Experiences in Designing a Mobile GIS Mapping Tool for Rural Farmers in Ghana

Sunandan Chakraborty[1], Tiffany Tong[2], Jay Chen[2], Afshan Aman[2], Talal Mufti[2], Yaw Nyarko[2], Lakshminarayanan Subramanian[1]
[1]Department of Computer Science, New York University, USA
[2]Center for Technology and Economic Development, New York University Abu Dhabi, UAE

1. INTRODUCTION

The task of balancing problems associated with population growth and food production has often been impaired by a lack of accurate information on food supply availability in any given region or time. Such data has conventionally been gathered by legions of field workers who must travel to individual farms and collect information by hand. Predictably, data collection has been slow, error-prone, and difficult to maintain. There is therefore a need to develop tools and techniques that can quickly and accurately generate relevant and up-to-date information on food production.

In this paper, we describe our experience in designing and implementing an Android mobile application (or "app") that is capable of building GPS-based food production maps of a region. This hand-held app collects data as the user walks along the boundary of a farm. It records the user's movement by tracking the GPS coordinates and subsequently constructs the boundary of the farm. The user has various options to enter key information about the farm, such as the crop that is currently being cultivated in the bounded region. The user can enter additional metadata through audio recording and photo capturing features of the app.

We field-tested our app in the Hohoe Municipality of the Volta region in Eastern Ghana with local farmers and agricultural extension agents. Based on observations and user feedback from these repeated trials, a revised version of the app was deployed in Hohoe, in April 2013. Here, 11 farmers were recruited as data collectors, including local leaders of community Farming Based Organizations (FBOs) and Ministry of Food and Agriculture (MOFA) Agricultural Extension Agents (AEAs). After using the app for 10 days, 201 farm boundaries and numerous other observations about the farms were collected from the municipality and uploaded to a remote server for further analysis. From this aggregated information, we were able to collect a snapshot on the current agricultural practices and productivity of the region.

2. THE MAPPING TOOL

ACM DEV 4 December 6–7, 2013 Cape Town, South Africa
Copyright 2013 ACM 978-1-4503-2558-5/13/12 $15.00
DOI: http://dx.doi.org/10.1145/2537052.2537081.

The ultimate goal of this app is to create digital maps of farmlands, particularly in developing countries, while also collecting useful metadata about the farms. One of the main reasons behind selecting mobile phones as our platform to build this tool is that they are cheaper, more available, and more customizable than many other sophisticated hardware alternatives for creating such maps. We are also aware that many successful ICT tools have been developed for mobile phones in rural areas of developing countries [1][2][3][4].

Nevertheless, there have been inherent challenges in designing this tool. Namely, our app was designed such that professional agricultural extension agents or rural farmers alike could learn how to operate the tool and be involved with the collection of information from rural communities. We therefore had to keep in mind that most of our targeted users, although generally familiar with standard mobile phones, would have never used smartphones before.

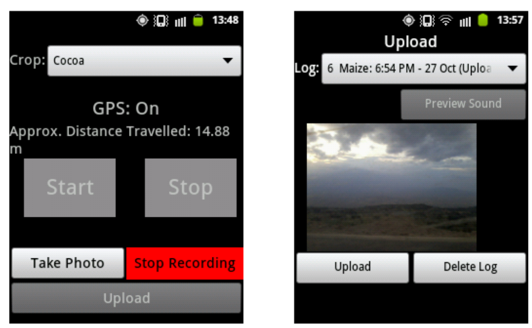

Figure 1: Mapping app interface

The app (Figure 1) is designed to be easy to operate without compromising on the accuracy of the collected data. It can run on any GPS-enabled Android device and tracks the movement of the phone by recording its coordinates. Once the phone is able to access a data network or wifi hotspot, these coordinates can be uploaded to a remote server.

A visualization of farms and food production can then be created on the server side by drawing their boundaries and projecting them over a base map (e.g. Google or Bing Maps) of the region. The database can then be queried for different selectable attributes such as crop type to give a distinct view of the data. Additional statistics and measurements, calculating the area of each farm using GPS coordinates, can also be derived from the data.

In addition to drawing farm boundaries, the tool has a secondary feature of collecting useful observations about the farm and storing these features as metadata associated with each farm boundary. This can be done by recording audio or taking photographs. For example, the user can record comments about the type of seed and fertilizers that were used, expected harvest time, predicted crop yield, etc. Similarly, photographs can reveal whether a crop was planted in straight rows or broadcast at random, healthy or over-run with weeds or pests, and even showcase machinery that the farmer may own. These observations add significant depth to the understanding of the individual fields.

