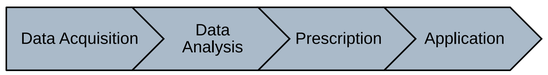
User-Centered Design for Data Collection in Precision Agriculture

Posadas, Brianna B.[1]

1. Computer and Information Science and Engineering Department, University of Florida, Gainesville, FL, United States.

Introduction

- Big data has become an integral aspect of precision agriculture and modern farming in the United States (Carbonell, 2016)
- While farmers have been collecting data about various conditions of their farm for decades, new technologies have been able to store, analyze, and create new software from the data to help farmers make better predictions about their yields and better manage their farm (Schuster, 2017)
- One of the challenges of using big data in agriculture is the dependence on people to create the ground truth data, or geophysical parameter data, to create the training data for precision agriculture machine learning algorithms (Bendre & Thool, 2016)
- As it has become cheaper and easier to collect aerial images and other remote sensing data, it is still vital that someone physically inspect the area to identify the target, i.e. identify the vegetation, disease, or pest of interest (Kamilaris et al, 2017)
- Ground truthing requires a lot of labor that farmers and researchers alone cannot satisfy (Kamilaris et al, 2017)
- **A solution to alleviating the labor shortage is to crowdsource the ground truthing**



Precision Agriculture Process. The project focuses on the data acquisition.

Objective

Design a prototype to

1) teach the user about the desired characteristics to be identified or "ground truthed"
2) direct the user to GPS coordinates
3) allow the user to make a real-world classification and report it
4) allow for the user to verify classifications of other users to ensure data quality

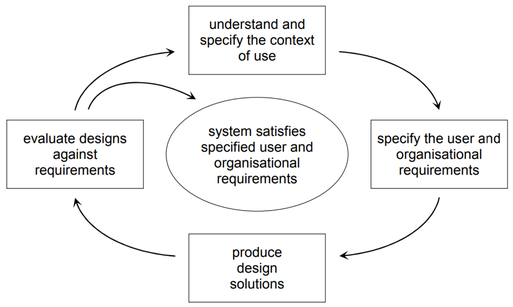
Materials

Lamb's Quarters

- Scientific name: Chenopodium album
- A nutritious and edible weed (Poonia, 2015)
- Grows in stressed conditions: hot sun, high altitude, and low rainfall (Poonia, 2015)
- Native to Europe, Africa, Asia temperate, and North America (Pyšek et al, 2017)
- **Researchers in the District of Columbia are interested in the local growing conditions of lamb's quarters**

Methods

User-Centered Design Methodology



The process for human-centered design modified from (Jokela et al, 2003)

Recruitment

- Volunteer listserv from University of the District of Columbia (UDC)
- Master Gardener class list from UDC
- Virginia Cooperative Extension

Locations

- Arlington Public Library
- UDC Van Ness Campus
- Firebird Farm in Beltsville, MD

Methods, continued

User-Centered Sessions

- Interviews with researchers at UDC to understand and specify the context of use
- Focus Groups to specify the user and organizational requirements
- Produce design solutions from **personas**
- Evaluate designs against requirements through user studies and evaluation against the **System Usability Scale (SUS)**

Sovann Childress

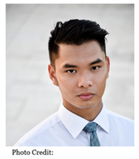


Photo Credit: https://pixabay.com/en/users/Pexels-2286921/?tab=about

Goals/Motivations:
- Correctly completing request
- Keeping informed

Frustrations:
- Lack of software knowledge
- Reentering the information

Day in the Life:
Sovann must request materials for nuclear facilities and must be careful with his hazardous materials.

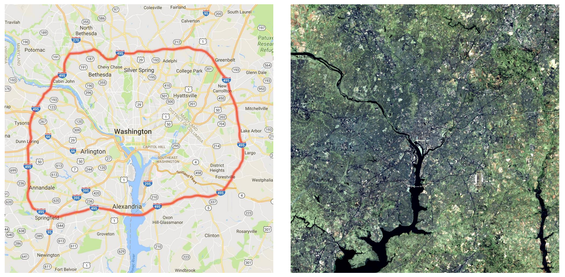
"This request needs to be completed quickly!"

An example of a design persona

The System Usability Scale Standard Version		Strongly disagree 1	2	3	4	Strongly agree 5
1	I think that I would like to use this system frequently.	○	○	○	○	○
2	I found the system unnecessarily complex.	○	○	○	○	○
3	I thought the system was easy to use.	○	○	○	○	○
4	I think that I would need the support of a technical person to be able to use this system.	○	○	○	○	○
5	I found the various functions in the system were well integrated.	○	○	○	○	○
6	I thought there was too much inconsistency in this system.	○	○	○	○	○
7	I would imagine that most people would learn to use this system very quickly.	○	○	○	○	○
8	I found the system very awkward to use.	○	○	○	○	○
9	I felt very confident using the system.	○	○	○	○	○
10	I needed to learn a lot of things before I could get going with this system.	○	○	○	○	○

An example of the System Usability Scale

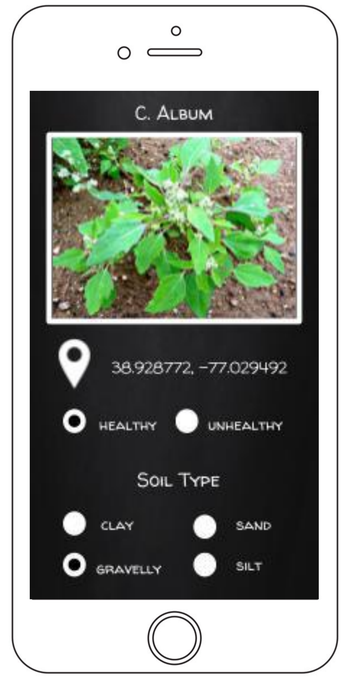
Creating classifier from ground truth data



An example of GPS-coded data (left) and remote sensed data from USGS (right)

- Ground truth data collected from prototype will be paired with remote sensed data from United States Geological Survey (USGS)
- A classifier will be developed to identify locations of lamb's quarters growth in the nation's capital

Expected Results



Mockup of a design alternative

- Develop an affordable and usable tool for laypeople to assist in the ground truthing aspect of big data in agriculture
- Design a classifier from the crowdsourced dataset and publicly available remote sensed data from USGS
- Introduce nonexperts to the field of agriculture, educating them on food sources, encourage participation in the digitalization of agriculture

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