A machine learning approach for UAV-based ground target geolocation in aerial images

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Contents

Introduction

1. Quadcopter aircrafts are widely used in security, rescue, plant protection, transportation, and other fields.
2. Real flight issues: assembly, maintenance, battery and so on.
3. These factors affect flight efficiency and extremely extend the development cycle. Therefore, simulation environments for the quadcopter test is used.
4. Simulation platforms: Gazebo [1] [figure 1], jMavSim [2] [figure 2] and so on.
5. Gazebo is widely used in the robots, cars, and drone simulation.

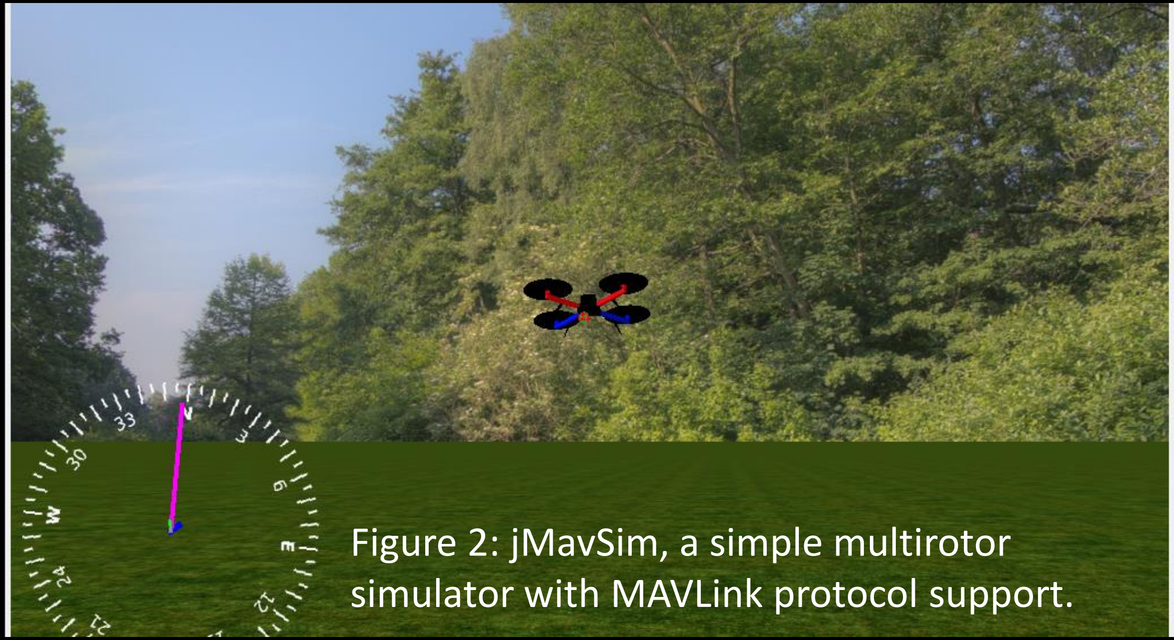
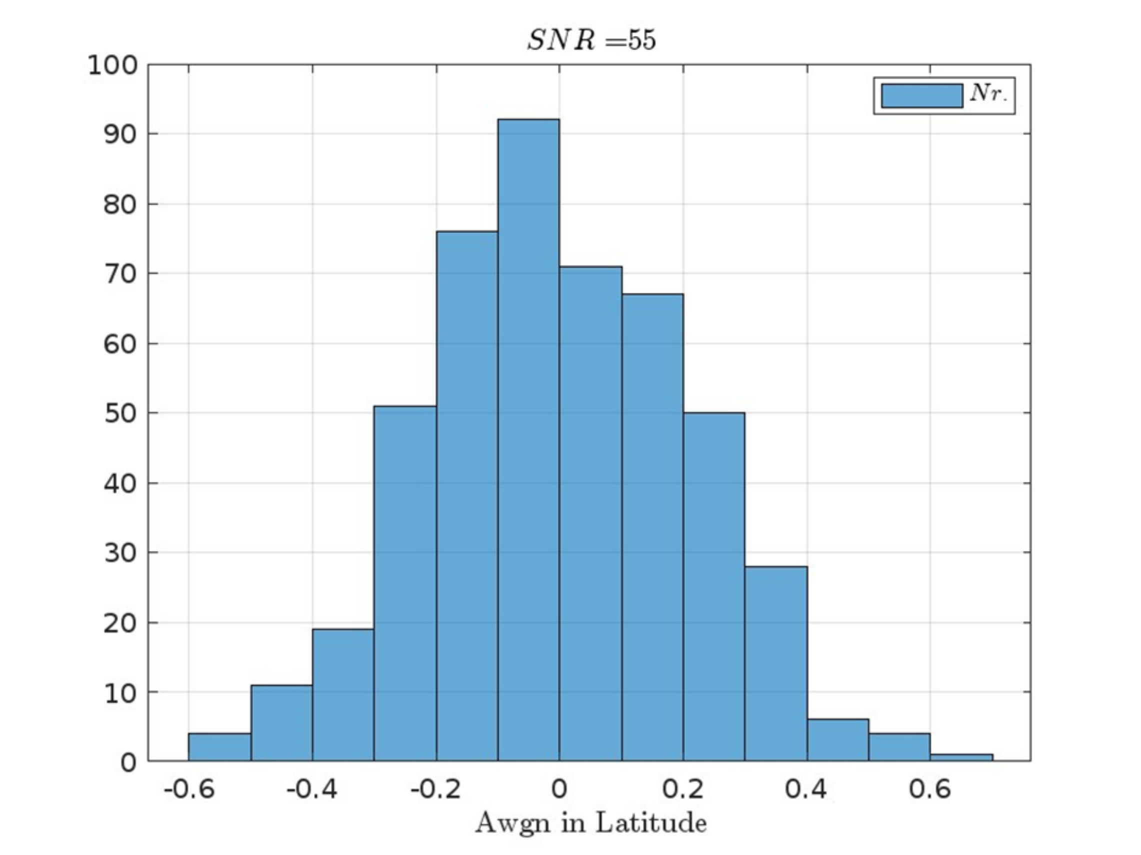


