Mobile computing in archaeological prospection: an update

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1 Introduction

We have emphasized in the past that we have been conscious of an increasing schism between methods and technologies in the laboratory as compared with work in the field. While the availability of advanced technologies has been rapidly growing, activities in the field have continued to make use of instruments and methodologies developed in the 1970s. The problems arising from this situation are mainly inherent in the collection of data that lack the accuracy required by GIS, or which work to a different kind of rational logic. There is also the problem of the unavailability in the field of the large amount of data stored in the desktop GIS.

The laboratory of Landscape Archaeology and Remote Sensing at the University of Siena started working on mobile computing in 1999 (Campana, Francovich 2003; Campana 2005). In the early years we mainly concentrated on studying the application to landscape archaeology of various research methods, and in testing different configurations of mobile systems (PDA, Tablet PC). From 2005 we have concentrated our efforts on improving the mobile software to make it better-related to our specific needs.

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1 Field-waking survey

In the past two years our digital achives have been moved from a FileMaker database to Microsoft Access. We were forced into this choice mainly because the FileMaker software, which we started using in 1995, has never achieved compatibility ArcGIS software. This has meant that our laboratory has never been able to use a genuine and sophisticated GIS.

Our new database 'Archaeological Map' has been structured intentionally in a simple way, in an effort to eliminate data redundancy and to make use of the Microsoft Access software and its compatibility with ESRI GIS software.

The DATABASE is composed altogether of six tables:

Environmental conditions. This section is directed at the storage of data on morphological characteristics and land-use. This gives us the background to each topographic unit in the archaeological evidence.

Topographic unit. In this table we store all the descriptive attributes of the topographic units recorded in the landscape – mainly artefact scatters but also off-site material and individual monuments.

Chronologlcal unit. This section describes the main characteristics of every historical phase present in the topographic unit. The table records attributes that have necessarily been the subject of interpretation. This section is required in order to draw a distinction between the different functions that the site may have served at different periods. It records for each chronological phase the relative function, and viceversa. A typical example in the Tuscan landscape might be a Roman villa. This kind of settlement appears in the field as a widespread artefact scatter, usually indicating a main period of building construction between the first century BC and the beginning of the second century AD. But in many instances Roman villas overlie earlier settlements, and also show significant transformations as rural settlements in the course of their long existence, which commonly finishes around the end of the fifth century AD (Francovich, Hodges 2003).

Finds: The database for archaeological finds has remained substantially unchanged. The most meaningful innovation relates to the addition of a field concerned with grid collection. If the artefacts are collected by this method it will be sufficient to specify the reference number of the grid in order to relate this to the finds recovered from it.

Pottery paste. This database has been completely revised and is now based on a new method of analysis of the ceramic body under the optical microscope.

The changes introduced in our laboratory instrumentation have a direct influence on the devices that we use in the fieldwork. The mobile GIS has been updated to Arc Pad version 7, the ACCESS database of which is perfectly compatible with Windows Mobile Pocket PC OS. The database is automatically converted into Pocket Access format through Activesync software.

The main limitation of Pocket Access is the unavailability of an editing tool. This means that you can seek information on your mobile but cannot update it.

To overcame this problem we have created a low-level tool for the PDA which allows us to edit the database. We are now, at last, able to share the same data bank in the

laboratory and in the field, and to update both databases through the synchronization tool Activesync every time we connect the mobile device to the Desktop PC or the server.

