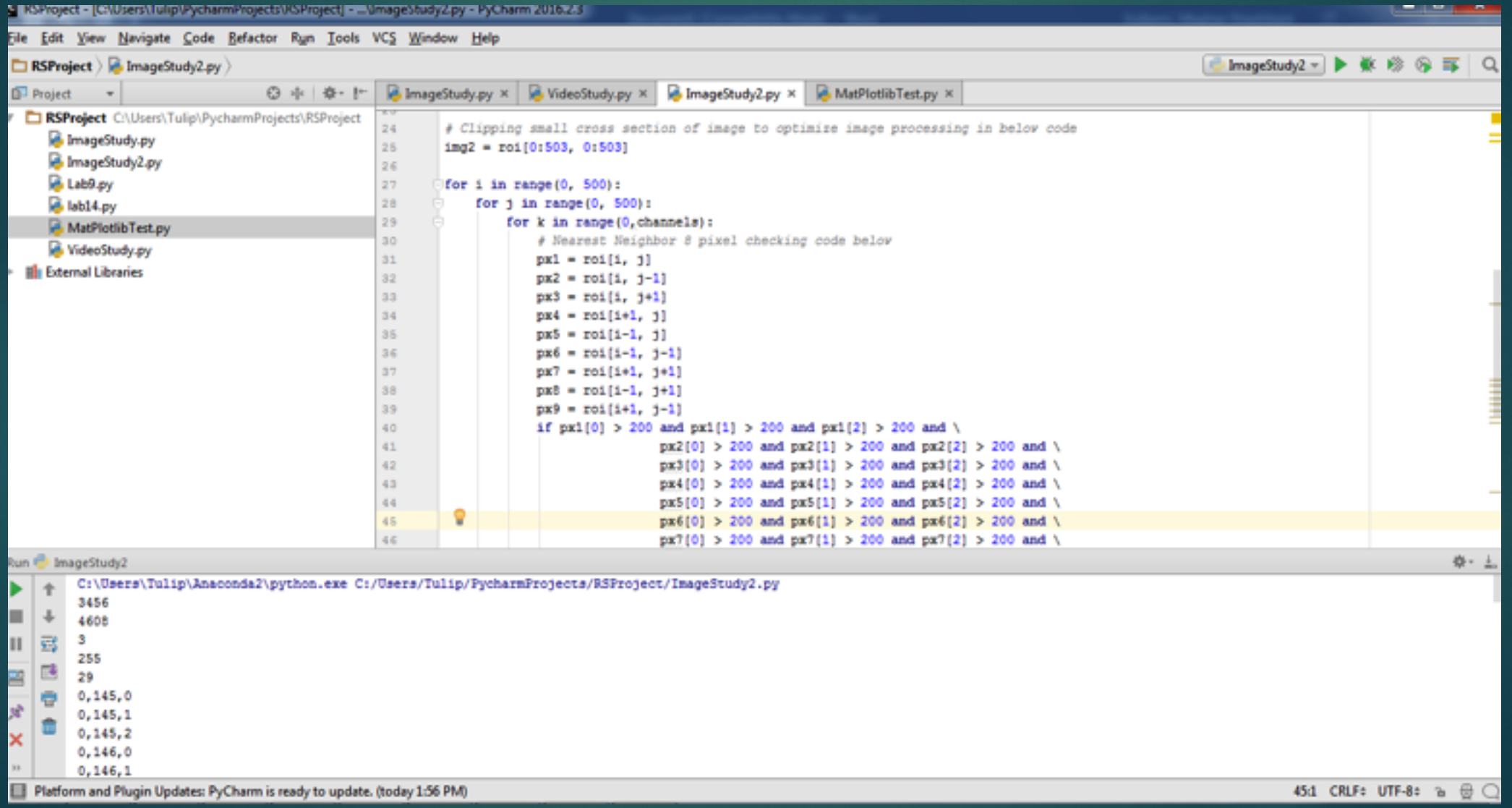
# Methodology – Image Acquisition



# Methodology – Coding & Analysis



# Methodology – Coding & Analysis



# Limitations/Delimitations

Limitations

- Employment of reliable UAV platform for adequate digital image acquisition is assumed, but not employed due to availability.