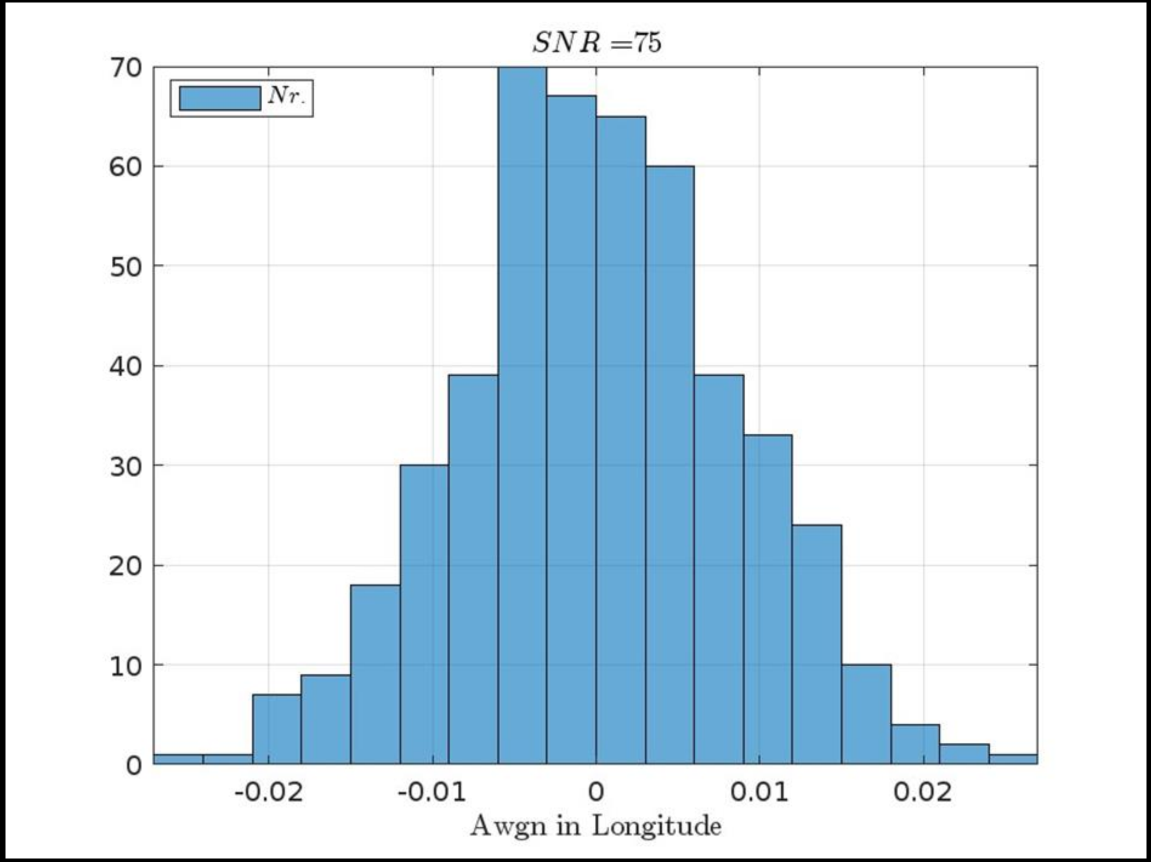
Figure 2: jMavSim, a simple multirotor simulator with MAVLink protocol support.

