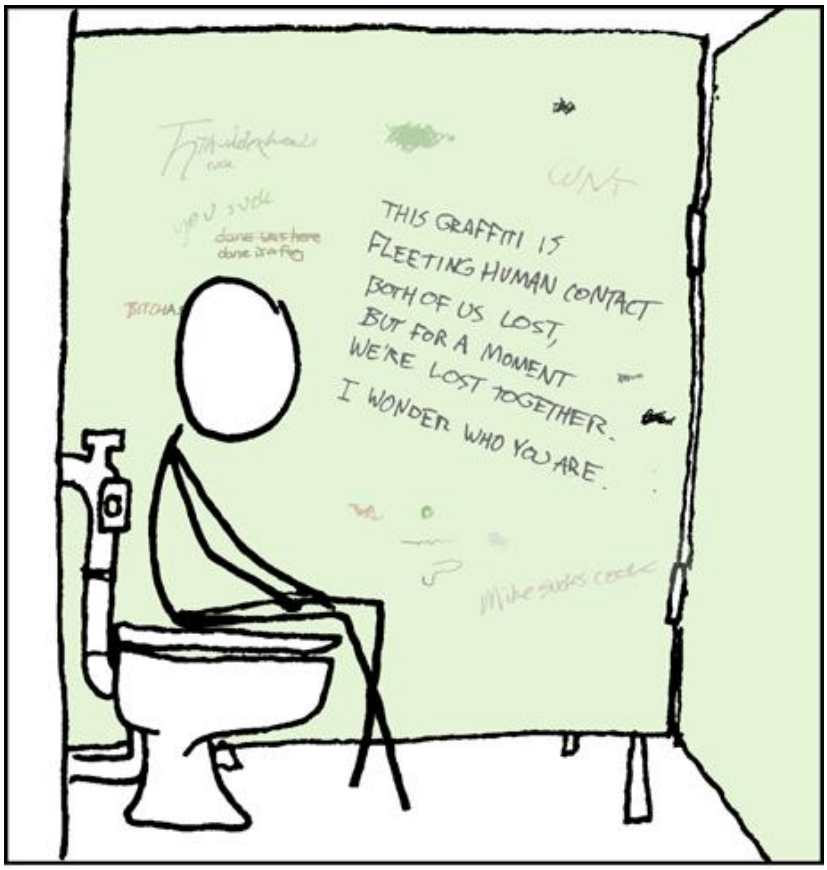
Arch6057: Archaeological Computing Systems

The uses of Polynomial Texture Mapping in the recording and study of historical graffiti found at Bodiam Castle and Portchester Castle



(xkcd, 2010)

Outline

This essay will examine the uses for Polynomial Texture Mapping (PTM) in the study of graffiti in the archaeological record. It will examine the development of PTM as a recording technique and focus on its uses in the recording and study of engraved graffiti found in places of historical interest with specific reference to Bodiam Castle and Portchester Castle. The essay will firstly examine the technology of PTM and its current uses in cultural heritage. It will then look at the current studies of graffiti in the archaeological world leading into focussing on how PTM can benefit further study and recording of this aspect of the past.

Polynomial Texture Mapping

Polynomial Texture Mapping (PTM) is a technique used for displaying the image of an object under varying conditions e.g. light, position or time. PTMs are constructed from multiple images of an object taken from the same position but with a changing direction of illumination. In a PTM, each pixel contains, instead of constant values, a function of x and y for each value of red, green and blue where x and y represent the location of a light source. This allows the creation of an "adjustable" image where the function of each pixel takes into account the varying light source. This allows a virtual light source to be moved, which varies the image accordingly. By taking multiple images one has collected enough samples of each pixels reflectance function to allow a low order polynomial to be fitted to each pixel which will produce the PTM, a PTM viewer can then evaluate this polynomial and produce the adjustable image (Earl et al., 2010).

In archaeology and cultural heritage, PTMs have been used for a number of years. They are helpful to the study of epigraphy as they are particularly good at picking out engravings and allow offsite examination of artefacts. Making use of ranging lighting conditions which until now have evolved around the use of a lighting source directly onto an object. This is apparent in the work done on the Antikythera Mechanism (Freeth et al., 2006). PTMs produced of the device have been used to help interpret its function by deciphering symbols engraved onto the device (Freeth et al., 2006). In addition to examining artefacts, they have also been applied to the study (Padfield et al., 2005) and repair (Klausmeyer et al., 2005) of oil paintings and the study of fossils (Hammer et al., 2002).

Background

The creation of PTM as a technique has its origins in the invention of photometric stereo. This technique was used in the 1980s and uses surface orientation to examine an image's geometry based on varying the lighting direction between different images while maintaining the same viewing direction. It was also used to determine object points which had a specific orientation (Woodhams, 1980). The uses of Photometric stereo were then re-examined and extended to take into account not just the surface geometry of an object but also its reflectance properties which can be used to reconstruct and interpret inscriptions (Einarsson et al., 2004).