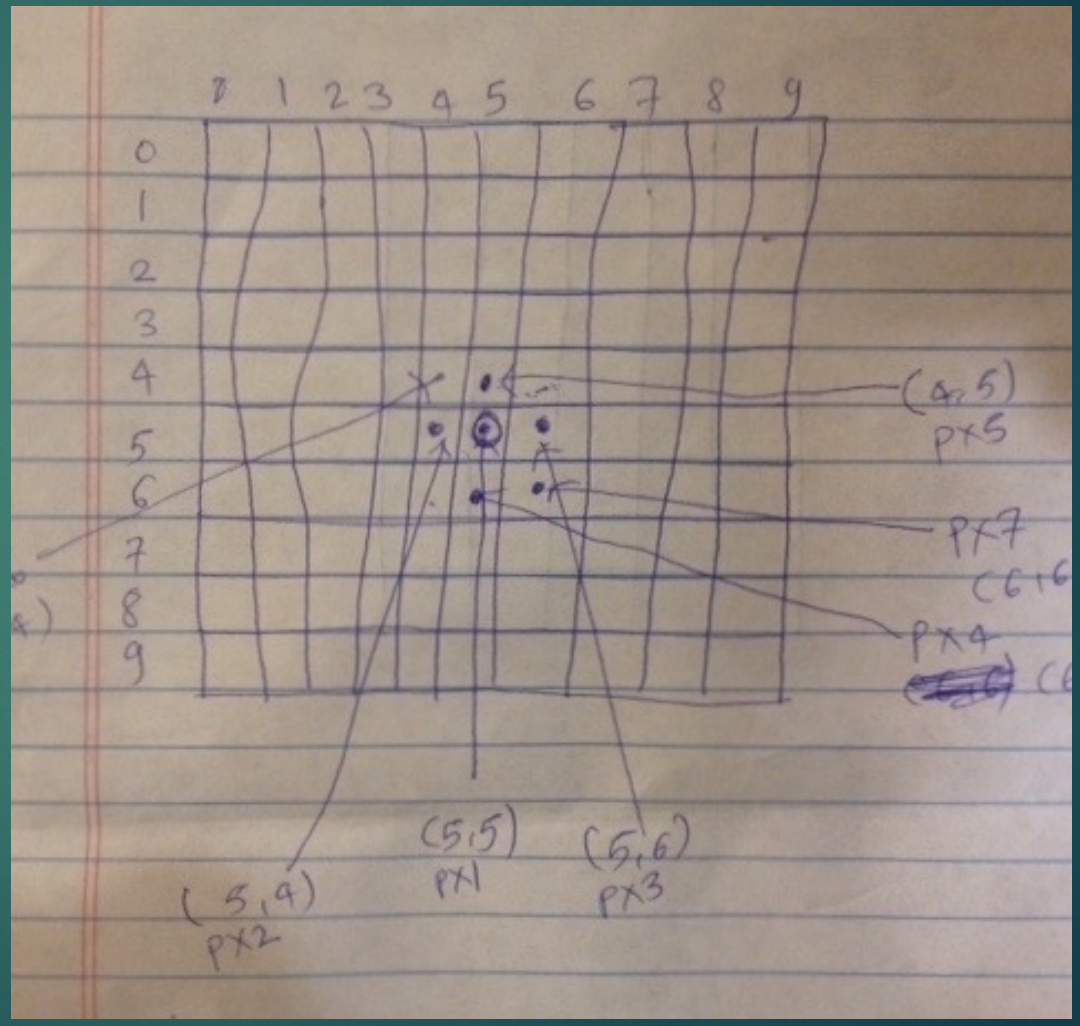
Delimitations

- Data corresponds to municipal roadway in McKinnish Park, Carrollton, TX.
- Limiting study to concrete (high reflectance) roads, pavement/asphalt roadways not included for preliminary findings.

