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Can the MIT App Inventor® application be integrated into soil protection strategies?

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ABSTRACT

This paper starts from the definition, descriptive characterization, and analysis of the MIT App Inventor® platform, according to the users' perceptions, to emphasize the malleability of the platform to the digital consumer society demands. The analysis of how the App Inventor® can be implemented in soil protection strategies is done in conjunction with the configuration of a digital field agenda. The analysis was conducted in the Office of Informatics, from October 2020 to December 2021, and involved identifying and scoring the elements that can make App Inventor® used to create specific soil protection apps. The analysis methodology included the main components of mobile devices that may be related to the acquisition and processing of field data (camera, video, navigation, map, and other sensors). As a result of the configuration and pre-testing of the application, it was observed that the App Inventor® can be used successfully in soils monitoring and protection.

Keywords: sustainable agriculture, soil protection, MIT App Inventor®, mobile applications.

1. INTRODUCTION

Since the Stockholm Conference (1972), which laid the groundwork for the United Nations Environment Program - a conference that coincided with the entry of the environment term into the international agenda [1] - it has become increasingly evident. the fact that both the collection and analysis of environmental data are of vital importance to mankind [2, 3]. As a result of the facilities offered by the new information and communication technologies, in all sectors of society and in all aspects of the activities undertaken, phrases such as *information society*, *communication society*, *information consumption society*, etc. were imposed. to designate in fact the same reality [4], but from a different perspective; a reality in which access to information and the formation of an information culture prevail [5, 6].

In today's society, defined by the new reality, the success and survival of many companies, many categories of institutions or individuals, with political or social responsibilities, depend on their ability to locate, analyze and use information resources efficiently [4, 5]. Moreover, the efficiency to which we refer is directly related to the achievement of the proposed purposes of information, documentation, or knowledge, as well as to the existence of concrete situations for making certain decisions, optimizing some processes, or applying some methodologies in favor of others [6, 7].

No matter what field of science and technology we look at, it is obvious that we are dealing with an *information overflow* unprecedented in human history. Environmental science is no exception, and recent advances in this field would have been inconceivable, unmanageable, and unattainable without the support of modern information technology, in the sense of Environmental Information Systems [8, 9], or Environmental Informatics [10,11,12].

In the sense of the above, it can be stated that specialists working in the field of environment or related fields need a large amount of data, information, and knowledge at each stage of management and evaluation of environmental processes [5, 13]. At the same time, in order to develop a project and implement it, they need to know and understand the conditions under which these processes take place. The analysis performed must be based on the best available data, methods, and techniques, and on the knowledge gained from one's own experience or from other specialists [5, 13]. Traditionally, this information and knowledge are obtained, according to current requirements, through direct access to databases, reports, and documents [5, 13], through the transfer of information and knowledge between specialists (managers, practitioners, researchers, teachers, etc), and on the occasion of training courses, workshops, congresses, and other specialized scientific events [14], which often emphasize the idea of sustainable community development [15, 16].

In order to improve management and environmental assessment skills, it is necessary for specialists, and not only, to be able to manage and implement the concepts of environmental monitoring and assessment. This goal can only be achieved through Environmental Information Systems and the full knowledge and understanding of the dynamics of socio-ecological systems [17]. As such, they must have easy and efficient access to up-to-date information and knowledge (in the form of big open-access data) [18], enabling them to make the best decisions for sustainable development, both for developed economies and for those under development.

The practice of gathering documents of any kind into collections and further researching their contents has existed for a very long time and is seen as an almost natural feature of humanity on its way to the formation of a culture. Our concern cannot be missing from this, in relation to the implications of Environmental Information Systems and Environmental Informatics in soil protection [19, 20, 21]. In Romania, is known for the fact that the activity of soil protection through the prism of the tools offered by Environmental Information Systems is just beginning and that it requires an approach that is both complex and multidisciplinary, we tried to fill these gaps through this research. The potential beneficiaries of the structured information during this research project are the students and teachers from the environmental engineering departments of the country's universities, engineers, computer scientists, and auxiliary staff involved in specific soil protection activities.

