**Abstract** This study presents a semi-automated method for detecting traces of Roman centuriation surviving in modern landscape. The method is borrowed from a feature detection algorithm developed in a different context, and adapted to scan large portions of land for remnants of regular square grids. A test case is presented on old aerial photos of the rural area around Pavia, Italy, where Roman heritage is still visible today.

**Centuriation** (Latin limitatio) was a Roman system of land organization characterized by the use of regular, square grids. The remains of these regular patterns still survive today, clearly visible in some places but concealed in others. Detecting the remains of these patterns is of great interest for historical landscape studies and in this context older sets of historical aerial photographs can be of great use in the sense that these images, which portray a less developed landscape, provide us with greater chances of identifying relevant landscape patterns. Analyzing large sets of aerial photographs manually, however, can be very time-consuming. This paper presents the results of an experimental use of automated analysis, not very applied in this field, to identify centuriation traces within large numbers of historic photographs.

**Road Extraction Routine**

The routine is a context-aware linear feature detector, developed by some of the authors while tackling the problem of detecting road network in Earth Observation data, which proved useful not only for the intended problem but also for other applications. It appeared a good candidate also for the problem at hand, which indeed starts from detection of linear features.

**Preliminary Results**

A few digitized, color aerial images from the 1971 campaign around Pavia, Italy, were selected among those archived in the heritage repository mentioned in chapter 2. An example of such images, already measured 30 actus (around 710 m) and which were oriented along two main crossing axes, the cardo maximus and the decumanus maximus. In parallel with these two main axes, all the other limits were arranged, the minor cardines and desumanns, which defined the centuriae, creating in this way a regular and ordinated reticulum. The form of agrarian division both improved the agricultural exploitation of the land and, at the same time, was conducive to the creation of settlements. This grid was, in theory, a reproduction of the cardinal points (i.e. the cardo maximus was oriented N-S and the decumanus maximus E-W) but, in practice, followed and was adapted to the line of the soil to better exploit the natural slopes and elevations and to guarantee an excellent water runoff. As a result this method of land division system is in use even today in some parts of Italy, and specifically in the Po river valley.

**The case study** presented here concerns the organization of the territory of Ticinum (Pavia), where two distinct types of limitatio were employed, specifically adapted so as to better exploit the geo-morphological characteristics of the land. The concerned area is roughly centered at 45° 11' N, 9° 11' E. Our starting point is the analysis of aerial photography which, applied to the study of topographical problems, has a long tradition at the University of Pavia. The aerial photographic archive of the Emeritus Professor of Ancient Topography, Pier Luigi Toselli, covers a significant part of Italy and contains a range of photographs, from the wartime images captured by the British Royal Air Force to contemporary photographs (some purchased from several sources, including Compagnia Generale Riprese Aerei Parma, and some actually made by the Professor himself). This archive (which is currently being collated and analyzed) represents an ideal starting point to study the transformation of the landscape and serves as a unique, preliminary, tool for archaeological investigations: tiny differences in ground conditions caused by buried features can be emphasised by a number of factors and then visualized from the air. Aerial photographs of the site of Santa Sofia of Torre d’Isola (currently investigated by the University of Pavia) have, for example, shown the presence of crop marks which indicate buried ditches - which hold more water - and possibly buried walls, which hold less water than undisturbed ground, as well as centuriation traces in the surrounding areas.

**Conclusion**

A histogram was built reporting the total length of lines in each direction range bin, to highlight the dominating directions in the considered area. Different bin sizes were considered, to tackle the trade-off between precision and sample size in each bin. The example histogram shows three preferred directions, two of which are at a square angle; their absolute values do not match the usual N-S, E-W pattern, but this may still be one of the orographic adaptation patterns and further visual analysis is requested to draw a conclusion.

Although experiments are still at an early stage, the road extraction methodology has shown significant potential in speeding up the large-scale mapping of Roman centuriation from heritage aerial photos. A processing chain is being experimented and tuned, that will eventually relieve the visual analyst from spending several hours in the lowest-level part of the work, i.e. detecting prevailing parallel and perpendicular lines across a vast area. Much work is still needed to make the processing chain accurate. This may include incorporating ancillary information on centuriation clues already detected by visual interpretation; incorporating local orographic pattern from a DEM, which may impact on the expected orientation of the limitatio grid; using public sources such as www.openstreetmap.org to remove linear features generated by more recent construction work, such as motorways. Still, it is our belief that it is worth investing in this theme.