Geolocalization App

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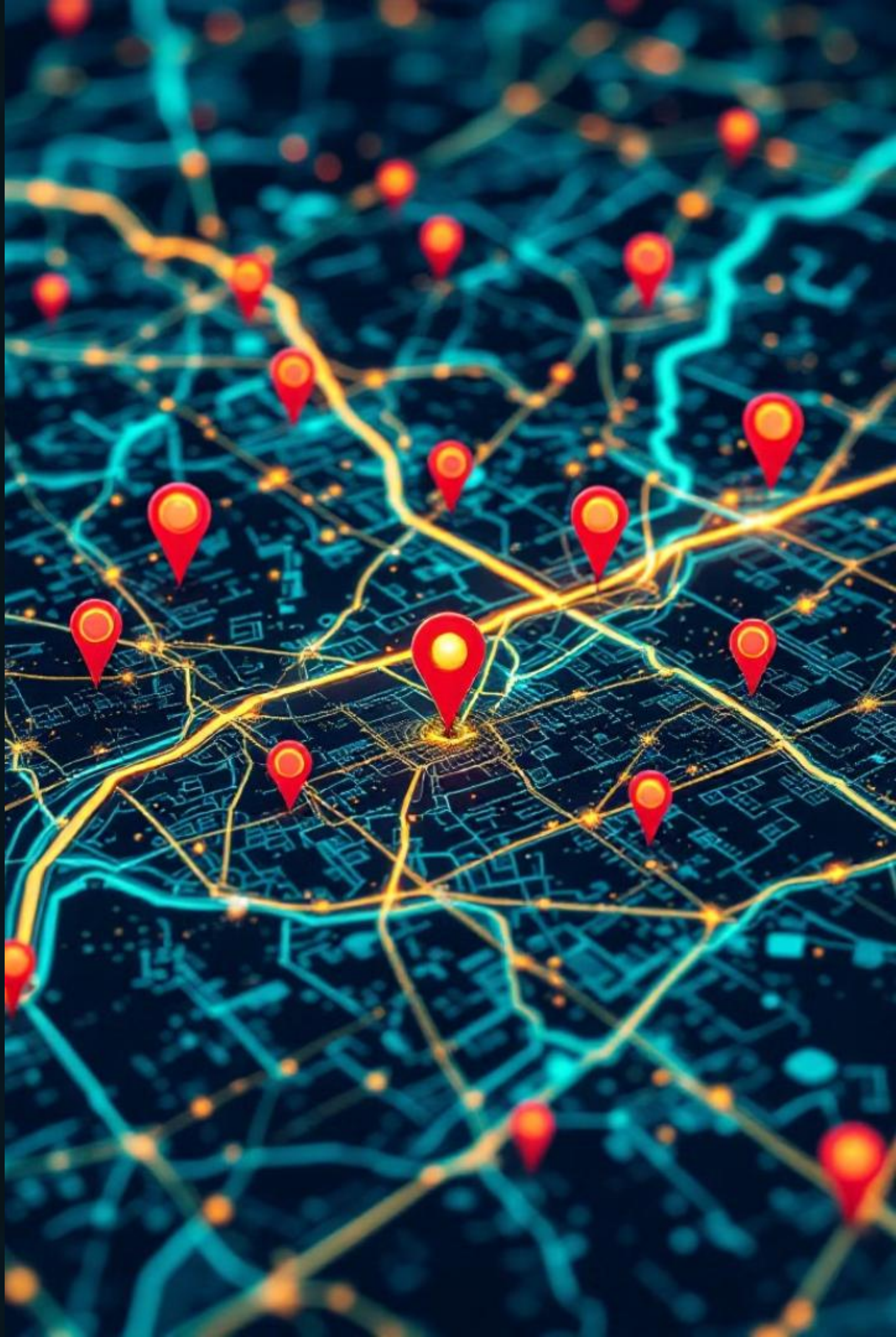
Under the Guidance of "Prof. Karim Hammoudi"



What is Geolocalization?

Geolocalization determines an object's geographic location using visual data.

It compares **unknown images** with **known images** to find matches and infer location.

Real-World Examples

- Google Lens identifies locations from photos
- Autonomous cars use image-based navigation
- AR apps overlay content using landmarks

Why It Matters

Problem Statement

Objective

Estimate a test image's location by comparing it with training images that have known coordinates.

