Low Vision with a Squint

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Abstract

Low Vision accommodation technologies range from visors which use peripheral vision mapping to sensors, to software applications like vOICe, which when used with wearables or handhelds, convert a field of view from images to soundscapes. Similar accommodation paraphernalia, like smart walking sticks and human assistance based services, like Google Lookout.[1] In this paper, the author compares these diverse technologies, proving peripheral vision visors are the most efficient and useful accommodations, and a combination of these technologies is available to an end user. The resulting information is made available through VUI to a low vision patient..

Keywords

Low Vision , visor, peripheral vision, soundscape, vOICe

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1 Introduction

The What:

Comparison of Low Vision Technologies, eSight Visor for peripheral vision mapping, vOICe with smart glass integration for immersive soundscape mapping, compared to Google's assisted accommodation service, Lookout using the definition of an ideal object mirror, described as a complete OOPS based segmentation technology.

The How:

Seamless Segmentation technologies like mapillary can create an object mirror, or an internal representation of segmented objects with labels, identified for conversion to sound or for assisting low vision or vision impaired individuals. While an object mirror is essential other technologies like transformation to sound with or without segmentation and mapping to peripheral vision in low vision individuals are compared, with studies in published literature reviewed.

1.1 Systematic review of wearables as assistive technology for low vision or vision imraired individuals.

Using the Prisma flow chart for SR, we shortlisted 27 publications which include reviews both systematic and meta of assistive wearable for no vision and low vision individuals and publications of the design of the technologies.

Inclusive criteria were purely technology literature and purely review material and exclusion of all studies of assistive technologies.

The review summary used text mining tools with a classification algorithm on the publications.

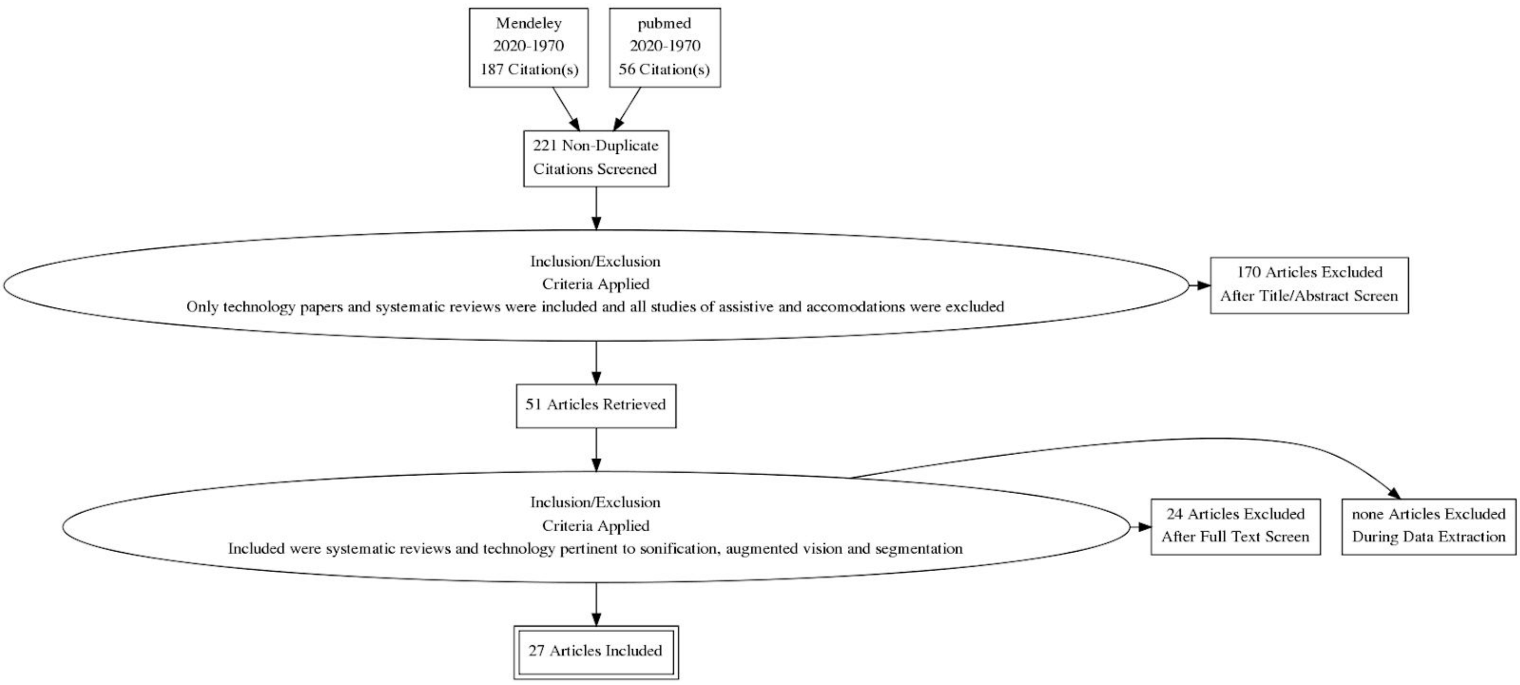
Four Review papers were considered, after a full text screen, ([2]) compares, stand alone CCTV devices with head mount wearables, with inconclusive evidence of the better of the two technologies, with evidence matching external CCTV accommodations.([3]) describes assistive active technologies, apart from other technologies like magnification, but concluded inconclusive evidence on usability in field, but high usability in research studies of accomodative active and passive technologies.([4]) adds other assistive technologies, such as speech to text and text to speech, reading technologies and concludes a lack of conclusive evidence of usefulness of assistive technologies in field and research, requiring future research.

