Are electronic devices finally superseding traditional optical LVA's?

Bierley

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At present, optical low vision aids such as hand or stand magnifiers, remain the device of preference offered by most low vision practitioners and low vision services. However we are all aware that an increasing number of our visually impaired patients are enquiring about electronic devices to either complement their current optical aids or to simply replace them altogether. Most households now have access to a personal computer and a growing proportion of the population, both young and old, are skilled computer users. In recent years there has been a surge in the development of affordable electronic vision enhancement systems. **Taraneh Eliasieh** and **Jane Macnaughton** discuss the development of electronic vision enhancement systems (EVES) and argue that low vision practitioners should now be expanding their service to routinely demonstrate this indispensable collection of magnification devices.

What is electronic magnification?

Electronic magnification, real image or transverse magnification simply displays an enlarged image on a screen or monitor. It is calculated as the ratio of the size of the image on the screen compared to the size of the original object. The magnification so produced is aberration free, but screen resolution determines the quality of the image. A simple example of electronic magnification can be demonstrated when a photo or picture is 'zoomed' in on a computer. The image is cropped and redisplayed over the entire screen face, thus causing the resultant image to be magnified within restraints of the quality of the screen (i.e. pixels) and the screen size.

History

The theory behind using electronic transverse magnification as a method of vision enhancement was historically first envisaged in the 1950's by Genensky *et al*.[1] Since then, the scope and availability of electronic magnifiers has developed to the point where Harvey[2] and later Macnaughton[3] also argue that the use of electronic magnification should be included in low vision consultations across all age groups.

Despite the advantages of an enhanced image and significantly more magnification than traditional optical devices, the high cost of equipment and lack of portability has previously limited their use to the workplace or schoolroom, where funding may be applied for. However the marketplace is now changing. With the cost of devices reducing, several publicly funded low vision services are now demonstrating and lending low cost electronic low vision devices such as those provided by Bierley to their patients along with standard optical devices.

The concept of using closed circuit television systems (CCTV) as a low vision aid has been a reality for some time,[4,5] and was initially developed from technology already widely used in CCTV surveillance systems (Figure 1). Other than magnification, CCTV systems used in surveillance do not tend to provide the many additional features such as contrast enhancement and image reversal, which are incorporated in those systems utilised by visually impaired users. Consequently, Wolffsohn *et al* suggest the term: Electronic Vision Enhancement System (EVES) to better distinguish and describe devices with such features. [6]

Just a quick search on the Internet for electronic magnification aids reveals a vast and varied market of products that are now available to the visually impaired user. Devices vary in size, price and degree of complexity; from the larger, traditional desk mounted apparatus to small, portable devices, the market is expanding rapidly. Some devices not only make use of magnification, but additionally

[1] Genensky, SM., Peterson, H.E., Moshin,H.L., Clewett, R,W. and Yoshimura,R.I. (1972). Advances in closed circuit television systems for the partially sighted. Santa Monica: Rand R-1640-HEW/RC

[2] Harvey,W.J. (2004) Electronic low vision aids, a new image for the visually impaired. Optician 227(5948), April 23rd

[3] Macnaughton, J (2005) Bierley's MonoMouse. Optician. July 22, 205

[4] 5 Potts AM, Volk D and West, SS. A television reader as a subnormal vision aid, 1959

[5] Grenensky SM. Some comments on a closed circuit TV system for the visually handicapped. Amer J Optometrist,1969; 46, 519-24.

[6] Wolffsohn,J.S., Peterson,R.C. A review of current knowledge on Electronic Vision Enhancement Systems for the visually impaired. Ophthal.Physiol.Opt. 2003 23: 35-42

incorporate OCR (Optical Character Recognition) that digitally encodes and converts scanned handwritten or printed text documents into electronic files. The data captured may then be converted to synthetic speech or printed in Braille for those who desire additional sensory cues.

Stand EVES with Monitor Viewing

The principle components of a traditional CCTV include a camera, a light source, an X-Y platform upon which the object is placed, and a monitor or screen on which is projected the image (Figure 2). With the larger screen size patients benefit from either an increase in image size or an improvement in the field of view at lower levels of magnification.

Current products that incorporate a traditional CCTV system as a stand mounted EVES include, as an example, the SmartView Synergy™ (Figure 3a). This stand mounted EVES can be used to view books, magazines, newspapers and colour photographs. The SmartView Synergy™ is available with up to 22inch screen which can provide up to 69x magnification. As with most of these traditional CCTV's the size and weight of these systems restrict the user to one place in the home or workplace. However, systems have superior quality image and the highest levels of magnification. They are currently still expensive and often beyond the financial capabilities of many elderly visually impaired users. Ideally, manufacturers should allow a full trial before there is a commitment to buy outright, but this is sadly not always the case.

