CARITAS UNIVERSITY AMORJI-NIKE, EMENE, ENUGU STATE

**Caritas Journal of Physical and Life Sciences**

*CJPLS, Volume 1, Issue 1 (2022)*

*Article History*: ***Received:*** *22nd September, 2022* ***Revised:****12th November, 2022* ***Accepted:*** *10th December, 2022.*

# Digital Eye: The Role of Technology in the Life of the Blind and the Visually Impaired

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***Abstract***

*It would have been unthinkable 30 years ago that cell phone would read, print documents and describe things to the blind. Today's technology not only makes life easier for everyone, but it allows the visually impaired to do numerous things such as write documents, browse the internet and send and receive emails. Screen Reading software and special talking and Braille devices allow those with no vision to use computers, cell phones and other electronic devices independently. Similarly, people with low vision can use screen magnification software and devices that will allow them to see letters, pictures and other objects without having to struggle or strain their remaining vision. It is now an established fact that, with proper training and opportunity, the average blind person can do the average job in the average place of business, and do it as well as his sighted neighbor. The skills of independent mobility, communication, and the activities of daily living are known, available, and acquirable. When an individual becomes blind, he faces two major problems: First, he must learn the skills and techniques which will enable him to carry on as a normal, productive citizen; and second, he must become aware of and learn to cope with public attitudes and misconceptions about blindness. These attitudes and misconceptions go to the very roots of our culture and permeate every aspect of social behavior and thinking. The first of these problems is far easier to solve and that is the focus of this paper.*

**Keyword**: *Bionic eye, Braille, Cortex, Echo-location, Occipital lobe, Ophthalmology*

## Introduction

Assistive technology has certainly opened a lot of doors and removed countless barriers for the visually challenged. In sighted people, visual information first goes to the visual **cortex**, which is located in the **occipital lobe** at the back of the brain. From there, it goes to the **parietal lobe**, sometimes referred to as the *where system,* because it generates awareness of a sensed object's location. Next, the information is routed to the **temporal lobe**, also known as the *what system* because it identifies the object. Evidence from brain-imaging experiments indicates that blind people's brains harness this same neural circuitry. When blind people read Braille using touch, the sensory data is being sent to and processed in the visual cortex, according to Morton Heller, a psychologist at Eastern Illinois University. Using touch, they get a spatial sense of the relative locations of the raised dots that form Braille letters.

For blind people who are adept at echolocation, sound information routes through the visual cortex as well. Their brains use echoes to generate spatial maps, which are sometimes so detailed that they enable mountain biking, playing basketball and safely exploring new environments. Clearly, detecting visual contrasts is only one method of many for perceiving reality. But when trying to imagine a world perceived using hearing or touch, one tends to automatically picture echoes and textures generating a visual image built out of contrasts between light and dark. The blind cannot conceive of light and dark.

Apart from routine tasks at work and school, assistive technology enables people with visual impairments to be more independent at home. They can now read the mail, listen to audio books, get step-by-step walking directions to unfamiliar places, record important information and so much more with special standalone devices designed for people with no or low vision. There are also devices like talking watches, thermometers, scales, blood glucose and blood pressure monitors that help them live independent and healthy lives. People with low vision can also benefit from devices that magnify or enlarge objects. This equipment can help them take notes, read small print on electronic devices and watch TV. In other words, simple tasks that might have previously required the assistance of a sighted person can easily be done completely independently by people with some or no vision, thanks to modern technology.

**Special software for the Blind**

*KNFB Reader*

KNFB is a result of four decades relationship between the American National Federation of the blind and Ray Kurzweil, a well-known artificial intelligence scientist and senior Google employee. This application allows blind people to listen to an audio read-back of printed text. This special application can take a picture of a print letter and allow the cell phone to read it out loud within a matter of seconds.

*Read2Go*

Read2Go is an e-book reader application. With Read2go, books can be downloaded in a matter of minutes or seconds onto an iPad and be listened to instantly. It lets the blind and poor sighted customize reading experience in many ways:

- Listen to words read aloud
- See and hear words as they are highlighted
- Connect and read with a Braille
- Enlarge font sizes
- Adjust colors and reading speeds

*TapTapSee*

TapTapSee is a mobile camera application designed specifically for the blind and visually impaired iOS users. The app utilizes the iDevice camera and VoiceOver functions to photograph objects and identify them out loud for the user. With TapTapSee, it is now possible for the iPhone, to describe the color, shape and size of objects to someone who is blind.

