Android App for Field Data Collecting with Speech Recognition

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ABSTRACT

The handheld computer (PDA) is an useful equipment for precision agriculture (PA) in many field operations. But with the growing trend of mobile devices such as smartphones and tablets, PDAs have become a more obsolete option in the technological context. With the idea of creating a new tool for PA based on the speech recognition to replace and/or minimize the use of touchscreen and worksheets in the field, Android was chosen as the operating system for the development of this application. The design was based initially on studies of mobile applications developed for PA through published articles or through monitoring procedures in field data collection. The application resulting from this development is based on three parts: settings, speech data collection and maps. Part of settings allows the user to set some options for operation of the application as: variables to collect, use of GPS, use of speech recognition, file storage folder to 'txt' file and registration information, etc. In the data collection the user configures the variables he wants to collect and the application creates a form that is filled through speech recognition automatically. The map is used to help the user navigate the route through the use of Google Maps® base. A 'txt' file is created containing data along with geographic coordinates obtained from the onboard GPS of the device and it can be used for creating maps in geographic information systems (GIS).
Keywords: Smartphone; Cell phone; Mobile computing; Precision agriculture; Brazil

1. INTRODUCTION

Precision agriculture (PA) is one of the major responsible for the insertion of increasingly advanced technologies within agricultural production systems. An equipment of consolidated usage in AP is the handheld (Personal Digital Assistant, PDA). This equipment has numerous applications within the field operations due to some favorable characteristics as navigation by satellite system (GNSS) embedded physical resistance, wireless communication and integration with various sensor elements. Some examples are shown on papers of Bange (2004), Li et al. (2011) and Molina-Martinez (2011). Thus PDAs integrate PA cycle of gathering information and has replaced manual techniques for annotation and recording.

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But with the growing evolution of mobile devices such as smartphones and tablets, PDAs have become an obsolete alternative. There are several characteristics that make these mobile devices more attractive technologically. The insertion GNSS was the first step to make them applicable for use within the PA. Features such as high processing power and storage, more sensitive and defined displays, and operating systems (Google Android, Apple iOS ®, Windows Mobile ®, Blackberry ®, etc.) that allow the development of more sophisticated and efficient applications; have allowed smartphones to process more elaborate calculations and maintain more extensive databases.

In recent papers it is possible to find some Android apps for use in the field, such as Dvorak & Price (2011) who developed an application to calculate required power in operations with machinery; Mesas-Carrascosa et al. (2012) developed an application to collect photographic and textual information in the field to gather farm registration information, and Delgado; Kowalski; Tebbe (2013) developed the first application for management of nitrogen application and calculation of vegetation indices.

But a problem that smartphones and tablets still inherit from PDAs with regard to the use of such equipment within the agricultural environment is the need to use the touchscreen for data entry. PDAs generally have resistive touchscreens, which need substantial pressure on device screen, while smartphones and tablets operate with capacitive touchscreens, which recognizes a touch from the change of capacitance in a given region of the screen. Both can observe some difficulties during the operation as: typing errors, inconsistency (touch a button and the device recognizes another), loss of auxiliary accessories as pointing devices; difficulty seeing the virtual keyboard due to glare.

Almost non explored technology in agricultural and which has gained ground in other areas such as education, tourism and health, is the voice recognition. Some important works on speech recognition in agricultural operations are DUX; STRICKLAND; ESS (1998) and SATO (1993). This technology allows the user to interact with a particular device through voice commands, and proves to be an alternative to manual data entry into various systems.

Against this background, this paper presents the development of an application for mobile devices with Android operating system that uses the voice recognition technology to collect georeferenced data field in a simple and practical way of lowering significantly the use of touchscreen and the difficulty of seeing the screen.

2. MATERIALS AND METHODS

Initially to design the application, methods for data collection in the field were observed and features that should make up the tool were listed. With these parameters, screens and UML diagrams (Unified Modelling Language) for modeling the interactions between the proposed features have been designed.

For the development of the app the Android SDK (Software Development Toolkit) was used with Eclipse IDE (Integrated Development Environment) and ADT (Android Development Tools) plugin. For testing the smartphone Samsung Galaxy GT-I9000B with 2.3.3 Android version was used.