Methodology

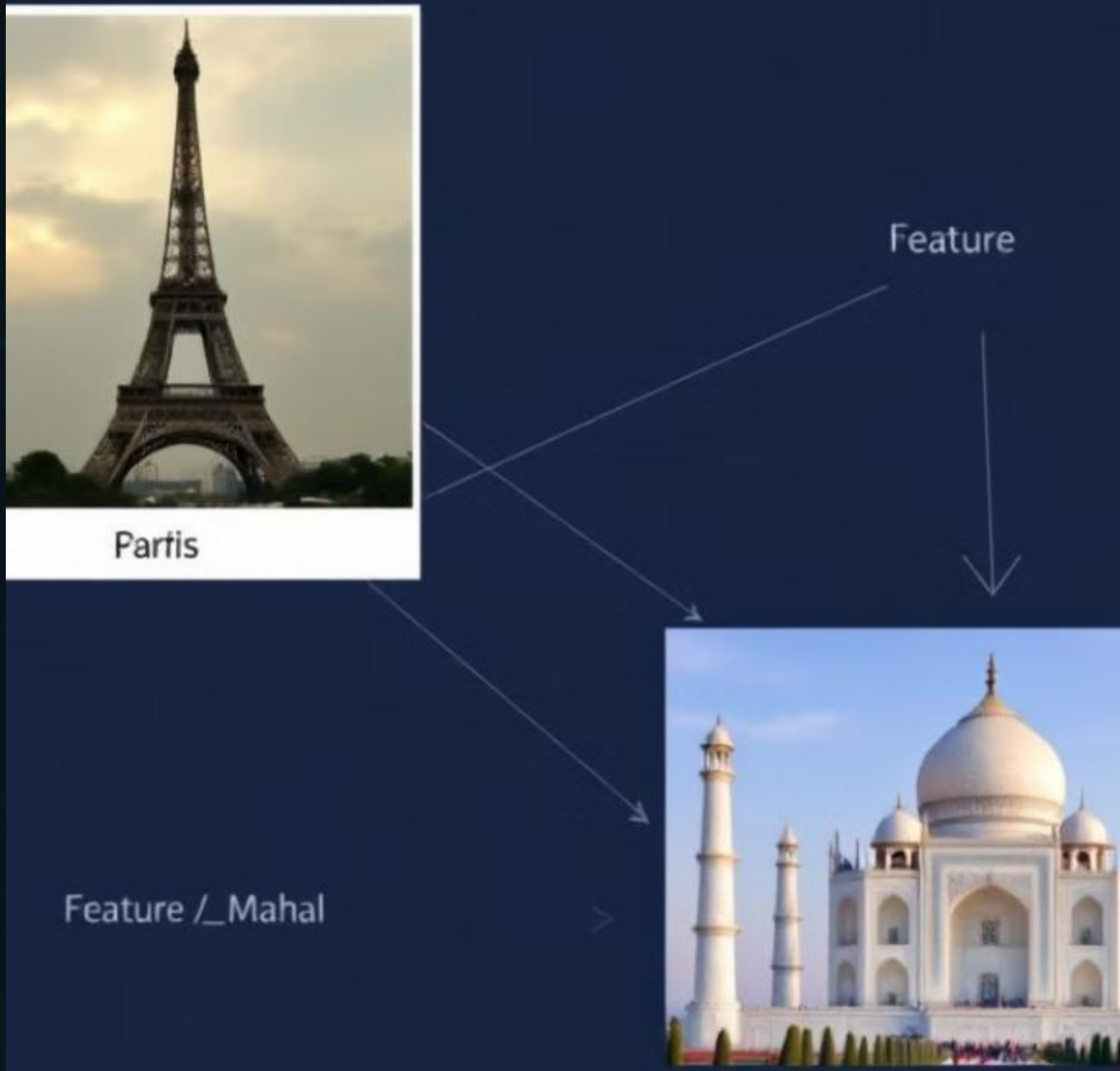
Extract features, match keypoints, and use best-matched images to triangulate location.

Challenges

Overcome lighting variations, perspective changes, occlusions, and computational demands.

Outcome

Interpolate estimated coordinates using latitude and longitude from matched training images.



Different Algorithms/Approaches

Triangulation

Geometric technique determining location by forming triangles from known points.

Estimates 3D position from multiple 2D images taken from different viewpoints.

SIFT Algorithm

Scale-Invariant Feature Transform detects keypoints invariant to scale and rotation.