This paper starts from the definition, descriptive characterization, and synthetic analysis of the App Inventor® platform developed by the Massachusetts Institute of Technology (MIT) - according to users' perceptions from the literature of the last 10-12 years - thus trying to emphasize the malleability and affinity of the platform in relation to the needs and demands of the digital consumer society.

2. EXPERIMENTAL DETAILS

The analysis of how the MIT App Inventor® platform can be implemented in 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® with specific data for soil protection (with the variation of texture, temperature, altitude and relief, relative humidity, atmospheric pressure, dynamics of local hydrometeorological conditions, etc). The analysis was performed at the Office of Informatics within the North University Center of Baia Mare - Technical University of Cluj-Napoca (Romania), during the reference period October 2020 - December 2021, and involved identifying and scoring elements that can make MIT App Inventor® be used to create specific soil protection applications.

The analysis methodology included the main components of mobile devices that may be related to the collection and processing of field data about soils (camera and video camera, image picker, player, sound recording, navigation and map, barometer and hydrometer, accelerometer and pedometer, sensor orientation, thermometer and light sensor, etc). As a result of the configuration and pre-testing of the alternative application to the field agenda, it was observed that the MIT App Inventor® platform has the ability to be used successfully in modern environmental impact assessment strategies, but especially in monitoring and protection. soils. In this way, we recommend to those who want and feel the need to have their own application for soil or environmental protection, to use MIT App Inventor®, because it is a free tool, of real use, which promises a better integration of the two areas of interest, namely computer science and soil science.

3. RESULTS AND DISCUSSIONS

3.1 Digital consumer culture and the MIT App Inventor® platform

Our consumer culture of digital content offers us all kinds of applications and opportunities for entertainment, pleasure, and sometimes even learning. However, in general, these are passive activities [22-24]. In addition to the attractiveness of consumption, there is also the satisfaction of producing, that is, of creating content or applications. It is the joy and pride that results are similar when we paint, build a model, or make a functional mobile application [25, 26]. The high-tech mobile objects (mobile phones, tablets, laptops, etc) that we use today to consume entertainment and access information are black boxes for most of us. Their operation is incomprehensible, and while there are capabilities in some of them that allow the user to draw images, make videos, or generate new content, they are not, in and of themselves, creative environments. In other words, most people cannot create applications running on these gadgets [25, 26].

In the sense of the above, what if we could change that? What if, for example, we could take creative control of our everyday gadgets, such as mobile phones or tablets? What if creating a mobile phone app was as easy as taking a picture or playing games?

Developing a successful mobile application that clearly reflects the idea of a content creator and addressing the needs of your target audience is not an overnight task. It takes a lot of effort and a significant amount of time to build an Android or iOS application [27-29]. Most people believe that mobile application development means choosing the right technology and hiring a reputable mobile application development company. However, keeping track of the proper mobile app development process from start to finish is just as essential to making your app top of the PlayStore® or App Store®. First, it could demystify those objects. Instead of being black boxes, impenetrable to our vision and creativity, they become objects with which new content can be modified and generated (see Fig. 1).

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They thus become objects capable of our understanding. We get a less passive and creative relationship with them and we get to play with these devices in a much deeper and more meaningful way when we can build applications for each of us [25]. The unique motivational power that mobile phones could have in education is also shown through the MIT App Inventor®, which can turn students from consumers into creators.

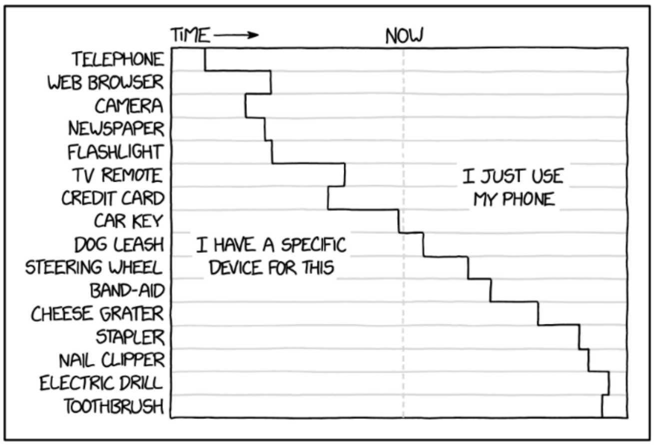

Fig. 1. A perspective on the current features of the mobile phone

Over the years, there have been many attempts (see Fig. 2) to simplify the software development process and allow more people to develop applications. MIT App Inventor® is another tool that can bring software development to the masses, rather than being in the hands of a small number of professionals [23, 26].

