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Writing 340 / Professor Warford

# Smart Glasses: Seeing the World in New Ways

*Smart glasses are a recent innovative technology integrating data and information into a pair of lenses that people can use in daily life. Engineers are developing smart glasses for a variety of practical applications including the commercial, consumer, and medical industries. The new technology is now finding its way into the general public.*

## The New Hands-Free

Imagine you wake up one sunny morning. Instead of reaching over for your glasses to check your mobile phone, what if you could slip on a pair of glasses that not only corrected your physical sight but connected you to the digital world? Smart glasses, a new group of technological wearables, are trendy aesthetic devices that are bringing individuals revolutionary ways to connect and interact with the world. Slip these spectacles on and you are instantly immersed into a virtual backdrop of data and applications, allowing you to access features such as the weather, traffic conditions, and news reports. Whereas smart phones placed digital information in our hands, smart glasses allow us to access a hands-free digital world directly through our senses.

## A Brief History of Smart Glasses

Today's digital smart glasses began as complex, primitive devices. They are a type of optical head-mounted display (OHMD), or a wearable head device that projects images to the user using display optics. In 1966, American scientist Ivan Sutherland tethered a helmet device with two cathode ray tubes, one attached beside each ear, that used silver mirrors to reflect images to the wearer [1]. A second system that determined visual direction and projected images was attached to the helmet, resulting in the first bulky OHMD known as the "Sword of Damocles" as shown in Fig. 1 [1]. While physical improvements were made to Sutherland's OHMD such as lightweight liquid crystal displays (LCDs), Canadian researcher Steven Mann developed the first head-mounted wireless webcam in 1994 that could transmit images to the Web using television frequencies [1]. The eventual integration between Sutherland's prototype and Mann's discovery of head-mounted transmission made the idea of smart glasses a possibility. Since then, companies such as Google, Microsoft, Canon, Epson, and Vuzix are now developing OHMDs with wireless capabilities that can transmit data around the world.

Figure 1: Ivan Sutherland's optical head-mounted display, the "Sword of Damocles" [6].

## The Device Features

Smart glasses are the latest, compact design of see-through OHMDs. See-through OHMDs are created using semi-transparent mirrors for the lenses that display images and information into the user's visual field. Like any pair of eyeglasses, smart glasses can have circular or rectangular lenses and some can even accommodate users with prescription glasses.The photo and video features of smart glasses allow users to use a mounted or embedded video camera to capture and record data from the surroundings [7]. The prism is a rectangular block of glass that acts as a transparent interface between the user and digital display. Motion sensors allow for head-tracking and a 360 degree peripheral view. Many smart glasses are voice-controlled using the frame's mic and speakers, much like a bluetooth wireless system. The device houses a miniature computer, complete with a central processing unit (CPU), global positioning system (GPS) sensors, and battery [12]. As seen in Fig. 2, frames are paired with media functionalities forming a compact headset complete with Internet connection for data storage and retrieval. Most smart glasses are lighter than sunglasses, yet they feature the same wireless capabilities as smart phones, revealing how a hands-free optical device with digital functionality is making the computer a more personal device.

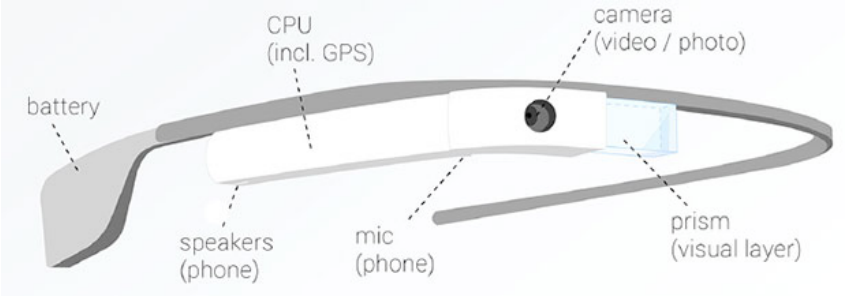


Figure 2: Basic frame components of smart glasses [12].

