BeeGIS: A New Open-Source and Multiplatform Mobile GIS

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Abstract

Following the release of the MAP IT field data-collection software, a new open-source and multiplatform software has been developed in order to conduct fieldwork in an easier and more intuitive way. This software, BeeGIS, has been designed to work with a Tablet PC, GPS, and digital camera, using a pen on the tablet screen to draw annotations and sketches on the digital map and to connect notes, pictures, and any other files.

A lightweight solution, GeoPaparazzi, has also been developed by exploiting the functionalities of the new Android mobile phones. This software can be easily synched with BeeGIS to import into a GIS or also in Google Earth the captured data (notes, pictures) with attributes (GPS position and orientation).

Introduction

BeeGIS is a new open-source GIS software for field mapping conceived for pen computer working with any common operating system (Windows XP and Vista, Mac OS, Linux). This software was designed to create an efficient and user friendly tool for professionals (mainly geologists and engineers) who may have a limited knowledge of GIS and who want to minimize the learning time for new technologies (Brown and Sprinkel, 2008).

After an unsatisfactory previous experience with design and release of MAP IT (De Donatis and others, 2005; De Donatis and Bruciatelli, 2006), which was developed in collaboration with a commercial software house, our lab (LINEE - Laboratory of Information Technology for Earth and Environmental Sciences) decided to focus our research on open-source software products. From the collaboration between LINEE and HydroloGIS, an environmental engineering company with extensive experience in Java-based GIS development, a new open-source system for geological mapping was developed. During the last year, ARPA Piemonte (a regional Agency for Environmental Protection) supported this project.

Developed in Java (Eclipse platform) BeeGIS has its roots in the Udig framework (open source). In this system, several new tools were designed *ad hoc* for integrated field work; these tools are for:

- data acquisition from any NMEA-compliant GPS receiver for capturing points, lines, and polygons in both automatic and manual mode;

- drawing and writing annotations directly on the map with a stylus, owing to the digital-ink technology that allows you to draw and paint;

- Geonotes: a tool conceived to draw sketches, write text notes, and attach any kind of file, with the ease of drag-and-drop. Digital pictures, once embedded, can be enriched with on-image annotations;

- Fieldbook: the organizer of Geonotes. Like a real field book, it can store, manage, and search all the information captured.

These tools were developed for field usage in order to preserve the traditional methods for mapping, while replacing the pencil and the paper (map and field book) with a digital stylus and touch-screen. BeeGIS is not only designed to help the user to fully support his/her data acquisition, as he would do with traditional tools, it also can drastically reduce the loss of information and time by immediately gathering and storing information just on site and keeping data immediately sharable.

GPS

BeeGIS can be linked to any GPS receiver that supports the NMEA standard protocol, using a serial port connection. Standard wired GPS can be connected by physical USB connection, otherwise by means of a virtual serial port it is possible to connect a wireless Bluetooth GPS. After the parameters setting is completed, a window shows the current main GPS information as coordinates, number of GPS sources viewed in the current constellation, speed and direction of movement, HDOP, data quality, UTC time, and so on.

The position of the surveyor is displayed in real time on the map by a square pointer (with an arrow indicating the direction of movement, in the latest versions); this function

allows the field geologist to know the exact position even when a good quality base map is not available or when the land reference point is strongly changed, for example, when surveyors work to map river floods after an extreme rainfall event. Coupled with the GPS connection, a set of functionalities is available. Map display can be centered at current coordinates and the position is updated while moving through the field.

BeeGIS lets the user capture points, lines, or polygons for any feature displayed on the map (fig. 1). This can be done by manual or automatic acquisition. In manual mode, the user can choose where to add a node from the current GPS coordinates to the active layer. If the active feature is "point", single units are stored into the current layer, otherwise, for lines or polygons a node is added into the current lines/polygon layer. This function is particularly useful to acquire the precise position of point features such as a photograph, spring, or well.