()[5] review smartphone based assistive technology, on a range of @edge algorithms, asymptotically approximating the ideal object mirror in external navigation and several tests including OCR use cases, the review indicates the success of both SLAM and DNN algorithms compared to older algorithms like SIFT, with no commercial systems like Google Lookout evaluated.

Twenty Three papers were considered as assistive technology publications, ([6]) describes the use of optical methods and computer technologies in the development of a number of new visual aids, all of which employ vision multiplexing to naturally restore the interplay of central and peripheral vision using eye movements. ([7])Touch receptors in the skin can convey various forms of abstract information such as words (braille), haptic feedback (cell phones, game controllers, feedback on prosthetic control) and basic visual information such as edges and shapes (sensory substitution devices). Patterns encoded in space and time or "intensity" (the coupled encoding of vibration frequency and force) both far exceed the performance of spatially encoded patterns.([8]) describe stereo camera stereopsis algorithms for sonification, with frequency series approximations to sound synthesia. ([9])examined the perceptual performance of humans, which is made possible by relatively impoverished information in nocturnal nature scenes. We used images of nighttime outdoor scenes rendered with image-enhanced low-light (i2) sensors, thermal infrared (ir) sensors, and an i2 / ir fusion technique with added information. We have found that night imagery provides reasonable, low-level imagery for effective perceptual organization in a classification task, but performance for specimens within a particular object category is image type dependent. Overall performance was best with the miscolored images.

([10]) describes AR4VI systems, overThere and camIO, both navigational assistance, compared to image enhancement technologies, like eSight and oxsight and orcam, as well as several mobile based applications like Brighter and Bigger and Super Vision.

([11]) describes LVA systems using, Generalised Confocal Lenslet Array (GCLA) technology. ([12])A novel concept of vision-multiplexing using augmented-vision head-mounted display systems to address vision loss has been developed. Two applications are discussed in this paper. In the first, minified edge images from a head-mounted video camera are presented on a see-through display providing visual field expansion for those with peripheral vision loss, while still enabling the full resolution of the residual central vision to be maintained. The concept has been applied in daytime and nighttime devices. A series of studies suggested that the system could help with visual search, obstacle avoidance, and nighttime mobility.



2 Problem Definition.

Several technologies exist in literature for assistive devices for low vision and no vision individuals, while sonic radar technologies have been proven effective for no vision individuals, several peripheral vision device technologies exist for low vision individuals with an intact peripheral vision. These devices are more robust and can actually present a visual view to the world in color vision in the mapping of an input stream to peripheral vision.

In this paper we use the concept of an object mirror to quantify and compare the technologies of OOPS and non-OOPS based mapping technologies, illustrated with three commercial technologies, Google Lookout[13,14], vOICe[15] and esight.[13]

2.1 Seamless Segmentation and the object mirror.

Mapillary[16] is an open source image segmentation software that is easily extended to create many object categories, for scene segmentation and object identification in real time form a nonlinear event calculus definition of triggers for image acquisition and segmentation creating a real time object mirror. This object mirror forms the basis for the comparison of sonic mapping and retinal projection technologies, compared with Google Lookout, a manned mobile camera based segmentation and obstacle avoidance system.

2.2 Accomodation for vision impaired.

Google offers the Lookout application for Android, which has scene segmentation and image OCR software for accommodation. It offers various modes, such as Explore, Quick Read Mode, Food Label Mode, Scan Document Mode, Currency Mode.

The technology is based on segmentation and categorizing deep networks, which are amenable to replication in Google Actions using Firebase and in TensorFlow.

GIven the object mirror framework, Google Lookout nearly implements an object mirror in internal representations with natural language information on objects segmented.

2.2 vOICe, sonic translator.

vOICe is used in conjunction with smart glasses such as

Fig 1: Vuzix Blade & The vOICe

Vuzix, the software uses synthetic synthesia to see in sound, with a sound map to images, rendering a synthesia in sound.