## How It Works

Smart glasses operate using voice recognition to access the device's features. The user is able to communicate with the glasses using voice commands to access the Internet or social media functions. An attached camera helps to identify and capture images while the user is viewing his or her surroundings. The information is then streamed to the user's lenses where the data can be registered and manipulated. The device's CPU and GPS functionalities retrieve relevant information and locations from the Internet and local satellites related to what the user is viewing [12]. Smart glasses utilize augmented reality (AR) to create a 3D user interface, a technology that enhances the real world with virtual environments filled with text and images processed by the CPU as shown in Fig. 3 [7]. AR is implemented in the lens using a combination of multiple layers including reflective shades and a transparent display depicted in Fig. 4. Using an OHMD such as smart glasses, the user can view the real world and overlay 3D graphics onto the lenses at the same time. Smart glasses work by projecting images from the CPU through a

prism which reflects the images to the eyes [12]. This interaction requires a high degree of correlation between the camera's object detection and human vision. Smart glasses must be able to adjust for different degrees of object illumination, field depth, and optical resolutions. The projected images then enter through the pupil and trigger the fovea, or the depression of the retina where visual acuity is sharpest, which is highlighted in Fig. 5 [10]. The light hitting the fovea triggers a signal cascade down the optic nerve where the brain eventually registers the sensory information as vision.


Figure 3: Smart glasses provide visual intuition through situational awareness and augmented reality (AR) technology [8].

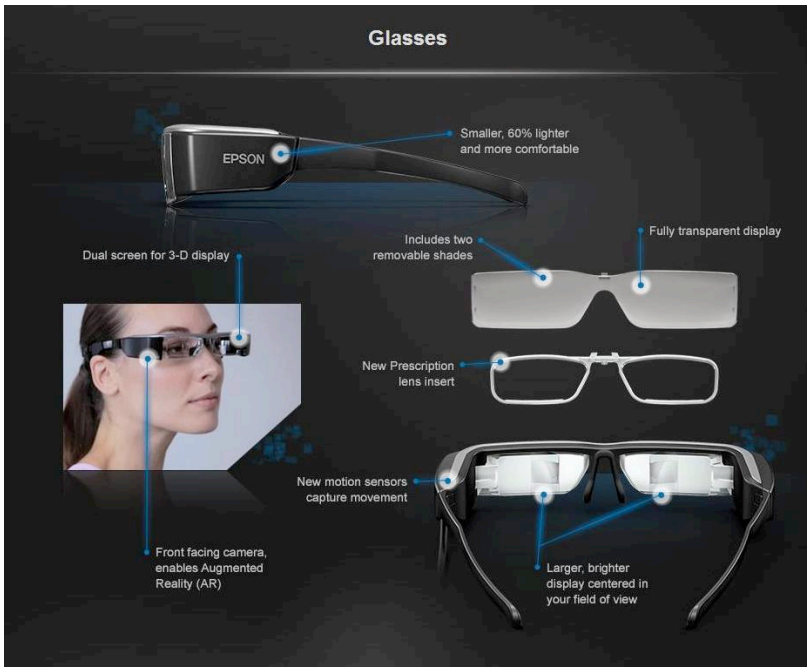


Figure 4: Detail of sensors and lens layers contributing to augmented reality (AR) [2].

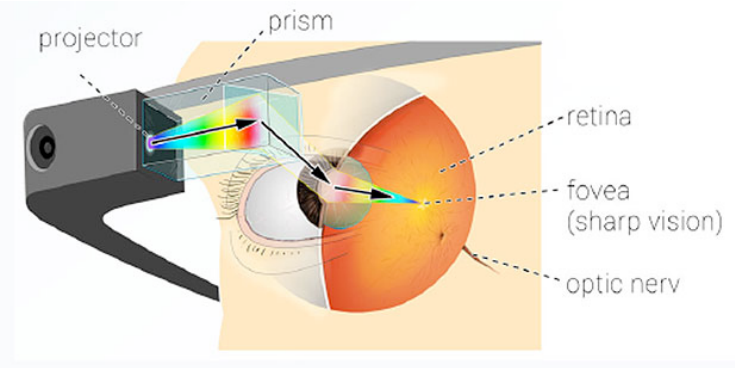


Figure 5: How smart glasses transfer digital information to our sight [12].