# Definitions (Key Terms)

## Nearest Neighbor (8 pixel) Formula

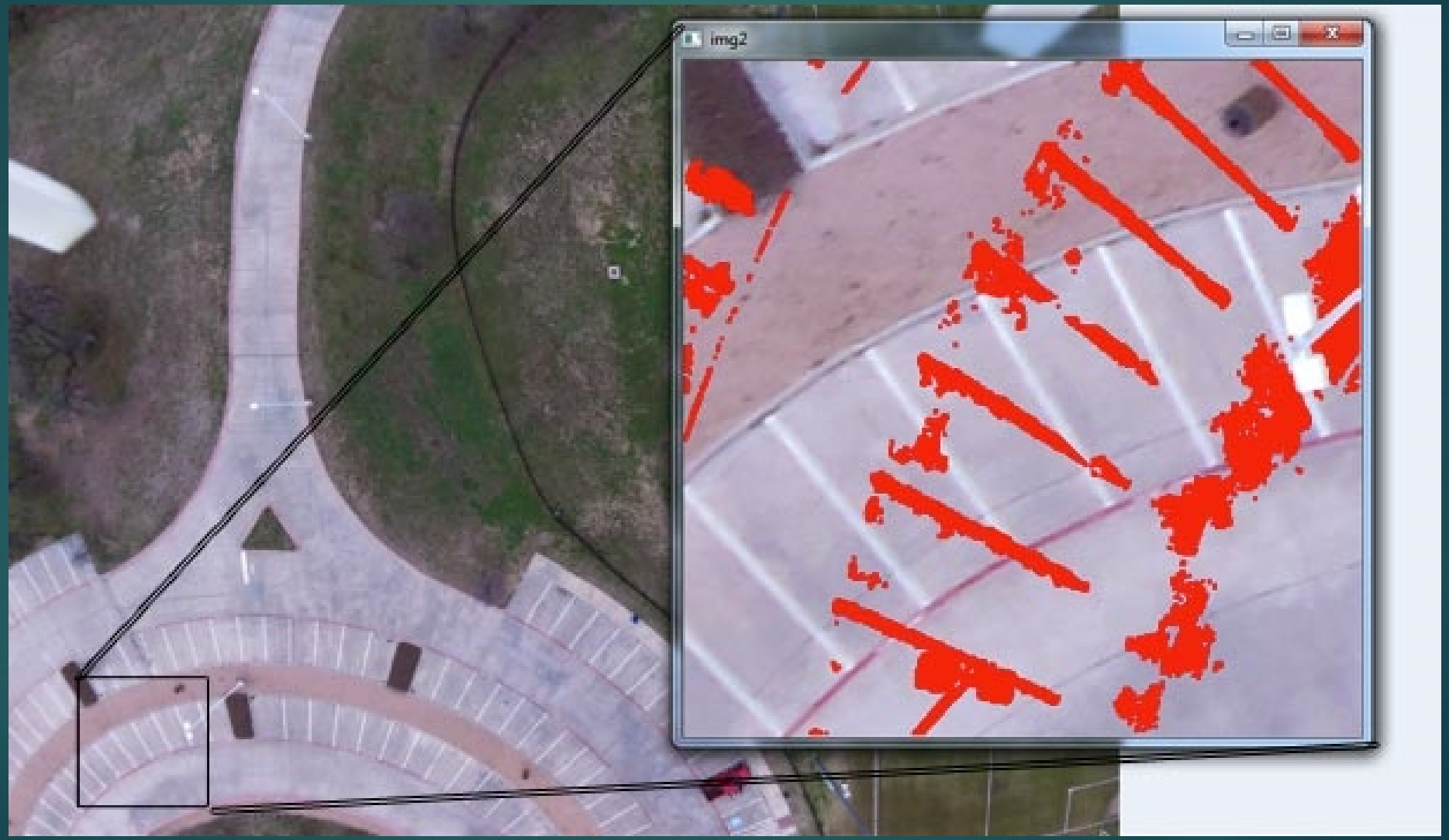
Nearest neighbor interpolation is the simplest approach to interpolation. Rather than calculate an average value by some weighting criteria or generate an intermediate value based on complex rules, this method simply determines the "nearest" neighboring pixel, and assumes the intensity value of it.



