Fine-Granularity Virtual Tags on Physical Objects

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Biodiversity research depends on the accumulation of multi-year datasets in varying ecosystems and seasons. This data cannot be collected by professional biologists alone. Well trained amateurs need to participate in the collection as well.

The Web has enabled such citizen participation. Several online facilities exist, such as Calflora, Globe for kids, and others. Unfortunately, biodiversity researchers are hesitant to trust this data, because they cannot be sure about its quality.

In [1,2] we described EcoPod, our PDA based tool that helps species census workers identify plants and animals in the field. The tool asks questions about the observations, and also offers image galleries to help users with visual identification. The system allows its operator to mark any of her answers as 'tentative' if she is unsure about that particular aspect of the identification.

Additionally, users can attach evidence to any answer. For example, when answering the system's question whether a plant has cerated leaves, the user can take a photo of the leaves and attach that image to the answer. The intent is for a professional to inspect large numbers of observations after the fact. The confidence markings and other clues can focus the professional's attention on the observations that are most in doubt. The biologist can then use the attached evidence to evaluate the observations.

In our new, still very experimental work we try to augment EcoPod with another facility. We want both amateurs and professionals to annotate physical objects in nature without modifying the environment at all. For example, an expert might attach a virtual tag to a tree, warning others who pass by later that the tree is not an Oak tree, but is of another, closely related species. She might further wish to annotate the tree with a spoken note that is 'attached' to the particular part of the tree that betrays its true species. In the note she would explain this identification detail.

Similarly, a plant in a preserve might be under multi-year observation. The accumulated data would be in the form of a spreadsheet that we want virtually attached to that plant. Whenever a researcher visits the plant, the spreadsheet is accessed, and new information is added.

Existing systems have provided such virtual tagging by associating the tag with a particular GPS reading. Unfortunately, such readings are nowhere near precise enough to attach a note, for example, to the forking branch of a tree. We are experimenting with a very simple method for enabling such annotations to physical objects at very fine granularity.

Figure 1 shows some examples of where one might leave data.

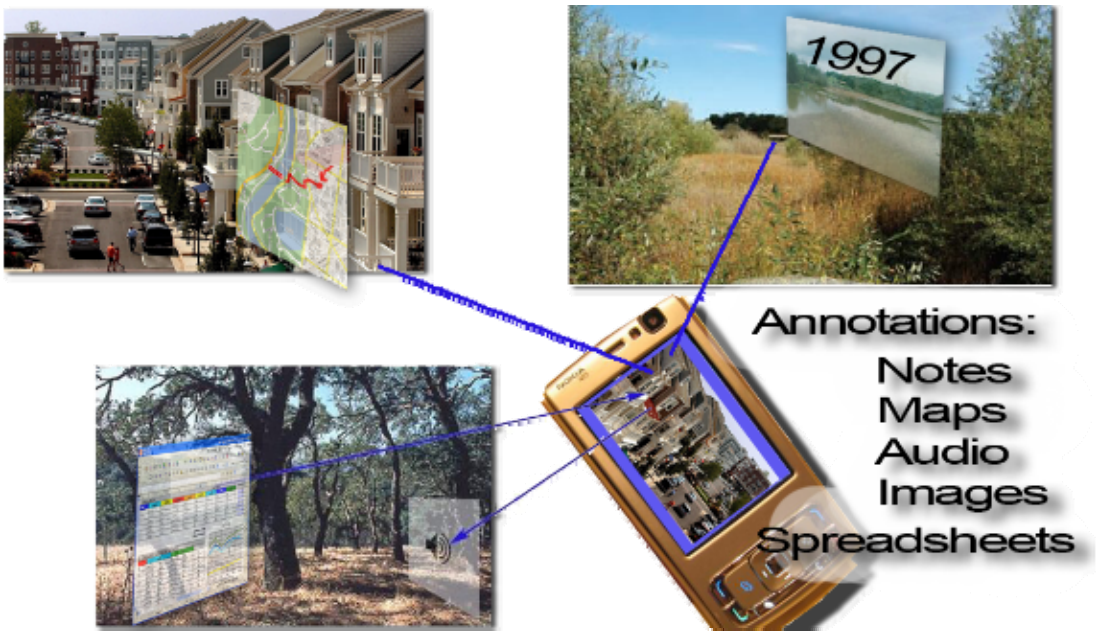

Figure 1: Cellphone or PDA is used to attach virtual notes to physical objects. Attachment anchors can be chosen at very fine granularity.

Annotating an object works as follows. The annotation creator uses a GPS enabled camera to take a photo of the object that is to be annotated. Once the photo is available on the device's screen the annotation creator can with two stylus taps define a hot region of any size on the photo. The annotation is 'attached' to that region. A thin bounding rectangle is superimposed on the photo at that spot. The user then creates the annotation using the appropriate media input application. Multiple hot regions on the image can be annotated in this manner.

