GEO-BASED MOBILE APPLICATION – CASE STUDY ON PRECISE FARMING

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ABSTRACT

The article describes the Mobigri platform. It is based on the interconnection between web and smartphone application used for collecting geographically based data. The case study is focused on precise farming, especially on sugar beet fields. The paper describes a more advanced application for mobile phones on the Android system. It allows collection and edit information directly in the field by smartphone. Massive progress in the IT field brings different views which strongly reflects the boom in mobile technologies, including in the area of precision farming and land-use registration. A case study on the territory of Olomouc region-Haná (Czech Republic) was selected for development and testing. The Haná region is one of the main rapeseed areas in the Czech Republic; sugar beet has been a long-standing tradition, and finally, there are many sugar factories in the area. The principle of collecting, analysing and evaluating data in the digital environment is an essential prerequisite for the possibility of realising precise farming. Data collection based on Geographic Information System (GIS) tools enables efficiently management and evidence areas of sugar beets.

Keywords: *precise farming, Android, map, agriculture, geographical information system*

INTRODUCTION

This article extends an idea of Mobile Mapping Client published in the paper "Mobile Map Application for Pasportisation of Sugar Beet Fields" [1]. While the original article deals exclusively with the online passport client, which is available only from a web browser environment, the featured solution describes a more advanced application designed for mobile devices, enabling the collection and editing of field information directly on the ground. Progress with different views on the subject reflects the boom of mobile technologies, including the field of precision economy and agricultural land registration. A case study in Olomouc was selected for development and testing. Haná region "is one of the main beet-growing regions of the Czech Republic, Haná has a long-term tradition of sugar beet growing, and many sugar factories are in the area" [1], [2]. The principle of digital data-collection analysis and evaluation in the digital environment is an essential prerequisite for the possibility of implementing precision farming. However, the data collection using the Geographic Information System (GIS) tools permits administrators of agricultural cooperatives or individual fields to record areas with sugar beet or similar crops efficiently.

ANDROID OPERATING SYSTEM

Android is an open-source software developed by Google, Inc. Android is built over the Linux kernel, that it is publicly available, free of charge, and users can freely distribute it. The first publicly available version was released in September 2008. Today's biggest competitor is iOS from Apple, Inc. It published its first release in June 2007, that is 15 months before the first version of Android. According to [3] the worldwide market share of both mobile platforms is 97.3% in January 2019 (Android: 74.45%; iOS: 22.85%) – see Figure 1. In the Czech Republic, the market share is 98.1% (Android: 76.19%; iOS: 21.91%) [3].

The Android platform covers a 74% worldwide market share, with a large device portfolio and generally, with a lower hardware pricing it is an excellent choice for application development and extending an application among potential users. The native Android programming language is Java, but can be chosen another programming language, such as Kotlin, C / C ++ or C #. The most significant positive features of the entire Android platform are market shares and the variety of prices and performance of the devices which were sold. The large variety of devices is, however, a significant negative on the entire Android platform. No Android version has a significantly dominant position on the market. According to [4] the market (Czech Republic, January 2019) appears smartphones with Android system version 4 (7.12%), v5 (12.88%), v6 (15.25%), v7 (23.8%) and v8 (36.56%). The rest (4.39%) of the market have other versions [3]. Each newer version of Android is backwards compatible with older versions. However, new features cannot be used. When creating an application, it must be determined in the manifest what minimum version of Android will be supported by the application and the associated capabilities of using available features. The developed application can be published in the worldwide official Google Play catalogue [5]. Alternatively, it can be directly installed by the installation file with the *.apk extension [6].

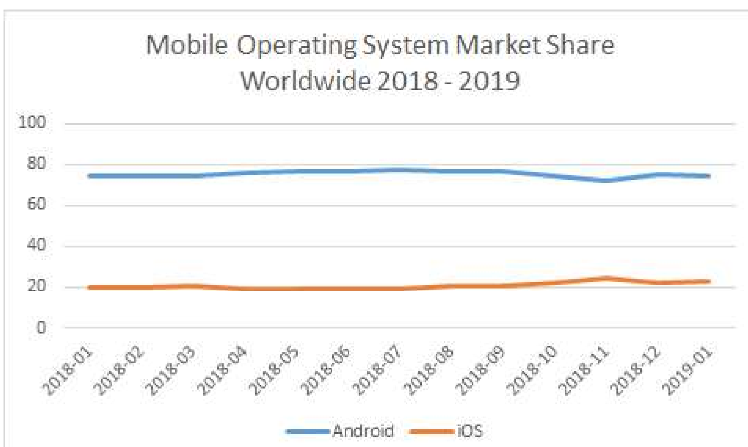

Figure 1: Mobile operating system market share worldwide 2018 - 2019 [3]

