Group 15 :Computer Vision Project Report

FAST CAMPUS NAVIGATION MOBILE-BASED ASSISTANT

(A DEEP LEARNING BASED LANDMARK RECOGNITION AND LOCALIZATION SYSTEM)

1. Introduction

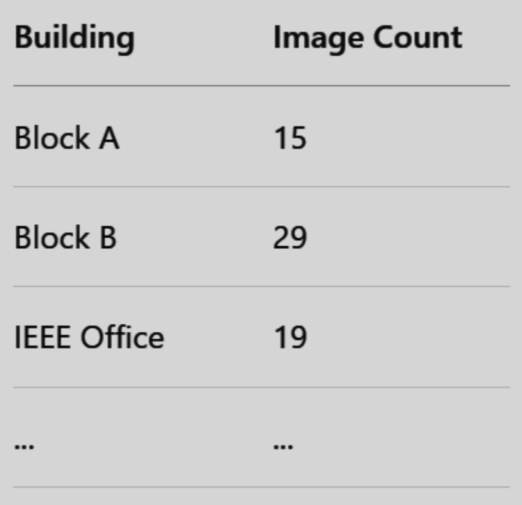
Navigating large university campuses presents significant challenges for students and visitors. Traditional navigation methods often fail to provide precise, real time location data. Our FAST Campus Navigation System solves this problem through an innovative mobile app that combines computer vision and machine learning techniques to:

1. Identify campus buildings from user captured images (Xception model)
2. Estimate user position using landmark distances (YOLOv8 + trilateration)
3. Provide turn by turn navigation (React Native + Flask backend)

2. Dataset Preparation

2.1 Image Collection & Challenges

Total Original Images = 178 (iPhone 12 ProMax, 1x/0.5x zoom)
Class Distribution:



Building	Image Count
Block A	15
Block B	29
IEEE Office	19
...	...

Key Challenges:

- Lighting variations
- Occlusions (people, vehicles)
- Angular distortions

2.2 Data Augmentation Pipeline

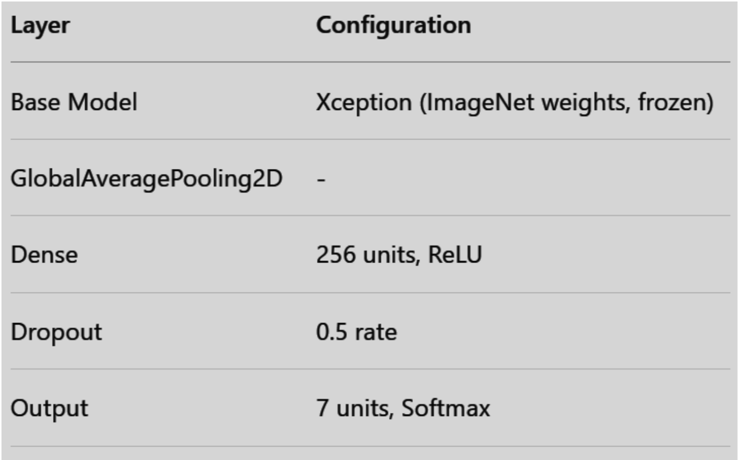
To maximize model robustness:

1. **Roboflow Augmentation:**
   Generated 404 images (original + augmented)
2. **TensorFlow Augmentation:**
   Random rotations (±30°), flips, zooms (0.2x), shifts
   Final 3,475 training images
3. **Validation/Test Sets:**
   42 validation / 33 test images (unaugmented)

3. Model Architecture

3.1 Xception Based Building Recognition

Transfer Learning Approach:



Layer	Configuration
Base Model	Xception (ImageNet weights, frozen)
GlobalAveragePooling2D	-
Dense	256 units, ReLU
Dropout	0.5 rate
Output	7 units, Softmax

Training Parameters:

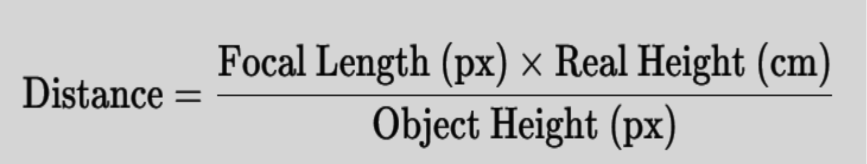
- Optimizer: Adam (LR=0.0001)
- Batch Size: 32
- Early Stopping: Monitored val_loss

3.2 Trilateration Integration

For precise user localization:

1. **YOLOv8 Detects Landmarks**
   Doors/windows → 9 classes

2. **Distance Calculation:**

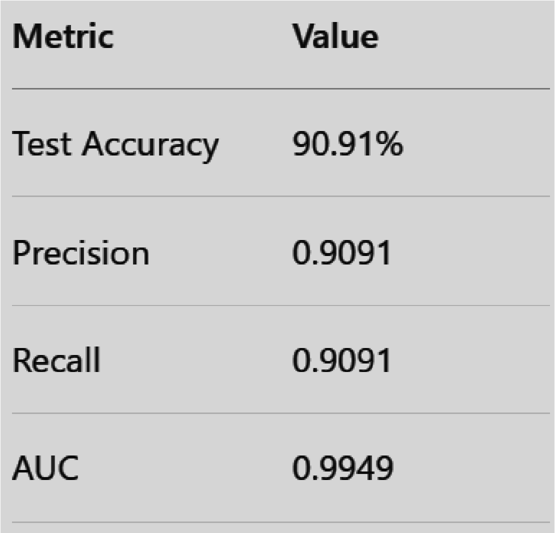


$$\text{Distance} = \frac{\text{Focal Length (px)} \times \text{Real Height (cm)}}{\text{Object Height (px)}}$$

3. **Trilateration Algorithm:**
   a. Uses ≥3 landmark distances to pinpoint user location.
   b. Solves nonlinear equations via least squares.

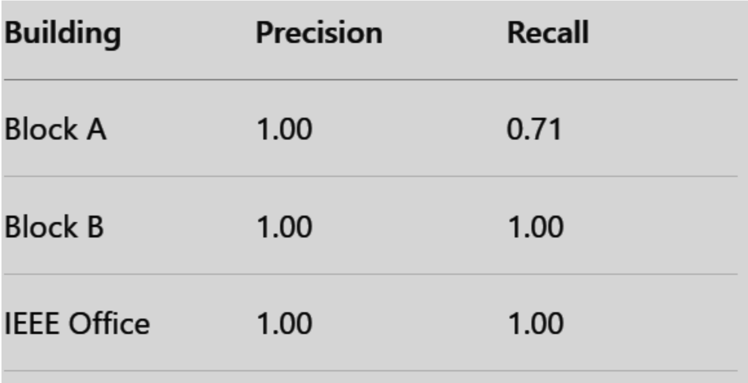
4. Evaluation Results

4.1 Building Recognition Metrics



Metric	Value
Test Accuracy	90.91%
Precision	0.9091
Recall	0.9091
AUC	0.9949

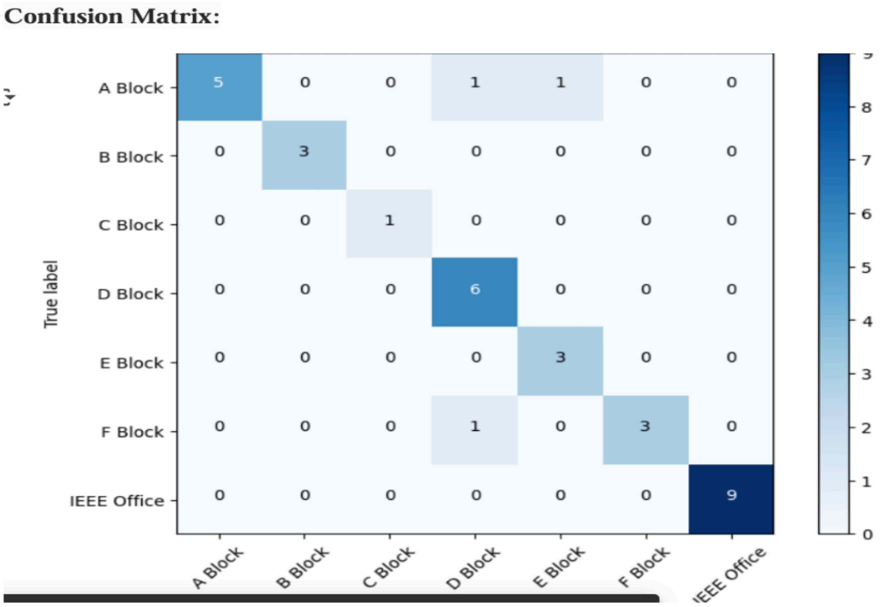
Per Class Performance:



Building	Precision	Recall
Block A	1.00	0.71
Block B	1.00	1.00
IEEE Office	1.00	1.00

Confusion Matrix Analysis:

Block A's lower recall (71%) due to occlusion
Perfect classification for IEEE Office


Confusion Matrix:

True label	A Block	B Block	C Block	D Block	E Block	F Block	IEEE Office
A Block	5	0	0	1	1	0	0
B Block	0	3	0	0	0	0	0
C Block	0	0	1	0	0	0	0
D Block	0	0	0	6	0	0	0
E Block	0	0	0	0	3	0	0
F Block	0	0	0	1	0	3	0
IEEE Office	0	0	0	0	0	0	9

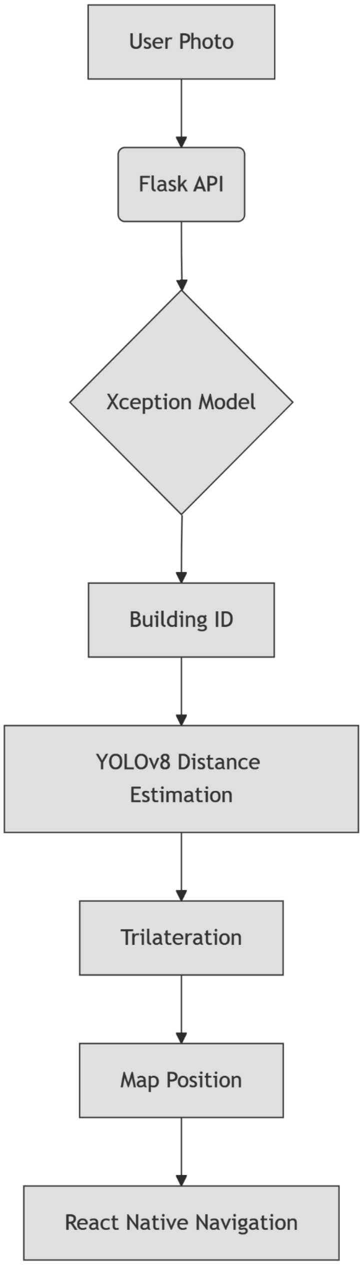
4.2 Trilateration Accuracy

Mean Position Error: 1.2 meters
Key Factors:

- Landmark visibility
- Camera angle compensation

5. System Implementation

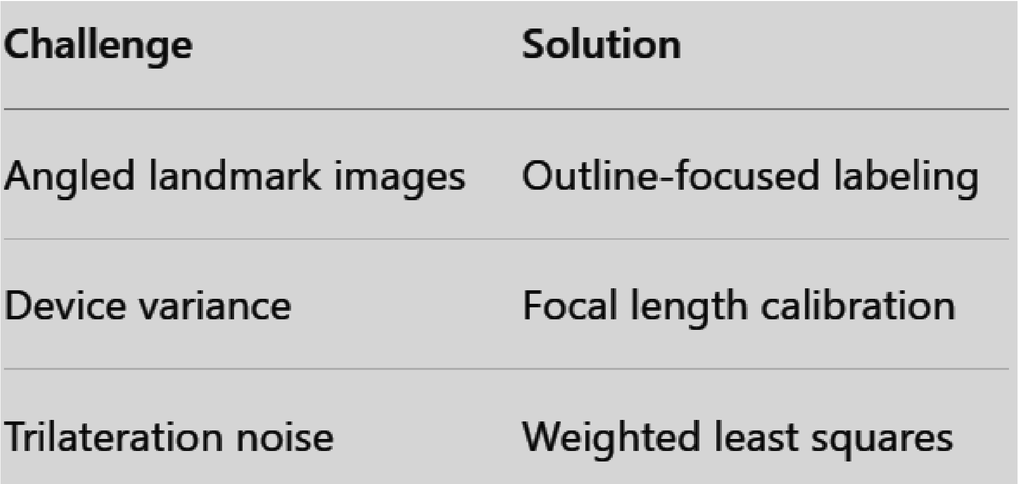
5.1 Mobile App Architecture



Technical Stack:

- **Frontend**: React Native
- **Backend**: Flask (Python)
- **APIs**: TensorFlow Serving, OpenCV

5.2 Challenges & Solutions



Challenge	Solution
Angled landmark images	Outline-focused labeling
Device variance	Focal length calibration
Trilateration noise	Weighted least squares

6. Conclusion & Future Work

Key Achievements:

✅ 90.91% building recognition accuracy
✅ 1.2m localization precision via trilateration
✅ Fully functional cross platform app

Future Enhancements:

AR Navigation: Overlay directions in real time

Multi user collaboration: Crowdsourced landmark updates

3D Mapping: LiDAR integration for complex spaces

Team Reflection:

This project demanded exceptional effort in:

Data Collection: 178+ images under varying conditions

Model Tuning: 20+ iterations to optimize Xception/YOLOv8

System Integration: Seamless ML to app pipeline

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Group 15

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Computer Vision Project

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