PTM makes use of Bidirectional Reflectance Distribution Functions (BRDFs) which describe how light is scattered across a surface. These functions are important as they can allow the "proper representation of reflectance data" (LaFortune et al., 1997). These were used to produce images with changing lighting conditions and allow places such as the Parthenon to be represented in its natural outdoor setting (Tchou at al., 2004).

The renewed interest in functions which represent light reflectance brought the invention of Polynomial Texture Mapping closer. They are important in the photorealistic rendering of surfaces and their reflectance (LaFortune et al., 1997). The ability to produce photorealistic rendering was an early focus for a number of image processing specialists. The issue with the earlier systems was that creating complex realistic scenes was not cost effective and would take a long time to render entirely. By creating an image that allows the illumination to be adjusted interactively, the problem is much reduced. The issue was that it would only produce "synthetic" scenes, not render objects, as needed in the archaeological world (Wong et al., 1997).

The first use of such techniques in the archaeological world began with surface reflectance transformation technologies. This used the same “per-pixel” reflectance modelling technique as PTM. It allowed a better perception of surface detail, geography of objects and allowed changing views to manipulate the object into a range of positions for analyzing than earlier techniques. The technique was tested with a range of objects, such as tablets with faded images and seals, which particularly benefitted from this technology as it allowed them to be deciphered. The difference between this method and PTM is that it does not allow the possibility of displaying images with varying camera position, rather than only varying light source position. However, it does allow the ability to represent shading effects (Malzbender et al., 2000).

The original form of PTM, produced by Hewlett Packard, appeared in 2001. They showed that by using only images, it was possible to generate photorealistic renderings of textured surfaces. The technique generated texture maps of objects using light dependant effects, such as changes in direction of illumination, while taking into account the fact that even shadowed sections can receive light reflected of neighbouring sections. They provide an interactive control of lighting conditions on objects and other textured surfaces allowing a greatly increased perception of surface structure in comparison to photographs alone (Malzbender et al., 2001).

Issues with this technique are that it was limited by the artefacts that could be represented. It was perfect for objects such as tablets, ceramics and fossils but there were many surfaces it could not deal with (Hammer et al., 2002). It was suggested that instead of representing artefacts according to their geometric properties they should be represented according to their reflectance field (Hawkins et al, 2001). These included items with complex reflectance properties such as:

- Fur which does not have a well defined surface;
- Crystal forms which exhibit much subsurface light scattering;
- Items of complex internal geography;
- Objects which contain both areas of high and low diffuse reflectance (Hawkins et al., 2001).

One of the most complex surfaces to recreate is that of human skin. It has a surface which has changing local optical properties and fine scale geometry; the lighting of which changes greatly according to the lighting the image is created in. To model skin a similar technique to PTM is used in terms of generating multiple images from a fixed point of view, whilst manipulating the lighting conditions. This created a large number of bidirectional texture images of facial skin (Cula et al., 2003).

The possibility of using techniques in a different range of the electromagnetic spectrum was identified. The range of visible light is small; it has been found that using an ultraviolet light to read manuscripts can improve the quality of the writings (Knox et al., 2003). A technique originally used in space exploration is now used to help interpret degraded or damaged manuscripts and papyrus scrolls. It works by capturing a range of images in different ranges of the light spectrum. By doing this it allows information to be obtained from areas which respond better to light which is out of range of the human eye (Chabries, 2003). This has been expanded upon by converting the images into pseudocolour to allow the results to be more easily comprehended (Falcone et al, 2007).

The uses of PTM have already been examined; however, until 2005 the majority of techniques available were lab based and not portable. They were produced using a lighting dome, which

consisted of a tripod holding the camera in position looking down on the object being recorded, this is surrounded by a dome directing where the position of the light should be placed for each image (Malzbender et al. 2001). In 2005 the first portable techniques were published. This began to not just widen the possibilities in the creation of PTMs but also highlight other uses of PTMs (Mudge, 2004). The possibilities of using PTM in data recording are apparent when looking at the work of Mudge et al. (2005) in using reflection transformation imaging to record and document a collection of coins found at Grand St Bernard Hospice, located on a mountain pass in the alps. It is notoriously hard to access in winter months. By digitising and publishing the results of the PTM, it allowed others to access these records and study the coins from around the world even when access to the coins themselves is unavailable (Mudge et al., 2005). This advantage is also displayed in the study of objects that have been scattered around the globe, such as Cuneiform, which has no base collection. To study all the objects would require frequent trips to isolated locations all over the world (Willems et al., 2005).