METHODS

Spatial data collection and digital recording of the agriculture field bring the more effective and precise process of management of precision agriculture technologies, which allows gaining effectivity procedures and yield of crops. Passportization clients, which using geographical information system principles, which means the interconnection of spatial and attribute (information) component, provide modern methods of data recordings about agriculture field utilisation, including update aerial photographs [7]. LPIS (Land Parcel Identification System) is the most extensive data source in the Czech Republic. There are some difficulties for processing agriculture data from office, e.g. probability of intentional or unintentional errors (spatial accuracy of boundaries, points), delay and postponement of data processing, not familiar with the real situation in field or impossibility of gathering primary data.

With the new era of smartphones, gathering the real field data by mobile applications is rising. Compared to the desktop application, the mobile phone application can collect more detailed spatial, multimedia, sensor, tabular and even informative information in real-time in real field conditions [8]. The mobile app is communicating with built-in hardware components of the mobile phone such as GPS chip, camera or microphone. That secure absolute accuracy of acquired data (precision of the position of the mobile device on Earth using global navigation satellite systems with cooperation with mobile internet, Wi-Fi or mobile phone signal has a few meters' tolerance). A mobile phone allows gain and edit records anytime and anywhere even without an internet connection. A GPS localisation and the actual state of crops directly in the field is a certain asset. Mobile field application extends the principle and functionality of the original web client. The purpose of the authors' team was to separate operations for managers of agricultural cooperatives. The existing web client is used to visualise and data management especially for office workers, while the mobile application is designed for field workers. Both systems are interconnected and allow two-way communication.

A pilot study illustrates the deployment of the mobile application for both field managers or agricultural cooperatives and field workers. Existing current spatial data (land borders, parcels, watercourses, points of interest), tabular, informative and multimedia information can be download into the mobile application through the internet (Wi-Fi, mobile internet or by data cable). In the case of primary data collection, the user does not have to download any data and will create new data sets. Gather and edit of data can be done off-line in the field for an unlimited amount of time. After connecting the application to the internet can be data sent to the server via the internet. The data is immediately synchronised with the web application – see Figure 2.

The web client allows the assignment of the displayed and downloaded region for each user. This solution aims to minimise the size of transferred data during two-way synchronisation. Secondly, it is leading to not overwhelmed a field worker with irrelevant information. From the server, it is possible to download into mobile application detailed aerial photo of the territory which leads to a better comparison of real condition and orientation in a field. Web client serves mainly for project preparation and data management. The mobile application is used for advanced and effective fieldwork with monitored data.

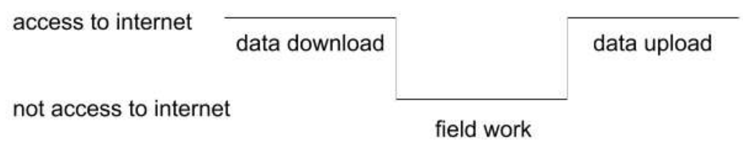

Figure 2: The field work does not require an Internet connection

APPLICATION BACK-END

The application was developed in the native environment called Android Studio, which is free for charge by Google company. A programming language Java was used as a native development language [9]. There are many benefits when using native resources. The compatibility of all components is ensured, supported by complete documentation available. The Mobigri app is designed to work in both modes: online and offline. The Internet connection is required only for updating and synchronising - it downloads current information and data from the server and. The app is available for Android version 4.0.3 and higher. The application requires the basic access permissions only for localisation services - write and read of the memory card and access to the camera/photos. External modules have been used to develop the application to enhance the functionality of the application itself. These modules are OSMdroid, OSMdroid Bonus Pack, OpenCSV and Commons Net [9]. The most important module is OSMdroid, which provides tools for working with vector and raster spatial data and provides access to freely available map data. Spatial data are stored in the native Android SQLite database.

