

Demo: Satellites in Our Pockets: An Object Positioning System using Smartphones

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ABSTRACT

We attempt to localize a distant object by looking at it through a smartphone. As an example use-case, while driving on a highway entering New York, we want to look at one of the skyscrapers through the smartphone camera, and compute its GPS location. While the problem would have been far more difficult five years back, the growing number of sensors on smartphones, combined with advances in computer vision, have opened up important opportunities. We harness these opportunities through a system called *Object Positioning System (OPS)* [1] that achieves reasonable localization accuracy. Our core technique uses computer vision to create an approximate 3D structure of the object and camera, and applies mobile phone sensors to scale and rotate the structure to its absolute configuration. Then, by solving (nonlinear) optimizations on the residual (scaling and rotation) error, we ultimately estimate the object's GPS position.

We present a demonstration of OPS, a system to appear in the *MobiSys 2012* main conference. The user is expected to bring the object of interest near the center of her viewfinder, and take as few as four photographs. GPS and compass readings are also recorded during the process. The position of the photographs can be separated by a few steps from each other in any direction. OPS uses *Structure from Motion* to extract keypoints across the photographs to come up with a 3D structure, composed of the object and the camera locations. Finally, OPS minimizes errors in GPS and compass readings with help of 3D structure to converge on the object location.

Categories and Subject Descriptors

H.3.4 [Information Storage and Retrieval]: Systems and Software

Keywords

Augmented Reality, Localization, Structure from Motion

1. DEMONSTRATION

OPS is implemented in two parts, an OPS smartphone client and a back-end server application. We built and tested the OPS client on the Google NexusS phone, as a Java extension

*This work was conducted at Duke University.

to the standard Android. Photographs are pre-processed locally on the phone to extract keypoints and feature descriptors. Along with keypoints and descriptors, the phone uploads all available sensor data from when each photograph was taken, to include GPS and compass.

We evaluated OPS in the most natural way possible. We took four photographs for each localization by moving few steps in no specified direction. Phone GPS and compass are subjected to noise and biases because of environmental factor. Computer vision techniques, such as structure from motion, can also break down in a variety of scenarios. The goal of this demo is to demonstrate how we addressed these challenges. We plan to ask participants to take four photographs of an outdoor object. We expect that participants will be able to see object position on the google earth, as shown in Fig. 1.

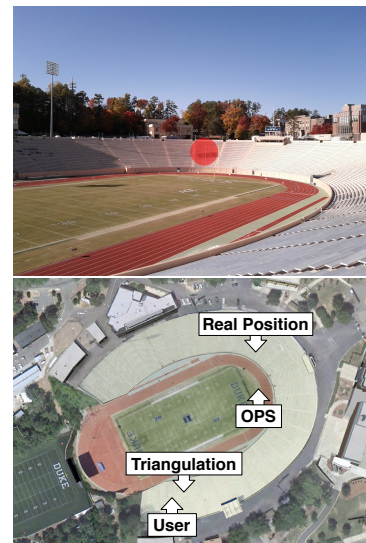


Figure 1: Sampled test; circle denotes object-of-interest (top), Google Earth view (bottom): stadium seats near goal post.

2. REFERENCES

- [1] J. Manweiler, P. Jain, and R. Roy Choudhury. Satellites in our pockets: An object positioning system using smartphones. In *Proceedings of the 10th international conference on Mobile systems, applications, and services*. ACM, 2012.