From here it also became apparent that recording large surfaces and objects was also challenging. By not being able to use a dome for recording the objects and not being able to remove them from their location caused a range of issues. To solve this Dellepiane et al. (2006) created a method that used the positioning of a single light source in a number of set positions to acquire the images while recording there position via a computer program. This was successful at recording large objects (Dellepiane et al., 2006). However, this method was quickly replaced by the introduction of the "shiny ball" technique. This is a new way of calculating the incident light direction. It works by using the presence of a black glossy ball in each image that makes up the PTM. The computer software can use the reflection found on the surface of the ball to calculate the direction the lighting came from (Mudge et al., 2006 and Barbosa et al., 2007). This method has been applied to see how changing lighting affects the appearance of large mosaics found in Byzantine churches in Cyprus and shows that it can be effectively applied to large surfaces (Zányi et al, 2007).

The ability to produce easily publishable images, both PTMs and laser scans, to provide helpful information about artefacts has been applied in the hope of creating a virtual exhibition or a digital archive to preserve the objects and allow better access to data in a better condition than that of just single images (Mudge et al., 2008). Combined with the ability to produce images in detail that cannot be seen by the human eye, this has greatly improved the analysis potential. Recent additions include producing PTMs in real time, which has been used by the film industry to either improve actor performances or alter the lighting conditions of scenes in post production, have shown applications in cultural heritage (Wenger et al., 2005). In archaeology, being able to view objects and scenes without having direct access to them has already been demonstrated as advantageous but also being able to manipulate the position of the artefacts as well as the lighting conditions is an excellent next step to this technique (Malzbender et al., 2006). It is obvious that techniques such as this are ideal for this application in the recording of historical graffiti in the hope of further interpretation.

Today PTMs have had multiple applications to the world of Cultural Heritage, not just in archaeology. The technique is now easily transportable as well as applicable to nearly all types of artefact and surface, in a nearly all sizes. However, there are still many issues associated with the process. By producing PTMs of surfaces, as will be discussed later, one is defining the size or extent of the surface being examined. In cases such as recording rock art, larger surfaces can extend great

distances and without accurately defining the extent of the pieces, areas could be missed and lead to misinterpretation when not examining the actual surface.

The same is true if the images are altered digitally. If one does not document every single alteration made to an image to improve the view or “tidy it”, it can, at a later point, be taken as fact. Changes could be assumed to represent how the object appears in real life and as such could influence how the object is interpreted at a later date. When recording any object or inscription one has to consider how a digital reconstruction, image or photograph can alter ones impression of the site or the object when it is being interpreted by others (Zuckerman, 2004).

The technology also has a number of similar issues to that of Geophysics. When the results are being interpreted, any previously unseen engravings or markings are not necessarily relevant. When undertaking a geophysical survey results do not automatically mean “archaeology”; they show anomalies to the norm which can then be interpreted as a range of things. In a similar way, finding a mark that was not originally noticed could be damage to the object or a mistake in the actual production, which was removed by the author.

From this we can see that again, as with all technologies, they have to be carefully applied and then the results analysed and examined without leaping to conclusions. As Wheatley states when discussing statistical patterns: “we try to connect the dots”. In other words, we look for patterns where there frequently are none (Wheatley and Gillings, 2002: 125). When looking at damaged or partial writings we try to find sentences between the lines and fill in the gaps. For example the common email message that is forwarded

> "Can you raed tihs?
>
> i cdnuolt blveiee taht I cluod aulaclty uesdnatnrd waht I was rdanieg. The phaonmneal pweor of the hmuan mnid; aoccdrnig to a rscheearch at Cmabrigde Uinervtisy, it dseno't mtaetr in waht oerdr the ltteres in a wrod are, the olny iproamtnt tihng is taht the frsit and lsat ltteer be in the rghit pclae.
>
> The rset can be a taotl mses and you can sitll raed it whotuit a pboerlm. Tihs is bcuseae the huamn mnid deos not raed ervey lteter by istlef, but the wrod as a wlohe. Azanmig huh? yaeh and I awlyas tghuhot slpeling was ipmorantt!
>
> If you can raed tihs forwrad it." (Is spelling important, 2010).

Most people can read this email despite the lack of order to the words. When looking at incomplete engravings the same would probably occur, the brain will fill in the blanks, which is good as interpretations can be uncovered. But at the same time this could lead to the wrong letterings being inserted and therefore the wrong translation being produced. So when interpreting writings and engravings one has to consider a range of possible translations and not just the first one that appears.

Graffiti

The study of graffiti is of increasing interest to the world of archaeologists. Graffiti itself causes reactions which differ according to person, the location and its age. To some it can be considered art, others self expression and at the opposite end of the spectrum, a menace. This has been taken

to the extent that, in the case of the Cave of Mayriere Superieure, a local scout group attempted to remove prehistorical paintings in the mistaken understanding that it was vandalism (New York Times, 1992).

Those who study the phenomena of graffiti often consider it to reflect: “ideas of how human beings perceive and interact with their living environment; how they signal their inhabitation of or transit through place; and how they gesture to ownership, occupation and even, or especially, arrival” (Frederick, 2009: 213). It can also be considered “a more casual and personal expression, often including social comments and humour”, of art (See figure 1). It can provide a more visual representation of insight into the lives of those expressing themselves (Cocroft, 2006: 5).

Figure 1: Piece by Banksy produced on the side of a sexual health clinic in Bristol shows the humour often found in graffiti (Banksy, 2010).

Today graffiti has been further defined and tends to refer more to the defacing of buildings as opposed to the term “Street art” which applies to areas of graffiti considered as socially significant or artistic. This would include the work of artists such as Banksy or that which is produced on allocated “legal” spaces. What is considered the defacing of buildings however, is more similar to the nature of graffiti at the buildings being examined in this essay. Today, a common practise among graffiti artists is tagging, in which an artist goes out and leaves their mark on a surface, like a signature (Graffiti Tags; The art of graffiti tagging). This is similar to the graffiti found at Bodiam and Portchester, which is most frequently a personal mark being left in a visible *culturally significant* place.

Figure 2: A “tag” (On Living by Learning, 2009)

“Tags” are frequently attached to larger pieces of work that the artist has produced. When asked “why tag?” a common answer was “to get your name out there, so people begin to recognise your work” (Anon, 2010: p.comm.). Another artist replied with this message

> “I tag my name because I want people to see it.
> I also I write the word "pie" in big bubble letters because the thought of people seeing it and then wanting a pie amuses me.
> Also, I draw large mushrooms with different faces because i no longer the time to draw and it lets my pent up doodles out.” (Marett, 2010: p.comm.)

This went into more detail where he discussed his wish for people “to know he had been there” and to “leave a bit of himself behind, no one wants to be forgotten” (Marett, 2010: p.comm.). This has very similar parallels to the nature of the work found at both Bodiam and Portchester. At both locations the graffiti tends to be initials and names often accompanied by dates of the visit. This shows the visitors in the same way as above, wishing to leave their mark on a building, to interact with the space and say “look I have been here”.

The way this graffiti has been produced, especially at Portchester, could be seen as the Prisoners of War forming a “community of practise” in a similar manner to those producing graffiti art today (Valle, and Weiss, 2010). They are sharing:

- A domain of interest; they all maintain an identity of being imprisoned.
- A community; the nature of the marks is highly defined. They do not cover over each others work but, are close together so communication between different engravers would have been required, or perhaps produced as part of a group.
- A practise; they are all producing the same pieces and these pieces at both sites are found in the same locations within the building so sharing knowledge about the better places to carve perhaps?

By producing these marks in the stone they are creating an identity for themselves as well as sharing something within the group (Wenger, 2008). This is similar to the identity of those visiting the site as a “romantic ruin” in the 1800s. They are creating an identity for themselves which is common with many others and leaving part of themselves behind at the site to share.

Historical Graffiti

The study of graffiti in historic places of interest is fairly limited. The majority of work in this area only considers the removal of graffiti. There are only a few papers which consider the importance of the graffiti as part of the site. Cunliffe (1994) when excavating at Portchester considered the graffiti of "comparatively limited" use. He considered their production as part of life in the castle that could contribute little to the study and understanding of the site. However, a study of the life of the castle and its later uses is now considered of great interest. Taking "a time slice" of sites is important in understanding them at a particular period; however, it is also important to understand a site throughout its occupation. This essay looks into how the graffiti can be used to understand the castle in terms of its prolonged use (Cunliffe, 1994).

When examining the protocol for dealing with graffiti on historic buildings very rarely is the need to record it considered important. Building surveys which have not been conducted recently do not include or mention the presence of any markings of previous occupants or consider them of "historical significance". This has improved, as today, any graffiti that would "contribute to an understanding of the building" is included in the transcription as well as images if necessary (Menuge, 2006: 11). This is not however, a detailed point in the transcript and is only mentioned once; the document does not mention the need to return to sites and rerecord this phenomena in other buildings. Military wall art has approved guidelines for its conservation and management. These however, are mostly applicable to sites which have current military purposes and do not deal with older sites. They also do not consider the cataloguing of graffiti on buildings as an essential task but instead suggest that any found should preferably be preserved, otherwise the recording of them should be undertaken by producing "written, graphic and photographic records". There are however, a number of short comings for this type of recording when it comes to the nature of graffiti at these sites. Primarily, before the recording of the graffiti is considered necessary, a team has to deem the nature and extent of the graffiti present as significant. This, combined with the instructions for photographic recording, does not address this form of graffiti (Cocroft et al, 2004).