Fig. 2. A perspective on publications that support the usefulness and benefits of the MIT App Inventor®

Mobile phone programming can provide an authentic and captivating hook in computer science, but also in other applied sciences. With App Inventor®, developed by Google® and recently moved to MIT®, programming Android apps are as easy as clicking blocks together. The MIT App Inventor®'s web-based platform has been used successfully in after-school learning programs, summer camps and schools, experimental workshops for teachers, and dedicated programs in classrooms from high school to college [29]. Over time, the MIT App Inventor® development environment has been defined in the literature as:

"(...) a visual, drag-and-drop programming tool for building mobile applications on the Android platform"

(WOLBER et al., 2011)

"(...) a visual programming environment developed at Google® and available for free at the MIT Mobile Learning Center®, which allows students without programming skills to create applications for Android mobile devices"

(ABELSON et al., 2012)

"(...) the latest visual block programming language designed to introduce students to programming by creating mobile applications"

(KRISHNENDU, 2012)

"(...) a block-based visual programming language that makes sophisticated computing concepts accessible to a wide range of students"

(POKRESS et al., 2013)

"(...) the fastest and easiest way to create custom Android apps (...) even if you have no previous programming experience; (...) can be used for personal, business, and commercial applications - even applications to be sold in the Google Play Store®"

(MITCHELL, 2014)

"(...) a programming environment that reduces barriers to the creation of mobile applications for Android devices, especially for people with little or no programming experience. App Inventor applications for a mobile device are built by arranging the components with a WYSIWYG editor in a browser, connected to the device via WiFi or USB"

(WOLBER et al., 2015)

"(...) the quick and easy way to develop Android apps"

(MITCHELL, 2016)

"(...) an informal online learning environment with over 5 million users and 15.9 million created projects/applications" and "(...) an environment that uses a language that allows people to create mobile applications for Android devices"

(XINYUE, 2017)

"(...) a visual programming environment that is similar to Scratch® and Alice®, which focuses more on developing mobile applications" and "a block-based cloud programming tool that allows everyone to develop applications fully functional for Android devices"

(TANG, 2018)

"(...) a block-based open-source programming tool that allows users with no previous programming experience to create applications specifically for smartphones and mobile devices"

(CHO, 2019)

> "(...) a free online visual programming environment, originally developed by Google and now maintained by the Massachusetts Institute of Technology®; allows people to create software for their phones and tablets, rather than just using those devices. "
>
> (LOGAN, 2020)

> "(...) a free and revolutionary MIT online program that allows you to create your own mobile applications" and "Matching easy-to-use code blocks allow even beginners to quickly create working applications"
>
> (LANG, 2022)

In the sense of the above, we define the MIT App Inventor® platform as a new visual drag-and-drop programming tool/environment or informal web-based platform that allows users - non-programmers (no programming knowledge), beginners, or novice programmers (with little programming knowledge) - to create applications for Android mobile devices.

3.2 MIT App Inventor® and its functionalities in relation to soil protection

Nowadays, digitalization is obvious in most activities. Regardless of the area of expertise or areas of interest of a professional, it is important to know not only the basic functionality and interfaces of computers but also the basics and basic principles of mobile computing (for example the elements that define the MIT App Inventor® platform) [65]. Block-based visual programming tools such as Scratch® or MIT App Inventor® are used to teach computer science to beginners and non-computer users alike; regarding the App Inventor® web-based applications, the situation is summarized in Fig. 4.