The current phase of our work is aimed at progressively reducing the *hiatus* between some of the functions in the desktop information system and those available in the mobile version. With the help of ESRI Italy we have been able to start working with a new software, Arc Pad Application Builder (version 7). This software allows us not only to implement visualization masks and data entry but also to build a real mobile GIS.
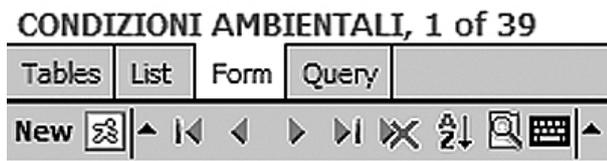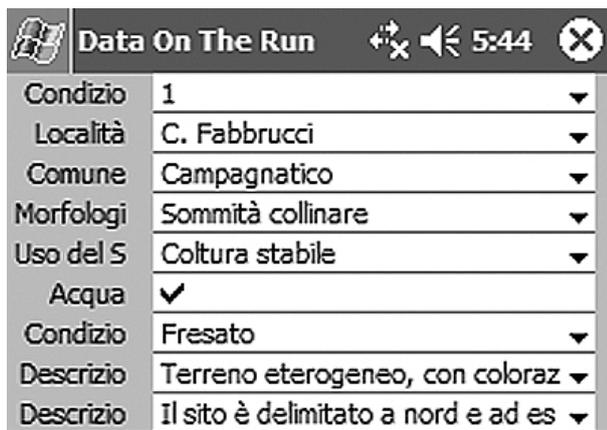

Figure 1 *Interface of the mobile database 'use of soil'*

This latest development will also facilitate the link between the geographical interface and the database or more detailed, the relationship between the shapefiles stored in the mobile GIS and those recorded in the mobile database (Tripcevich 2004).

This will further narrow the gap between the desktop and mobile systems. The user will also be able to access information which is progressively more similar to the amount available in the laboratory. We should emphasize here the compatibility between the ESRI and Microsoft software, which can be elaborated through use of a similar programming language – ESRI VBscript is in fact based on Microsoft Visual Basic.
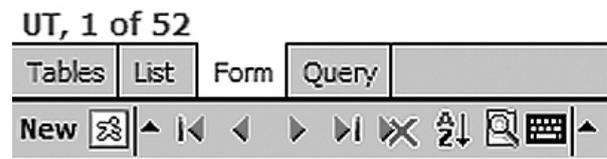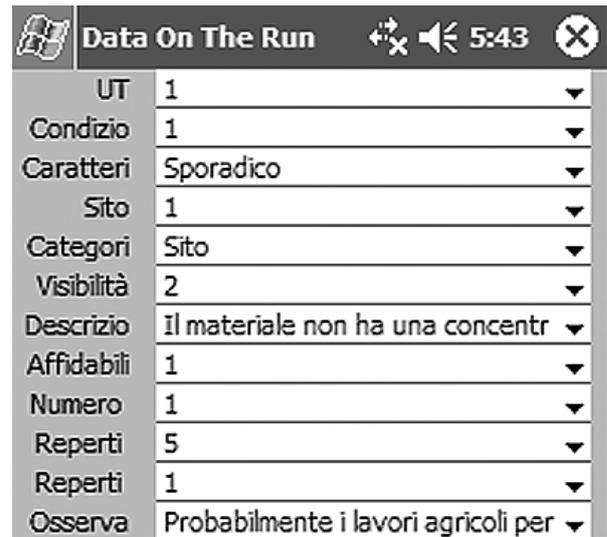
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Figure 2 *Interface of the mobile database 'topographic unit'*

2   Aerial survey

We began experimenting with mobile systems for aerial use in 2004. Initially we employed a mobile PDA originally developed for field use but we quickly turned to an integrated system based on the Tablet PC.

This pattern of devices, involving an HP 1100 Tablet PC linked to a Socket Bluetooth GPS, has been designed to undertake both navigation and data management tasks (Campana 2005). While this is still 'work in progress' three significant aspects have emerged during the first stage of use in the air. The capacity to take a PC into the air, in addition to satisfying the primary needs of survey and navigation, also provides an instrument that can be used in a variety of other ways. For example, aerial archaeologists are making ever greater use of digital cameras and the Tablet can be used to download data if the camera's memory becomes full. Also, in cases where the quality of the recorded image is of prime importance (for instance in the recording of historical monuments or excavations in progress), the results can be downloaded and examined on-screen in real time. It is also possible to install software such as Jeppesen Flitestar, giving access to aeronautical maps and assisting route planning. A second consideration is that of writing. Unlike the PDA, the Tablet has a system for the recognition of writing, which means that it is possible to make entries in lists and tables with Tablet's own pen, just as one would with an ordinary biro. In addition to facilitating work in an

environment which (we must not forget) is subject to constant movement and disturbance, this allows us to record both 'standardized' and 'free-form' information. It is practically impossible to do this with a traditional digital keypad, even less so in the air than on the ground. A final consideration, before describing the system, lies into the tasks that need to be performed when using this equipment. Aerial work is very difficult and intensive. The archaeologist has to follow the route, read and interpret the landscape below, keep cameras and other equipment under control so as to arrive at the next target with the right lens already in place, make sure that there are enough exposures still available, check the lighting-conditions and write detailed flight reports and site records – and these are just *some* of the many tasks that need to be done.