The graffiti at Bodiam and Portchester Castles appears to be very similar but, appears to have very different origins. At Portchester Castle the graffiti appears to have been produced by Prisoners of War who were incarcerated at the site between the 16th and 18th centuries. This can be studied and examined as part of the larger category of war art which is defined as "any deliberate expression that has been applied onto, or is integral to understanding any built structure, site or area in the context of its military occupation or use" (Cocroft, 2006: 6). The current understanding of the "war art" produced by prisoners of war is that it tends to imitate art currently being produced from their homeland. However, in Portchester, this does not appear to be the case; the majority of pieces again tend towards initials and dates to shows when the prisoners were there. In War Art an observation of the positions of the graffiti implied there was a tendency towards them being situated in areas where prisoners were being punished and areas of lit space. This would again lead towards prisoners trying to establish communal identity and less towards national identity and reminders of home (Cocroft, 2006: 33).

Portchester is a site of specific interest, as graffiti from this period, produced in this context is rare. Many prisoner of war camps that were used at this time have been converted to other purposes, have been destroyed or the graffiti covered up.

Previous methods in academia to study and record graffiti include Pritchard, (1967) and the use of rubbings made in hard pencil. He has, also indicated that in a number of places the images have been altered, as some of the scratches he believes originate from the cleaning of the walls, he has therefore removed a few lines from a number of his rubbings (Pritchard, 1967: xii).

A more recent study, undertaken at Stonehenge, implemented laser scanning as a method of recording early carvings then using these scan to attempt to date them. These consisted of a number of axe head carvings which have been considered morphologically similar to that from the later Bronze Age from when they are attributed (Wessex Archaeology, 2005). This was also used to record graffiti on Salisbury Plain which was produced by soldiers stationed there during both World Wars. This method was implemented for similar reasons to the use of PTM in the recording of graffiti in Prisoner of War camps; to attempt to decipher and correlate the writing with military records (Wessex Archaeology, 2010).

In the Tower of London, graffiti are covered by glass to prevent them being further worn away and are accompanied with an explanation close by. Copies are beginning to be produced so they can be touched and traced by visitors without harming the engravings, therefore making them more accessible to the public. Laser scanning was decided as being the best method for these reproductions as taking casts could possibly damage the graffiti. However, this method is expensive and was not used to record everything (BBC: Palaces, 2008). The laser scans were used to create models of some of the pieces which have been displayed in the Beauchamp Tower but; they are still not really accessed that much by the public as their settings appear protected and in a “do not touch” zone (Personal visit).

What is apparent is there are no defined standards in the recording of historical graffiti and as has been seen by the above examples, methods vary according to researcher, location and opportunity. The next section will present the use of PTM in both the recording and study of Graffiti as an appropriate method for these sites.

Using PTM in the recording and study of Graffiti

The graffiti of interest at these sites tends to be engraved. As in the case of the Cuneiform Project the need to have a varying light source to help decipher the writings would be helpful as this would allow names and accurate dates to be picked out (Willems et al, 2005). These could then be compared with documents about the prisoners of war held at Portchester. At Bodiam, a better understanding of the uses of the site and the types of visitors might be possible. This is one of the applications of PTM that could be exploited by epigraphers and has obvious applications to the graffiti present at Bodiam and Portchester (Mawr, 2001: 5-6).

Another similar project is the work done by the Cultural Heritage Imaging (Bryan, 2009) on Rock-Art sites in the Côa Valley in Portugal, dealing with engravings found on a range of stone surfaces. It has many parallels with the study of engraved graffiti at Bodiam and Portchester. The “rescue” nature of the tasks in recording the rock-art before it is lost is supported by implementing PTM to help others to decipher the styles of images found on the walls and possible meanings (C-H-I, 2006).

Using PTM in Bodiam and Portchester would be advantageous as it has been successful in other similar projects. The nature of the sites in Portugal show that the technique is applicable to the environment at Portchester and Bodiam; the areas of interest are outside and the pieces range in

size. In terms of interpreting the recordings, the Cuneiform project shows that the technique does improves the ability to interpret engravings without having to be onsite to obtain information (Willems et al., 2005: 7). The areas where some of the graffiti has been covered or has become unclear may benefit from varying the direction of light.

As has been seen at the cellars in Winchelsea, East Sussex, the use of lighting from extreme directions can often uncover previously unnoticed engravings and give new feeling to a site. Especially when the engravings can have obvious similarities to those found recorded by Pritchard (1967) in a number of places in Norfolk, Suffolk and Lincolnshire (see image below).