# Tools

1. OpenCV (Open Source Image Processing Library)
2. Python - NumPy Library (a part of SciPy Toolkit)
3. Google Earth for input images

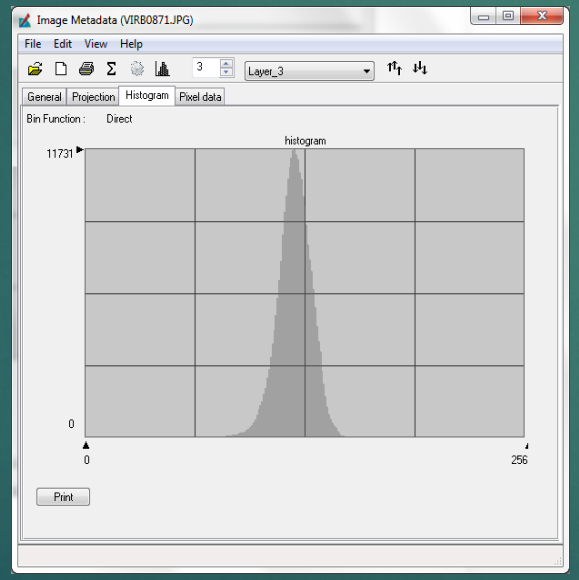
# Preliminary Results



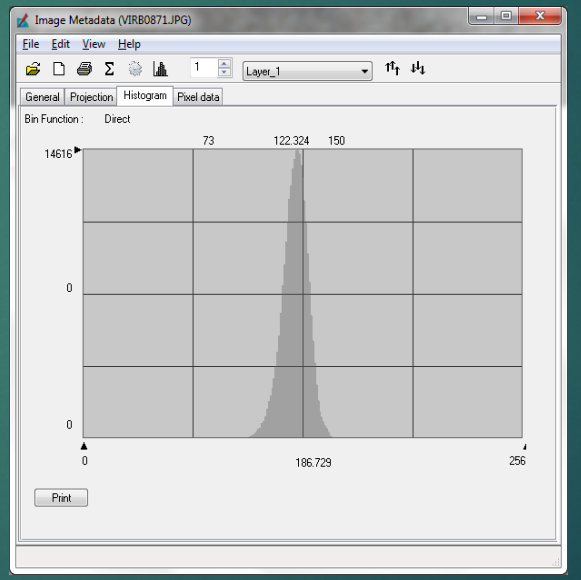
# Preliminary analytical results render homogenous target features relatively indistinguishable in all three bands (RGB).

