Original Research Article

Acquisition of Field Data through Mobile-based Apps dedicated to Soil Health Protection

ABSTRACT

Mobile applications dedicated to soil resource protection are increasingly common among users worldwide. What makes them popular among them is the possibility they offer in the acquisition, respectively saving and storing data from the field. Regarding the possibility of acquiring soil resource data, we propose to make an analysis, to emphasize the malleable nature of specific mobile applications with what software development platforms allow; for the present paper, we examined an application created through the MIT App Inventor® platform. As a result of the research, three ways of data acquisition were determined - through the interface, internal sensors, and external sensors. The obtained results showed that the acquisition of soil-related data depends to a large extent on the specifics of mobile devices (especially the presence and access of sensors), but also on the implemented functionalities that the user wants to have access to at that time. Consequently, any application created through platforms such as MIT App Inventor® can and must have at least one of the data acquisition methods presented in the paper; the dynamics and specificity of the application must agree with the user requirements and the requirements imposed by the research context.

Keywords: soil-related data acquisition, mobile applications, App Inventor®, soil protection.

1. INTRODUCTION

In today's digital age, the mobile devices at our disposal present a special informational connection between the community and the environment, and, in this case, Environmental Informatics (EI) and Environmental Information Systems (EISs) play a major role in decision-making [1, 2]. In addition, the evolution, definition, and role of Environmental Informatics (EI) and Environmental Information Systems (EISs) in the development of mobile-based systems are tightly connected to the environmental awareness of the last three-four decades, with access to an almost infinite supply of content on the web, to which is added the content captured through other devices and sensors [3, 4]. For example, the connection between mobile devices with applications dedicated to the protection of soil resources and users (specialists or non-specialists) is also an interesting one that needs more attention. Beyond the definition and conceptual delimitations, from Enviromatics to Sustainable Informatics, only a few users manage to fully understand the mobile-based systems and users connection [4, 5]; the vast majority of them find it difficult to harness the full power of mobile devices, ubiquitous in their communities and everyday activities.

From Human-Environment Interaction to Environmental Information Systems (EISs) and Environmental Informatics (EI), where sustainable development is perceived as a finality of the community-environment relationship [6, 7, 8], it is noted that most mobile device users consume information without being able to produce it. In the same space and time, even if the Social-Ecological Systems dynamics in a Knowledge-based Society are well-known [9], filling the Environmental Science gaps with Big Open-Access Data [10], many of the problems of communities that can often be solved with mobile-based applications remain unsolved. How might they learn to use the capabilities of mobile devices to solve everyday real-world problems? How could they solve the problems of soil monitoring and protection by turning to the capabilities provided by mobile devices? The answer is very simple. By configuring, developing, and implementing their applications [11-14]. Valuable help in this regard can be provided by the MIT App Inventor® platform, which is designed and used (for about 10-12 years) as a tool for learning computational thinking in a variety of real-world contexts [15, 16]. MIT App Inventor® is an online development platform that anyone can use to solve real-world problems, as it provides a "What You See Is What You Get" (WYSIWYG) web editor for creating applications for mobile devices with Android OS and iOS. Moreover, the platform's user-developer interface is very friendly and intuitive. As part of working with the platform and learning, MIT App Inventor® uses a block-based programming language built on Google Blockly®, and inspired by languages such as StarLogo TNG® and Scratch® [17, 18]; thus empowering anyone (even students) [19, 20] to build a mobile phone app to meet a need, by creating a tangible [21] and/or an educational application [22]. Up to today, 6.8 mil. people in more than 190 countries have used MIT App Inventor® to create more than 24 mil. applications, providing practical mobile solutions to real problems in their families, communities, and around the world.

Mobile device programming combined with software application development can provide a genuine and engaging hook in computer science, but also within the other applied sciences (including those in the soil sciences category). With App Inventor, developed by Google® and recently moved to MIT®, programming Android apps are as easy as clicking blocks together. MIT App Inventor has been used successfully in after-school learning programs, summer camps and schools, teacher workshops and experiments, and dedicated programs in middle school through college classrooms [23-25]. Several development environments specific to mobile applications were used to configure the soil protection software application [26, 27], with the design of the work screens as well as its functionalities. The creation of various applications is done by working with the App Inventor Designer - where you select the graphic components for the desired application, the App Inventor block editor - where you assemble the program blocks (fitting them together like pieces of a puzzle), which specify how they must include the components. The app appears on the phone, step by step, as parts are added to it so that the work can be tested as the build continues. Users who don't have an Android phone can create apps using the Android emulator (software that runs on a computer and behaves like a phone).

2. MATERIAL AND METHODS

Through the present work, we aimed to highlight, present, and descriptively analyze how field data can be acquired through mobile applications dedicated to soil monitoring and protection. In this regard, the facilities offered by the MIT App Inventor®, a platform that helps in the configuration, design, implementation, and testing of the aforementioned mobile applications, were closely researched. The analysis of how the MIT App Inventor® platform can be integrated into modern soil protection strategies is done simultaneously with the configuration and development of a field-like digital application. The application requires the correlation of the MIT App Inventor® platform with specific data for soil protection (with the variation of texture, temperature, altitude and relief, relative humidity and atmospheric pressure, dynamics of local hydrometeorological characteristics, etc). The analysis was performed at the Office of Informatics within the North University Center of Baia Mare - Cluj-Napoca Technical University (Romania), during the reference period October 2020 to December 2021, and involved identifying and scoring elements that make MIT App Inventor®

be used to create dedicated soil protection applications. The analysis methodology included the main components of mobile devices that may be related to the acquisition and processing of field data about soils (camera and video camera, image picker, player, sound recording, navigation and map, barometer and hydrometer, accelerometer, orientation sensor, thermometer and light sensor, etc).

In addition, as a result of the configuration and pretesting of the alternative application to the field agenda, it was observed that the MIT App Inventor® platform can be used successfully in modern environmental impact assessment strategies, but especially in monitoring and protection of soil resources. Moreover, the application created through MIT App Inventor® is prompt and responsive in acquiring data from the field, which makes us recommend such monitoring initiatives in the future, especially to those who want and feel the need to have their application for soil or environmental protection; we recommend all to use App Inventor®, because it is a free tool, of real/practical use, which promises a better integration of the two areas of interest, namely computer science and soil science.

3. RESULTS AND DISCUSSION

The quantification of field data acquisition possibilities offered by Android OS and iOS mobile device applications was realized starting from the analysis of the App Inventor® platform. At its level, a series of functionalities have been configured, designed, and developed, starting with those presented in the data sheet for taking soil samples. They have been tested and validated in the field, step by step, according to the research requirements stipulated by the users. The acquisition of data from the field, through the created application, can be achieved in no less than three ways (see Fig. 3):

- through the application interface itself;
- through the application interface, but with the help of the device's internal sensors;
- through the application interface, but with the help of external sensors (which can be placed directly in situ).

The first category includes applications that are based on simple functionalities, which allow the acquisition of data only by manually completing the information according to the user's field observations.

The second category implies, in addition to the acquisition facilities already offered by the first category, a greater interaction, both with the user and with the various documentation and information media. Applications in this category are based on functionalities that act on various components of mobile devices in an attempt to capture data.

In these conditions, the photo and video cameras, but also the audio component of the mobile devices, as well as the components that connect the documentation and information environment internally and externally to the devices in question, are activated. The geo-location sensor (GPS of the device), the sensor for determining the position of the device about the user, and even the sensors for temperature, brightness, and humidity (if the device has such built-in sensors) are also activated.

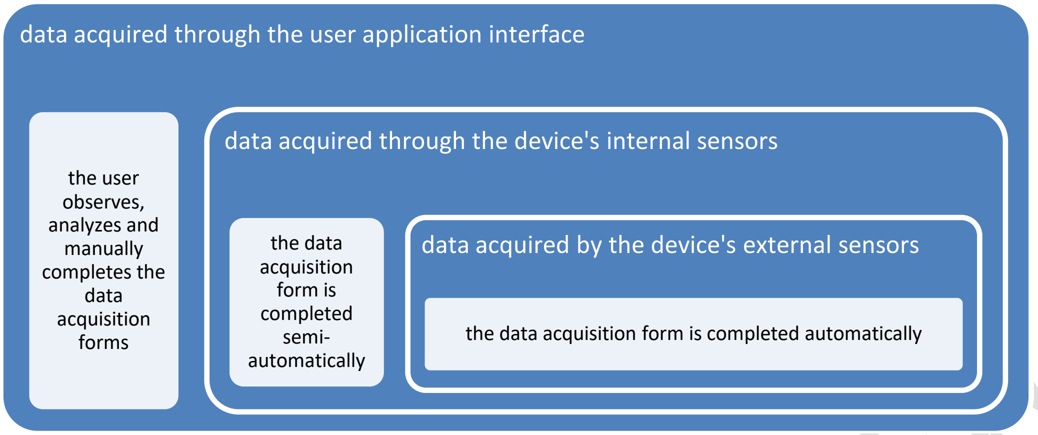

Fig. 1. Reference chart for soil data acquisition through soil monitoring and protection mobile applications

The acquisition of data from the field, strictly through the created application, can only be done according to the included functionalities, which the application has. Through its configuration, design, and development, an attempt was made to capture the most representative number of data from the field; the minimum required data - to have an idea of the land use, the qualitative state, and the prospects for the protection of soil resources - is reflected in the content of the digital sheet for taking soil samples. The digital sheet for soil sampling captures four information instances, which are presented as follows:

- information regarding the location under investigation - the location, date and time, the exact address of the location, and, last but not least, the specific GPS coordinates of the testing location are concerned;
- general information regarding the conditions in the field - the use of the land, the hydrometeorological conditions, the organoleptic conditions, and the biocenosis conditions on the site are concerned;
- detailed information on the hydrometeorological conditions in the field (optional) - this includes sunrise time, relative humidity, temperature (℃ and ℉), precipitation, and wind speed;
- information regarding the testing conditions - the purpose of the testing, the depth of the testing, and the manner of the testing are concerned.

As can be seen, the acquisition of data related to ecopedological indicators, specific to agro-pedological studies, as well as studies related to the protection of soil resources, can be done in three working variants, each of them having a separate dynamic. To the working variant imposed by the application interface, different ways of data acquisition are followed, which involve a greater or lesser interaction on the part of the user. If the user is at the beginning of the journey, using such an application for the first time, he/she should take into account the application guide (if there is any such document), and use the application strictly about the functionalities provided in the guide (Fig. 2 and Fig. 3).

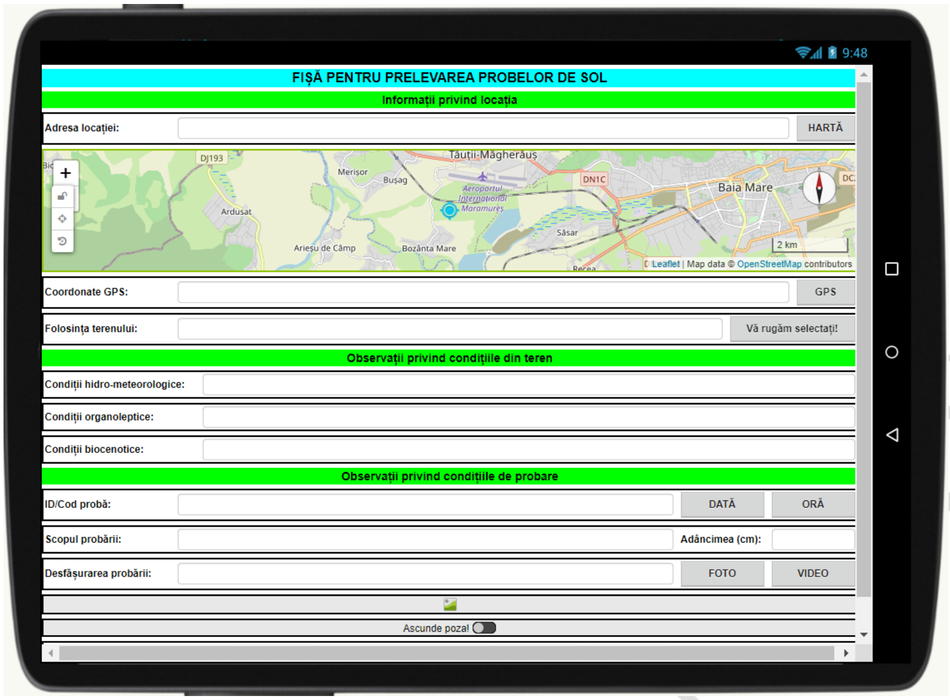

Fig. 2. Screen for "Soil Sampling Sheet" - application interface in App Inventor®

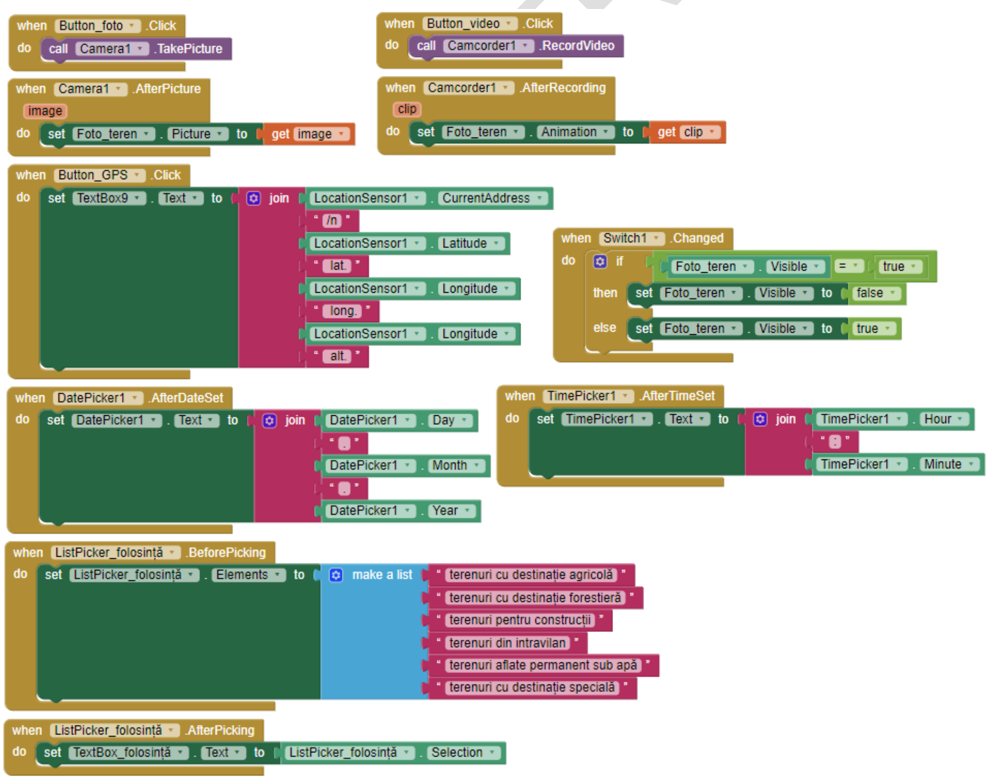

Fig. 3. "Soil Sampling Sheet" - part of the application source code

4. CONCLUSION

Through the present work, we set out to see to what extent field data can be acquired through a mobile application; In this sense, we used a newly created application through MIT App Inventor, which can be defined to acquire data through the interface or with the help of sensors. Of course, in both versions, the major focus falls on the intervention and involvement of the user, who can choose how to manipulate the application, so that he can acquire the data as he pleases. As a result, we can record three official versions available and test for the acquisition of data related to the quality and health of soil resources.

What is interesting to observe in the applications created with the help of MIT App Inventor® is the fact that they allow the development and implementation of a varied range of functionalities. From the multitude of functionalities, we have at our disposal, in this paper we have selected only those that can be used for the interface of an application for the protection of soil resources' health. There are therefore three possible work options, with the involvement of the user in a greater or lesser proportion, which includes the use of internal and external sensors, if the device in question allows such connections. From our perspective, all three work options are interesting to follow within the application we created, in the sense that they allow a different approach to the acquisition of data from the field, which gradually helps the user to adapt to the environmental conditions.

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