Widely used for object recognition, image stitching, and tracking.

AKAZE Algorithm

Accelerated-KAZE improves speed while maintaining robustness against scale changes.

Uses nonlinear diffusion filtering for feature detection.

Mathematical Approach for Triangulation

Define Coordinates

Test Image: (Lattest, Lontest)

Training Image 1: (Lattrain1, Lontrain1)

Training Image 2: (Lattrain2, Lontrain2)

Calculate Averages

Latest = (Lattest + Lattrain1 + Lattrain2)/3

Lonest = (Lontest + Lontrain1 + Lontrain2)/3

Example Calculation

Test: (40.4414, -80.0036)

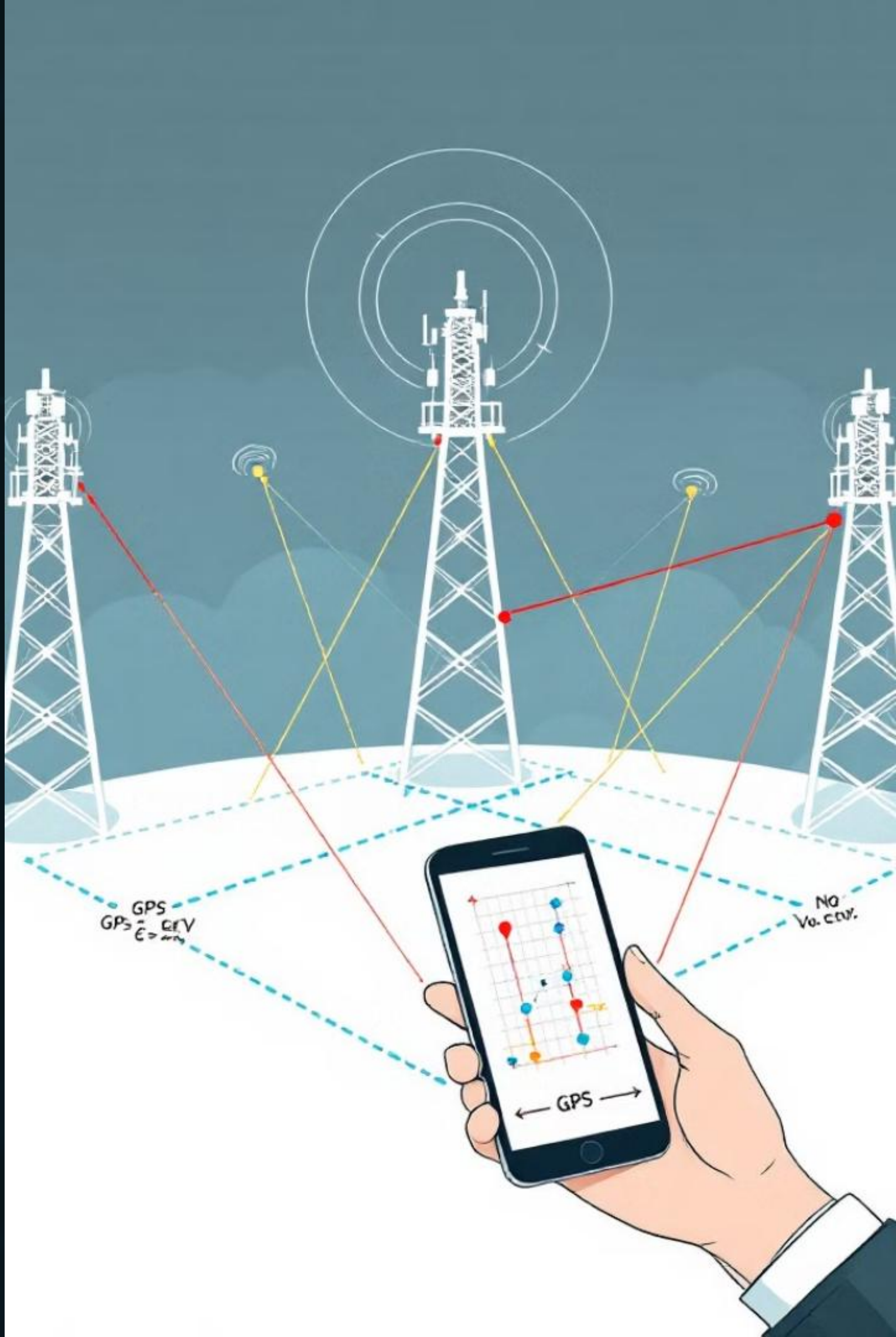
Train 1: (40.4415, -80.0035)