Figure 3: AirSimNH environment.

Figure 1: Gazebo drone fleet simulation.

Methodology

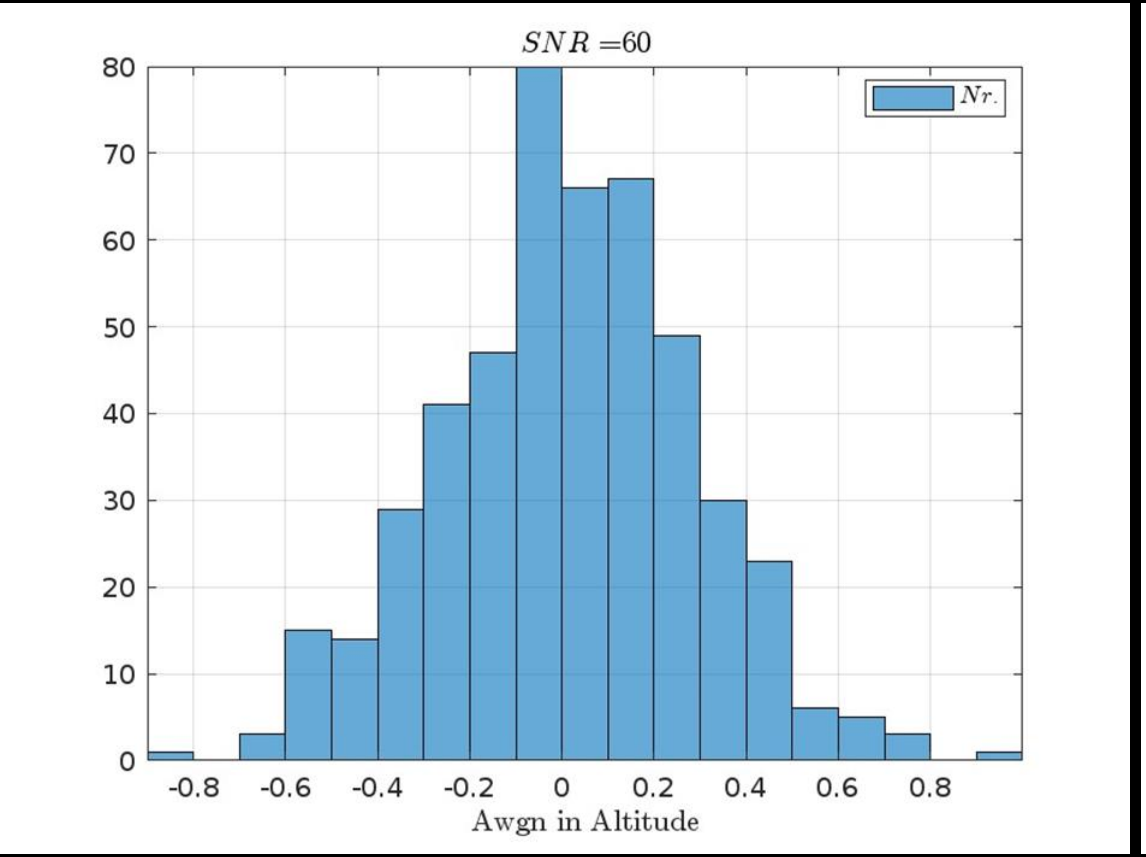


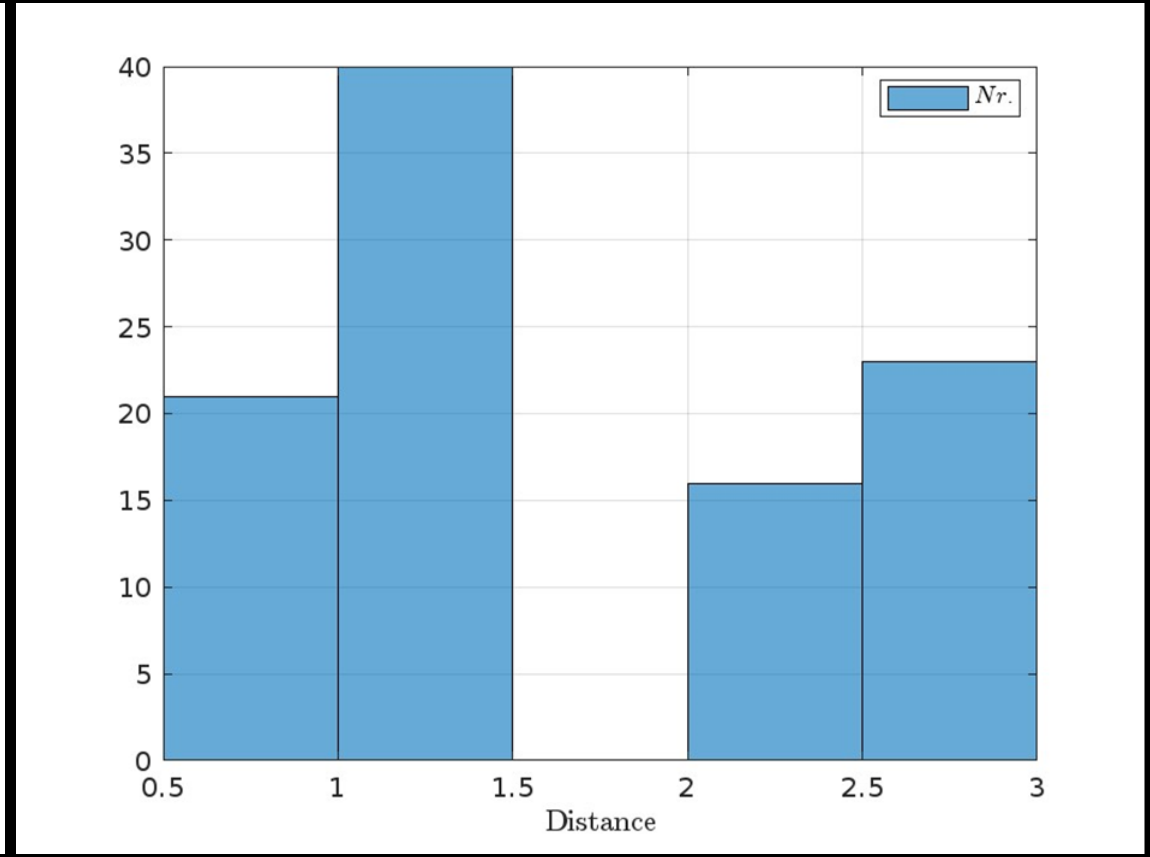


Altitude	Longitude	Latitude	PixelX	PixelY	YLatitude
123.7985229	-122.140125	47.6419267	256	144	47.6419267
174.5480347	-122.140165	47.6419267	257	167	47.6419267
174.8162537	-122.140165	47.6419267	257	168	47.6419267
176.4992676	-122.140165	47.6419267	257	169	47.6419267
177.9062653	-122.140165	47.6419267	257	169	47.6419267
178.6100311	-122.140165	47.6419267	257	171	47.6419267
180.3651276	-122.140165	47.6419267	257	171	47.6419267
181.2619781	-122.140165	47.6419267	257	171	47.6419267
182.8026276	-122.140165	47.6419267	257	173	47.6419267
184.0067596	-122.140165	47.6419267	257	173	47.6419267
185.7004089	-122.140165	47.6419267	257	174	47.6419267
186.8738556	-122.140165	47.6419267	257	176	47.6419267
187.9985809	-122.140165	47.6419267	257	176	47.6419267
189.4416962	-122.140165	47.6419267	257	177	47.6419267
190.2579041	-122.140165	47.6419267	257	177	47.6419267
191.8865051	-122.140165	47.6419267	257	177	47.6419267
193.0978851	-122.140165	47.6419267	257	178	47.6419267

Haversine distance

$$D(x,y) = 2\arcsin[\sqrt{\sin^2((x_{lat} - y_{lat})/2) + \cos(x_{lat})\cos(y_{lat})\ sin^2((x_{lon} - y_{lon})/2)}]$$