All necessary data files are stored in the device's internal memory – see Figure 3. The "osmdroid" folder contains the "tiles" folder, where the tiles for the OpenStreetMap tile-layers are stored. The basemap is available at both online as well as offline mode. It is fully accessible also without internet connection if the users pre-download the map on the Internet. Moreover, data are automatically downloaded tile-by-tile if the user goes through the map online. Data are downloaded for the current zoom level only. Other files are created when the application is used. The "aktualni.mbtiles" file is a file that holds an aerial/satellite map; the file "export.csv" contains the submitted changes. The current aerial/satellite basemap (orthophoto map) can be uploaded into the application via Wi-Fi or uploaded manually to the "osmdroid" folder. The "import.sql" file contains data about user uploads. The "photos.zip" file contains new photos that have been captured and sent.

The application is installed by using a *.apk file. Since the app is not currently available from the official Google Play store, you need to enable *.apk installation in your phone settings. This can be found in Settings -> Security -> Unknown Resources (Enable). Mobigri app requires only the basic necessary permissions - access to localisation services by GPS (and Wi-Fi or GSM to improve location), permission to write and read data to and from the smartphone (downloading new fields, capturing photos). Finally, an access to the camera is required to take pictures. Authors assume that the publicly available version will be distributed via the Google Play Store [5].

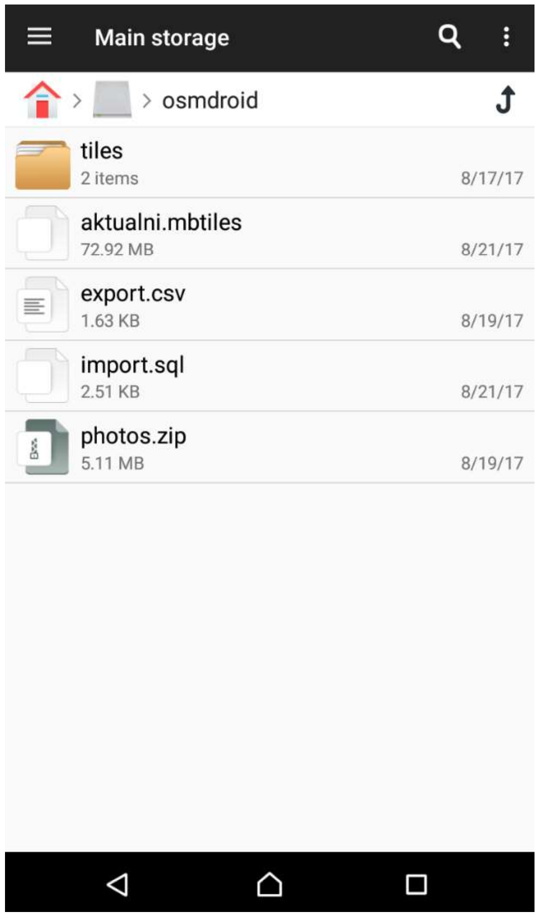

Figure 3: Data structure of "Mobigri" app in Android storage

USER INTERFACE (FRONT-END)

The application was designed for the simplest and the most intuitive operations. It has been assumed that the application will be working in the field without the ability to access the Internet, even in the worst weather conditions. The application consists of four parts: sign-in screen, signpost, map screen and the attribute input screen.

Due to the Android application design architecture the application can be translated into any language, changing display information and appearance without changing any logic systems of the application itself. The user can download some aerial map in the online mode which will be stored in the memory of the device and will be available anytime later without the internet access. Its size may be hundreds of megabytes and the time of downloading depends on the internet connection. Therefore, it is not necessary to download aerial pictures every time. The menu of the map screen includes options for sending the changes to the server, shutting down the aerial images and shutting down the application. These following features are available in the map box: adding a point of the current location using GPS, adding points manually and returning the map to the current position of the user.

The user can find the spatial, attribute or multimedia information about each field by clicking on the pop-up window in detailed information – see Figure 4. Multiple pop-ups can also be opened at the same time to be compared with each other. In the top right corner is the "pen" icon for editing the attributes. Furthermore, the user will be informed before submitting the changes about the number of changes and confirmation about the status will be displayed. If the user takes a new photo, it will be recorded along with the new attributes. Therefore, sending that information can take a long time depending on the size of the pictures.