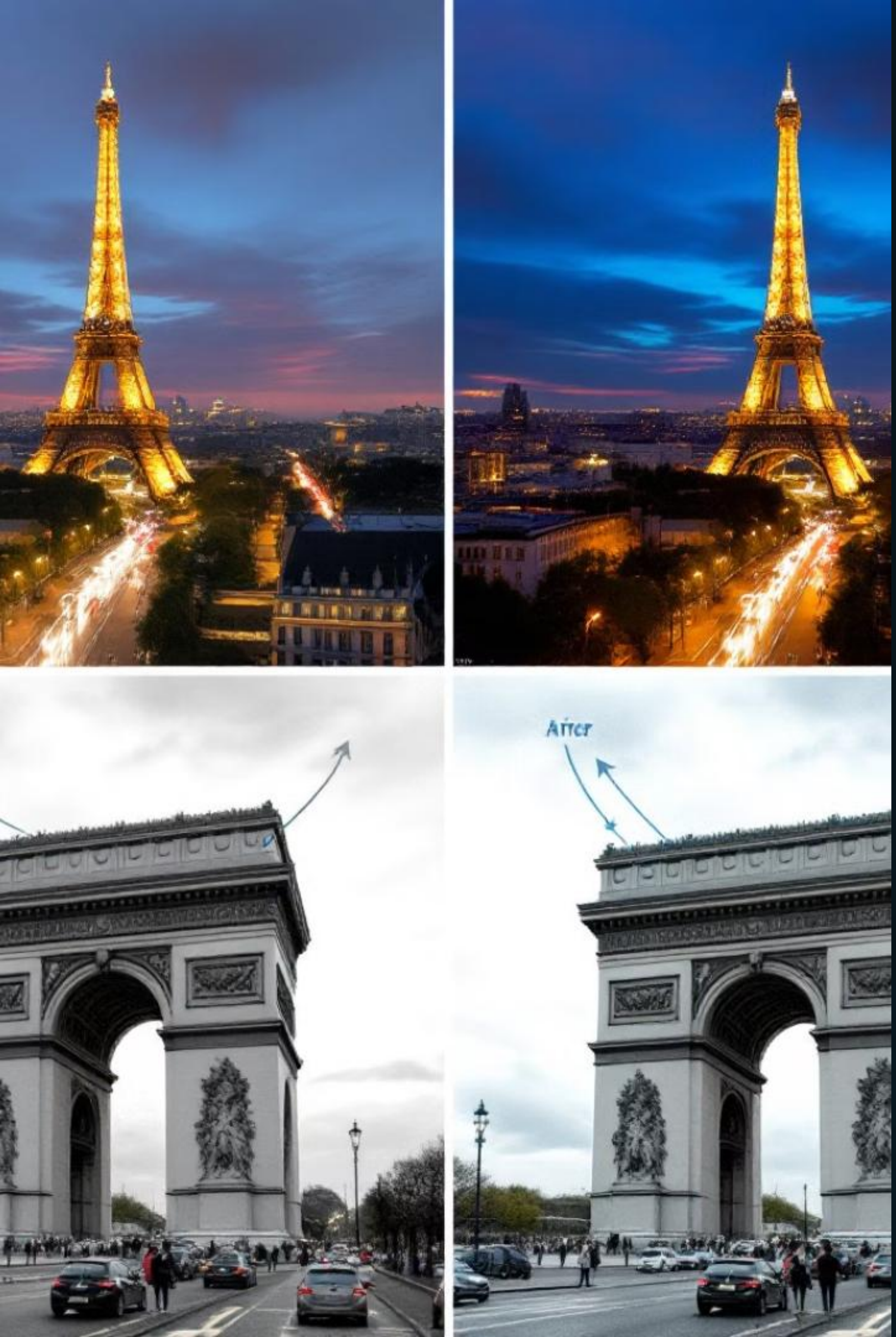
Train 2: (40.4416, -80.0037)