Only APIs from Android SKD were used for internal algorithms, such as: Speech API (speech recognition and speech synthesis), Location API (communication with GNSS), Google Maps®.

The 2.2 Android version was chosen as the minimum to support the application execution.

3. APP DESCRIPTION

Figure 1 shows all application screens. The home screen uses large buttons with icons to start a collection for voice; to access the maps, access the about screen, or close the application.

Figure 1. App home screen.

To perform georeferenced data collecting with speech recognition is necessary that the user sign identifying information and variables he want to collect. Figure 2 shows this sequence of screens for data collecting by voice.

When starting a data collecting, the first screen that appears to the user is the identification screen (figure 2a). This screen has two text fields to be populated with a name or code of user and area. In this screen there are two colored indicators to signal that the smartphone is or not receiving GPS coordinates, is or not connected to the internet. If it gets coordinates, and the indicator signal is green, the received coordinates are displayed and updated in real time. There is also a fixed message reminding the user that is necessary to be connected to internet via mobile network or wi-fi to make use of speech recognition. The blue arrow in the upper right allows the user to proceed to the next screen once you he completed all fields.

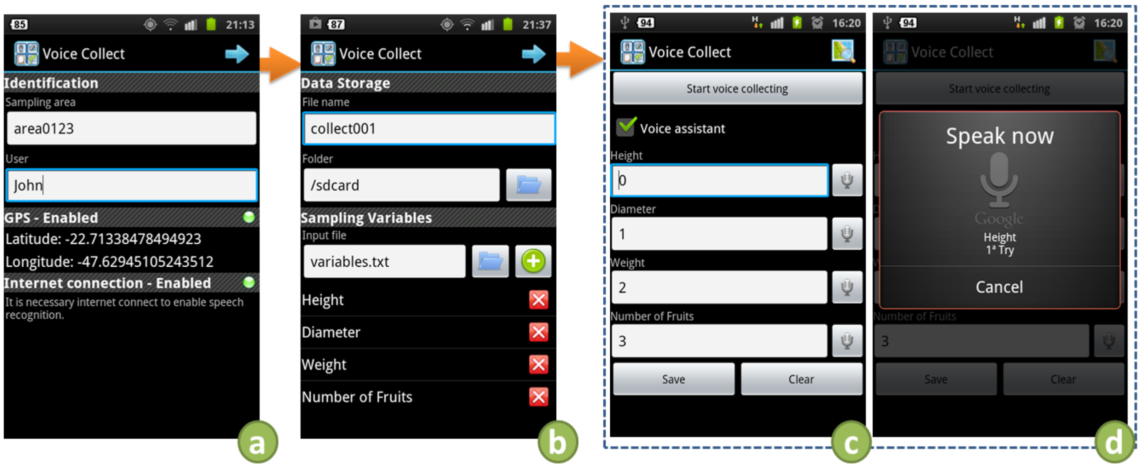

Figure 2. Screens for speech data collecting.

On variables screen (figure 2b) the user is first asked to compose the output text file name that will store the results of the samples taken. Then he should choose which folder he wants to store this file, and for that, he must click on the icon to the right side, which contains the folder symbol. To set the variables he wants to collect, the user can either choose a text file that contains a list of variables or manually add the variables with the green icon button "Add". The list of variables created can have its elements individually deleted.

In the upper right, a blue arrow will allow the user to proceed to the collecting screen if all fields are filled and there is at least one variable registered in the list. If any of these conditions is not satisfied a message is transmitted and the following screen is not displayed.

The last and main screen of the app (figure 2c) is a kind of form composed with text fields that must be filled with the values user needs to register at that particular point in the sample he is performing. In this form there is a text field for each variable entered in the previous screen, and these fields can be filled in either by automated speech recognition system or manually by clicking up on the field and using the virtual keyboard that appears on screen application. Before starting a collecting of variables by voice, it is allowed to enable voice assistant, this feature make use of speech synthesis technology for the mobile device to tell the user what was understood after the speech recognition. It is important to remember that on Android devices this feature is only available when a voice synthesis application is installed and enabled on the device.