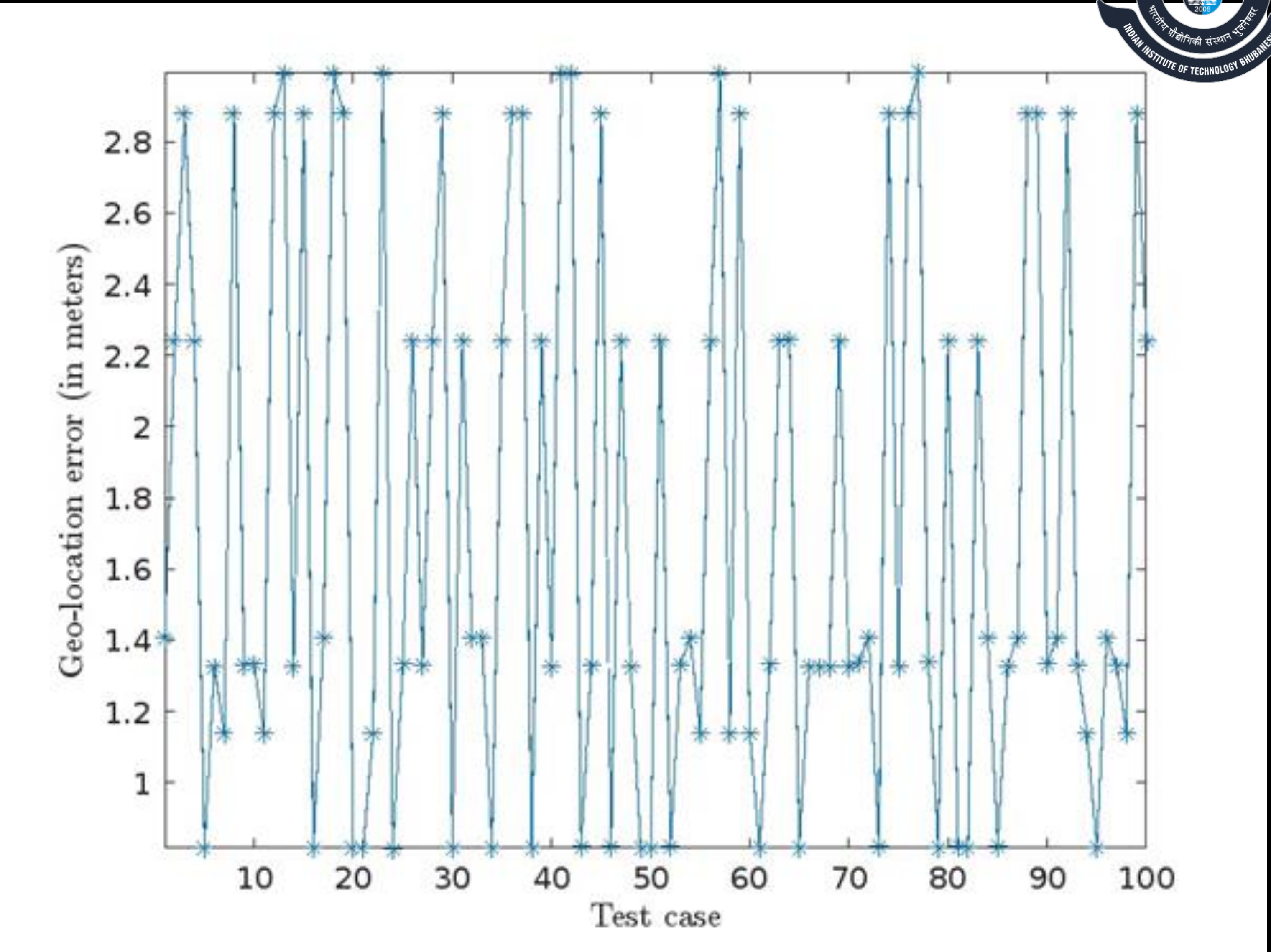




Results

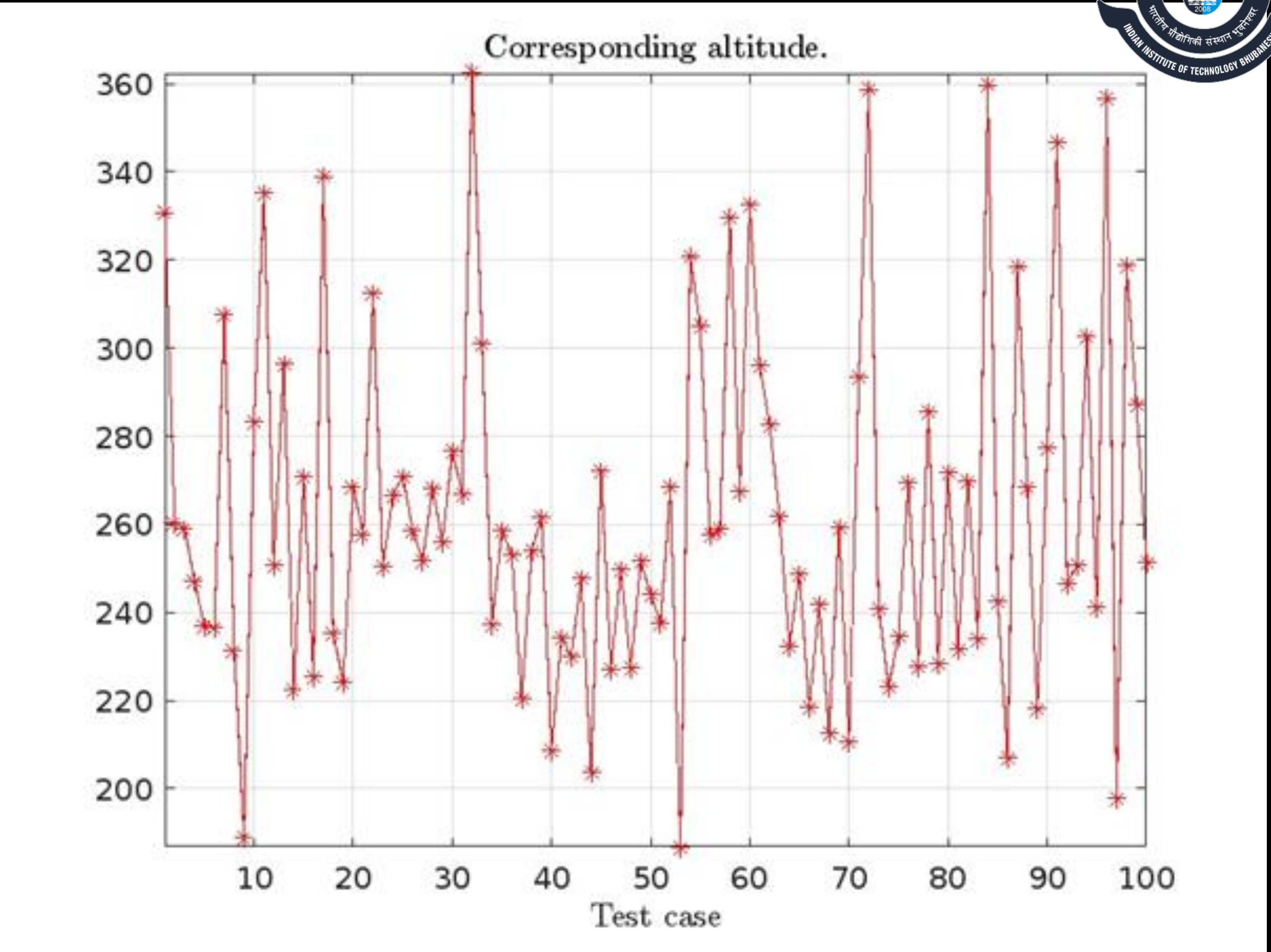
Sr. Nr.	Drone		Target		Distance
	Latitude	Longitude	Latitude	Longitude	
1	47.64192669	-122.140165	47.64192669	-122.1401251	1.91 nm
2	47.63749272	-122.140165	47.64185602	-122.1384163	3.88 nm
3	47.63749273	-122.140165	47.64116615	-122.1384163	9.94 nm
4	47.63749272	-122.140165	47.641468	-122.140165	7.07 Å
5	47.63749253	-122.1401649	47.63749253	-122.1401649	1.7 mm

Results



Geo-location error (in meters)
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
10 20 30 40 50 60 70 80 90 100
Test case

Results



Corresponding altitude.
360
340
320
300
280
260
240
220
200
10
20
30
40
50
60
70
80
90
100
Test case

Future Work

1) Some more sets of images, n target locations will be acquired for training, testing and validation.
2) Moving vehicle detecting, tracking, and geolocating.
3) Efficiency for small object detection in complex scenes.
4) Flight control method in terms of the previous image processing results to lead the UAV that is following the moving vehicle.
5) Optional parameters: Gimball's roll, pitch, yaw; Target altitude, TimeOfDay

References

1) N. Koenig and A. Howard, "Design and use paradigms for Gazebo, an open-source multi-robot simulator," *2004 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) (IEEE Cat. No.04CH37566)*, Sendai, Japan, 2004, pp. 2149-2154 vol.3, doi: 10.1109/IROS.2004.1389727.
2) *jMAVSim*. url: https://github.com/DrTon/jMAVSim.
3) S. Shah, D. Dey, C. Lovett and A. Kapoor. "AirSim: high-fidelity visual and physical simulation for autonomous vehicles". In: *IEEE Transactions on Geoscience and Remote Sensing* (2017), p. 14.

THANK YOU