*Intellitalk*

This is a talking word processing program that allows user to hear the letter, word, sentence or phrase as it is entered into the computer. The Pull down menus also has speech output. User can choose background and font colors.

*JAWS* (Job Access With Speech)

JAWS for Windows offers such features as Smart Screen Technology; helpful Wizards; a bitmap recognizer; logical, easy-to-use speech pad; various Braille displays support. Smart Screen is the hands-off screen reading technology that allows Jaws-For-Windows (JFW) to speak any program automatically. It intelligently looks at the screen and determines what to speak so unfamiliar applications can be used immediately. Menus, dialog boxes and HELP files are spoken without the need for user setup. JFW announces each time a new window is opened or closed, and whenever it gets the focus. JFW uses two cursors. The PC cursor tells you where you are typing on the screen, menu item selected, etc. The JFW cursor acts like the Mouse cursor. It roams around the screen like a person's eyes, going and seeing where the PC cursor cannot go or see.

*Be My Eyes*

Other applications, such as "Be My Eyes", can connect blind or visually impaired individuals with a sighted person, who will then assist him by describing things. Thus, the sighted person can be a virtual pair of eyes for the blind individual.

*TalkBack*

TalkBack is an application that is part of Google's Android Accessibility Service, designed to help blind and visually impaired users with using their mobile devices. It will greatly help blind people hear what they are trying to do with their mobile phone as the app will tell them the item that they have just selected or picked. It can also read texts aloud and every movement the user makes on his phone is carefully being monitored and spoken by the app.

**Screen magnification software for the Visually Impaired**

**ZoomText:** This is a family of products which magnifies text and graphics programs. It is capable of magnifying the full screen, a portion of the screen or a single line at a time; all up to 2x to 16x. Simple pop-up menus give user instant access to all of ZoomText's features.

**InLARGE***tm*: This screen magnification software package is for Macintosh users. The program features the ability to enlarge any portion of the screen from 2x to 16x, automatic scanning, a crosshairs option for easy cursor location, the ability to invert the screen to white on black, horizontal and vertical image stretching, and a control panel interface.

**Lunar:** Lunar is the world's leading screen magnification program for visually impaired computer users. It has a number of advanced features to help you manage the enlarged screen more efficiently. Magnification is from 2x to 32x, with five different viewing modes. Hooked areas enable you to keep a particular area of the screen permanently displayed. This allows you to keep an eye on important on-screen information, such as the page number in a word processor, or the current cell coordinates in a spreadsheet.

## Braille software

**Braille2000**

This is a Braille editing tool that handles all kinds of direct entry Braille tasks with automated page layouts to aid the production of literary, textbook, and music Braille. It is fully Internet-aware, making it simple to send a Braille document to a fellow blind student.

**Braille Embossers**

This is simply a printer whose output is Braille instead of print. It can be used with any computer using a Braille translation software program.

**Braille Displays**

Braille readers can use Braille Terminals to navigate through Windows and UNIX. These Braille terminals can be used with a desktop PC or a laptop. They utilize what is called refreshable Braille cells to allow the computer screen to be read line by line in Braille.

**Scanned Material Access**

**Open Book**

Open Book uses a scanner to take a picture of the page, which it sends to the PC, translates the picture into understandable text, and then speaks the text aloud or outputs to Braille. You can scan and read a page in less than a minute in English or in more than a dozen other languages.

**Kurzweil 1000**

This is another product by Ray Kurzweil, the artificial intelligence scientist. It works on the personal computer and a scanner to convert the printed word into speech. It has the ability to find key words or phrases within a document, and to edit scanned text, magnify scanned documents to accommodate users with visual impairments, and the ability to specify unlimited bookmarks within a document.