As with all modern technology, advances are continuing to improve and increase the usage of EVES with the incorporation of additional features to aid viewing and functionality for day-to-day use. The ClearView PC+™ from Optelec has options for viewing both magnified images and computer files simultaneously using a split screen mode. (Figure 3b).

Figure 1: A CCTV surveillance system makes use of a video camera imaging system that transmits a signal to a specific place, on a limited set of monitors.

Figure 2: Aladdin Rainbow Elite - video magnification with auto focus, reverse contrast and full colour options.

Figure 3a: SmartView™ Synergy by HumanWare with control panel with added features of page locator light, lines and blinds and computer screen sharing.

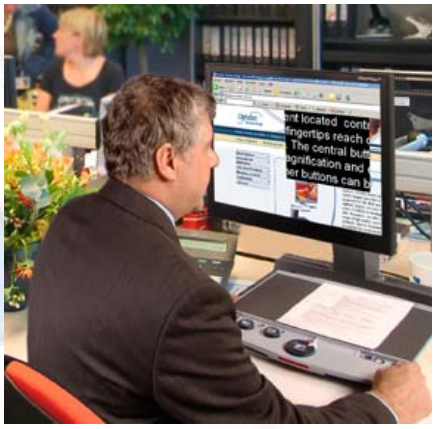

Figure 3b: The advanced ClearView+ PC (Optelec). At the press of a button, the video magnifier image is displayed in a foreground window, whilst the PC image window remains in the background - Picture-in-Picture.

Figure 4: Selection of screen features available from many Stand EVES with screen monitor view

Some of the main features of stand EVES with monitor viewing (Figure 4) include:

- Higher levels of magnification
- Zoom capability
- Colour Screen
- Reverse contrast and colour contrast options
- Enhanced contrast
- Split screen view
- Horizontal or vertical masking
- Highlighting or underlining
- Moveable reading table
- Pivotal screens to assist posture
- Foot pedal control options
- Computer connectivity - dual function capability with Windows®

Advantages & Disadvantages

A fixed working space where all controls are together means an easier set up and a more compact system. Moreover, this set up provides a more natural working distance which aids posture during use, as well as the luxury of binocularity which is not an option with high powered optical aids. As a result, prolonged tasks are more comfortable and manageable. An appropriate low reading or intermediate spectacle addition e.g. +1.00D, may be appropriate

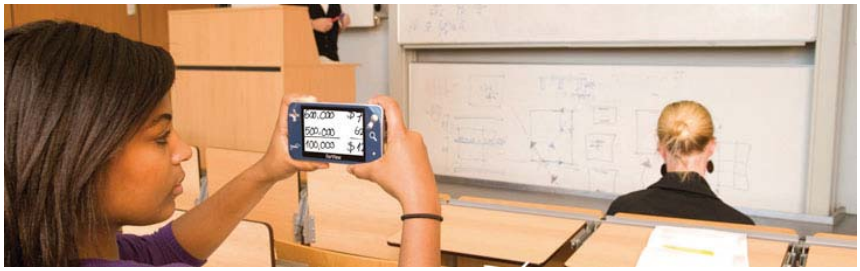

Figure 5a (above): FarView by Optelec: Distance and Near viewing Options. Up to 24x magnification with up to 4 hours continuous use from fully rechargeable battery

Figure 5b(Left). The Traveller from Optelec has autofocus up to 16x. In stand up position is may be used for writing. In the fold-up position the Traveller guides along magazines, newspapers, books and displays the enlarged image on it's 6.4"LCD display.

Figure 5c: (left) Bierley's Explora Plus™ is a portable electronic magnifier measuring 77 x 85 x 25mm and weighing 108g. Magnification is provided up to 9x and there are options such as image freeze, and contrast reversal

Figure 5d (left) The SmartView Versa+™ combines a portable EVES with features of MP3 and video players. Sophisticated memory functions are provided with a SD (Secure Digital) card that can store large file sizes such as music video and images.

for presbyopes if viewing the screen at a working distance of approximately 1m or less. However, the field of view can be restricted depending on screen size, level of magnification used and also from sitting too close to the screen.

Stand mounted EVES also provide additional functions which are not possible with optical low vision aids. For example, there is the ability to change magnification without loss of focus or working distance; it is possible to achieve levels of magnification in excess of 60x, and of particular importance is the ability to enhance or reverse contrast, a feature that is only capable with electronic devices.

Development of Portable Systems

Over recent years more portable video magnifiers have become available, offering good quality images at a lower cost than conventional systems. Designs and functionality vary and include hand held portable units with integral screens, units that are head mounted and those which include the use of an optical mouse connected to a monitor or separate screen. Some require mains supply whereas others have rechargeable battery packs. Almost all combinations are available in one form or another. (Figure 5)

There are many portable electronic aids now available offering electronic vision enhancement with many of the accompanying benefits without the restrains of the space and weight of larger traditional CCTV systems. Portable systems are targeted for flexible, day to day tasks with the flexibility to be used in different locations. For both short tasks such as checking medication to more sustained reading tasks, such as reading the newspaper, such devices provide an inexpensive, functionally excellent, cosmetically acceptable low vision aid

Increasingly, the ability to use multimedia applications in conjunction with the magnifier is becoming an option with some hand-held magnifier systems. The SmartView Versa+™ from Human Ware (Figure5d) combines an electronic magnifier with multimedia features such

as the ability to save and manipulate images, record conversations, listen to music and watch videos. These features really come into their own when the magnifier is used as a tool for studying, office work and leisure activities.

Until fairly recently, portable video magnifiers have been using CCD (charge-coupled device) semiconductor technology to capture digital images in much the same way as our personal digital cameras or camcorders. One of the drivers behind the falling prices in digital cameras, however, has been the introduction of CMOS (complimentary metal-oxide semiconductor) image sensors that were first established within EVES by Bierley.

Using CMOS Technology: Bierley's MonoMouse™

By using CMOS technology, Bierley had simply taken an optical mouse and modified it to be used as a video magnifier for the visually impaired. The result was Bierley's first MonoMouse™ (Figure 6a and 6b). The net result was an affordable device with low power consumption and superior image quality.

CMOS sensors are significantly less expensive to manufacture than CCD sensors. Continued development in this technology has produced sensors which are less susceptible to 'noise' and which have excellent resolution capabilities now comparing favourably with previous high quality CCD semiconductors. Furthermore, CMOS offer more integration (more functions on the chip), lower power dissipation and are therefore more suited to portable devices.

CMOS Advantages:

The MonoMouse™ can automatically calculate the brightness of the material that is being read and make 'instant' adjustments so that the screen image is always in perfect balance. This means that a user can move the MonoMouse™ from a bright white sheet of paper to a piece of regular newspaper and the MonoMouse™ will take care of the image quality automatically.

The MonoMouse™ expands the use of electronic magnification within the home environment. The MonoMouse™ is simply connected via the SCART socket point in the back of a television set and the image captured is displayed on screen (Figure 7). Most televisions in the UK, and throughout Europe, have been equipped with SCART connectors for the last 10 to 15 years and so the MonoMouse™ was designed to take advantage of a special SCART feature called 'auto-detect.' When the patient is watching the television on any channel, it is possible to simply press the large blue on/off button on the MonoMouse™ and the television screen automatically switches to display the text that the viewer wishes to read. Once finished, the on/off button is pressed again and the television automatically reverts back to the channel that was originally being viewed.

One of the most useful aspects of the MonoMouse™ is its portability. Although it does need to be plugged into a mains socket, it still remains highly portable; patients may take it on holiday, or to a relative's when visiting. Compared to optical devices and in similar principal to traditional CCTV systems, patients retain a binocular view at a comfortable viewing distance from the TV screen, eliminating the problems of convergence and the uncomfortable reading posture that is often problematic with high-level optical magnification. With this advantage, sustained reading tasks may be possible, although success will ultimately rest with the patient's acuity reserve, as with all devices.

The simplicity of the optical mouse design makes it popular with young children and adults who have been familiar in handling a standard computer mouse.

Figure 6a (right) MonoMouse™ by Bierley is compact and comes with up to 24x zoom. It is easy to use. Some patients may benefit by additional training with steady eye strategy (SES).

Figure 6b (far right): The CMOS sensor on the underside of the MonoMouse™ with a SCART plug connection.

Figure 7a: The MonoMouse™ fits comfortably into the patient's hand and the simple one-touch blue button is highly visible. The slightly larger than average size of the MonoMouse is easier to use than a standard-sized optical mouse, which makes it attractive to those who find handling an issue.