Final Result

Latest = 40.4415

Lonest = -80.0036





Mathematical Approach for SIFT based Triangulation

Define Weighted Formula

Estimated Latitude = $((M_1 \times L_1) + (M_2 \times L_2)) / (M_1 + M_2)$

Estimated Longitude = $((M_1 \times G_1) + (M_2 \times G_2)) / (M_1 + M_2)$

Gather Input Values

M_1 = 15 matches with Eiffel Tower (48.8584, 2.2941)

M_2 = 5 matches with Louvre (48.8606, 2.3376)

Calculate Weighted Latitude

$(15 \times 48.8584 + 5 \times 48.8606) / 20 = 48.8590$

Calculate Weighted Longitude

$(15 \times 2.2941 + 5 \times 2.3376) / 20 = 2.3049$

Mathematical Approach for Akaze

Define Reference Points

Training Image 1: (48.8584, 2.2945) - Eiffel Tower

Find Matches

S_1 = 30 matches with Image 1, S_2 = 20 matches with Image 2

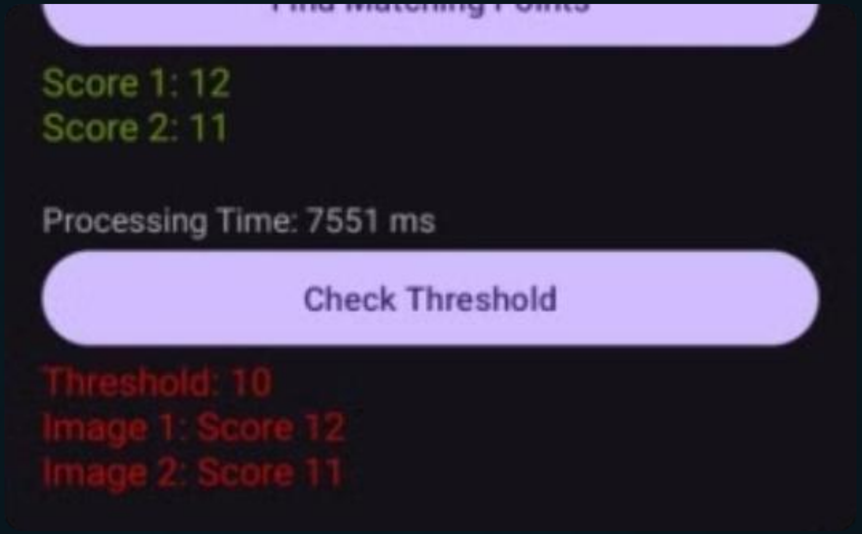
Calculate Weights

W_1 = 30/50 = 0.6, W_2 = 20/50 = 0.4

Estimate Location

Lat = 0.6×48.8584 + 0.4×48.8606 = 48.8594

Comparison between SIFT Triangulation and Akaze



Score 1: 12
Score 2: 11

Processing Time: 7551 ms

Threshold: 10
Image 1: Score 12
Image 2: Score 11

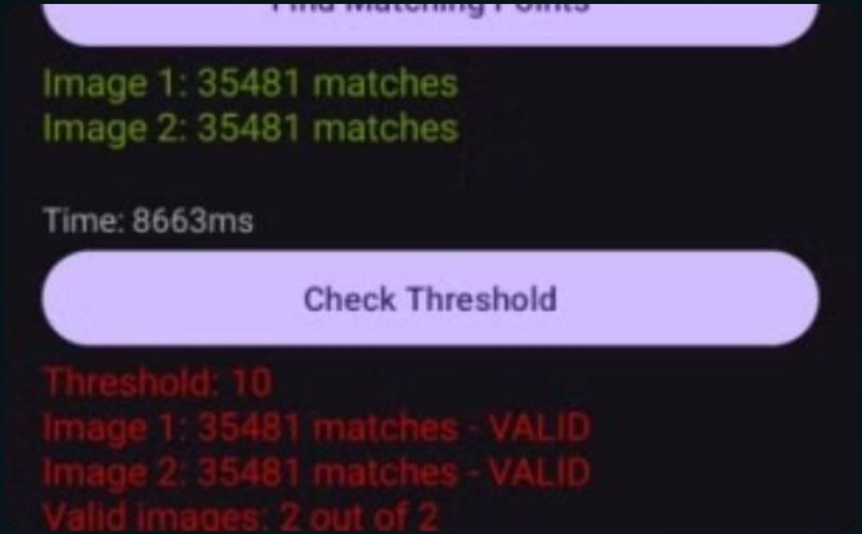
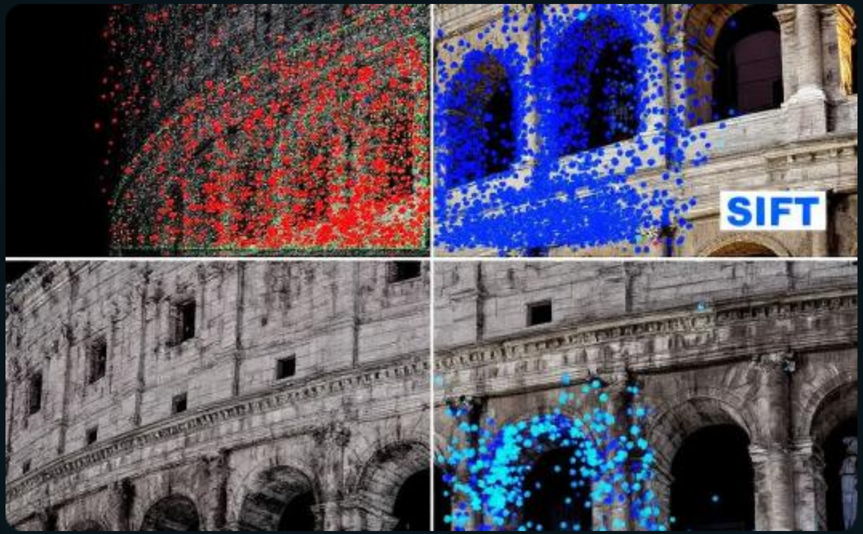


