ECLIPTA FORGE

Star Constellation tracking using SSD, Yolov8 and Faster R-CNN on MobilTelesco Database

Computer Vision

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In this research project, a comparative analysis of the three light weight object recognition models: SDS, Yolov8 and Faster-RCNN are implemented on a novel dataset of astrophotographs. In the model, a position mapping of the star constellations is done through the above mentioned models and then the tracking code is to be built on the said models. The objective is to built near real time object tracking.

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Introduction

Astrophotgraphy is a complex task, the main issue with democratizing the activity to substitute the bulky and expnsive setup. The biggest impediment apart from the optical apparatus is the tracking mechanism which at times can cost even more then the telescope itself and requires dedicated calibration for each use along with a knowledge of Sidereal calculations.

To eliminate these issues and reduce complexity, one solution is to use the objects in the camera's focus to track objects in sky. This technique is not new and has been extensively used by space-borne telescopes like JWST, Hubble and Chandra X-Ray telescopes. In those satellite based telescopes, the mounted camera aims at relatively stationary stars called guide stars in the background of space and using those as guidelines, the calculations for the shift in axes is performed.

Background:

While working on creating the dataset for MobilTelesco, an image processing library, precursor to this project, I faced difficult in having to manually retarget objects in pace every couple hours. There are equatorial mounts available which are generally used for telescopes but could be modified to mount a smartphone. However, these are quiet expensive and weight nearly 30-40 Kilos along with the requirements of external power source and calibrating the GNSS unit every single time before use.

Inspired by my struggle and that of fellow amateur astronomers, I was inspired to make develop a non calculative, user friendly and self reliant technique to track objects in the night sky. While an external camera could also be used to dedicate the task of tracking, in the aim of building a project that will be accessible by most people and to limit the cost of the end device, I was motivated to build a model that runs on the images already captured within the smartphone to track the objects.

Necessity:

Capturing astrophotogrpahs is a testament to a person's skill, patience and attention to detail. This coupled with the high initial cost and lack of domain information has mystified the activity for many and reduced public interest. MobilTelesco will democratize the activity of night sky gazing using something as simple as the user's smartphone.

While the task of astrophotography may seem recreational, it is integral to bring people together for this common goal. Peering into space and grazing into the vastness of cosmos, people get a sense of togetherness, the Overview effect. This reduces psychological differences in groups of people as they understand given our differences, we are all just voyagers in the vast emptiness of the cosmos on the same small piece of blue green rock, the earth.

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Idea/Project Description:

In this project, a comparative analysis of the three fast object recognition models, Faster RCNN, Yolov8 and Single Shot Detection SSD is performed to find the best model for near real time object recognition. In the MobiltTelesco dataset currently 1000 images containing 4 constellations, 25 objects including planetary objects and distant stars are labeled and the dataset is increasing by the day.

The flow of information will be so:

1. Image captured on Smartphone

2. Sent through USB or WIFI to the GPU enabled microcontroller

3. Objects like Jupiter, Pleiades cluster are detected

4. Constellations are interpreted by the position of these objects or recognized as object themselves

5. Over every 40 images, a difference in a special co-ordinate system is performed

6. The direction of the difference is mapped.

7. Based on the direction, the servo motors are triggered

The rate, amount and direction of the tilting of the mount wild depend on the difference value coupled with the time difference in between the difference. In short the speed of the jump in the object/constellation's position.

Some specification about the data: Input data will consist of a stream on jpg image files each having a 30 seconds max exposure rate and each image of size 3000X4000 px ideally. Additionally, the size of image varies from 7-25 MB in most of the cases and the sampling rate will depend on the target but more so on the target speed as defined earlier. In long exposure shots, it has been observed that taking 10-20 reading over 100 captured images would be more than sufficient to calculate the difference along with the margin of 4-5 images were the objects would be obscured by noise.

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Requirements:

NVIDIA 7010 GPU or a MicroChip's GPU enabled microcontroller

Iterative modeling for the telescopic mount and servo motors

Currently, SSD, Yolo and Faster RCNN are available for open source use and would be used.

Teammates are required and potential candidates have been contacted.

Might need the use of High computing lab for labeling, setting up the CUDA distribution flow if required and initial testing of the CV models.

Timeline:

January - April 2025

The ideation phase is already over and even a few runs of Yolo have been done.

Immediate goals are to reach to same day labeling along with everyday data record streak.

Documentation for the project will include a research paper and will be build alongside the progress of the project.

A fully running workflow is difficult to demonstrate with hardware constraints, an object detection model is planned to be done by the end of February and a complete tracking model by mid April.

Would spend approximately 2 hours daily on labeling the images, 4 hours a week on setting up the models and later on about 14 hours a week on making the tracking mechanism.

Hours are scheduled to be changed as project progresses.

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Addendum:

https://github.com/Shantanu909/MobilTelesco

Yolov8 runs

Test run 4: https://hub.ultralytics.com/models/qxYrFDDNiiEEoEuA0pny

Test run 3: https://hub.ultralytics.com/models/ud2Y0Gog2CrPP5AZBkQl

Test run 2: https://hub.ultralytics.com/models/5eWIDvmXKj96zcLx0myb