

MAE 6291 - Final Project Presentation

Live Image Intensity Tracker

Yazan Sawalhi, MAE

4/23/2025

Background, Motivation and Goals

- Too much light - information can be lost
- In the TFL lab, we image fluorescent particles in water to reconstruct the velocity profile of the flow
- Point Spread Function (PSF): Imaging a small point source (1 μ m) to quantify the “blurring” of our camera
- Used in a deconvolution scheme to remove blurring from the particles we image (thank you Fourier)
- The profile of the PSF is an Airy Disk, the Full Width Half Max (FWHM) of the curve tells us the lateral resolution
- We cannot have saturation, and it is tedious to determine that with conventional methods
- Goal:
 - Develop a device that takes an image of an Airy Disk
 - Plots the intensity profile and detects saturation
 - Reports back saturation and relevant statistics (FWHM)

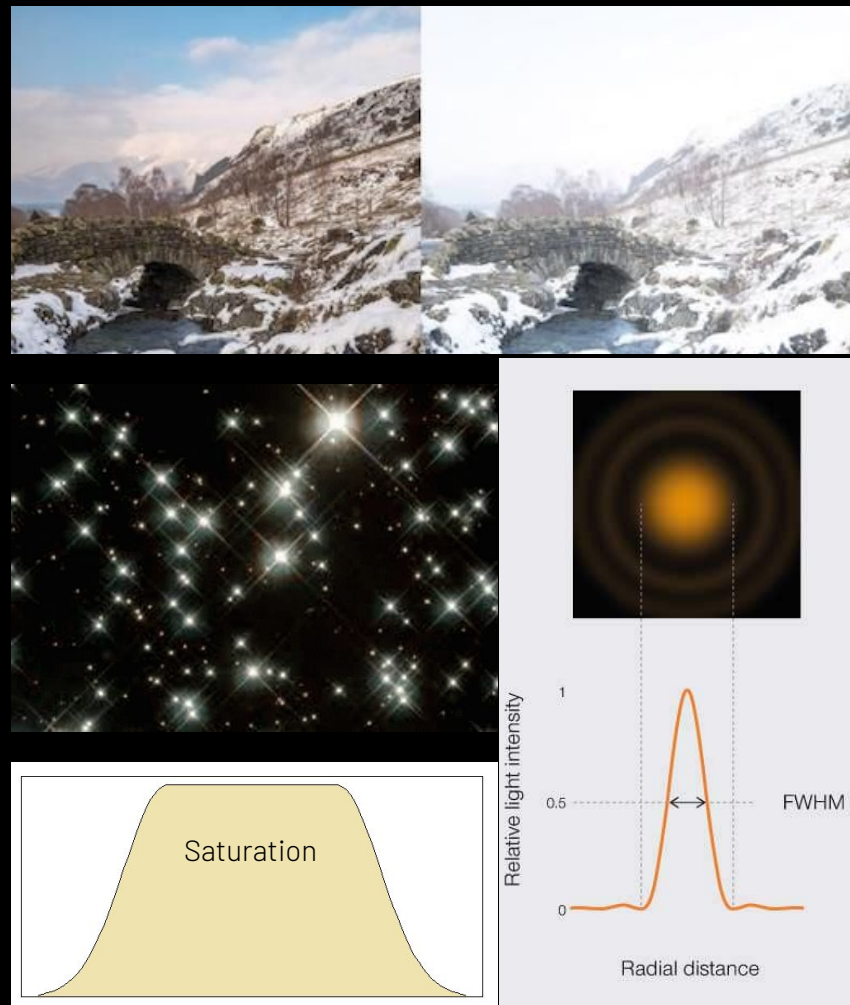


Image 1: <https://oohhighrow.com/the-exposure-triangle/>

Image 3: <https://ahbarior.rocks/knowledge-base/what-is-resolution-part-one/>

Image 4: <https://stats.stackexchange.com/questions/203629/is-there-a-plateau-shaped-distribution>

Layered Model

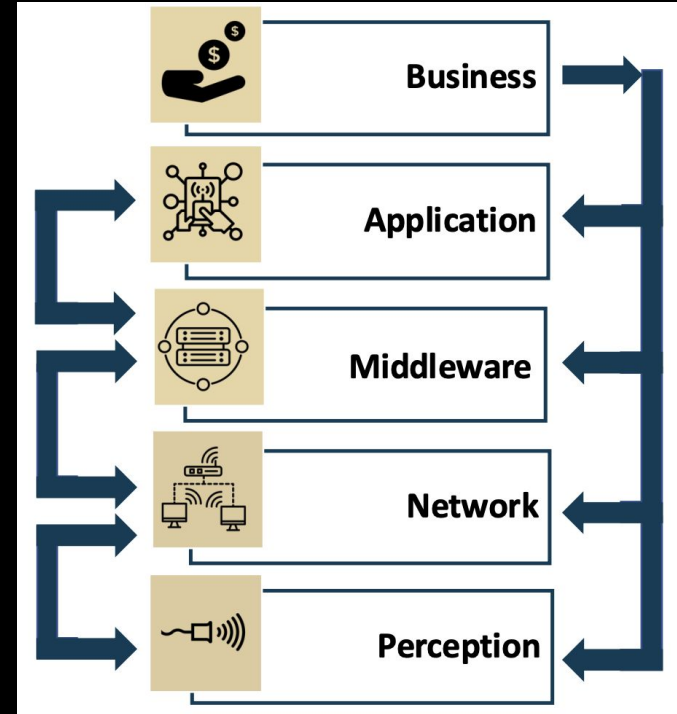
Business: Market for researchers that could do with on-the-fly data of their images