With automatic acquisition the node will be captured in real time by the GPS unit without any user action. It is possible to acquire different nodes by choosing a minimum spatial distance (in meters) or a time period (in seconds). By means of this function it is possible to draw a boundary or a path with GPS accuracy just by walking along it. Geologists, for example, can acquire a fault, a landslide limit or a scarp, whereas a forest ranger can acquire a hiking trail simply by walking along it.
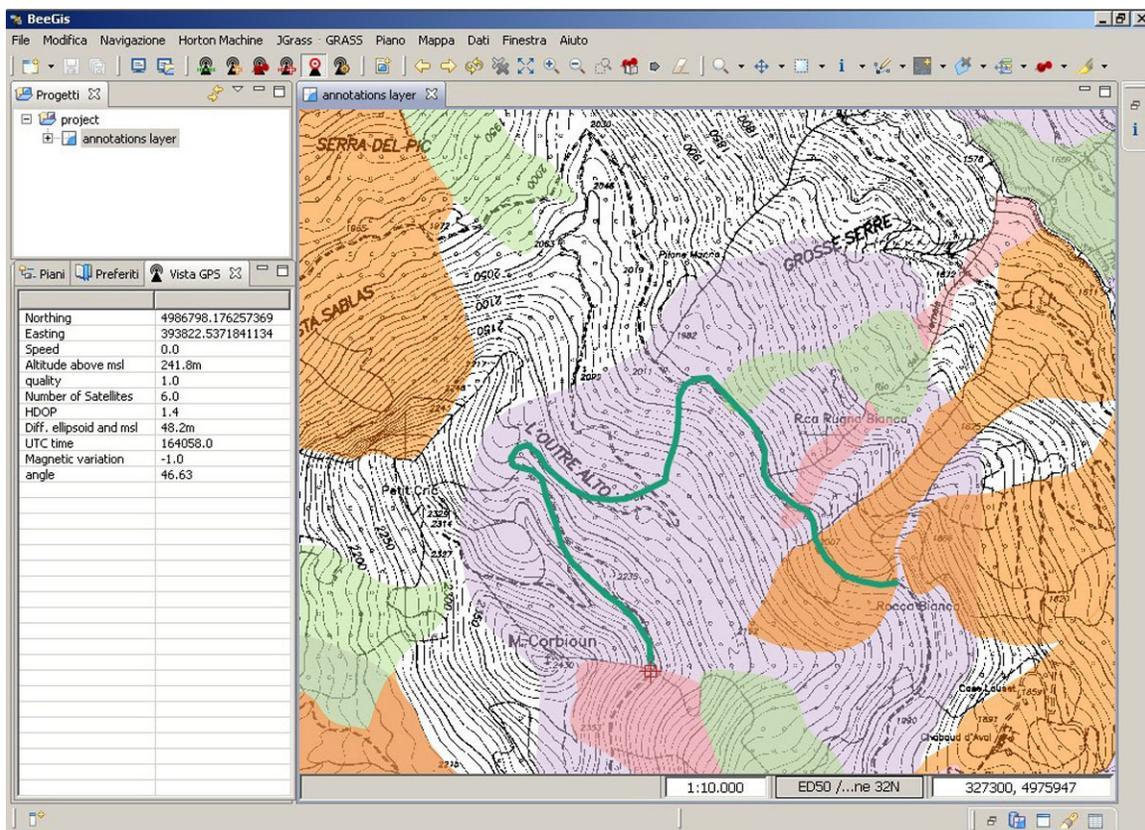

Figure 1.   Line (path) captured in BeeGIS using GPS with automatic acquisition.

Geonote and Fieldbook

Another powerful tool of BeeGIS is Geonote. This tool allows the field geologist to add notes on the map in the same way as a sticky-note. All notes are georeferenced and are stored in a specific layer. In the upper part of the Geonote interface, there is a title label field, a few small buttons through which the background color of the note can be changed, and two buttons used to save and close the note or discard it. The lower part of the notes interface shows tabs, where the user can store different kind of data.

The first tab (*drawing tab*) contains freehand drawings and is particularly useful to quickly take notes in the field or to draw sketches with the tablet digital stylus as geologists used to do in the traditional field book.

In the second tab (*text tab*) the user can type notes with the PC keyboard or use the virtual on-screen keyboard on the tablet PC.

The last tab (*media tab*) is a very useful one. It allows users to include any kind of file into the note just by a simple drag-and-drop. These files can be either digital camera images, spreadsheets, or any kind of document the user wants to associate with the subject. All these data are stored together in a database (embedded in BeeGIS) and are readily available. The files can be opened with the default system application for that particular media type just by double clicking on it. When a note is closed, a red pin remains on the map; notes can be viewed by clicking the pin. The note is saved with its coordinates and reference system. This is important because the position is reprojected on the fly in the current view projection system and can therefore be easily used with data stored in other reference systems.

Geonotes are stored in the embedded database and so are not lost when the BeeGIS files are given to a colleague. Moreover, one or more Geonotes can be exported with the dump function in human-readable or binary format. In the first case, BeeGIS creates a new folder containing a set of files: a text info file with position, projection system, names and other useful information, a text file containing the text stored in *textbox tab*, a .png file with the *sketch tab*, and another folder with all linked media file. With the binary dump, all files are stored in a zip file and can be imported to another database or project or can be stored for later use.

For image files, BeeGIS provides an editor that gives the user the opportunity to draw notes on the image with the digital stylus, using different colors, pen thickness, and transparency levels (fig. 2). With a digital camera, users can easily shoot a photo and download it to the tablet PC using a USB cable, a smart-card reader, or a Bluetooth connection (available in some new digital cameras). Making graphical notes on a digital image, while in the field, is very helpful because it allows you to store more complex information than by using the old style field book. For example, a structural geologist can sketch a preliminary interpretation on the outcrop image, or a geomorphologist can fix the main landscape feature on a panoramic view.