**Other Technological Revolutions**

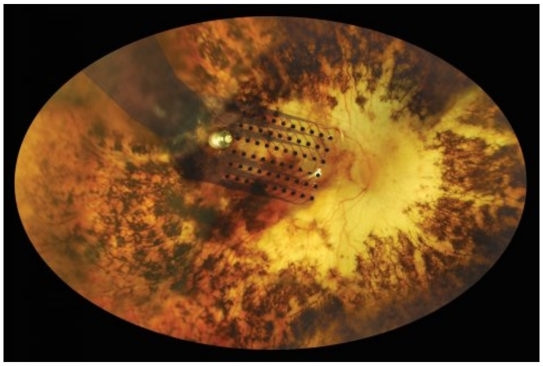
Technological revolutions and advancements in artificial intelligence have become a beacon of hope for people with vision loss. IBM, Microsoft, and Baidu are the pioneers in Smart glasses and better computer-vision to serve as digital eyes for the visually impaired people. With digitized Braille systems and text-to-speech software that reads the words on a webpage aloud, the blind can now access the internet and do researches the way people with sight do. Even Facebook has now started translating images into read-aloud text.

The blind may benefit most from the tech world's obsession with self-driven cars, not only in being able to use them to get around, but because the embedded artificial intelligence that helps cars see and navigate streets is now being customized as assistive technologies for the blind.

Scientists are finally beginning to innovate on the cane which is widely used as assistive tool for the visually impaired people to navigate around. Researchers in the U.K. have developed a prototype *smart cane* with a camera, facial recognition software, and GPS that can reportedly detect objects, like faces, from 30 feet away.

Microsoft has joined the effort to improve accessibility for the blind. It is currently hosting a pilot project in London that will use Bluetooth and Wi-Fi signals to create maps of the environment. Such a map can tell users about nearby features of interest, including restaurants, stores, update on public transportation, and warn them when on the main road or straying far off to the curb. Communication is through a headphone that uses vibrations of the bones inside the skull to convey sound.

**The Bionic Eye**



For people with the incurable genetic eye disorder retinitis pigmentosa, the world can be a dark place.

Genetic mutations cause their photoreceptors, the cells in the retina at the back of the eye that convert light into an electrical signal the brain can interpret, to stop working and die. Without functioning photoreceptors, people with retinitis pigmentosa go blind.

But with the help of a retinal implant, or "bionic eye" called **Argus II**, some patients with the rare disorder are regaining their sight.

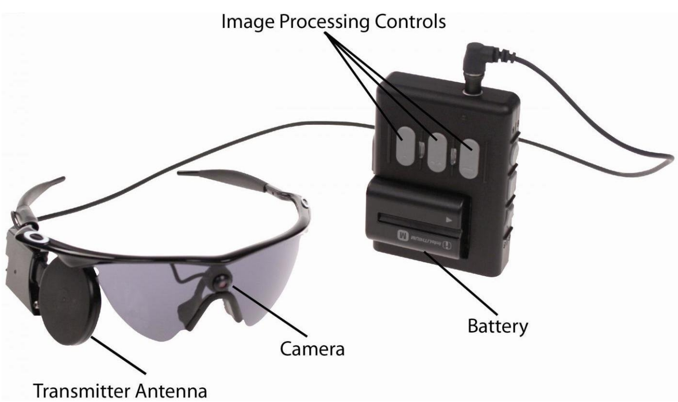
A clinical trial of the device has been ongoing in 10 vision centers across the United States and in Europe. Researchers from those centers published results from the first three years of the trial in *Ophthalmology*, the journal of the American Academy of Ophthalmology.

Before the Argus II, at best patients could detect only bright light. With the device implanted and turned on, some patients did significantly better on vision tests, like touching a white square on a black monitor and finding a door in real life.

Beyond lab tests, visual rehabilitation experts evaluated the effects of the Argus II in the daily lives of patients. For 65% of the study participants, the device positively impacted their lives, improving their quality of life and their ability to perform basic tasks.

**How it works**

The *Argus II* system has two separate components: a **camera** and **visual processing unit** a patient wears (see below), and the surgically implanted receiving antenna and electrodes.