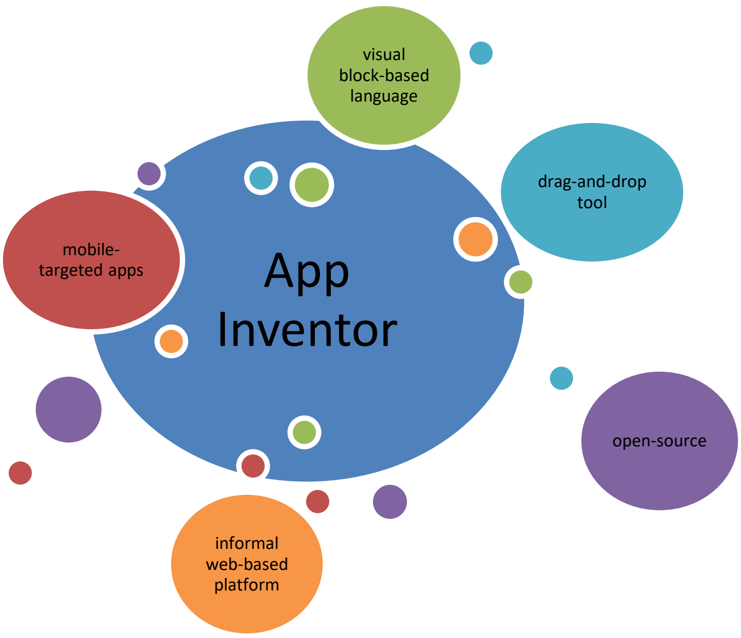

Fig. 3. The main elements that define the MIT App Inventor®

The value of the MIT App Inventor® may seem questionable to a professional developer with years of experience in Java. Why use MIT App Inventor®? The answer to this is to understand that more and more non-technical people will discover MIT App Inventor® and it is the duty of the professional developer to understand the tools that these people will use [23]. It gives us the ability to understand the challenges they face and gives us a context to help future software developers take the next step. If you're working professionally with Java or Android, it's only a matter of time before you're approached with a demo or prototype developed with MIT App Inventor®.

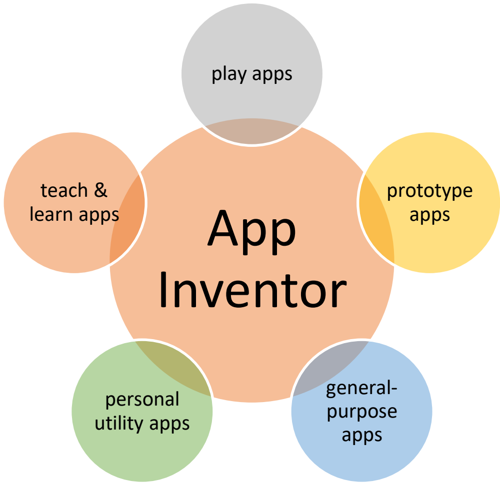

Fig. 4. The 5 main categories of applications that can be made using MIT App Inventor®

The MIT App Inventor® is available for free for anyone to use. It runs online (instead of directly on your computer) and is accessible from any browser - Designer and Blocks Editor (see Fig. 5). You don't even need a phone to use it: you can test your apps on an included Android emulator.