To start automated voice collecting the user needs only to click the "Start voice collecting" button and a sequence of interactions with the user will start. First, if the voice assistant is enabled, the application will synthesize the first variable name, "talking" to the user explicitly. Then the application opens a speech recognition dialog box that contains the symbol of a microphone and waits for the user's speech. In this dialog box is also written the name of the variable and how many attempts are being made to recognize that speech accordingly app's vocabulary. When the user speaks the numerical value of the variable to collect, the application performs the analysis of what was said and if it is a number the application will understand what user said and tells the content recognized. However, if the application does not recognize what has been said it will speak the sentence "I did not understand" and ask again for the given variable. Vocabulary is composed by integers from zero to 999, and floating point numbers with a digit after the point in the range of 0.1 to 999.9. For these floating point numbers the user must speak the first number, then say the word "point" and then speak the second number. Once a valid value is recognized the application writes it in the text field. This sequence is repeated for each of the variables to be collected.

At the end of collect, if the voice assistant is enabled, the application will do the following question: "do you wish to save you collect?" And then if you answer "yes" the application will store the values collected in text file, and if you say 'no' the application simply closes the dialog box, thus ending the collecting routine of variables.

At the moment the user is storing data, the application also seeks the geographic coordinates that device is capturing and inserts then into the text file. However, this is not a mandatory condition of operation because user is allowed to make collecting without having communication with the positioning system.

The maps screen (figure 3), which can be initialized by the home screen or by the icon on the collecting screen, indicates the current position of the user on the map and shows points that help the field orientation. The menus for interaction with maps allow you to: importing KML or GPX, add a place to the map point; delete one or all points and calculate the distance to a user selected point.

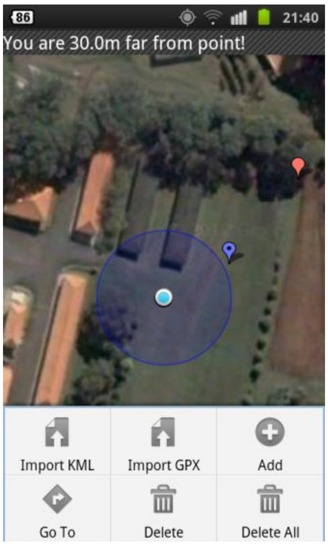

Figure 3. Maps screen.

The file generated by the collected data is divided by columns. The lines represent each of the routines executed and stored in this file. The index, time, latitude, longitude and altitude columns are always presented regardless of the variables registered by the user and are automatically filled in by the application. Figure 4 shows part of a file generated by the application.

COLLECT DATA								

Index	Time	Latitude	Longitude	Altitude	Height	Diameter	Weight	Number of Fruits
1	17:46:12	-22.7130803	-47.6288102	559	26	2.5	646	45
2	17:47:13	-22.7131417	-47.6287098	557	14	26.8	35	102
3	17:48:01	-22.7131417	-47.6287098	556	11	0.6	12.1	922
4	17:48:58	-22.7132013	-47.6286913	554	8.7	99.6	245	800
5	17:49:36	-22.7131639	-47.6286706	553	6.6	5.5	92.3	95.3
6	17:51:14	-22.7131409	-47.6286436	553	32.5	45.6	89.7	6
7	17:52:02	-22.7131347	-47.6286792	553	5.1	1.2	1.3	532
8	17:52:55	-22.713105	-47.628816	552	7	463	515	458

Figure 4. File filled with speech recognized data.

The app can be operated entirely in English or Brazilian Portuguese language.

4. CONCLUSIONS

It can be seen by recent papers that many areas as education, health, tourism and agriculture have adopted smartphones and tablets in various applications with different goals. In the app shown in this article it is possible to observe that speech recognition technology can be applied to a basic task of precision agriculture due to a more integrated and modern software development technology, which belongs to a new generation of devices mobile.

This work is the first to conceptualize the use of speech recognition on mobile devices for precision farming. It is believed that this will be a trend due to the quality of speech recognition services available, with high hit rates, independency of speaker and multilingual support.

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