Our aim is to aid significantly the work in the air, simplifying navigation as well as the recording of (and access to) information in ways which will allow the archaeologist to give more attention to the landscape below.

During 2005 and 2006 we have been attempting to solve a number of problems which we encountered in our earlier work. As noted above, our main objective has been to develop instrumentation and software that will make the work of the archaeologist in the air easier, quicker and more efficient.

After each flight the features (or 'topographical units') recognised in the air and documented through oblique photography must be entered and mapped in the GIS, so that they can be interpreted and integrated with all of the other data available.

In order to make these operations easier it is necessary to link each series of photographs, or 'shots', to its related geographical coordinates. Only if we are able to perform this link systematically will it become possible to access the information and to process the data in the GIS.

The systems available on the market did not take account of the conditions encountered in the cockpit of a light aircraft: cramped, noisy and constantly affected by vibration. To help the airborne archaeologist to record the geographical coordinates of each archaeological site or landscape feature we decided to write a purpose-made software using Microsoft Visual Basic. The resulting tool has been named *Aerialsurveytool* and it has been made compatible with the ESRI ArcGIS software.

During aerial survey this tool allows us to link every photograph or set of exposures, identified by the number shown on the camera's display, with the current GPS position. The tool's architecture has been designed so as to be used with Tablet's own pen. Its operation is closely related to the GIS/GPS system, from which it receives the North/East coordinates. The resulting data are stored in a Microsoft Access database.

Figure 3 *Starting interface of* Aerialsurveytool

The tool uses three interfaces and the data are entered by pushing buttons or by selecting for each field pre-programmed terms from the relevant menus, greatly simplifying the updating of the database. Our aim, at every stage, is to make each task simpler by making the greatest possible use of automated actions or entries.

The first set of entries records specific information about the flight, such as atmospheric conditions, participants (pilot, photographer, assistant etc), flight time, flight path (track), and so on. Once this information has been entered the user presses the button 'Take-off' and there appears the ESRI ArcGIS screen with the bar 'Position'. This is another interface of the *Aerialsurveytool*. It is worth noting that this bar does not prevent use of the normal navigation aids of the GPS. Furthermore, ArcGIS can also be used at the same time.

The bar always appears at the top of the screen and includes two buttons, named 'GPS position' and 'Schedule'. Using the Tablet's own pen and clicking the button 'GPS position' the software automatically acquires the geographical coordinates of the aircraft's current position and stores the data in a table. Pressing Schedule allows the user to return to the starting interface to make corrections or to add final information at the end of the flight.

Once the geographical coordinates have been recorded the software asks the user to link the GPS position to the reference numbers of the related photographs (shots) through an interface called 'image'.

We are also considering to possible use of the scrollbar to avoid the need to write the numbers. The selected numbers, for the first and last shots recorded at each site or location, will through this process be linked to the GPS