Figure 7b: MonoMouse™ USB works with any desktop or notebook PC. When the software is activated, a pop-up window is launched and the image captured is within that window. The window can be resized with effective change upon the magnification and may be left running alongside other applications. A visually impaired person undertaking office work would find this flexibility useful.

Head Mounted Systems

This design of EVES may be used for viewing objects at different distances (Figure 8), although is primarily used to view at intermediate and near distances. Units have the advantage of blocking out problematic glare, but their weight does restrict usage for extended periods of time. When using a head mounted system, the magnified image ratio between the movement and the size is out of balance and this can disturb the vestibular ocular reflex causing symptoms of sea-sickness in susceptible patients

Other Developments

Recent devices such as **the iPod™** (Figure 9) and **Kindle™** (Figure 10) can also be used as hand held electronic magnifiers with similar features as hand held EVES devices such as zoom and freeze screen.

Computer Software

A relatively inexpensive option to enhance text on screen is to use specifically designed Text Enlargement software (Figure 12). This software once installed, is capable of enlarging on screen text up to 36x. There are several products on the market with varying degrees of functionality and applications which may include, for example, colour adjustment options, image enhancement and additional voice synthesis.

Patient Selection

With approximately 70 per cent of visually impaired in the UK being over 75 years of age[7], there is a need to produce simple, ergonomic systems which are affordable and attractive to our visually impaired users.

The Department of Health has estimated that the total number of visually impaired is set to rise by 25 per cent in the next 20 years.[8] This will undoubtedly result in a greater demand for services for visually impaired people, which will include the provision of low vision aids.[9] As an increasing number of the elderly population are now regular computer users, it is sensible to assume that the use of electronic devices that have similar functionality and features to a laptop, a computer screen and an optical mouse will soon be favourable to all but a few.

The important thing to consider when offering electronic magnifiers as an option to low vision patients is not the age of the patient, but rather what specifically the patient wants to do with the device. A magnifier based around the design of an optical mouse is fine for reading text or viewing an object in a fixed location but is of limited value, for example, whilst out shopping. Although there are several hand held or portable electronic devices that can be taken shopping (Figure 11) it is important to establish whether or not the patient is comfortable using the device in a public setting. In addition, does the patient have the motivation to persevere with the device which will ultimately be a major factor in determining the success of the device in this environment?

As electronic magnifiers tend to provide variable levels of magnification compared to optical magnifiers, they are useful for varying degrees of visual loss and a great variety of text sizes. Units may also be used for eccentric viewing when using a marker on the screen for the patient to look at and devices with movable XY tables may be employed in training steady eye strategy, where the object is moved rather than the magnifier.

Figure 8 Vuzix SightMate™ is a portable lightweight video magnifier that combines an integrated miniaturised camera and high resolution technology to display near or distant images or text. The 2 mega-pixel camera sensor and 3x optical zoom lens projects onto twin high resolution LCD displays. Battery life is approximately four hours.

[7] RNIB: Estimates and Registration Statistics for the UK 1995
[8] Low vision Services Consensus Group Recommendations for future service delivery in the United Kingdom, 1999
[9] 3 Ryan B, McCloughlan L. Our better vision: what people need from low vision services in the UK London, RNIB,1999

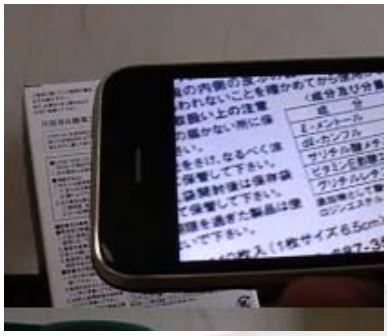

Figure 9: iPhone™ being used as a magnifier with a magnifying application which has been downloaded onto the device. Available with up to 8x magnification

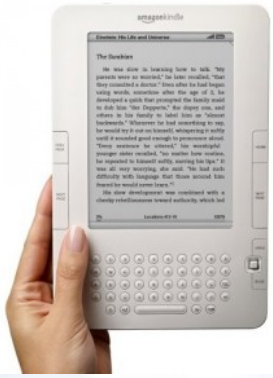

Figure 10: Kindle™ uses high resolution screen with high contrast letters, font size can be increased.. Text to speech options are available with some books

Figure 12: Text Enlargement Software such as ZoomText ™ or iZoom™ enlarge and enhance everything on your computer screen, making all of your applications easy to see and use. Our revolutionary new 'xFont' technology displays crystal clear text at all magnification levels. Once you've seen it, no other screen magnifier will do.