Image 1: 35481 matches
Image 2: 35481 matches

Time: 8663ms

Threshold: 10
Image 1: 35481 matches - VALID
Image 2: 35481 matches - VALID
Valid images: 2 out of 2



SIFT Triangulation

SIFT algorithm detects distinctive invariant features for robust matching.

AKAZE Algorithm

AKAZE offers faster processing while maintaining accuracy in feature detection.

Key Differences

AKAZE prioritizes speed while SIFT emphasizes accuracy across transformation types.

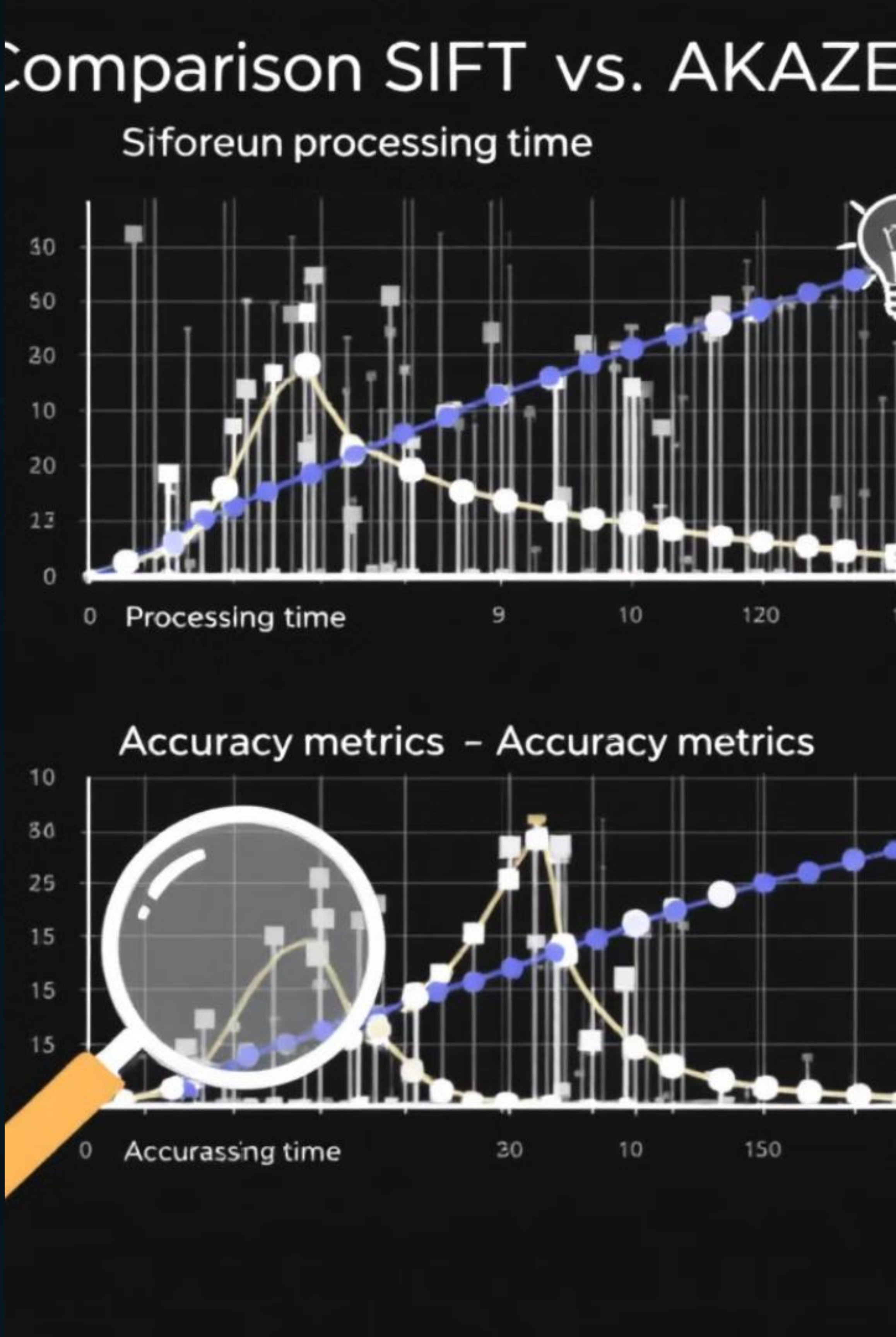
Comparison Table

Aspect	SIFT Triangulation	AKAZE Algorithm
Train Image 1 Location	49.38327789, 1.07740509	49.38327789, 1.07740509
Train Image 2 Location	49.38346862, 1.07714319	49.38346862, 1.07714319