Consumer Interest

You may be asking: Is there really any consumer interest in smart glasses? To decide, it is important to evaluate the overall market of smart wearable devices. Juniper Research performed a market study on smart wearable devices and concluded that almost 70 million units would be sold by 2017 [3]. This market not only consists of smart glasses but also includes health, fitness, and enterprise digital wearables [3]. As wearable devices become more acceptable in public, analysts are optimistic that consumer adoption will increase as the technology becomes more affordable.

According to market research firm IHS iSuppli, an estimated 10 million smart glasses are expected to ship worldwide to consumers between 2012 and 2016 as shown in Fig. 5 [4]. Speculations suggest there will be a 250% sales increase in 2014 as companies such as Google and Vuzix roll out their first products [4]. Sales are estimated to be slow the first year but expected to increase by 2017 as retail price declines and more consumers have access to smart glasses, much like the introduction of smart phones. Juniper's market study also revealed that North America and Europe will represent over 60 percent of smart wearable consumer sales [3]. The development of an application system similar to the one on smart phones is expected to increase interest in smart glasses. Juniper senior analyst Nitin Bhas acknowledged that the integration of an application system with smart glasses is likely to stimulate consumer interest "by combining mobility with an efficient method of software delivery" [3].

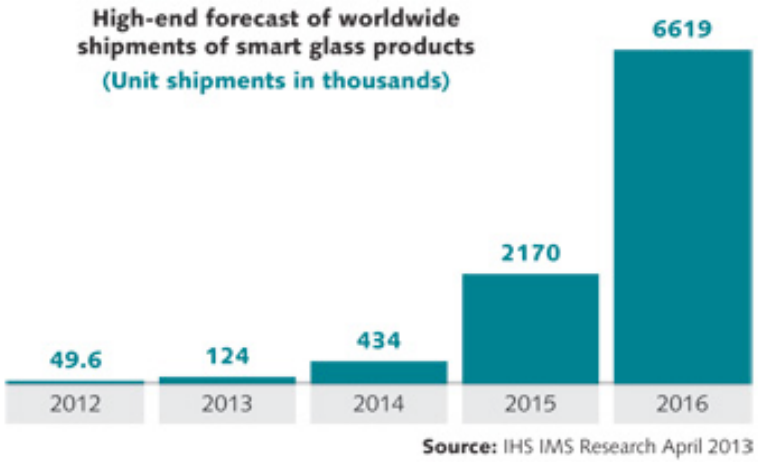


Figure 6: Predicted consumer demands for smart glasses [4].

A Diversity of Applications

Smart glasses complement natural vision in many different technical fields and commercial industries as shown in Fig. 6. These industries include engineering, healthcare, military, sports, and entertainment. Engineers use smart glasses to visualize complex schematics and manufacture circuits and machinery [7]. In healthcare, smart glasses are used to aid clinicians in surgeries, analyze radiographic data such as computerized axial tomography (CAT) and magnetic resonance imaging (MRI), and help people with disabilities such as blindness and hand-eye coordination [7]. For example, scientists at Oxford University are creating smart eyewear, shown in Fig. 7, that will warn blind people of surrounding objects [9]. The eyewear works by using cameras to distinguish object outlines and translating them into light-emitting diodes (LEDs) on the lenses via a pocket computer [9]. An earpiece provides the blind person with audible time and directions [9]. The spatial perception is made possible due to most blind people retaining some residual vision that can detect shapes and light contrast [9].

The military has developed helmet-mounted goggles that display tactical aviation and ground information to pilots and soldiers. Common features include GPS mapping and thermal imaging that help distinguish geographic landforms and body heat. In the sports industry, specially designed goggles for skiing, biking, and racing use GPS features and LCDs that provide athletes with information such as time, speed, and altitude [11]. Perhaps the best known industry associated with smart glasses is entertainment. The technology is used in conjunction with 3D games and social networking. Stereoscopic displays, 360 degree head-tracking sensors, and wireless communication immerse users in the imagery and sounds of movies and games.

