

Eyegaze System Primer

(note that this document will be upgraded as more information becomes available)

Getting a proper eyegaze system depends largely on your use pattern. If you just want to speak audibly, pretty much anything can handle that for you. If you are a power user like me who has a lot of programs open, many web browser tabs, and uses programs which require a lot of CPU power, your acceptable options dwindle quickly. I ended up choosing an older system because it was built on top of a rather powerful computer packed inside a tablet format. I required such power because I would be running a lot of the same applications which I used in my Information Technology career. So your decision should be based on the power of the computer upon which the eyegaze system is built.

Let me discuss options below.

Tobii I-15:

Tobii is the most popular system in the AAC market, but that's due to their predatory M&A activities (consuming their largest competitors) and their large marketing budget. Their Communicator software has very many options for typing text or using symbols depending on the needs of the individual user (ie, severe dyslexia and/or cerebral palsy would make letters difficult so images such as an apple, drinking glass, or bed might be easier although more limiting). The I-15 comes with the infrared camera device and Communicator software and has a 15" screen in 4:3 (old television) square format rather than the more usual 16:9 (widescreen) format in use today on televisions and computers. It boasts an Intel quad-core CPU but it's a Celeron with half the onboard cache and several advanced features of modern CPUs disabled. This means significantly reduced performance compared to its more expensive I7 counterpart, although it does have lower power consumption and thus longer operation time when running on battery. The I-15 also has only 4GB RAM with no way to increase that post-purchase. This is a serious limitation, especially when using a 64-bit OS like Windows 10 (which is what's loaded on the I-15). 64-bit operating systems were created specifically to be able to address more RAM, something required in today's modern usage patterns.

Pro:

- Loaded with everything necessary to begin communicating right out of the box.
- