

## Spatial Visualisations of Aerial-Archaeological Marks

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Practical photoarchaeology uses aerial imagery for the interpretation of weak groundmarks and output of image-enhancement, whether of an oblique photo or a vertical photogrammetric image, does not differ essentially from the input. On the basis of vertical imagery from the state surveying department, the potential of spatial presentation forms (i.e. grey-value-mountains) will be demonstrated not with expensive tools that are available in the modern computer world but with universally used standard image processing tools or office components (i.e. Microsoft Excel – tabular calculation). The enhancement and ‘upgrading’ of the original aerial images results in endproducts that yield advanced interpretations of ancient subsurface details through new views on the archeological footprints. The result will not only help the expert who has to interpret the ‘raw’ content, but also will provide a visual product that may assist public relations.

Two different objects provide the base for the ongoing visualisations. Both images are clipped areas of small-scale verticals (1:12,000). Nevertheless already in their original two-dimensional view their physiognomy stands out with great clarity and further processing seems not to be required.

- a) A dual-concentric ring-ditch-system of unknown function, situated in northern Germany (Lower Saxony) in the so-called Schotenheide of Rodewald. This object is one of many that are clustered in groups within a 6 x 3 km area. They are similar to those of Davy Strachans’ *Stour Valley Project*.
- b) The Lüningsburg, one of the bigger circular fortifications in Lower Saxony (~ 3.5 acres), is situated on a terraced ledge above the river Leine. The site was a wood-earth-construction of the 9<sup>th</sup> to 10<sup>th</sup> century AD.

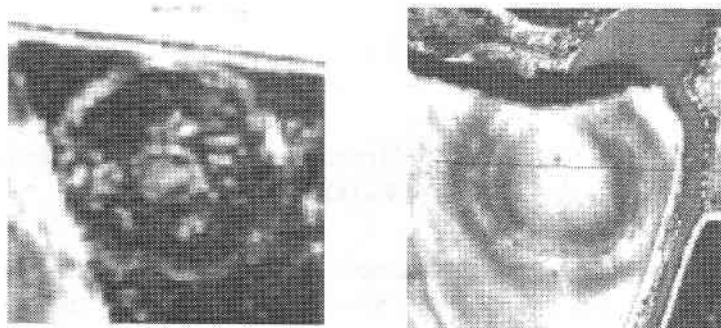


Fig. 1. Original photographs of Schotenheide and Lüningsburg.

The following processes begin with a ‘more than two-dimensional’ view called a relief-map (1), which is followed by a three-dimensional ‘terrain’ model (2). With further processing, specific section-profiles (3) can be derived from this digital model that can be compared with those from excavation, or may even partly replace such work.

### 1. Relief-Map ('21/2'-D)

Representation of relief lies between a 2-D single photograph and a 3-D model which could be compared with hatches in older cartographic maps. Both reproduce in a graphic way the plastic terrain surface. Use of an imaginary light source produces a highlight and shadow effect that appears to give form to an otherwise 2-D image. Illumination from the upper left (ie, with the sun in the north-west) shows the positive and negative height differences in one subjective right way. Lighting from the lower right causes human perception to inverse that effect. Before converting the image into the right form, it is necessary to decide what is high and what is low. Darker image details – are they indicators for concentrated humidity? Are brighter structures former elevations?

The following sequence (Fig. 2) begins with the 'source' image (left), then a 'hybrid' where the transition from plain level to relief is indicated. The treated images show positive relief with a circular rampart, and negative relief where the 'rampart' becomes a ditch. Relief in both is false but may usefully upgrade weak features on a 2-D image. Figure 3 shows similar application at Lüningsburg.

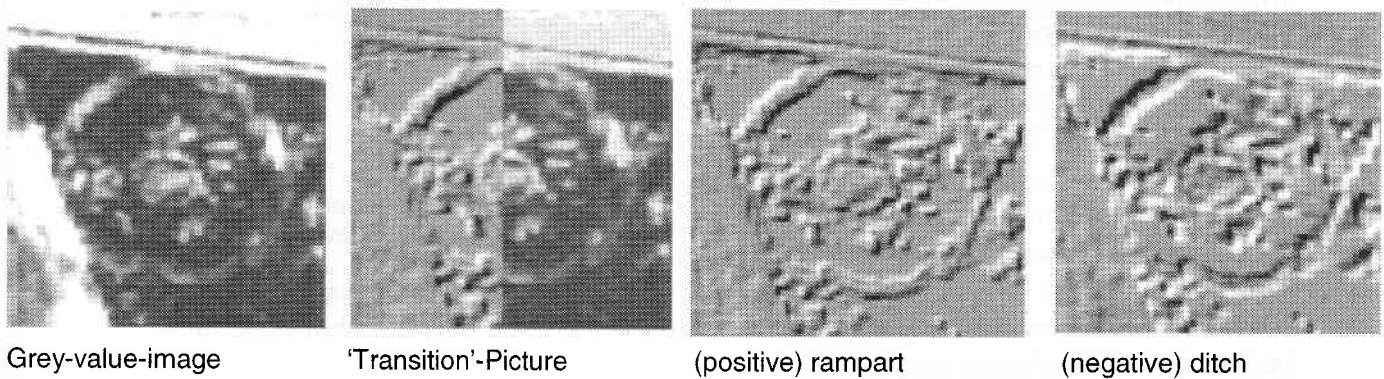


Fig. 2. Relief-representation of a ring-ditch (Rodewald-Schotenheide).

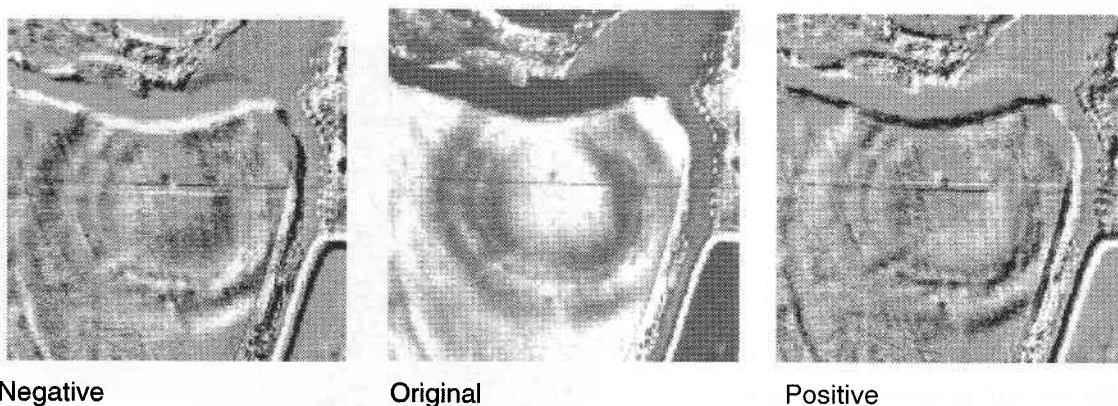


Fig. 3. Relief-representation of the Lüningsburg.

### 2. Digital Terrain Models from aerial photographs

For further analysis and visualisation it could be more promising to create or relate three-dimensional 'views'. These are created on the assumption that there is a linear relationship between the brightness-intensities of the original grey-scale image and a corresponding topographic height value. Software will then use these values to create a vertical metric profile of a terrain surface.

Generally image processing tools have an interface to convert an image into another format. Using Adobe PhotoShop 7.0 and Jasc PaintShopPro 7.0, for example, the 'save as'-function can convert the pixels of the image into the 'raw-data'-format in which the image content is a long string of ASCII-character-values arranged in a text file. This digital raster (depending upon the geometric resolution in length and width), here only 50 by 50 pixels resolution, can be imported again into the rectangular shape of MicrosoftExcel tabular calculation (Fig. 4). The ORD-function produces the ordinal value of all digital matrix pixel elements. The value range starts at '0' (black – no intensity) and ends at '255' equivalent to 'maximum white' with the intermediate grey-scale between.

This step – the transformation of ASCII-characters to the corresponding ordinal integer values – creates in first step only another rectangular scheme of digit numbers. Marking this matrix of Fig. 4 (right), then choosing the menu-item 'insert diagram', opens a five-step wizard, where all the viewing parameters of the resulting 3-D model are to be set. This diagram-feature of MExcel transports the abstract information into a graphical and plastic terrain topography model (Fig. 5). The soil/moisture feature of the Lüningsburg shows bright and dry regions. These may be visualized as positive heights. Darker parts with humid components (filled ancient ditches) are represented as negative heights below an arbitrary surface zero.

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Fig. 4. Excel-Sheet: ASCII-characters and corresponding ORD integer values

Here the height intervals are coloured with grey values; alternatively one can use all natural colours to produce a nearly realistic view with blue water and green topography and so on. Views from any perspective angle can be generated interactively.

### 3. Digital Excavation Profiles

After a specific feature has been represented as a terrain model it is possible to 'cut' a series of sections using the same integer values as is demonstrated at the dual-concentric ring-ditch at Schotenheide (Fig 6, lower). The reliability of the digitally-derived profile may be assessed by comparison with one drawn from excavation results (Fig 6, upper).

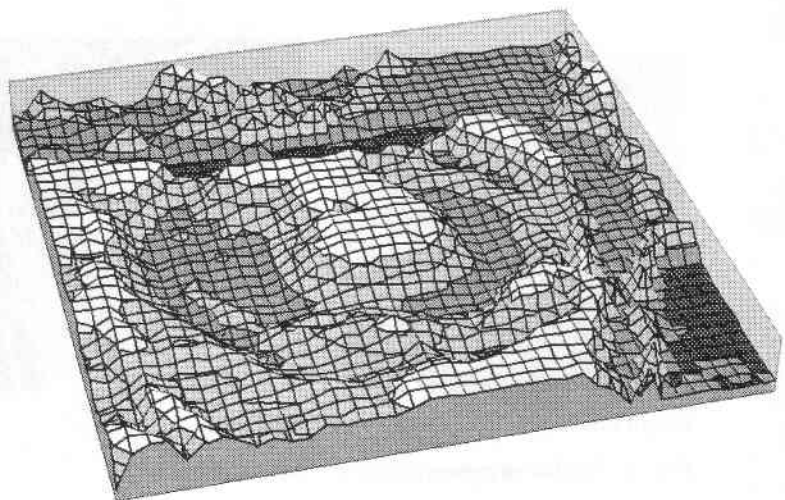


Fig. 5. 3-dimensional Digital Terrain Model.

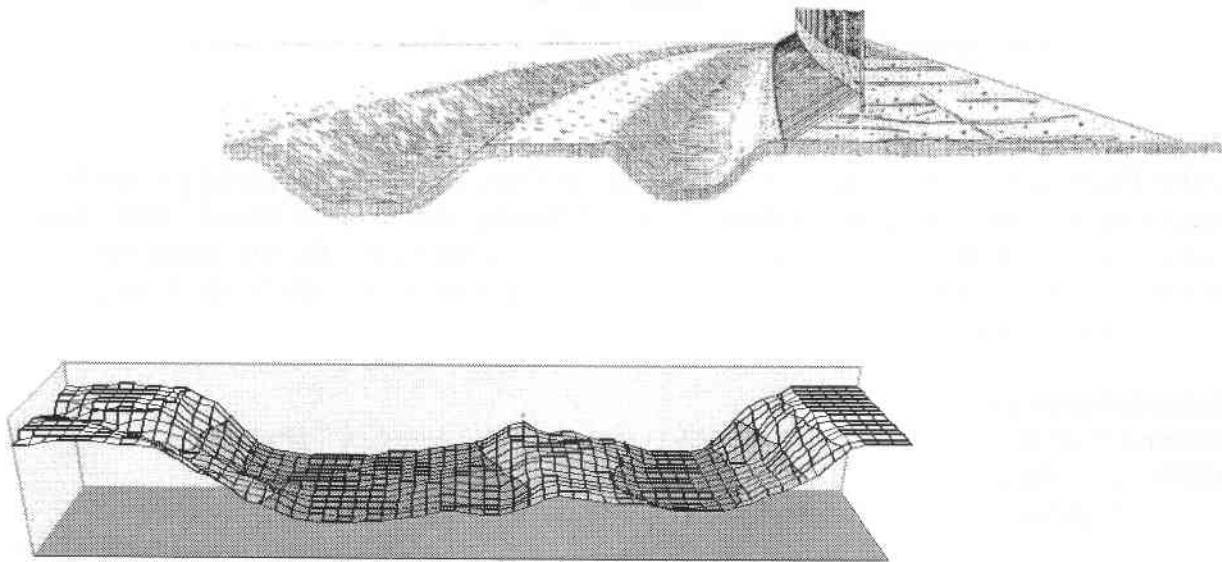


Fig. 6. Comparison of digital terrain profile section with a manual drawing from excavation.

### Conclusions

These applications extend the visualization of archaeological monuments from that available in a single vertical photograph. The potential of more than a two-dimensional view has been demonstrated at two sites. At one of these the digitally-derived model compared closely with results from excavation.

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