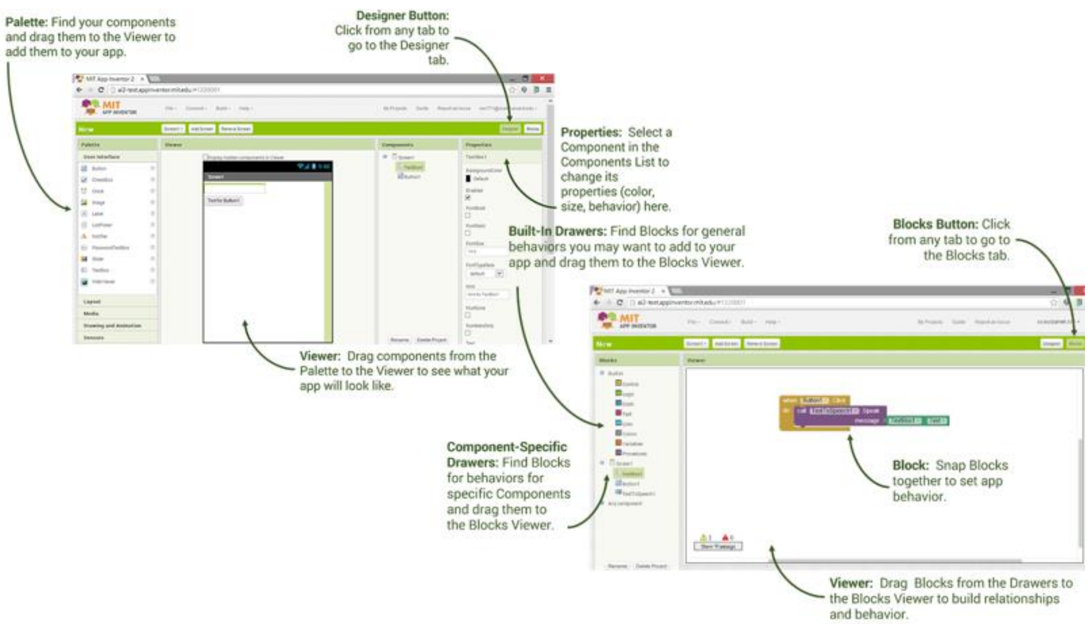

Fig. 5. Description of MIT App Inventor® specific work screens: Designer and Blocks Editor

The following describes the components that can be used in the MIT App Inventor® to create mobile applications for soil monitoring and protection (see Fig. 6 and 7). Each component can have methods, events, and properties. Most properties can be modified by applications - these properties have blocks that you can use to get and set values (see Table 1). Some properties cannot be changed by applications - they only have blocks that can be used to get values, not to set them (see Table 2).