In order to easily manage the Geonotes, BeeGIS introduced the Fieldbook browser (fig. 3; see also Briner and others, 1999). Users can search by text in the title, by Geonote color, by creation date, or by whether the observation was located with GPS. The filtered Geonotes can be selected and highlighted, and the map display can be centered at the selected Geonote position.

Picture Georeferencing and Synch

On a survey it is important to be able to connect the measurements and observational data with pictures taken during the field work, particularly in the postprocessing of the collected data. One of the BeeGIS aims is the reduction of postprocessing work, in order to limit the possibility of errors in transcription, redigitalization, and interpretation.

BeeGIS provides a tool to synchronize digital camera pictures with the internal GPS log. In this tool, the picture's timestamp is compared with the internal GPS log points and the position of the nearest GPS point by timestamp is identified; a new Geonote is then created, containing the picture in the Geonote *media box*.

Pictures without matching GPS points are ignored: at the end of the import process, a list of pictures not imported is shown to the user to help verify if the import has been successful.
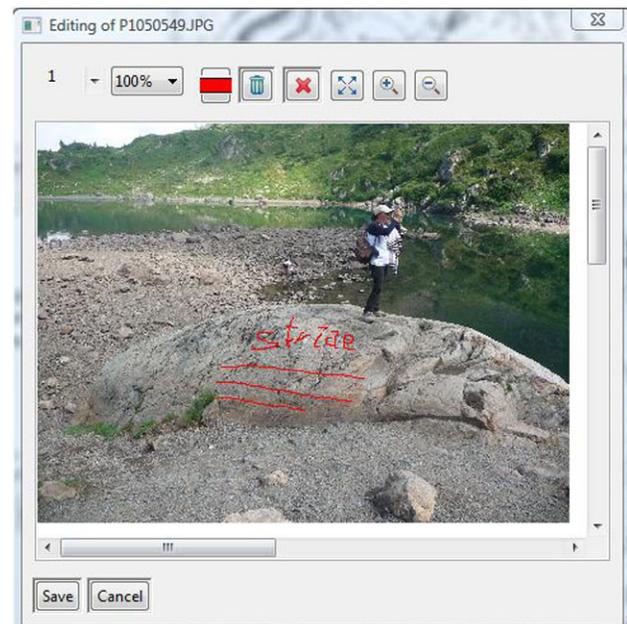

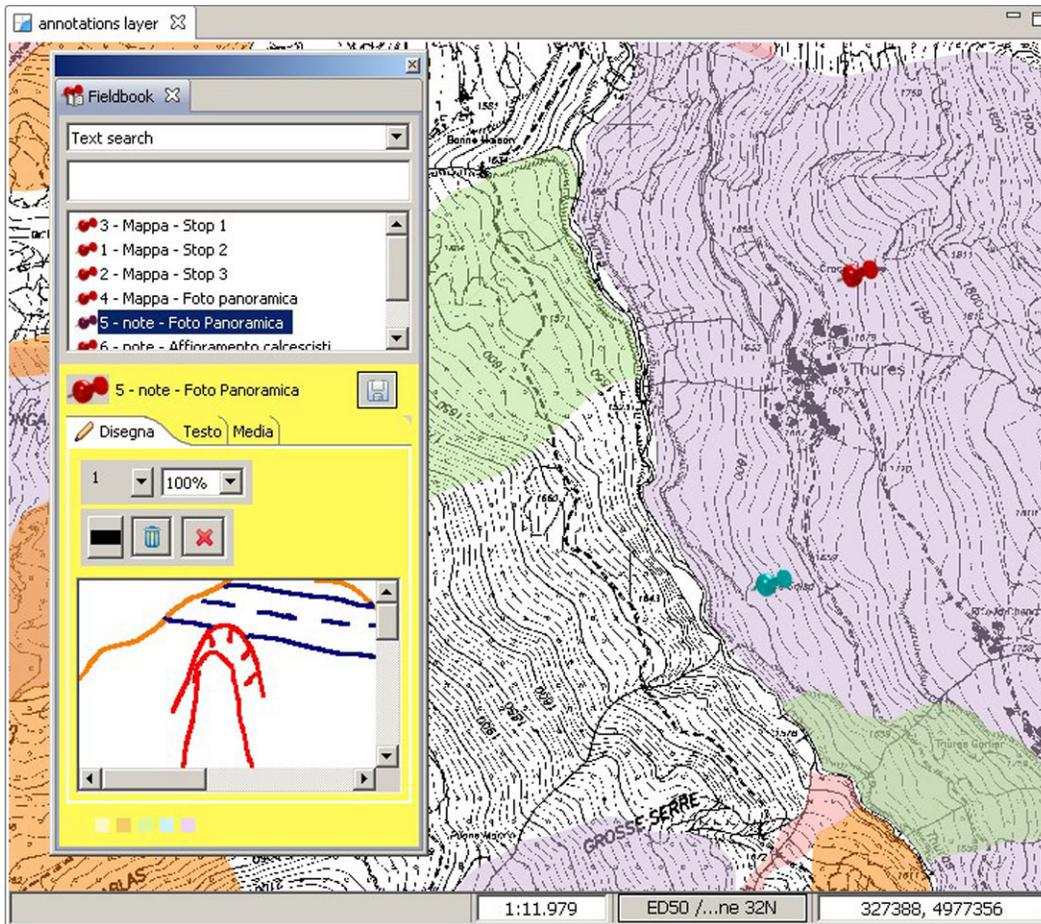**Figure 2.**   Example images and notes in BeeGIS's Image viewer and editor.