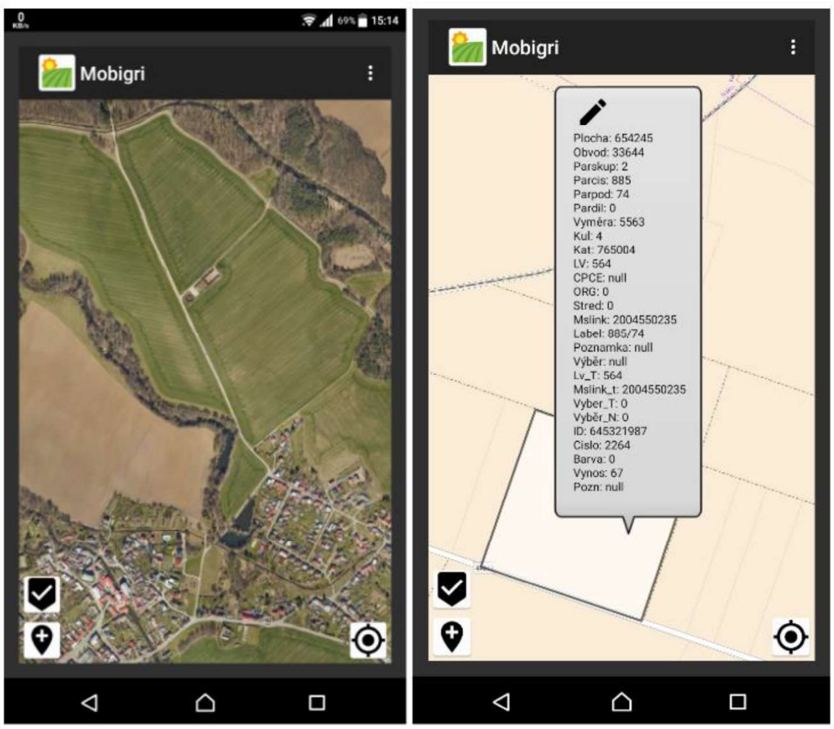

Figure 4: User interface of "Mobigri" app

PILOT STUDY

Installation of the application is being done using the *.apk file. However, it's considered to publish an app in the Google Play catalogue in the future [10]. After (depending on the version of Android system) the installation you need to allow some minimal access rights to localisation services, memory and camera. After the first start of the application, a new "osmdroid" folder is created in the memory of the device (the default name that can be customised). The folder is used to store all (except photo) data for the application. Namely, the raster tiles for underlying the map, the user´s bitmap tiles, some data file sent to the server storing the changes in the data communication and compressed photograph sent to the server [11]. The application can be used without internet access. Only for loading and transmitting the data, it is necessary to connect the internet in order to communicate with the server and perform synchronisation [12]. The application can be used to view data, control data, create new records and edit existing records.

In total, the application contains four screens. It is about a sign-in screen, a signpost, map and editor. After logging in with the user name, it can download farmland data from server and raster user tiles (in *.mbtiles format). The map, dot, line, and planar elements that are going to be activated are displayed on the map. The pop-up window displays information about the shown elements, and it is also possible to switch into the editing mode. Creating the new elements can be done either from the current position or by clicking into the map. You can also add photos in the popup window of the chosen attribute. Clicking the CAMERA button will activate the camera. Images are stored in internal memory in the DCIM (Digital Camera Images) folder, which is a common part of Android systems. In this folder, a new "mobigri" folder will automatically be created which stores the images captured using the application. Two photographs can be taken for each record which will also be automatically signed to the attributes.

Positioning accuracy depends mostly on the used equipment and the size area of the visible sky. Nowadays, the mobile devices (phone, tablet) with the Android operating system are almost always equipped with a chip for receiving a signal from the US GPS, but also Russian Glonass or European system Galileo. All three mentioned global satellite navigation systems could be used to calculate a more accurate location of the device. It can also be used a less precise and less energy intensive method for positioning using the Wi-Fi and GSM networks.

CONCLUSION

The article aims to demonstrate the benefits and possibilities of a terrain mobile map application called Mobigri. It is a fully functional mobile application for the Android platform which enables the real-time capture of attributes (descriptive), spatial (localisation) and multimedia (photos) data through the smart mobile phone. From the field data collection or native mobile phone applications perspectives, the records of crops and cultivated crops can be edited and downloaded at any time and from anywhere nearby the mobile signal, even without the need of the Internet connection. Above all, for both own (primary) data collection and status monitoring, the localisation and actual recording of farmland status - directly on the ground - are indisputable benefits. The case study and its testing are carried out as a pilot study on beet fields in the Haná region around Olomouc. The Mobigri application will be available at the official Google Play store for the Android operating system. It requires an Internet connection only for the downloading underlying data and synchronising with the server. On the other hand, the Internet connection is definitely not required for the data collection in the field.

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