

# Wearing Computers - An Archaeological Case Study

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## 1. Abstract



This presentation will discuss the results of an archaeological field trial using a wearable (PC/104) image capture system in order to demonstrate the potential of image sequence tagging methods for efficient data retrieval in documentary applications.

The goal of a field archaeologist is to extract as much information as possible from a working excavation site. It is important that information is gathered during the excavation to ensure that artefact position and orientation information is preserved, because once excavated the site is effectively destroyed. Data recording is often performed through time-consuming hand-drawing of the site, although it may be better achieved with photographs and detailed topological plans. However, as with many documentary applications, one could usefully take many photographs which themselves need to be carefully catalogued.

Figure 1 The Existing Wearable System  
The system is worn around a belt with a Head Mounted Display as the monitor

## 2. The Wearable Computer Specification

The wearable computer system used in this study was first built as part of a Final-Year MEng project in the School of Electronic & Electrical Engineering. The project specification was to create a hands-free wearable imaging device that would automatically collect images from the users' surroundings and store them for later viewing or processing. The 'WearCAM PC' was designed as a generic and expandable wearable device, which can be modified to perform any function of a normal PC whilst being wearable.



### The Birmingham 'WearCAM' Wearable Computer Specification

- PC/104 Based Embedded System Board
- P266 MMX CPU (Upgradeable Smart Core)
- 64MB RAM (Upgradeable)
- 6.5Gb IDE HDD (Upgradeable)
- VGA, LCD, COM, LPT, USB, 10-Base-T, IDE Ports
- Composite Video Capture
- 8 Hour Battery Life

Figure 2 The Complete Capture System (WearCAM Prototype<sup>[4]</sup>) one pence piece as size reference. Note Camera (bottom) (See <http://www.wear-it.net>)

### 3. Field Archaeological Case Study, Forum Novum (Italy)

The Forum Novum field archaeological trial provided a number of interesting challenges to a wearable system similar to the WearCAM. The original prototype system was configured to take a picture every 20 seconds without any user intervention. The original system requires no interface in this configuration, but the Head Mounted Display (HMD) could be added quickly if required. The site at Forum Novum provided an ideal opportunity to test the device in a real situation.



*Figure 3 The system in use (Pictured: Dr Vince Gaffney)  
Birmingham University Field Archaeology Unit (BUFAU)*

The 'WearCAM' is based around an embedded PC/104 board (designed for use in machine monitoring and assembly lines), which is inherently very rugged and able to tolerate considerable abuse, so the harsh conditions encountered in use should not pose a problem. With this in mind, it was put to use quite literally in the field. From this field trial it was hoped to gain the answers to:

- Will it work in the high temperatures and dusty environments?
- Does the device impede the user?
- How would the user make use of the images?
- What information do the archaeologists wish to gain from it?
- What changes need to be made to this system in order to fulfil their needs?

The 'WearCAM' was configured to take pictures every 20 seconds throughout the day. This allows one to follow the movements of the wearer, and allows us to test the device in harsh conditions. Clearly this does not offer the archaeologist a great deal of assistance at this stage, but modifications can be made once more information is gathered.



Figure 4 WearCAM Pictures Forum Novum Italy (Selected from over 1000)

#### 4. Results

The selection of pictures in Figure 4 (above), show that the device functioned on the site and produced useful material. Even at the relatively low resolution that these pictures were captured, it is possible to make out the site boundaries and even capture high detail on the site. The images are better than expected from the small CMOS camera (See Figure 2). From the pictures it is possible to determine where the picture was taken, at what time and also possible to see the site changing with time. This is useful for field archaeology since, unfortunately, learning about the site is only possible by destruction of the site.

#### 5. User Feedback

Generally the device was welcomed and there were some very good suggestions for improvements. The belt used for the device was approved; it was found that the WearCAM's weight is not an issue when worn around the waist. The idea of the battery on one side and the computer on the other works well to balance the load. The main problem encountered was the lack of feedback from the device. The device has a Micro-Optical<sup>a</sup> Head Mounted Display unit, but for the test this was not used. The main problem with the HUD is that it has been shown to cause significant distraction, interfering with the users normal conduct <sup>[1, 2]</sup>. The particular device that is used on WearCAM covers one eye, and it is not transparent. Research has shown that simply wearing a video-camera can be beneficial, e.g., users can view the recording after performing a task and discuss the images <sup>[3]</sup>. However, it was felt that some form of viewfinder is still necessary for this application.

Typically, for the images to be of maximum benefit they must contain more information. Currently the images are stored as separate files that are indexed by the time and date. The need for the image to be tagged with other information such as its location e.g. GPS, direction in which the picture was taken and other textual information would be of great benefit.

Other novel extensions to the system are possible with existing hardware for example geological-rectification is a function which the device could perform in real-time. This is where a picture of the ground is taken; the system then corrects the perspective in order to product a birds-eye-view of the ground. The

<sup>a</sup> Micro-Optical Corporation Prototype Display <http://www.microopticalcorp.com/>

image resolution is key here, since there needs to be a high enough resolution for detail in the background to be captured since when the image is processed this will appear the same depth as information from the foreground. So far image capture has been achieved using a small CMOS imaging device connected to the analog video-in. A more direct capture system based on a high-resolution CCD image sensor would be more versatile, allowing fast capture at different resolutions.

## 6. Summary

The wearable imaging system has many applications, including, but not limited to, the Field Archaeology application. As with off-the-shelf wearable systems, the WearCAM can provide a significant amount of processing power that can be worn about the body, however, more research needs to be conducted into interfacing with this type of system. Computers have come a long way in a relatively short time but wearable systems will continue to be of limited use, until an interface is developed that allows better unobtrusive interaction. The images collected in the field trial show that the system worked well in the field, and they offer a good account of the archaeologist's movements and actions during the day, which can then be viewed later. To enhance the usefulness of these images, they could be tagged, using voice or textual information that would then enable the user to search more easily. If the site had multiple users, wireless communication of the images and text could prove a real benefit and this is the focus of more research.

## 7. Acknowledgements

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<http://www.bufau.bham.ac.uk/newsite/staff/gaffnevl.html> (Dr Vince Gaffney)

[http://www.bufau.bham.ac.uk/newsite/projects/forum\\_novum/Default.htm](http://www.bufau.bham.ac.uk/newsite/projects/forum_novum/Default.htm) (The Forum Novum Project)

<http://www.bufau.bham.ac.uk/newsite/home.htm> (BUFAU),

## 7.1 References

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WearCAM Personal Imaging <http://www.wear-it.net/> and <http://www.eee.bham.ac.uk/wear-it/files/ECpaper.pdf>  
Electronic engineering challenges in the design of a wearable ubiquitous computer system, based on a Pentium™ PC/104.

## 8.0 Further Information

At the University of Birmingham we have more wearable projects in progress. Further information on these may be found on our Wearable Information Technology website <http://www.wear-it.net> where the latest developments are posted.