Once the annotations are completed, we send the following tuple to an annotation server:

<LAT/LONG, PERMISSIONS, IMAGE, {ANNOTATION FILE,HOT-REGION COORDINATES}*>

As part of the upload the annotation creator authenticates to the server. The server adds this creator-identifying information to the above tuple. Note that submission to the server can instead be batched at a later time.

Now, assuming network connectivity, when an annotation consumer enters the general geographic area of an annotated object, the person's device can contact the server and communicate its GPS position. The transmitted information is the following tuple:

<AUTHENTICATION, LAT/LONG, RADIUS>

The radius specifies for up to how far away the annotation consumer wishes the server to provide annotations.

Using a simple, approximate range query, the server retrieves annotations that are intended for the requesting annotation consumer and are within the specified radius of the consumer's location.

This information is transmitted to the consumer's device, where the consumer can view the marked images. Tapping on any of the regions renders the associated annotation.

As for currently available devices, the Nokia N95 cell phone includes a GPS unit. Alternatively, a separate GPS receiver can communicate location to a camera phone via Bluetooth connections. Another possibility still is to use cell tower or WiFi triangulation to approximate position. We are prototyping on a Nokia N800, paired with a Globalsat BT-338 GPS receiver.

Figure 2 shows how annotations are added and retrieved.

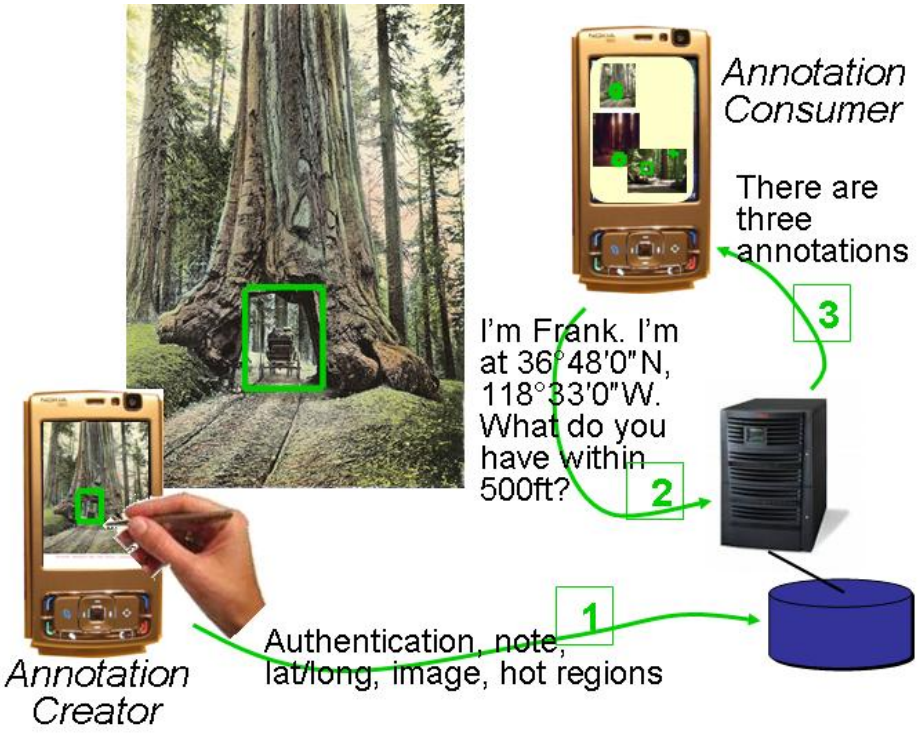

Figure 2: Process of adding and retrieving annotations

For communication between device and server we currently use WiFi. A GPRS or similar data link could, of course, be used instead. Our database is currently MySQL.

While our interest in virtual, high-precision tags on physical objects focuses on biodiversity applications and teaching, other applications are relevant as well. For example, telephone repair crews could leave notes to their colleagues that are attached precisely to the equipment that is the subject of the note. Patrons could leave reviews on the door knobs of restaurants. Anthropologists could attach annotations to dug-out ruins. In general, communities of users could create large collections of geo-retrievable information on physical objects out in the world.

References

1. Yu Y, Stamberger JA, Manoharan A, Paepcke A: **EcoPod: A Mobile Tool for Community Based Biodiversity Collection Building**. In: *Proceedings of the 6th ACM/IEEE-CS joint conference on Digital libraries 2006; Chapel Hill, NC, USA* ACM Press; 2006: 244-253.
2. Manoharan A, Stamberger J, Yu Y, Paepcke A: **Optimizations for the EcoPod Field Identification Tool**. In: *Computer Science Technical Reports (2007-22).* Stanford University; 2007.