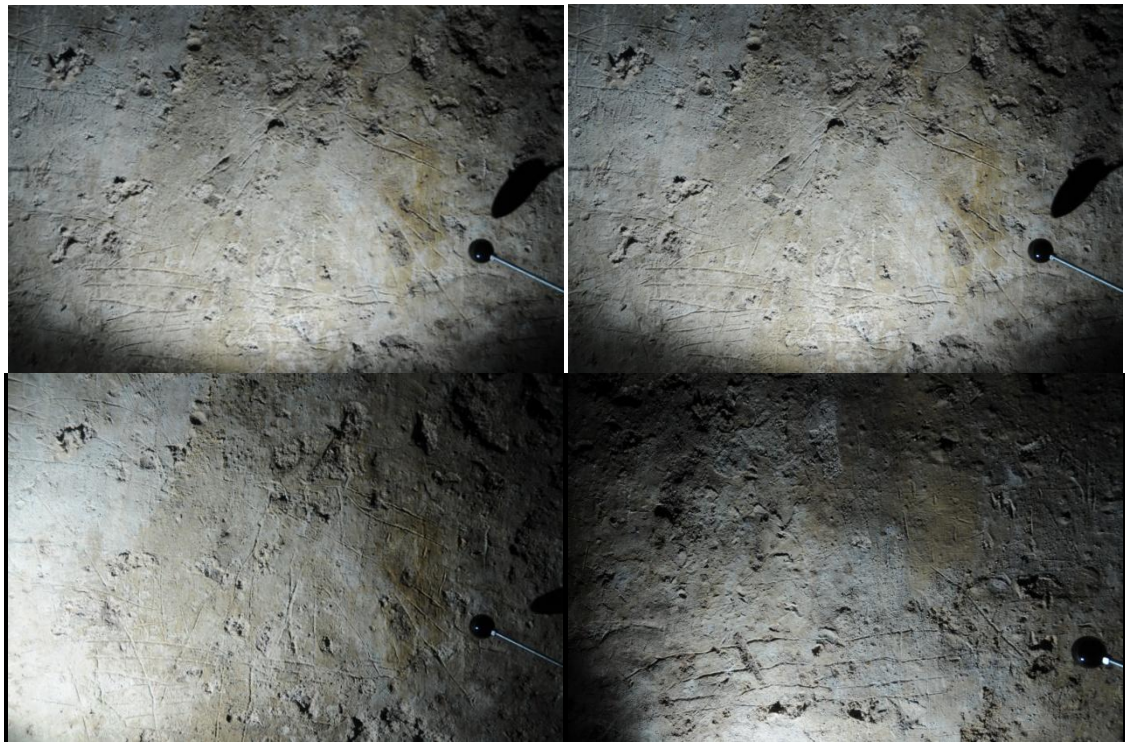


Figure 3: Engravings of a boat found at Winchelsea

Figure 4: Graffiti of a ship found in St Michael's church in Marton, Lincolnshire (Pritchard, 1967: 123)

This would, in some cases, help date different uses of the building and uncover who had visited the site. In the case of Portchester Castle, in certain areas the markings are quite detailed and give a lot of information about the prisoner who produced it including where they are from, who they were and how long they were there for.

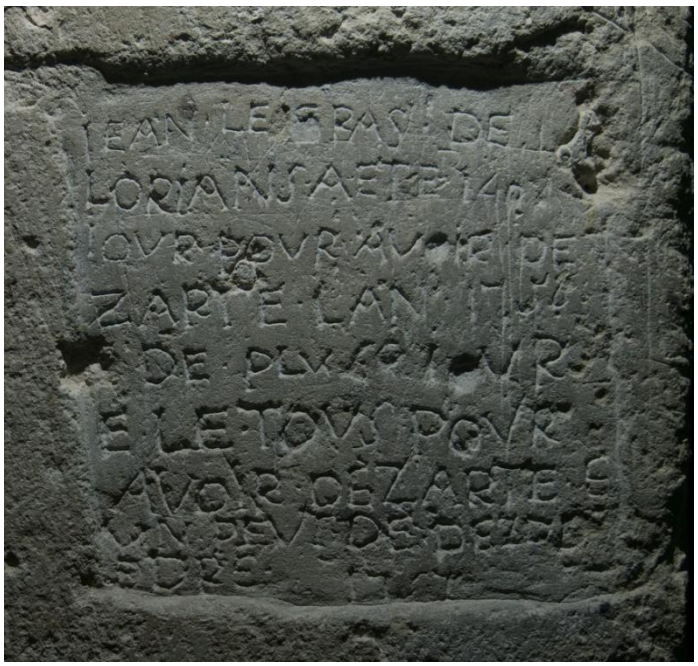


Figure 5: Graffiti in Portchester Castle

In Bodiam a lot less is known about the nature of the graffiti as the older historical engravings are believed to have been produced when the building was used as a romantic ruin in the 1800s. It was common practise to visit buildings similar to Bodiam for days out, as is done today when visiting National Trust properties. It is from these visits that a number of engravings appear to originate. One

of the clearest engravings of this type can be found in the interior and shows clearly the names “Shelley”, “Bretton” and “Mills” (Figure 6). This can be reasonably well interpreted, the name “Shelley” is common to the region; the Shelley family were great landowners in the Sussex area from at least the 1500s.