2.3 Comparison with eSight.[17]

Retinal projection wearables like eSight,

" The device has been clinically proven to significantly enhance vision for those living with low vision and legal blindness.[6] Its users typically have between 20/60 and 20/800 visual acuity, with some up to 20/1400 acuity, across over 20 different eye conditions, ranging from cataracts to macular degeneration, optic atrophy, and retinal detachment."[18]

Retinal projection wearable technology, project OLED displays with advanced A.I , including image stabilization, auto focus and segmentation, ROI determination, similar to the object mirror, but with a visual sensory mapping, mapping to the intact peripheral vision in low vision patients. This includes most classes of low vision conditions ranging from cataract to macular degeneration.

2.4 Discussion and Future Work.

Google Lookout, eSight and vOICe, are compared within the framework of a complete object mirror, in a theoretical construct if the ideal object mirror is defined as [o] where every object o is segmented with properties o.[p], then Google Lookout is in the framework, with a partial implementation of the object mirror, and eSight, visors have the potential of an object mirror assistance, and the existence of smarter synthesia software for vOICe systems for object segmentation and synthesia in sound. Both eSight and vOICe would evolve in the framework of the ideal object mirror, but in a comparison, retinal projection remains more comfortable as direct vision rather than a synthesia of sound as vision. Given the position of forward stereo vision of humans as compared to peripheral vision rich visual systems in avians and other mammals, the low vision with a squint may adopt humans in the vaster visual systems and allow for a different ability in vision, rather than an artificial synthesia or a google glasses based integration to the lookout, the closest to deep learning based object mirror technology. To conclude the object mirror remains a valuable framework for accommodation in low vision, and future work is simply the evolution of wearables to the ideal object mirror.

References

1. Website. https://play.google.com/store/apps/details?id=com.google.android.apps.accessibility.reveal&hl=en_US&gl=US.
2. Virgili, G. *et al.* Reading aids for adults with low vision. *Cochrane Database of Systematic Reviews* vol. 2018 (2018).
3. Barker, L., Thomas, R., Rubin, G. & Dahlmann-Noor, A. Optical reading aids for children and young people with low vision. *Cochrane Database of Systematic Reviews* (2015) doi:10.1002/14651858.cd010987.pub2.
4. Thomas, R., Barker, L., Rubin, G. & Dahlmann-Noor, A. Assistive technology for children and young people with low vision. *Cochrane Database of Systematic Reviews* (2015) doi:10.1002/14651858.cd011350.pub2.
5. Budrionis, A., Plikynas, D., Daniušis, P. & Indrulionis, A. Smartphone-based computer vision travelling aids for blind

and visually impaired individuals: A systematic review. *Assistive Technology* 1–17 (2020) doi:10.1080/10400435.2020.1743381.

6. Peli, E. Vision multiplexing: An engineering approach to vision rehabilitation device development. *Optom. Vis. Sci.* **78**, (2001).
7. Novich, S. D. & Eagleman, D. M. Using space and time to encode vibrotactile information: toward an estimate of the skin's achievable throughput. *Exp. Brain Res.* **233**, 2777–2788 (2015).
8. Balakrishnan, G., Sainarayanan, G., Nagarajan, R. & Yaacob, S. Stereo image to stereo sound methods for Vision based ETA. *2005 1st International Conference on Computers, Communications, & Signal Processing with Special Track on Biomedical Engineering* (2005) doi:10.1109/ccsp.2005.4977188.
9. Essock, E. A., Sinai, M. J., McCarley, J. S., Krebs, W. K. & DeFord, J. K. Perceptual ability with real-world nighttime scenes: Image-intensified, infrared, and fused-color imagery. *Hum. Factors* **41**, (1999).
10. James M. Coughlan, J. M. AR4VI: AR as an Accessibility Tool for People with Visual Impairments. *International Symposium on Mixed and Augmented Reality : (ISMAR) [proceedings]. IEEE and ACM International Symposium on Mixed and Augmented Reality* **2017**, 288 (2017).
11. Courtial, J. *et al.* Design, manufacture, and evaluation of prototype telescope windows for use in low-vision aids. in (2017). doi:10.1117/12.2272992.
12. Peli, E., Luo, G., Bowers, A. & Rensing, N. Applications of augmented-vision head-mounted systems in vision rehabilitation. *J. Soc. Inf. Disp.* **15**, (2007).
13. eSight - Electronic eyewear for the visually impaired. https://esighteyewear.com/.
14. Lookout by Google. https://play.google.com/store/apps/details?id=com.google.android.apps.accessibility.reveal&hl=en_US&gl=US.
15. The vOICe web app. https://www.seeingwithsound.com/webvoice/webvoice.htm .
16. Bheemaiah, A. K. Mapillary based plant distributions of ethnobotanical afforestation. doi:10.31224/osf.io/8nwfj.
17. eSight - Electronic eyewear for the visually impaired. https://esighteyewear.com/.
18. Contributors to Wikimedia projects. eSight. https://en.wikipedia.org/wiki/ESight (2017).