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```java
package org.appinventor;
import com.google.appinventor.components.runtime.HandlesEventDispatching;
import com.google.appinventor.components.runtime.EventDispatcher;
import com.google.appinventor.components.runtime.Form;
import com.google.appinventor.components.runtime.Component;
import com.google.appinventor.components.runtime.VerticalArrangement;
import com.google.appinventor.components.runtime.Image;
import com.google.appinventor.components.runtime.HorizontalArrangement;
import com.google.appinventor.components.runtime.Button;
import com.google.appinventor.components.runtime.ListPicker;
import com.google.appinventor.components.runtime.Notifier;
class Screen1 extends Form implements HandlesEventDispatching {
  private VerticalArrangement VerticalArrangement1;
  private Image Image1;
  private HorizontalArrangement HorizontalArrangement1;
  private Button Button1;
  private ListPicker ListPicker1;
  private Button Button2;
  private Notifier Notifier1;
  protected void $define() {
    this.AlignHorizontal(3);
    this.AlignVertical(2);
    this.AppName("DOCTORAT");
    this.Icon("Picture1.jpg");
    this.Title("Soil Monitor v. 1.0");
    VerticalArrangement1 = new VerticalArrangement(this);
    VerticalArrangement1.AlignHorizontal(3);
    VerticalArrangement1.AlignVertical(2);
    VerticalArrangement1.BackgroundColor(0x00FFFFFF);
    VerticalArrangement1.Width(LENGTH_FILL_PARENT);
    Image1 = new Image(VerticalArrangement1);
    Image1.Picture("Picture1.jpg");
    Image1.ScalePictureToFit(true);
    HorizontalArrangement1 = new HorizontalArrangement(this);
    HorizontalArrangement1.AlignHorizontal(3);
    HorizontalArrangement1.AlignVertical(2);
    HorizontalArrangement1.BackgroundColor(0xFF00FF00);
    HorizontalArrangement1.Width(LENGTH_FILL_PARENT);
    Button1 = new Button(HorizontalArrangement1);
    Button1.FontBold(true);
    Button1.Width(100);
    Button1.Text("ACASĂ");
    ListPicker1 = new ListPicker(HorizontalArrangement1);
    ListPicker1.FontBold(true);
    ListPicker1.Width(200);
    ListPicker1.Text("ALEGE APLICAȚIA!");
    Button2 = new Button(HorizontalArrangement1);
    Button2.FontBold(true);
    Button2.Width(100);
    Button2.Text("IEȘIRE");
    Notifier1 = new Notifier(this);
  }
  public boolean dispatchEvent(Component component, String componentName,
       String eventName, Object[] params){
    return false;
  }
}
```

Fig. 6. The main screen of the created application: a) the application interface in MIT App Inventor®; b) the source code of the application interface in App Inventor - Bridge to Java®

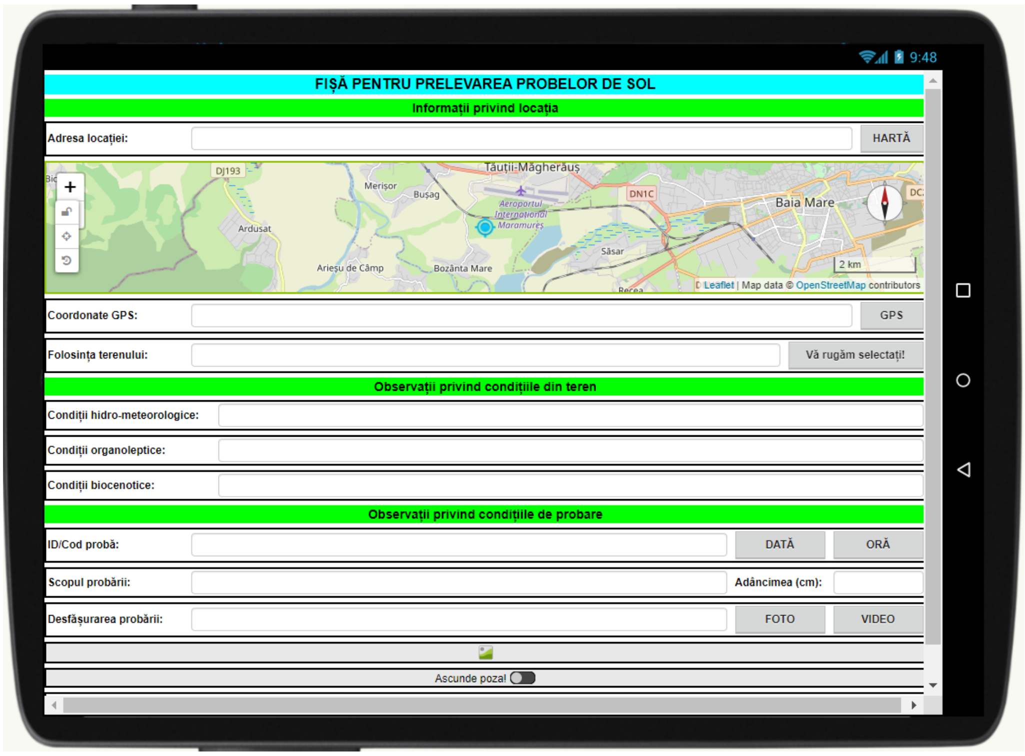

Fig. 7. The "Soil Sample Sheet" application interface in MIT App Inventor®

Table 1. User Interface components: typology, features, and functionalities in relation to the soil monitoring and protection activities

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Main category	Components	Properties	Soil monitoring and protection activities		
			soil classification	determination of specific properties*	other observations**
User Interface components	Button	Its properties can be changed in the Designer or in the Blocks Editor.	xx	xxx	x
	CheckBox		x	x	x
	DatePicker	A button that allows the user to select a date on the Gregorian Calendar.	x	xx	x
	Image	Its properties can be changed in the Designer or in the Blocks Editor.	xx	xxx	xx
	Label		xx	xxx	xx
	ListPicker	A button that displays a list of texts for the user to choose among.	xx	xxx	x
	ListView	A component that displays a list of text and image elements.	xx	xx	x
	Notifier	A component that displays alert messages.	x	xx	xx
	Password TextBox	Users enter passwords	x	x	x

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		in a component that hides the text.			
	Screen	A component that contains all other components.	x	xxx	xx
	Slider	A Slider is a progress bar that adds a draggable thumb.	x	xx	xx
	Spinner	A Spinner component displays a dialog with a list of elements.	x	x	x
	Switch	A Switch component raises an event when the user taps it to toggle between states.	x	xx	xx
	TextBox	Text boxes are usually used with the Button component.	x	xxx	xx
	TimePicker	A button that opens a dialog to allow the user to select a time.	x	xx	xx