Figure 3. The Fieldbook tool allows the geologist to easily collect the Geonotes.

Annotation Tool

The Annotation tool allows sketches to be drawn directly on the map, as geologists used to do on the traditional paper map using colored pencils (fig. 4). Annotation properties can be chosen as colors, whereas width and transparency can be chosen from drop-down menus or dialog windows.

Unlike traditional paper maps, BeeGIS offers the chance to quickly and easily delete the inserted stroke, by means of the rubber tool; moreover, users can sketch on the map at different scales, so the precision of the strokes can be dramatically improved.
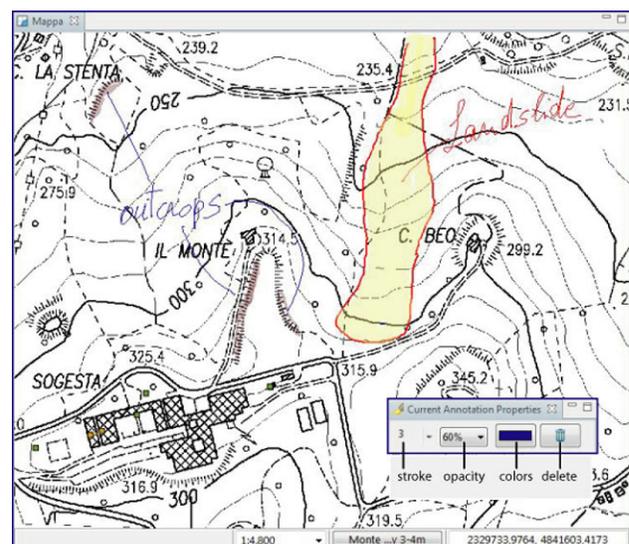

Figure 4. Using the Annotation tool to add field notes to the map.

Synch with Geopaparazzi: Photo and Data Capturing Tool for Android Mobile Phone

Having experienced that sometimes a lightweight and handy tool can be the best solution for capturing data and information in the field (Clegg and others, 2006), GeoPaparazzi was created in order to:

- provide a field tool that fits in any pocket and is always at hand, when needed;

- give the possibility to take georeferenced and possibly oriented pictures during the survey and to import them into the main GIS application BeeGIS (fig. 5);

- use an Internet connection, if available; and

- provide a simple, intuitive tool, with just a few important functionalities.

The main features available in GeoPaparazzi are:

- a map view for navigation (by downloading Open Street Map or, if online, accessing Google Maps);

- georeferenced notes (using GPS functionalities);

- georeferenced and oriented pictures (using GPS, compass and gravity-sensor functionalities);

- GPS logging; and

- easy export of collected data (into BeeGIS or Google Earth).

Figure 5. GeoPaparazzi in Android mobile phone synched with BeeGIS in a Tablet PC.

Some Remarks and Further Developments

BeeGIS is a very promising tool for geologists or any field operator. GPS, Geonotes, Fieldbook image editor, and annotations tools are the most noteworthy and distinctive features of this software. They can help make a geologist very comfortable during field work, as one may now be with pencil and paper.

In the latest versions of BeeGIS, the management of raster images (that is, aerial photographs), maps (that is, topographic maps), and vector data has been significantly improved, as well as the performance and functionality of the embedded database. Also, the ability to synch with other devices has been implemented in order to exploit the use of tools such as cameras, GPS, and the compass available in the new generation of smart phones.

Some field work project needs a prearranged form to store standard data. At the moment, the development roadmap schedules the creation of new tools that allow any people/organizations/companies with limited knowledge of digital work to create and to manage their own survey forms.

To download the latest version of the software and to join the community of users and developers, please see *http://www. beegis.org*.

Acknowledgments

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