Application: A localhost web server will be created using Flask with live plot of intensity values using plotly

Middleware: RaspberryPi with Python (OpenCV library to read image as intensity values, numpy and scipy for computing)

Network: Webpage will be tunneled to the internet using cloudflare and paho-MQTT will be used to publish relevant information on the profile (whether there is saturation and the FWHM)

Perception: Camera picking up live images, a 1D slice of the intensity values of the image are used as the data to be processed and plotted



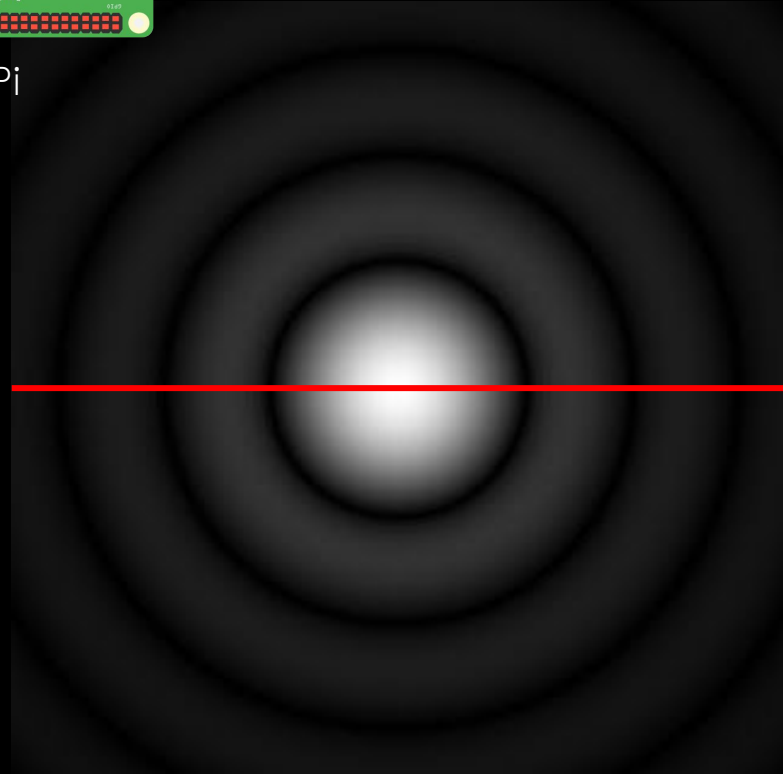
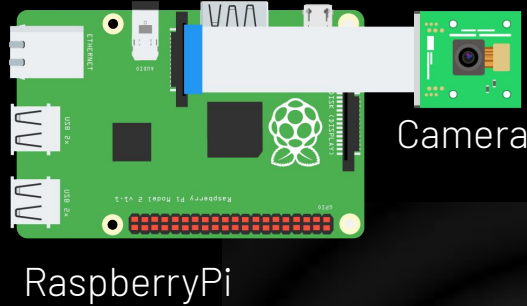
The Design/Methods

Hardware:

- RaspberryPi 4
- PiNOIR Camera: to obtain the live images
 - (3280x2464 resolution)

Edge Computing:

- Linear algebra used to grab a 1D slice of the image
- Truncate the array by taking every 80th value (41 data points)
- Signal processing for a cleaner signal using a Gaussian fit from scipy
- If the "no saturation" criteria is met, the FWHM will be calculated using numpy



Conclusions and Demo

Developed a device that can help researchers with their real-time data collection by saving time and storage

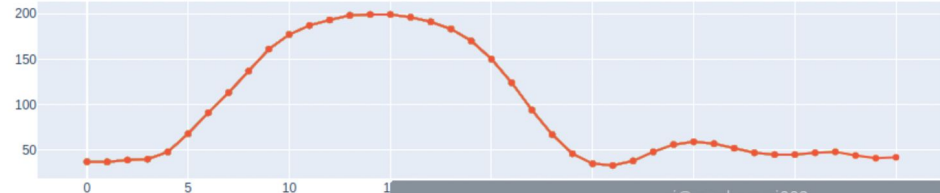
Successfully plotted the data with plotly on a Flask webserver and tunneled it to the internet using cloudflare

Additionally implemented MQTT to provide quick statistics that were computed on the RaspberryPi

This is very niche and will not have a large market as it currently stands

Improvements could be made in it's flexibility for other applications and provide even more statistics

Intensity Profile of the Image



```
pi@raspberrypi003: ~  
File Edit Tabs Help  
pi@raspberrypi003:~$ mosquitto_sub -v -t '#' -h 192.168.86.37  
Saturation: No  
FWHM: 1.3272
```