	WebViewer	Component for viewing Web pages.	x	xx	xx

* soil texture, color, density, humidity, temperature, etc; ** local conditions (weather, relief, etc), or other conditions which require access and connection to external devices and additional sensors

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Table 2. Media and sensor components: typology, features, and functionalities in relation to the soil monitoring and protection activities

Main category	Components	Properties	Soil monitoring and protection activities		
			soil classification	determination of specific properties *	other observations **
Media components	Camcorder	A component to record a video using the device's camcorder.	xx	xx	x
	Camera	Use a camera component to take a picture.	xx	xxx	x
	ImagePicker	A special-purpose button.	xx	xx	x
	Player	A multimedia component that plays audio and controls phone vibration.	?	x	x
	Sound		?	x	x
	SoundRecorder	A multimedia component that records audio.	?	x	?
	SpeechRecognizer	Use a SpeechRecognizer component to listen to the user speaking and convert the spoken sound into text.	?	x	x
	TextToSpeech	Its properties can be changed in the Designer or in the Blocks Editor.	x	x	x
	VideoPlayer		xx	xx	x
	YandexTranslate		x	x	x
Sensor components	AccelerometerSensor	A component that detects shaking and measures acceleration in 3 dimensions.	?	x	x
	BarcodeScanner	-	?	?	?
	Barometer	-	?	xx	xx

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	Clock	-	?	x	?
	GyroscopeSensor	-	?	x	?
	Hygrometer	-	?	x	x
	LightSensor	-	x	x	?
	LocationSensor	A component that provides the device's location, using GPS if available.	xx	xxx	xx
	MagneticFieldSensor	-	?	?	?
	NearField	-	?	?	?
	OrientationSensor	A component that determines the phone's spatial orientation	x	xx	x
	Pedometer	This component keeps a count of steps using the accelerometer.	?	xx	x
	ProximitySensor	A component that can measure the proximity of an object (in cm) relative to the view screen of a device	?	?	?
	Thermometer	-	?	x	x

* soil texture, color, density, humidity, temperature, etc; ** local conditions (weather, relief, etc), or other conditions which require access and connection to external devices and additional sensors

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4. CONCLUSIONS

Soil monitoring and protection, as well as field activities carried out by specialists or staff with concerns in the field, are elements that require an integrated approach, which cannot lack the mobile technological component. At the same time, the incursion of the latter must be carried out with equipment that allows a more efficient control in the acquisition, processing, storage, and dissemination of information on soils (from a simple picture to determine the texture and color of soils to specific aspects, nuance, field conditions, and soil classification).
As a result of consulting the literature (especially from the last 10-12 years), we were able to see that there is a historical framework, well nuanced, of concerns for monitoring and protection of soils through mobile devices and associated software. In the last category, we took the MIT App Inventor® platform as an example - for the development of Android and iOS mobile applications, to analyze and observe how it can be integrated into soil protection strategies. Thus, starting from the components it makes available (although we only chose the ones related to the user interface and the media), we set out to explore the functionalities that mobile application development platforms assign to mobile applications. The results of our research have shown that there is a well-defined set of components, features, and sensors that can be integrated into mobile device-specific applications to assist in soil monitoring and protection. Consequently, mobile devices can be seen and used as a means of acquiring, storing, and disseminating data, information, and knowledge on land, land use, and the practice of systematic farming.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Author BVC designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author MC managed the analyses of the study. All authors read and approved the final manuscript.

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