However, much of the graffiti at Bodiam is not as clear as this and in a number of places has been covered over by new pieces. This is where the application of PTM would be helpful and appropriate as it would allow the layers of graffiti to potentially be deciphered, leading to a greater understanding about the use of the building after its destruction and abandonment as a place of habitation. PTM has had applications in this area before; a number of papers argue that PTM can be used to interpret over written manuscripts and damaged papyrus. They also implement the uses of other areas of the electro magnetic spectrum. However, even without this technology a varying light source could help further decipher letters (Booras, 1999).

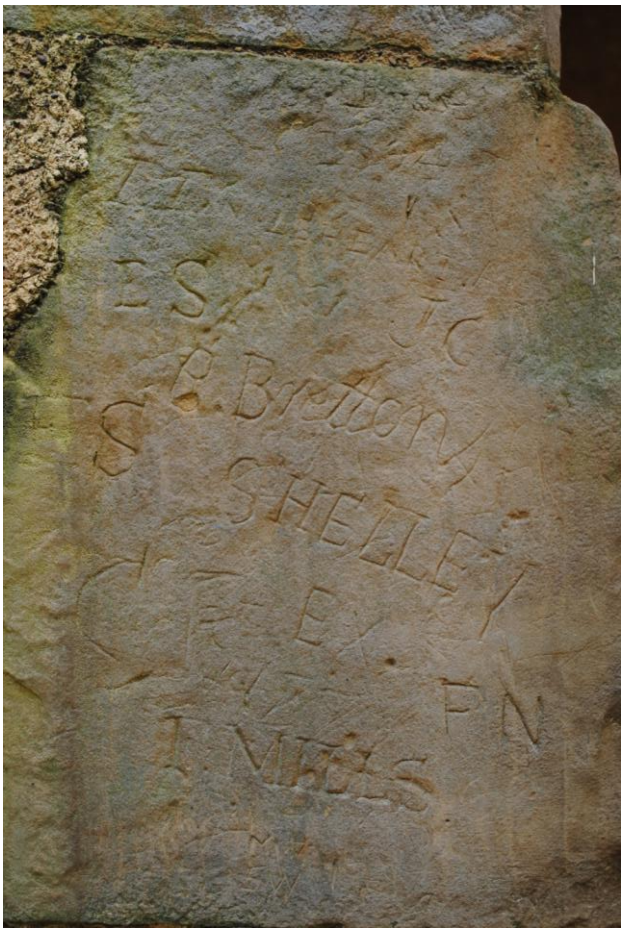


Figure 6: Clear engravings at Bodiam

Analysis of graffiti Polynomial Texture Maps

At Bodiam, a study of the graffiti was undertaken. Photographs were taken of every piece of graffiti found on the site and these were recorded along with their location within the building and the type of surface they were produced on. From here a few of the pieces were identified for further study and possible applications of PTM. These were selected based on the following criteria:

- Accessibility with a camera and flash;

- Effectiveness of application; where the inscriptions were not perfectly defined;
- Possibility of uncovering useful dates;
- Where a stylistic comparison could be undertaken.

The main aim was to try and uncover possible dates for the graffiti and gain an understanding of the types of people who were producing it.

The first noticeable point to make about the graffiti is that it was usually located on particular types of stone; usually Ashlar masonry (well arranged and cut stone). This pattern is likely to have occurred as this was easier to carve into as well as the results being a lot clearer. The next point was that much of the well drawn carvings, which must have taken some time to produce, had similar stylistic properties to that of the prisoner of war graffiti found at Portchester Castle. The less well carved (the scratched and drawn) graffiti not only tended to be less well-formed, but also in some cases to be incomplete (possibly due to an interruption). This also tended to be situated in the areas of the building which are hidden from direct view of the gate. The next note on some of the drawn graffiti is that the darker blue coloured ink seems to remain and some of these writings are of a similar style to that which can be found in Winchester cathedral and could therefore possibly be of a similar date; around the 1800s.

By looking at the PTMs, one can begin to discern a number of dates and initials. In these images of ranging light, it is possible to pick out the date 1851 and the initials FSB which were hazy when just examining the first image.

