# Vision Based Outdoor Localization of IIITD Campus

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CV Final Presentation

Srinidhi Hegde 2013164
Tarun Malhotra 2013112
Neeraj Vaishnao 2013142

# Introduction

- **WHAT ?**
  - ➢ To estimate the GPS location (outdoors) of the user in the IIIT-Delhi Campus from images

- **WHY ?**
  - ➢ Applications - **Egocentric Localization**, **Oil Pipeline Inspection**, **Mine Exploration**, **Military Applications**, **Crime Scene investigation**
  - ➢ Motivated from **“Where am I  ?” by ICCV, Computer Vision Contest**

- **HOW ?**
  - ➢ That’s what we will see in this presentation.

# Location Recognition - Feature Extraction

- SIFT Descriptors - Basic Idea : invariance to geometric transformation and illumination
    - extracts blob like feature points and describe them with a scale, illumination, and rotational invariant descriptor.
    - does not give an overall impression of the image (Not a global descriptor).
    - But, for recognition, Global descriptor is needed.  Solution : Bag Of Features

- Bag of Words descriptors -
    - create a vocabulary of features with k words
    - this partitions the continuous SIFT feature space into k regions
    - represent images as bags of quantized SIFT features, based on the vocabulary

# Motion Estimation

- Pick 2 best candidate images based on number of matches.
- GPS estimation based on number of matches among inliers as:

$$\frac{N_{ref1}P_{ref1} + N_{ref2}P_{ref2}}{N_{ref1} + N_{ref2}},$$

- If only one image in inliers then assign the GPS of the best match image.
- More accurate GPS estimation using structure of motion techniques of triangulation - uses epipolar constraints.

# Vocabulary

Formed the vocabulary by sampling many local features from our training set and then clustering them using k-means.

- The number of k-means clusters is the size of our vocabulary and hence the size of our new feature space.
    - Tried for 100,200 and 1500 bags
- Clustering is a time consuming process. Built the vocabulary once, and stored the centroids of the clusters.
- For any new SIFT feature we observe, we can figure out which region it belongs to using the saved centroids of our original clusters.

# Training Classifiers

A. 1-vs-All SVM

   a. Two Classes : Positive/Negative

   b. Features : Bag of SIFT (Dimensions : 50/100/1500)

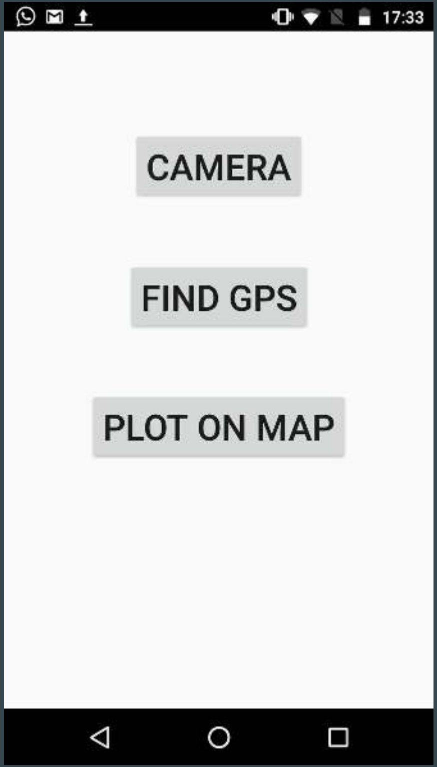
   c. Training Set : Maintained training ratio of 1:4 (Positive:Negative Images)

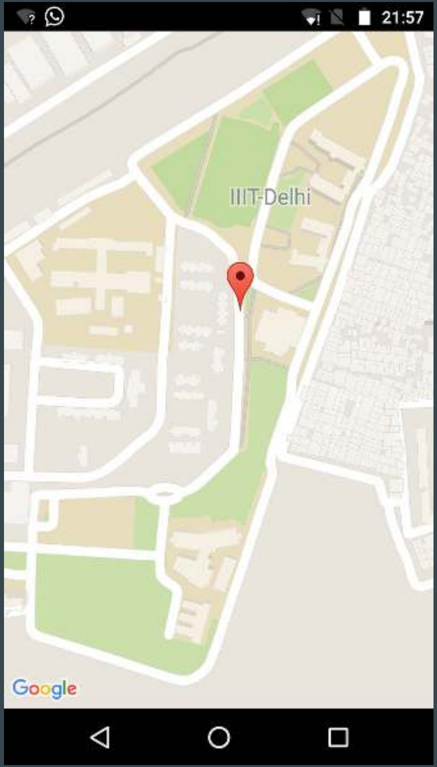
B. Multi Class SVM

   a. Ten Classes : 4,3,3 faces for Student Center, Library Building and Boys Hostel, respectively

   b. Features : Bag of Sift

# Server and Mobile Application





Flask
web development,
one drop at a time

+

**Retrofit 2.0**

*A type safe REST Client for Android & Java*

ANDROID

# Data Collection and Dataset

Two Spots were chosen along a straight line from each of the (open) faces of the buildings (5m and 10m away)

From every spot 5 images were taken. The data of each of these images was later parsed in a 6 dimensional tuple.