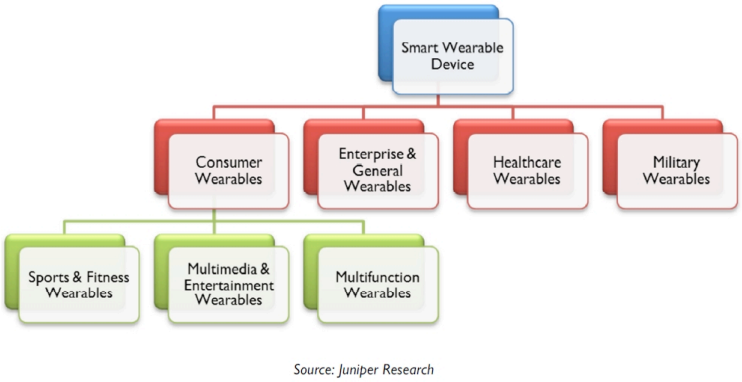


Figure 7: Diverse consumer industries for smart glasses [3].

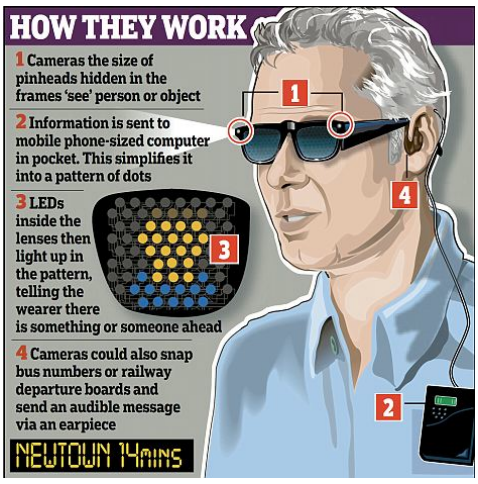


Figure 8: Smart glasses using light-emitting diodes (LEDs) for blind people [9].

## Societal Implications

While technology has its strengths and benefits, mobile hands-free devices have associated risks and problems when not used properly. Smart glasses allow users to access real-time data whenever and wherever they need it. As a hands-free device, wearers are able to engage in simultaneous processes while interacting with the world to access, record, and respond to data. Although smart glasses demonstrate a quick, efficient means of receiving and transmitting information between the individual and the world, there can be severe drawbacks for a technology integrated closely with the human senses. A particular problem that smart glasses are attracting is the issue of individual privacy infringement. Manufacturers of smart glasses may monitor the behavior and activities of users to gather feedback and statistics on their devices' applications and features [5]. Although smart glasses allow users to process and respond to real-time data from their surroundings, people in the user's visual field are at risk of being recorded and researched in public without consent. In response, smart glass developers are creating features that will make users and people in the vicinity of the glasses aware when data is being recorded [5]. Smart glasses will also be restricted in public businesses such as movie theaters and casinos where recording and manipulation of data is prohibited [5].

As with other mobile hands-free devices, smart glasses risk endangering people's lives in society. Because the device is in the user's physical line of sight, the user is more prone to preoccupation with the lenses and decreased focus and attention to his or her surroundings. The discreet, compact design of the glasses can be worn virtually anywhere and simultaneous processing of multiple information sources can cause individuals to become distracted in family, work, and public settings. When using smart glasses, users need to be careful when acting in dangerous situations such as driving and working with machinery, as technology is not a substitute for natural human senses [5]. The law may soon extend restrictions to smart glasses in certain situations and work environments that require greater attention to detail. Although smart glasses provide convenient features and tools for analyses, users must exercise self-control and responsibility like any other mobile digital device.

## Conclusion

Smart glasses are much more than an aesthetic pair of lenses. They are a technological testament to how engineering is bridging the individual's experiences to the world. The Internet connected people around the globe through information exchange, the smart phone became the mobile computational device for accessing that data, and now smart glasses are integrating our real world surroundings with the virtual data. Technology is continually bringing the individual closer to digital information and ultimately the world.

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