Field of View

With optical magnification, the closer the patient is to the plus lens of the magnifier, the greater will be the field of view, and the greater the number of characters visible. By using a television screen to view the magnified image, the field of view is not influenced by the eye-monitor distance, unless the patient is very close to the monitor, when the reverse becomes true. Both the field of view and the magnification of the system will be largely dependent upon the screen size. Reducing the screen size will therefore result in a smaller field of view and less magnification.

Image Reversal

For most patients the image reversal facility is useful, and for some a necessity. By reversing the contrast from black on white to white on black, there is a reduction in light scatter within the eye which will improve performance in those patients who have media opacities or who are photosensitive.

Reading Speeds

The success of any device given for sustained reading tasks can be determined in part to the patient's reading speed. Devices that comprise of a monitor view, whether a traditional stand mounted EVES or a mouse connected to a monitor such those found in the Bierley MonoMouse™ range have been shown to produce best results. The effectivity of electronic devices and reading speeds have been studied in clinical trials with mouse EVES connected to head mounted display viewing resulting in the lowest reading speeds compared to traditional stand EVES with monitor viewing. At smaller print sizes, reading with a traditional optical magnifier is slower than with the mouse or stand EVES with monitor. Overall, however, although EVES provide objective benefits to the visually impaired in reading speed and acuity, together with some specific near tasks, some can be performed just as fast using optical magnification.[10]

Conclusion

The advancements and improvements in the quality and efficiency of components have widened the use of electronic magnification. All age groups are now regular computer users and as relative costs reduce and portability improves it is predicted that domestic use will become commonplace. In time the elderly will turn to electronic magnification as a principal method of magnification. It is arguably fundamental for low vision practitioners to discuss and preferably demonstrate the advantages of electronic devices alongside the established optical approach to prescribing magnification during the consultation.

Figure 11 Bierley's Shoppa. An ultra lightweight multifunctional device with a large 7inch screen and 4 hours battery life

Taraneh Eliasieh *is a newly qualified optometrist working in the optometry department in Royal United Hospital Bath.* ***Jane Macnaughton*** *is a specialist optometrist at the Leicester Royal Infirmary, Leicester and has a specialist interest in working with the visually impaired.*

[10] Peterson, Wolffsohn, RJ, et al (2003) Benefits of electronic vision enhancement systems (EVES) for the visually impaired. AmJO 136,6: 1129-1135

MULTIPLE-CHOICE QUESTIONS – C14917

Take the test online: Note that the answers to each question will appear in a random order and not in the order listed below.

Successful participants in this online test will receive one General CET point.

1. Which of the following statements about electronic magnification is false?

- **A.** Electronic magnification is aberration free.
- **B.** Electronic magnification is calculated by comparing the size of the image on screen to the size of the original object
- **C.** The degree of magnification achieved by an EVES is independent of the image resolution.
- **D.** Electronic magnification is dependent upon pixel count

2. Electronic magnification is not limited by,

- **A.** Screen size
- **B.** Pixel count
- **C.** The size of the integrated CMOS chip.
- **D.** Eye - screen working distance.

3. Which of the following is not a feature of an EVES?

- **A.** Contrast enhancement
- **B.** Image reversal
- **C.** Digital output to Braille reader
- **D.** Focusing adjustment to incorporate patients prescription

4. Which of the following will limit the patient's field of view whilst using an EVES?

- **A.** A eye-screen working distance
- **B.** The screen size
- **C.** The level of magnification
- **D.** All of the above

5. Which of the following statement regarding CMOS image sensors such as those found in Bierley's MonoMouse is false?

- **A.** CMOS image sensors are less expensive to manufacture that CCD
- **B.** CMOS image sensors offer comparable resolution capabilities to CCD and at a lower cost.
- **C.** CMOS image sensors have a higher power consumption than equivalent CCD
- **D.** CMOS image sensors have excellent resolution capabilities

6. Which of the following statements is false?

- **A.** EVES are available on loan to elderly patients via the Local Health Authority following a needs assessment
- **B.** Funding is available for EVES from the Local Education Authority for children with a Statement or Record of special educational needs.
- **C.** Mouse EVES connected to head mounted displays result in the poorest reading speeds compared to other EVES.
- **D.** The use of a MonoMouse results in a reading speed similar to that using a stand EVES with monitor when viewing small sized print

To take the CET Test online or to find out more about the full range of Bierley electronic magnifiers go to the Bierley website: www.bierley.com.