ABSTRACT:
- The goal of this project was to incorporate the functionality of mobile cameras with computer vision to address the problem of location recognition.
- We developed a system that analyzed feature components of an image and compared the image descriptors with an established database of landmarks on the University of Pennsylvania campus.

COMMUNICATION AND USER INTERACTIONS:
- Communication with user is established via email. This enables any user with a mobile camera and email capabilities to be able to use the system without additional specialized software.
- Upon receiving an email with image attachment, VBA script is run in Microsoft Outlook to save attachment and sender’s email address. The program then calls a MatLab executable file for image processing.
- Once the image has been processed, the building information corresponding with the top 3 image matches are returned to the user.

IMAGE ANALYSIS:
- Want to limit run-time computation by pre-training the application with a database of images to be used in comparison
- Database included 60 Penn buildings with a total of 600 images, photos taken at various times in the day to allow for variable lighting
- Analysis can be broken down into three stages:
  - Detection of key points and visual features
  - Comparison of SIFT descriptors
  - Color histogram analysis

KEY POINT/DESCRIPTOR DETECTION AND CALCULATION:

Point-to-Point Comparison Approach
- Executes an exhaustive search to compare the Euclidean distance between all key points of the query image and image from previously defined image database
- Calculates the ratio of the smallest two distances for a given image in the database to ensure overall correspondence. If ratio is below a certain threshold counts it as a point-to-point match
- Similarity rating is determined by the image with the greatest percentage of point-to-point matches over the number of total key points identified

K-Means Clustering Approach
- Algorithm used to cluster objects based on certain attribute into a specified number of partitions. In this case, the SIFT descriptors are partitioned into 20 bins.
- Randomly divides set of points into 20 partitions and calculates the center location, called the centroid. Each point is then associated with the closest new centroid location. Alternate two processes until a convergence is reached, when no points switch upon calculation of a new centroid
- Use the intersection of the distribution of points across the clusters histograms to determine similarity rating

COLOR HISTOGRAM ANALYSIS:
- Used to analyze photo for similarities in building exterior caused by materials and color
- Used imhist() function to generate a color histogram
- Calculated the intersection of the color histograms for the query image and database image
- Similarity rating was based on the largest intersection value per number of points in the image

CONCLUSIONS:
- No great difference between SIFT and MSER approach for key point detection, K-means method for comparison more accurate but slower
- Future applications include incorporation with web based maps (Google Earth, Live Maps), compatibility with photo mail and text messaging, replacement of mobile museum guides