PROJECT PROPOSAL

"Building Identification and gain access using AR Drone"

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Introduction:

The popularity of research in unmanned Aerial Vehicles (UAVs) has increased significantly in the last decade. Quadcopters are a very popular choice among the aerial vehicle platform and quadcopter like AR drone is widely being used as platform for research and education due to its robustness, mechanical simplicity, low weight and small size. There are software packages freely available from the internet, which allows researchers to overcome initial problems and focus more on advanced issues. It has been used for object following, position stabilisation, autonomous navigation and has wide applications in military reconnaissance and surveillance, terrain mapping and disaster management. Our project has been inspired from Mission # 4 in Aerial Robotics Competition which involved flying to abandoned building and identifying a particular structure based on a symbol on the building. Once the structure has been identified, the UAV has to access the structure through open portals (doors, windows, other openings) that had to be identified by the aerial robots. In this project we look at problem of building identification and entering the building through open door or window. The identification in turn helps in navigation in GPS denied environment.[1]

Description:

We propose an automatic approach to identify large structure like buildings from aerial imagery. Upon recognition, we aim to enter in the building via open window or door. To achieve the same we plan to use Parrot AR DRONE 2.0. The proposed techniques are based on image feature description and matching via SVMs. Finally, we wish to scale the data set to the entire campus of IIT Kanpur.

Approach:

There are three major tasks to detect and identify the architectural buildings:

1. Feature Detection and Description:
   The underlying idea is to transform the image into a set of keypoints found according to the SIFT transform and to detect building through such an image representation. The algorithm has strong robustness to deformation, shelter and other influence which makes it highly valuable in description task with UAVs. [2][3]
2. Bag of Words Model:
   Using the sift features, the visual words are learned from a collection of local patches sampled from the training images using the k-means clustering algorithm, which efficiently groups visually similar patches into one cluster. The distribution is computed according to the statistical information of words' occurrence and an image can be represented as a BOW, or specifically, a vector containing the count of each visual word in that image. In this process, the visual vocabulary provides an intermediate helping to convert the chaotic local feature set to a regular representation vector, based on which it is convenient to apply the machine learning techniques, such as support vector machine (SVM), to yield good performance. [4]
3. Keypoint Classification:
   Since the dimension of the extracted features is relatively large, it is recommended to adopt a suitable classification method such as the Support Vector Machine (SVM)

classifier. Two strategies to build multi-class classifiers based on binary SVM are one vs one and one vs all. Since one vs all classifier needs to deal with all the data of all the samples thus consuming much time; we are planning to adopt one vs one method which improves the speed of classification a lot.[5][6]

Dataset Used:

The training set includes images of various building at IIT Kanpur captured using front camera of AR Drone (720px).

Possible Extension:

1. One of the immediate extensions of the project is detection of building and gaining access to it while flying autonomously.
2. This is followed by terrain mapping in which the Drone maps the already recognised buildings and using this map it finds a suitable path to navigate between two given locations autonomously. The autonomous navigation has varied applications such as implementing a "Tour Guide" which can provide tour of a particular locality.

Papers Referred:

[1] *AR-Drone as a Platform for Robotic Research and Education*- Tomas Krajnık, Vojtech Vonasek, Daniel Fiser, and Jan Faigl

[2] *Image target identification of UAV based on SIFT.* - Xi Chao-jian,Guo San-xue

[3] *Architectural Building Detection and Tracking in Video Sequences Taken by Unmanned Aircraft System (UAS)* Qiang He, Chee-Hung, Henry Chu and Aldo Camargo

[4] *Contextual Bag-of-Words for Visual Categorization* - Teng Li, Tao Mei, In-So Kweon

[5] *A SIFT-SVM METHOD FOR DETECTING CARS IN UAV IMAGES* - Thomas MORANDUZZO and Farid MELGANI

[6] *Multi-Information based Safe Area Step Selection Algorithm for UAV'S Emergency Forced Landing* - Aiying Lu, Wenrui Ding and Hongguang Li