record. By selecting pre-programmed terms from the menu it is also possible to record a simple site interpretation, such as enclosure, ditch, building, mound etc.
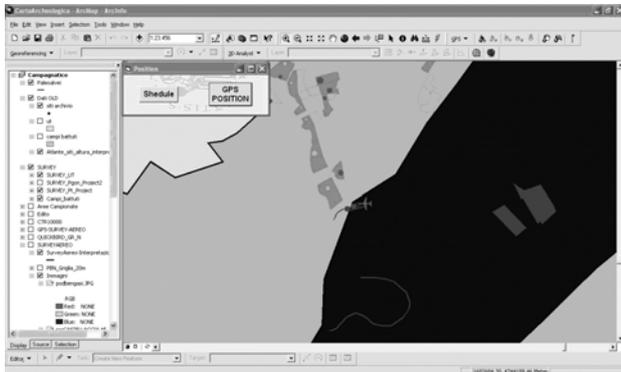
Figure 4 *Interface* Aerialsurveytool, *for entering the GPS coordinates overlaid on the ArcGIS software showing the real time position of the aircraft*
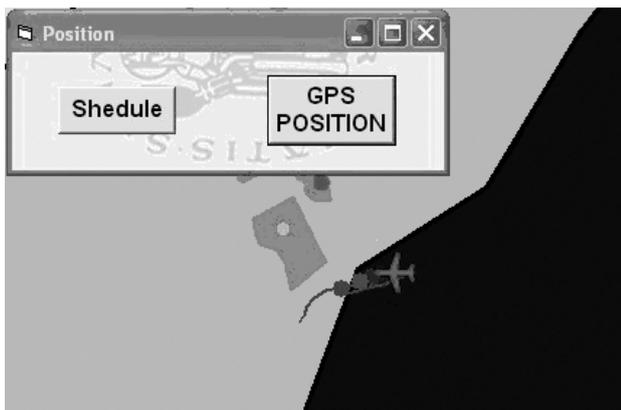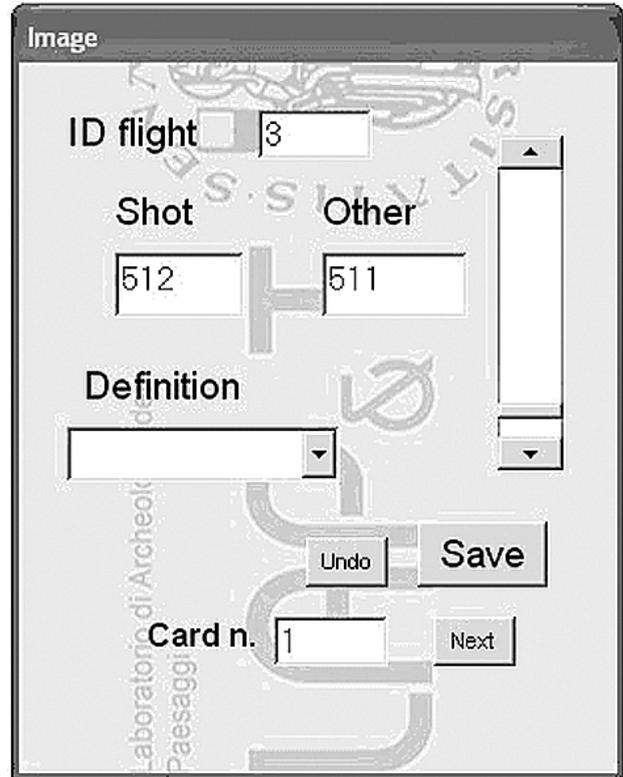

Figure 5 *Detail of the interface in* Aerialsurveytool *used to enter GPS coordinates*

The tool automatically resolves a common problem of image numbering through a simple mathematical function. The display on most digital cameras (in our case a Canon 20D) shows the number of photographs *still available on the memory card*, in decreasing order. Unfortunately after downloading the images to a PC the numbering becomes inverted, so that they appear in increasing rather than decreasing order. This destroys the correspondence between the photo (shot) reference numbers taken in the air and the related GPS position. *Aerialsurveytool*, however, automatically converts the numbering from decreasing to increasing order, thereby saving the user from having to carry out calculations in flight or to waste time during the already lengthy post-flight processes in the laboratory.

Finally, we have addressed the question of changing the memory card without creating problems in the linking of shots to GPS coordinates. All that the user needs to do is

to remember to download the images to the PC using a *different* folder for each memory card.

Figure 6 *Detail of the interface* Aerialsurveytool *to enter photo (shot) numbers through the scrollbar, along with a preliminary interpretation of the site photographed*

Using this system, all of the information recorded during flight is stored in the database and is it possible to create, export or print a record in the form of a flight report that shows the the GPS track of the flight and the GPS position from which the key photograph for each site was taken.

In conclusion we would like to emphasise that this short paper does not present the final result of our experiments, but simply the present state of work-in-progress that will be updated year on year as our experience grows.

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Acknowledgments

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