Figure 7: the initials and dates found in these inscriptions can be more clearly seen by manipulating the light

Figure 8: Another example where a date can be seen more clearly

Figure 9 shows a photo taken of some of the graffiti found in the gatehouse, in Portchester Castle. The first image shows a photograph of the graffiti, the second and third images have enabled specula enhancement and diffuse gain, which has allowed me to further pick out details which have been highlighted on the forth image. As you can see in a number of places new letters have been observed that were not apparent in the original image. Attempts at translation suggest this was produced by Master Jean le Bas from Lorian (possibly Lorraine), in either 1756 or 1757, who was there for about 14 days. The rest of the text suggests either why he was imprisoned or how he came to be there. The key to the translation appears to relate to the word Zarte or possibly Zartoe. The translation is much confused by the assumption in a number of places that where a “V” is depicted the writer intended to produce a “U”. However, curves are harder to produce in stone.

Figure 9: (Clockwise) Graffiti from Portchester, Graffiti from Portchester taken from PTM with Specular Enhancmenet enabled, Graffiti from Portchester with highlighted lettering, Graffiti from Portchester taken from PTM with Diffuse Gain.

Issues with using PTM

There are a number of issues with using PTM in these situations. The primary issue is the conditions that PTM can be implemented. When collecting images at Bodiam it was found that wind frequently interfered with keeping the camera still and this meant that when it came to processing the data at a later date the images were not all taken from the same position and could not be used to create good PTMs.

Another issue with implementing PTM as a way to record graffiti is that in a number of cases it would have been impossible due to their positioning. In cases where they were high on the walls reaching above to get acute angles with the light source would have been impossible to do without the addition of a ladder or similar device. However, this could have been overcome in these situations with the methods outlined by Dellepiane et al. (2006) in the recording of large objects.

There are also issues in the removal of the graffiti from its context. For example, relighting a number of the messages to further interpret them could affect the nature of the message being represented.

Does the context of the Portchester pieces, a dark enclosed room, affect how the message is interpreted or what engravings say? Is it possible to understand the images when not standing in the castle where they were produced, in the same conditions as they were expected to be read?

Also the nature of the graffiti in these locations tends to be as part of a larger group, by closely examining certain areas of the wall is a larger message being ignored. The interpretation of which pieces are meant to be read alone and which are part of a group could affect the nature of what is being said, especially if they were all produced as part of a large group, possibly being placed together to show companionship. A way to counteract this would be to attempt to integrate a number of PTM to allow a larger surface to be viewed. But in a location such as this where there are so many markings it would be hard to know if the correct space had ever been defined.

Figure 10: In this case a number of inscriptions are visible but not if they continue outside of the image

Following on from this point, as was stated in the first section, when interpreting these engravings one has to be careful to ensure that patterns or interpretations are not created. This means ensuring the translation of the graffiti is not based on "joining the dots together". Although this can be a useful and accurate approach, the problem is that a small change in lettering or an accidental scratch can alter the translation of a paragraph and be interpreted incorrectly.

Conclusions

The advantages of using PTM in furthering the study of graffiti in archaeology are apparent. Being able to manipulate the direction of the light source can be used to help confirm dating which can be further used to help uncover, in some cases, who produced the pieces and why they are there. As in the case of the Portchester example above, making use of the novel lighting option has allowed a person's name to be extracted from the writing as well as dates and other information about him. With help from a trained Epigrapher one could probably discern a large amount of his story and therefore, more about the nature of his imprisonment, as well as using this information to trace him back to why he was imprisoned.

In the case of Winchelsea, positioning the light source at an extreme position along the surface of a wall helped to uncover the graffiti present. This essay demonstrates that the further exploration of

the surface using PTM has highlighted a number of stylistic parallels with graffiti of the early medieval period found around the country.

Although there are a number of issues with implementing the technique, this essay shows that they can be used in particular situations to further the understanding of the graffiti. It also demonstrates the need to be cautious when interpreting the results. Although, fantastic results are possible, they also need to be analysed carefully to ensure that the technique is, in the first instance, used appropriately (in ensuring that the correct area is selected) and then interpreted carefully without "joining the dots" (Wheatley and Gillings, 2002) too quickly.

In conclusion, one can see that using PTM is an effective method for studying and recording graffiti. Not only does PTM provide a useful, efficient and easy way of recording graffiti, it allows further study when not on site. It can also be used to further investigate areas of text which have been partially destroyed or overwritten. The uses of the pieces of graffiti found at Bodiam and Portchester show that the graffiti itself is a valuable asset to the study of buildings particularly where the later uses of the building are uncertain.

This essay has highlighted the uses Polynomial Texture Mapping has in further interpreting the nature of historical graffiti and how it can be used to further understand the nature of the buildings it is found on, as well as find out more about those producing them. It also shows that it is a useful technique for the more permanent recording and archiving of the pieces to allow both more access to them, and a comparative study of them to be undertaken. It shows that there is future potential for the preservation of this part of the historical record as well as the need for further study into the graffiti itself.

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