3. FIELD STUDIES

In April 2013, a Beta Version of the app was deployed in Hohoe, Ghana, following three previous field tests that incorporated feedback from local farmers and agricultural extension agents to improve the features and design of the app (Figure 2). The data collection team was composed of 6 AEAs from the local MOFA office and 5 local FBO leaders. All of the participants had a good understanding of English and had used mobile phones before for a diversity of functions. Yet only a small handful had any prior exposure to advanced mobile equipment such as smart phones. Participants were given an Android phone, charger, instruction manual, and collection tracking worksheet for the duration of the study.

Figure 2: A user maps out a rice field

We asked that participants target a variety of farms across attributes such as crop type, farm size, and location. They were also asked to use the media capture functions to annotate their data with interesting observations from the farms. The average start-to-end time for each mapping session, including any additional audio or image recordings, was calculated to be just 8 minutes.

The collected data was uploaded to the server and cleaned to remove incomplete and erroneous results. Figure 3 shows a subset of the farms that were mapped in Hohoe in our study, projected over a satellite image base map of the region. The color of each farm is linked to the dominant crop that is currently under cultivation in that farm. Apart from this visual depiction, web applications running on our geoserver were used to generate a variety of graphs and plots as a descriptive summary of the data collected, such as the breakdown of farms based on crop type (Figure 4).

68 farm boundaries were supplemented with audio recordings that were subsequently transcribed into structured in-

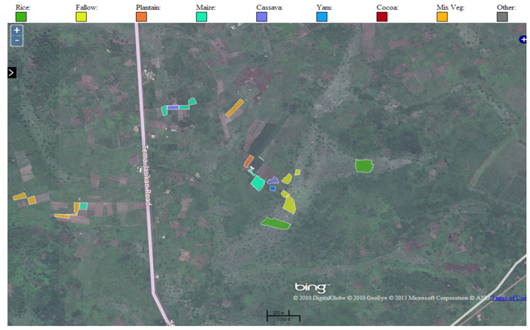

Figure 3: A sample of our farm boundaries overlaid on a Bing satellite base map of Hohoe, at 200m resolution

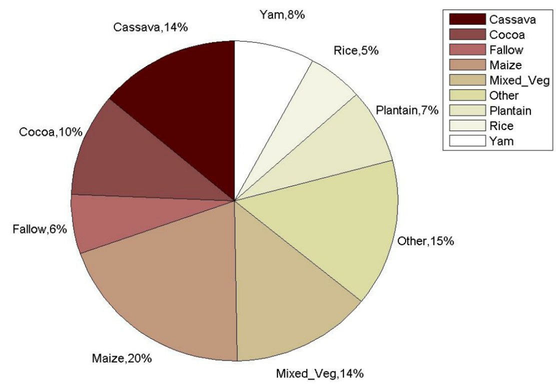

Figure 4: Distribution of crops under cultivation in the sample study, based on number of farms

formation. Recorded observations ranged anywhere from the number of years that the individual had been farming to the markets that were taken into consideration when choosing which crops to plant. Similarly, several hundred photos were taken directly from the farms to visualize characteristics such as planting method and crop health. Our mapping tool has therefore been shown to quickly and easily collect a wide variety of information that can significantly improve our understanding of agriculture in rural communities.

4. REFERENCES

[1] W. Brunette, S. Sudar, N. Worden, D. Price, R. Anderson, and G. Borriello. Odk tables: building easily customizable information applications on android devices. In *ACM DEV*, 2013.

[2] A. Kumar, P. Reddy, A. Tewari, R. Agrawal, and M. Kam. Improving literacy in developing countries using speech recognition-supported games on mobile devices. In *CHI*, 2012.

[3] I. Medhi, S. Patnaik, E. Brunskill, S. N. Gautama, W. Thies, and K. Toyama. Designing mobile interfaces for novice and low-literacy users. *ACM Trans. Comput.-Hum. Interact.*, 18(1):2:1–2:28, 2011.

[4] N. Patel, D. Chittamuru, A. Jain, P. Dave, and T. S. Parikh. Avaaj otalo: A field study of an interactive voice forum for small farmers in rural India. 2010.