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Final Task (project)

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project subject:
Development of an optical ground station - based on a robotic telescope for satellites tracking and imagery.

Participants:
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Abstract:

In our project we will try to build an optical ground station which will constracte from the NEXSTAR 8SE COMPUTERIZED TELESCOPE for get the imagery and Python code using the OpenCV library will be use as well for the target of detecting and tracking satellites, the ISS and other moving targets in the sky.

NEXSTAR 8SE COMPUTERIZED TELESCOPE is Celestron's signature orange-tube telescope that combines advanced features and excellent optics in one easy-to-use system, the NexStar 8SE.
One of the advantages of the chosen telescope is that its open source code is suitable for controlling the telescope mount in a python script.

To enable the telescope with X and Y motions we will need an image detection software which will guide the telescope mount.
For that matter we will divide our mission into two main tasks:

1) Motion detection algorithm - which is based on comparing the current video frame with one from the previous frames or with something that we'll call background will show as all the moving objects in the frame.

This will be useful to sense the objects, satellites are very hard to detect with human eye and we will want to be able to determine all the moving objects and categorize them.

2) Enable to lock on specific targets and use optical flow concepts of estimation using Lucas-Kanade method to keep on tracking the object we chose.

In the next link we include a short video to demonstrate the use of the system on the last experiment we made during class https://youtu.be/7Gz70xCxhMI .

We can see all the moving objects in the frame and when locking on the object of choice we can get the object position in the frame and calculate the movement of the telescope to keep it in the center.

By receiving the tracked object data (x,y coordinates in the frame) we would be able to direct the telescope to this object automatically by tilting it to the same direction in which the object is located from the center of the frame.
(for example if the object found in the top of the frame we know to move the telescope upward).

Background material:

- Computer vision based on real-time tracking system.
  https://pure.unileoben.ac.at/portal/files/2374320/AC15019735n01.pdf

- implementation of software for object tracking.
  Article 1

- target tracking.
  https://iopscience.iop.org/article/10.1088/1742-6596/1454/1/012007/pdf

- Open source for object tracking:
  https://github.com/shaanchandra/Multi_Object_Tracking/tree/master/results

- Nexstar 8se computerized telescope -api.
  https://www.celestron.com/products/nexstar-8se-computerized-telescope

- Object Tracking in Satellite Videos Based on a Multi-Frame Optical Flow Tracker.
  https://arxiv.org/ftp/arxiv/papers/1804/1804.09323.pdf

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Project work process:

- The first working process will be to fix the object tracking program so we will be able to track small light moving in the sky (such as satellites ,airplanes, Space Stations in space).

- The next step will be to get from the program movement commands based on the object location.

- The last part will be to integrate the object tracking and movement commands to a complete system which will be able to move the telescope position to keep the desired object in the center of the frame while keeping the telescope movements steady as possible to prevent the frame from get out of focus which will results in blurry image (making it easier to identify).

Requirements:

-Camera (can be pc camera that mounts to the telescope).
-PC (laptop) with Python & OpenCV libraries.
-Telescope. (NEXSTAR 8SE COMPUTERIZED TELESCOPE).
-Telescope tripod with DC motors.
-Connection cables between the PC and the telescope.
-(Optional) Microprocessor - for controlling the tripod DC motors.