Image Data File
VIRB0871.JPG

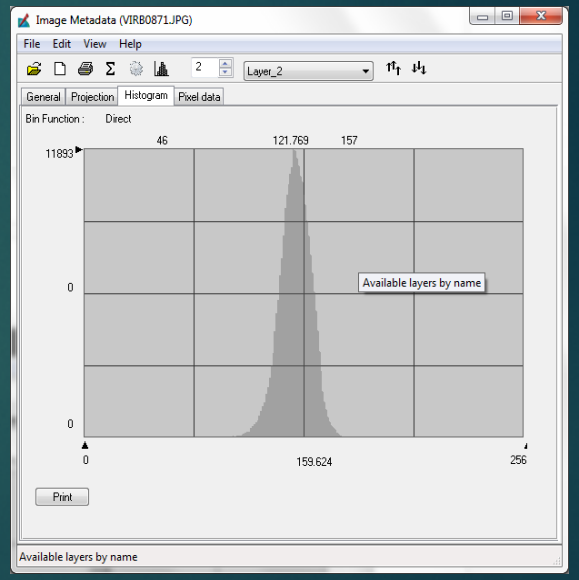
Band 1 (Blue)
Histogram




Band 2 (Green)
Histogram



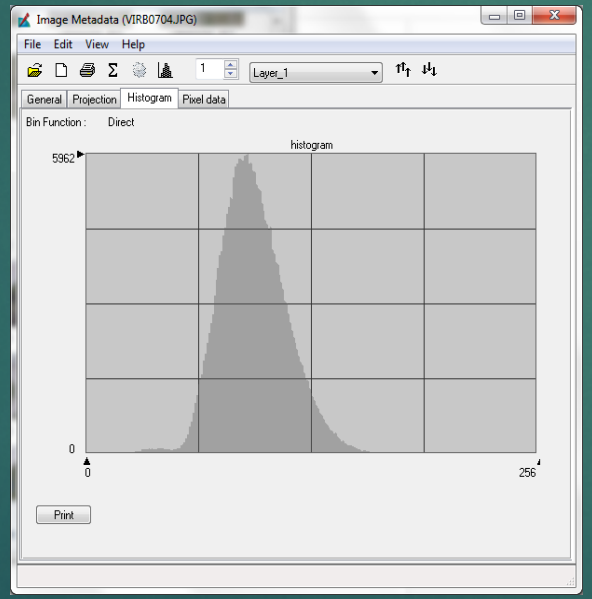

Band 3 (Red)
Histogram



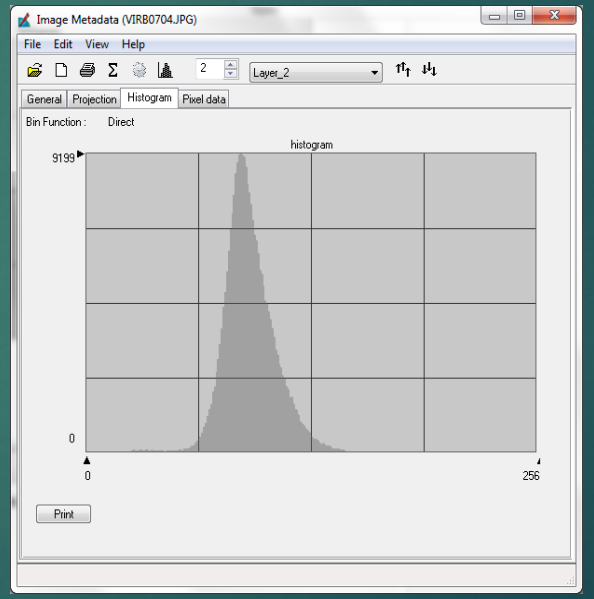
Whereas, procedures applied to contrasting pixel sets exhibit differing histogram widths according to Digital Number. Simply stated, our analytical procedure identifies target based on bands.

Image Data File
VIRB0704.JPG

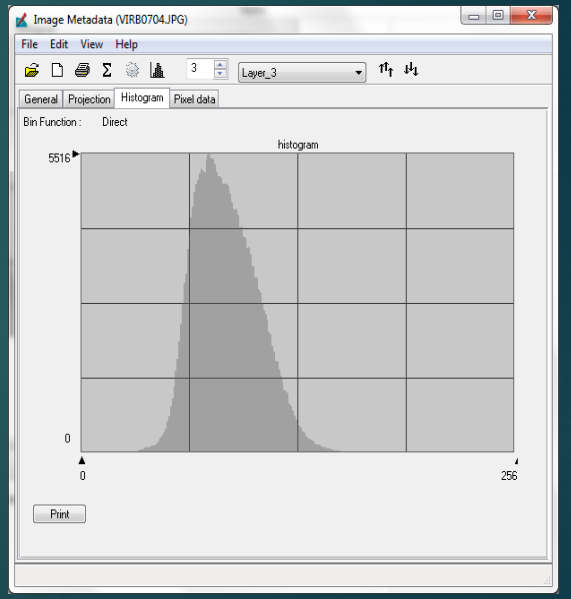
Band 1 (Blue)
Histogram




Band 2 (Green)
Histogram




Band 3 (Red)
Histogram



# References

- References:

1. L Huidrom et. al, "*Method for automated assessment of potholes, cracks and patches from road surface* video clips*", 2nd Conference of Transportation Research Group of India*

2. OpenCV with Python for Image and Video Analysis

https://www.youtube.com/watch?v=Z78zbnLlPUA&list=PLQVvvaa0QuDdttJXlLtAJxJetJcqmqlQq

3. UAV Data provided by Dr. Anthony Cummings