CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Citizens science mobile app for hydrology reporting	
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Project Overview:

Wetlands are a vitally important feature of our environment for a wide variety of reasons, including their important role in water filtration and purification, providing habitat for an incredible variety of plant and animal species, and acting as water buffers critical for flood control. Thus, wetland health is a key indicator for overall environmental quality.

Hydrologic data in the United States is collected primarily by the US Geological Survey; see for instance the National Water Information System (NWIS, https://waterdata.usgs.gov/nwis). But look closely, and you will notice that it contains only observations of larger rivers and reservoirs; it would simply be too costly and effort-intensive for a agencies to extend detailed observation and measurement to the fine scale waterways and wetlands which, unfortunately, are also the richest habitat and the most important for quality of life and for flood control services. This is where modern data-connected mobile devices (smart phones) could play a vital role in vastly improving the precision of available hydrological data: with the proper web app, amateur citizen scientists could be motivated to collect this important hydrological data in their own communities. An additional positive side effect of citizen science is a greatly increased degree of education and engagement of people in the community with respect to their wetlands and waterways. More awareness leads to better decisions, a virtuous cycle.

Since 2014, the client and his colleague Dr. Pastel (at Michigan Tech) have been developing a rudimentary citizen science project to address exactly this need, using basic image processing of pictures snapped with cell phones and uploaded to a rudimentary web server. The system uses a "Hydroserver" database in the backend, which is an open-source database product preconfigured to store hydrological measurements and to share that data to national repositories. The basic process works as follows:

1. Citizen volunteers register and set up a local site, using detailed instructions. This basically involves installing a basic home-made water level gauge, and printing a sign (see Figure) with a QR code for passers-by to see.
2. People passing the site see the sign. They scan the QR code, which takes them to the project website. They then snap a picture of the gauge and upload it to the site.
3. Basic image processing is used to extract the water level from the site and enter that reading into the hydroserver.

This effort, which has been accomplished almost entirely with volunteer effort, has proved the concept, but has considerable clunkiness and instabilities.

The goal of this project is to take this concept from an early-prototype stage to a polished and fully implemented and user tested beta, by (a) professionally redesigning the existing site and underlying server to stabilize and streamline functionality; and (b) creating an attractive mobile application for citizen scientists to use that simplifies taking readings and improves accuracy in several ways. Key functionalities of the project include:

- Mobile app should use geo-location to identify location, i.e., to match incoming reading to site. QR could may still be useful to resolve ambiguities.
- Mobile app should allow taking picture, and will apply rudimentary image processing to suggest probably water level (i.e. draws a line on the image taken). Users may adjust line up or down to correct image processing inaccuracy.
- Pictures and extracted data are submitted via backend webservice and added to hydroserver. If not network is available, pictures and data are stored for later submission.
- As a "reward" to users, submission of a datapoint returns a high quality interactive visualization that allows contributors to see their streamflow observations plotted alongside weather data from the National Weather Service (rainfall) and other nearby streamflows from the National Water Model. This visualization should be returned whether submission is via the old-fashioned website or the new mobile application.

If successful, this project will vastly increase data accuracy for detailed local hydrology, and will become the main venue for people around the world to learn about and contribute data on their local streams, lakes, wetlands, and water supplies, and will provide also a key source of data to inform hydrology science around the world.

Knowledge, skills, and expertise required for this project:

- Web2.0 framework and techniques, to (re)develop webpage, including web-based visualization.
- Development of a web service to act as access point for the mobile application.
- Relational database design & programming, SQL, SOAP, XML, WSDL access; in order to configure and deploy the Hydroserver product.
- Mobile application development. The exact platform (iOS, Android) will be determined in negotiation with client during early design.
- Basic image processing, to adapt/improve existing algorithms.

Equipment Requirements:

- Nothing special beyond standard development station and publicly-available tools.
- Access to an appropriate mobile device for development and testing will be provided by the client, if needed.

Software and other Deliverables:

- Mobile application as outlined above, installed and demo'd on device of client's choice.
- Rebuilt submission website, as outlined above, installed on server of client's choice.
- User manual written for non-technical (ecologist) users, covering installation and configuration of website and related web service. Also covers operation of the app, including installation and connection to database.
- A strong as-built report detailing the design and implementation of the product in a complete, clear and professional manner. This document should provide a strong basis for future development of the product.

- Complete professionally-documented codebase, delivered both as a repository in GitHub, BitBucket, or some other version control repository; and as a physical archive on a USB drive.
- User testing with 5-10 Flagstaff area users.