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Geomemories
a Spatial-Temporal Atlas of the Italian Landscape

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Abstract

The AeroFototeca Nazionale of the Italian Ministry of Cultural Heritage in Rome maintains an extensive set of some million aerial photographs constituting an important memory archive of the Italian territory throughout the 20th century. Together with the Institute of Informatics and Telematics of CNR in Pisa the GeoMemories project was launched with the aim of creating a web platform covering spatial-temporal dimensions and also integrating multimedia data from other archives that displays the evolution of the Italian Landscape. We present some challenges of the project and achievements so far as well as examples of how the tool presented here has a great potential to become a valuable resource for both historians and archaeologists.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [Information Interfaces and Representation]: Multimedia Information Systems—Artificial, augmented and Virtual RealitiesImage Processing and Computer VisionI.4.3EnhancementI.4.6Segmentation

1. Introduction

The AeroFototeca Nazionale (AFN) [AFN] of the Italian Ministry of Cultural Heritage in Rome maintains an extensive set of some million aerial photographs constituting an important memory archive of the Italian territory throughout the 20th century. This huge archive provides a picture of Italy as it was 70 years ago before its transformation by the post-war reconstruction, the economic boom and also by natural disasters such as severe earthquakes and floodings.

In 2010, the AFN and the Institute of Informatics and Telematics [IIT] of CNR in Pisa signed an agreement to make this archive accessible via Internet through a Web 2.0 mashup application that displays the evolution of the Italian Landscape. Thanks to funding from the Italian Internet Domains Registry, the GeoMemories project [Geo] was launched with the aim of creating a web platform covering spatial-temporal dimensions and also integrating multimedia data from other archives.

Version 5.0 of Google Earth (GE) includes a timeline [Goo] to display historical imagery. However, this new feature has important limitations, in particular, most of the Google images are from satellites and are relatively recent. Italy, for example, has significant coverage only from 2003. The only samples of actual historic images (1943) concern some large cities (Rome, Florence, Naples, Turin, Trieste and Venice) and the image resolution is very low. In addition, GE manages geographic data layers without considering the time variable.

Our aim is to rebuild a virtual globe, similar to GE but oriented towards the management of the temporal variable. We present some of the achievements so far and demonstrate how the tool presented here has a great potential to become a valuable resource for both historians and archaeologists, as well as an overview of the remaining challenges.

2. From Photos to Historical Maps

The photos made available to the project are digitized and stored to form a virtual archive. In this way, the originals, on paper or film, can be protected and preserved. The images are then processed to create historical maps. Each digitized photo is cropped and eventually normalized to eliminate any

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differences in exposure; they are then orthorectified and georeferenced [Hil06], using Google Imagery as the reference map. Finally, the georeferenced photos are joined together using stitching techniques [BL07]. This procedure includes finding feature points using SIFT [Low04] in the images and matching points are found using RANSAC [FB81]. Figure 1 shows how matches are found in two aerial photos. Figure 2 shows an example of matching three photos.

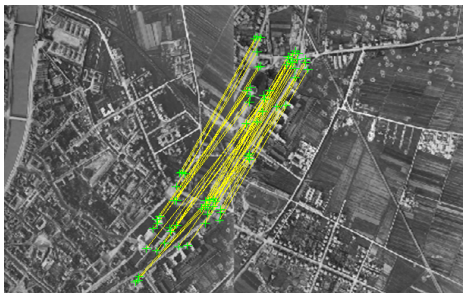

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Figure 1: *Matching of two aerial photos. The procedure finds feature points that are matching using SIFT and RANSAC.*

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Figure 2: *After the feature detection and matching the stitching process builds map is built from the images.*

The workflow for creating historical maps is very heavy. Although we will develop automatic procedures in order to reduce the human effort required, the size of the archive means that it will be necessary to develop solutions based on social contributions. An important future activity of the project will concern the development of collaborative web applications for georeferencing activities.

2.1. Data Display

The historical maps - each referring to a specific historical period - will be browsable in the four dimensions via a web application based on a Google Earth plugin and some javascript libraries. Figure 3 shows the first prototype of the application. It has several different uses and can be used to explore not only the final mosaiced maps but also to examine the individual photos from a specific flight or photos that covers a specific area that the user defines by marking it out with the mouse. The changes in time can be studied by fading in or out with the modern photo as a background.

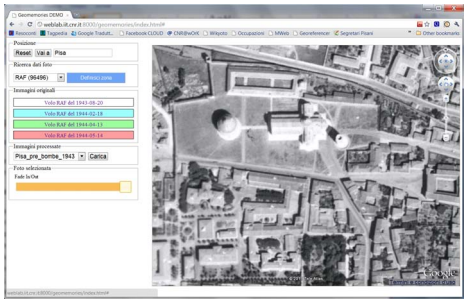

Figure 3: *A snapshot of the prototype application showing the Piazza dei Miracoli in Pisa with its famous leaning tower. In the left side is visible the different flights constituting the basis for the mosaics that the user can choose from for studying the originals further.*

2.2. Data Integration

With the use of geographic reference (geotagging), Google Earth integrates into its maps different layers, such as video, pictures and webcam. We intend to use the same mechanism adding the time value (timetagging). The geo-historical data layers will be obtained through web mining techniques, or filtered from open archives such as Wikipedia, Youtube, Flicker, or via social contributions related to initiatives for memory preservation. The result will be a sort of Historical Geographical Atlas, where it will be possible to build spatial-temporal tours.

3. Preprocessing and Automatization

This project includes automatization of the different steps from image extraction to mosaicing. The available images usually contains both borders that needs to be removed. These usually also contain information about the photo itself, when it was taken and during which flight etc. Hence it is necessary to apply different image processing techniques like edge detection [Can86] in order to be able to extract the part of the scanned photo that is useful for the stitching. This is a time consuming task to execute manually and unfortunately it is not an easy task to implement for an automatic extraction procedure as the border can be very different as shown in figure 4. Therefore we foresee that some user interaction will always be necessary for this important step.

Figure 4: *Two photos from different occasions showing how different the border of the actual photo can be.*

When the photo has been extracted the next step is to remove any uneven illumination in the image. This is important as the stitching process needs photos of similar illumination in order to be able to perform a good blending between photos that are overlapping. Figure 5 shows an example of a photo of the river Arno near Pisa that have quite a drastic change in illumination to the right and the corrected image to the left. The illumination correction algorithm [HM11] was developed specifically for the historical greyscale images used in the project and improves not only the overall illumination but also increases the contrast in low contrast areas.

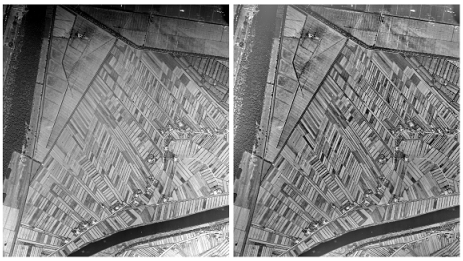

Figure 5: *A photo of the river Arno near Pisa, before (right) and after (left) illumination correction.*

4. Historical and Archeological Value

The tool presented here has a great potential to become a valuable resource for both historians and archaeologists and aerial photos have opened up a new field called aerial archaeology [Wil00]. An example is shown in figure 6, where so-called crop marks [BAJ] are visible on the left. To the scrupulous eye of an archaeologist, it is very clear that those marks on the ground represented an archaeological site. Unfortunately, they are almost completely covered by modern buildings, as it is shown on the right in a recent satellite image obtained through Google Earth. However, thanks to the images provided by AFN in our application, archaeologists can now study the site and understand its origins (for instance, whether it is Etruscan, Roman or Medieval) despite the fact that it is impossible to proceed to any excavation.

Figure 6: *Visible crop marks (left) that reveals some ancient buildings and modern constructions (right) that covers the same area.*

Researchers in Modern History, as well as geologists and geographers, can revisit the whole 20th century and study the changes that occurred in the country, due to human intervention or environmental phenomena. Using the fade in/fade out tool, they can compare past and modern images (shown overlapping in the application) and observe where changes occurred, as shown in figure 7 (Rome 1919) and figure 8 (coastal erosion).

In figure 7, we can see some of the major changes that Rome has undergone in the 20th century, especially in the fascist era: for instance, the large Via della Conciliazione that leads to the Vatican was narrow and markedly different in 1919, due to the presence of the massive building called Spina di Borgo.

Figure 8 shows how the combined action of the Tyrrhenian sea and the Arno river has eroded the coastline near Pisa: approximately 450 meters of coastline were lost in almost 70 years, a phenomenon that mainly occurred where there was no human intervention, that is, where no barrier walls were built. Historians can also obtain extremely valuable information regarding the conflicts that occurred in Italy throughout the 20th century. As a matter of fact, several images from AFN show traces left by major air raids as well as ground bombardments. For instance, in figure 9, we can observe craters in Pisa's countryside resulting from a bomb raid that occurred in 1943 to the left and plane that seems to have made a quick landing on a field during the bombings of Pisa the 18:th of February 1944 to the right. These examples, by emphasising the multiple ways with which an image can be read, encourage further investigation and show the large potential of this project.

5. Conclusions and Future Work

The process of making a spatial temporal atlas includes many different steps like digitizing, cropping, orthorectifica-

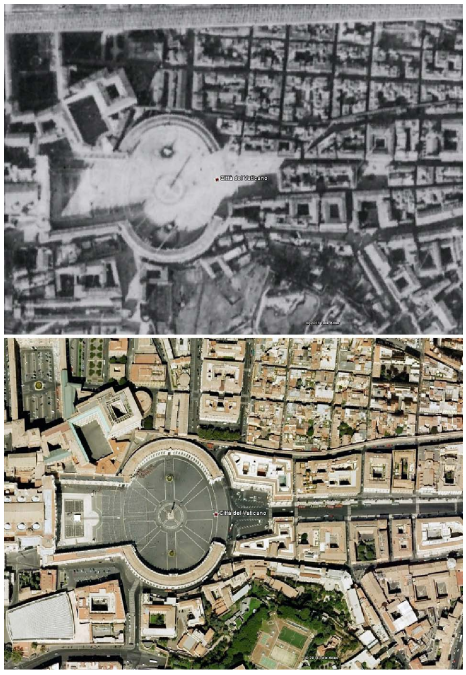

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Figure 7: *Rome and the Vatican from a foto taken 1919 (top) and a modern photo from the same place (bottom) that shows how especially the Via della Conciliazione has been broaden in the 20:th century .*

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Figure 8: *The Arno river has eroded the coastline near Pisa and the superimposed images (left) compared to the modern photo (right) shows that approximately 450 meters of coastline is were lost in almost 70 years.*

tion, illumination correction, georeferencing, feature matching and stitching. Obviously it is important to make the flow as automatic as possible. The challenges currently being addressed in the Geomemories project is to design different tools that will make the job easier for the people involved to do things like cropping and georeferencing. Tools and even new algorithms for illumination correction and faster stitching have been developed and others are already under development.

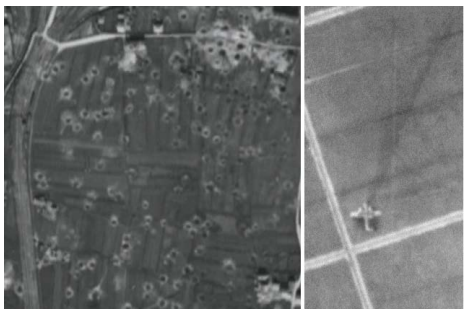

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Figure 9: *Craters from the bomb raid of Pisa 1943 (left) and a landed plane during the bombardment in 1944 (right).*

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