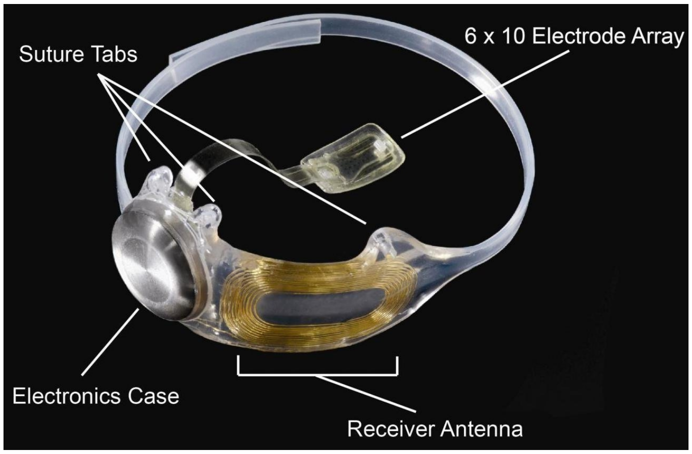



*Courtesy of Second Sight Medical Products, Inc.*

Visual information from the camera mounted in the glasses is converted into an electrical signal the brain can interpret.

The camera and visual processing unit do what the photoreceptors in people with retinitis pigmentosa no longer can do: convert visual information from light into electrical signals the brain can understand.

An antenna on the glasses transmits the data from the camera and visual processing unit to a receiving antenna implanted into the patient (see below).




*Courtesy of Second Sight Medical Products, Inc.*

An electrode array stimulates the retina according to the signal received from the camera and visual processing unit outside the body.

The data received goes to an array of 60 electrodes implanted over the **macula**, the part of the retina that is normally the most sensitive.

The electrodes produce small pulses of electricity that stimulate the nerve cells still left in the retina, which then carry information about the stimulation to the part of the brain that interprets this into vision.

It takes therapy and practice for patients who have been blind for decades to *relearn how to see* from the implanted electrode's stimulation. Besides needing a refresher on how to interpret visual information at all, patients have to adapt to the new kind of information the *Argus II* electrode provides.

The *Argus II* isn't able to restore completely normal, sharp vision, but the functionality it does give back to people who previously could only perceive bright light is quite substantial.

In the clinical trial, 89% of patients performed significantly better on a test that required touching a white square on a black screen using the retinal implant system, compared to when they tried the test with the implant turned off.

Patients were also better at an important practical task with their implants turned on, successfully identifying a door 54% of the time on average, compared to only 19% of the time without implants on.

**So, what's next?**

The blind struggles to navigate and find specific items, even in the home. Stepping into an unfamiliar environment can elevate such difficulties from somewhat challenging to incredibly stressful. Scientists are working on all fronts to improve existing products and manufacture new ones that will make the life of the blind and poorly sighted more tolerable.

Gerard Medioni, professor of computer science at the USC, wants to make it easier for the visually impaired people to get around. He and biomedical engineering Professor James Weiland, created a pair of glasses and a vest that help the visually impaired navigate his surroundings. With the glasses-vest combination the glasses observe the environment and the vest gives directions, much like a *seeing-eye* dog sees and leads.

Using two cameras, the glasses create a 3-D image of the surrounding environment. Though the blind person cannot see this image, the computer can; using it to analyze the setting.

With this image, the computer can distinguish between obstacles and open space. Using this information, the computer sends signals to a vest through four sensors; much like the brain sends messages to the body. Getting close to an object triggers a warning buzz. If a person is too close to an obstacle on his left side, the lower left sensor would buzz, telling the person to move away from that object. No sound means all clear.

But in real-life scenarios, obstacles are not always stationary. So Medioni and his team advanced their technology to differentiate between threatening obstacles/buildings, branches or benches and nonthreatening obstacles, such as people. Their advanced technology was tested on a life football field with a game on and spectators milling around. The glasses and vest successfully led a team member to a destination without the vest buzzing incessantly.

Medioni and his team did not stop there. They recognized that lack of vision makes it impossible to understand nonverbal communication, such as hand gestures or facial expressions. The team wants to change that. This would allow a blind person to fully understand the situation, such as a meeting taking place at work. With facial recognition technology, the blind people would be able to tell who is being addressed based on where someone is looking or how serious or lighthearted the speaker is, based on facial expressions. The project is still in its early stages.

**Social Isolation**

Suppose you're at a fast-food joint and a guy walks in with dark sunglasses and a walking cane. He goes up to the counter, looks at the menu, and orders from it with seemingly no problem. At that point you are thinking:

- He is just pretending to read the menu, or
- He is some kind of a scam.

That's because the average person thinks you're either blind or you're not. The reality is a lot more complicated. Blindness comes in a huge variety of shades. *Legally blind*, for example, does not mean your eyes don't work; it just means they're one-tenth as powerful as they should be, which effectively means that you cannot see below the big E on an eye-doctor's chart. So, even a number of legally blind people can read books, provided they use a computer screen or anything with large enough fonts. Not all blind people can see the same way. That's because there are several conditions that can cause blindness in different ways. This disparity between what blindness *is* and what everyone *thinks* is a source of discomfort.

In Italy, for example, harassment of the blind has become a national pastime. Because of their economic problems, Italians have taken to spying on neighbors who are receiving government blindness benefits. The aim is to *catch* them doing things that sighted people believe blind people shouldn't be able to do, like walking across a street without getting hit by a vehicle. These perceived *fakers* are reported to the police and have their benefits taken away until they can prove in court that they're not faking.

Therefore, part of the problem is the lack of understanding and the misconceptions which exist. Despite the fact that many achievements are being recorded by the blind and that a good deal of constructive publicity is being given to these achievements, the word *blind* still carries with it connotations of inferiority and helplessness.

Now, how does a blind person tell a ₦100 bill from a ₦200? Blind people are amazing. They generally fold their bills differently depending on their values, or store them in different folds of their wallets. Of course, for blind people, paper money is hard to use. But now, there are apps that help identify bills using a smartphone camera. Industrialized nations now incorporate raised or embossed numbers on a variety of bill sizes. This would help keep the blind from accidentally handing ₦1000 to an unscrupulous store attendant for a ₦200 merchandise. While Braille is an excellent language code that gives many blind individuals independence and the ability to read printed words, for the blind, Braille printers are extremely expensive. For the cost of a Braille printer, you could pay your rent and have enough left over for a laptop and a sound system. The price of Braille needs to come down.

The social isolation in the society has to be dealt with. It is easy for the sighted person to walk over to his next-door neighbor for a visit; the blind cannot. In the workplace, a sighted person can see that someone is busy and decide not to interrupt. The blind cannot. So, as a result, the blind just stays in his office. It is up to us sighted people to come by and say, 'how are you doing?' Most of us would not because we feel embarrassed. At lunchtime, no one asks or takes the blind to lunch because that takes a little bit of effort. There is a big mental health component to the problem of blindness. For example, less than half of all blind people actually attempt to leave their homes each day. The reason being that, once they take a couple of nasty falls, they lose a lot of confidence. This leads to agoraphobia and depression. Hopefully, the vision enhancer glasses can help reverse this trend.

Much of the problem has less to do with actually being blind and more to do with how the blind are treated by other people. That may explain why it took so long for the tech world to direct attention to assistive technology for the blind and vision impaired. If society wasn't so weird about it, you'd find that most sightless people could get around just fine. Think about it this way: As a species, we all managed to overcome our lack of hair, low physical strength, and slow speed by inventing clothes, robots and toupee. In other words, we *adapt*. It's the one single reason we're at the top of the food chain. The blind are no different, and they can get around just as well as you, with the right tools; if only everyone would stop being finicky about it.

**Summary**

The advent of the microchip has been a boon for people with vision loss. Information encoded as magnetic signal in a computer can be decoded into speech through a speech synthesizer, Braille, or enlarged print visible on the computer monitor. The result has been a virtual explosion of opportunity for independent reading and writing by people who cannot use print. No longer do they have to depend on someone else's eyes to translate printed information. This technology revolution has forced corporations to rethink the notions of physical limitations on job performance in information processing. Technology has removed many barriers to education and employment for visually impaired individuals. Students with visual impairments can now complete homework, do research, take tests, and read books along with their sighted classmates, thanks to advances in technology. Adults with visual impairments can continue to work and pursue a tremendous range of careers because of the use of computers and other devices.

There is a lot of work and research being done to find ways to improve life for partially sighted and blind people. Reading and recognition devices could make smartphone, tablets, and smart glasses into indispensable aids for the visually impaired. Assistive technology programs that run on off-the-shelf computers can speak the text on the screen or magnify the text in a word processor, web browser, email program or other applications. Stand-alone products designed specifically for people who are blind or visually impaired, including personal digital assistants (PDAs) and electronic book players provide portable access to books, phone numbers, appointment calendars, and more. Optical character recognition systems scan printed material and speak the text. Braille embossers turn text files into hardcopy Braille.

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