A typical tuple corresponding to an image looks like :
(NE,28.54,77.27,1455617230886.jpg,F,1) =
(Direction,Lat,Long,FileName,Face,Building-Index)

Student Center : 300 Images

Library Building : 200 Images

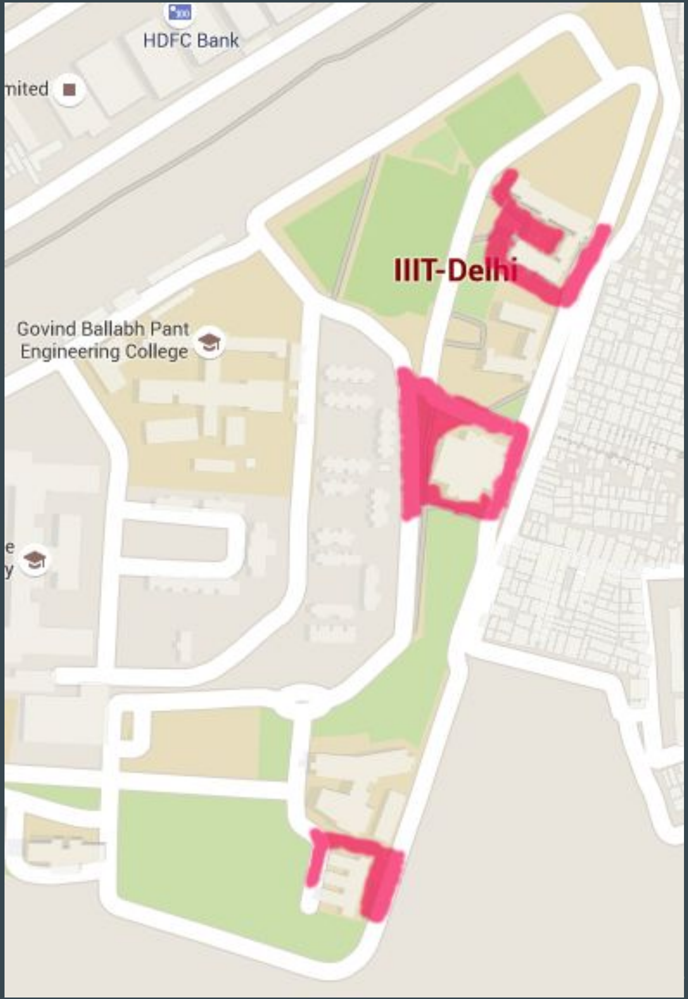
Boys Hostel : 150 Images

Link to Database.

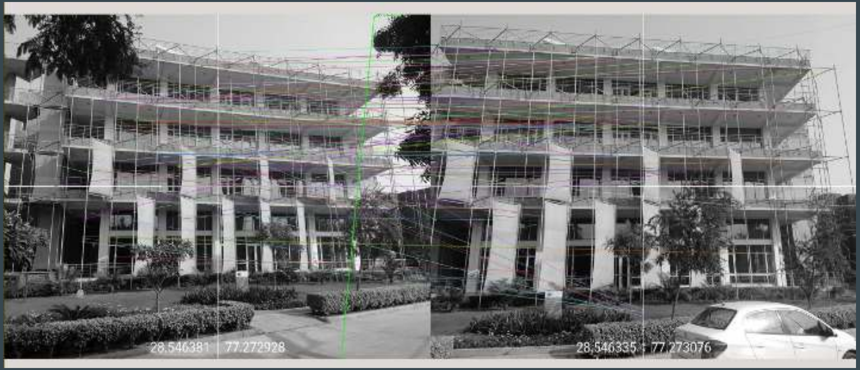
# Evaluation Criteria

A. Location Detection (Classifier Prediction)
   a. Accuracy = ( TP + TN )/( TP + FP + FN + TN )
   b. Sensitivity (TPR) :  TP/( TP + FN )
   c. Specificity (TNR) : TN/( TN + FP)

B. GPS Localization
   a. The error in the GPS measurements by our physical devices was large (~10 ), and hence could not analyse properly



# Results



- Maximum Error in GPS estimation: 3m
- Location Recognition :

| Face of Building | Accuracy | Sensitivity | Specificity |
|---|---|---|---|
| Back(Facing West) SC | 0.73 | 0.64 | 0.75 |
| Front (Facing East) SC | 0.86 | 0.79 | 0.82 |
| Entry Face (Facing South) LB | 0.72 | 0.60 | 0.88 |
| Back Face (Facing West) LB | 0.62 | 0.54 | 0.64 |
| Front Face (Facing West) BH | 0.81 | 0.72 | 0.82 |
| Left Face (Facing North) BH | 0.80 | 0.66 | 0.83 |

1500 bags,
1-vs-All Classifiers

# Future Works

- Use cross-validation to measure performance rather than the fixed test / train split.
- More accurate GPS estimation using structure of motion techniques
- Add a validation set to tune learning parameters.
- We can try using the various Machine Learning models, like Artificial Neural Networks, Random Decision Forests, to classify the building faces, and compare the results.
- Add spatial information to the features by creating a grid of visual word histograms over the image, as discussed in Beyond Bag Of Words by Lazebnik et al.

# Questions ?

# Thank You