Estimated Test Location	49.38337326, 1.07727414	49.38337326, 1.07727414
Deviation	14.210066 meters	14.22 meters
Processing Time	6890 ms	0 ms
Deviation Calculation Time	1 ms	1 ms

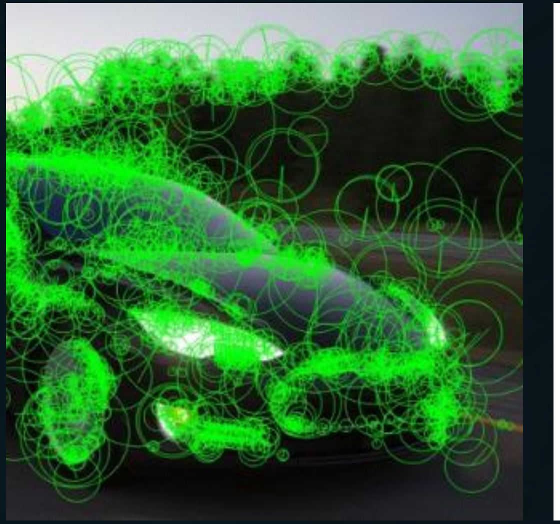
All the tests have been Performed in Galaxys24

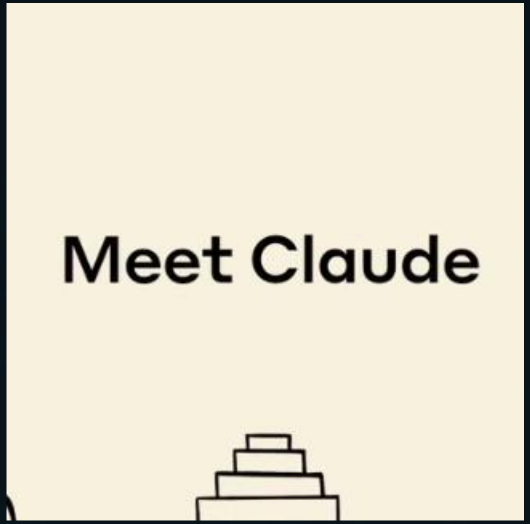
Processor Details- Snapdrangon 8 Gen3

RAM- 8 GB \ OS- Andriod 15



References





Algorithm References

AKAZE Algorithm: https://github.com/pablofdezalc/akaze/blob/master/README.md

OpenCV: https://github.com/opencv/opencv

Software

AndroidStudio

AI Tools Used

ChatGPT, Claude, Google Gemini, Blackbox AI, Gamma.app

THANK YOU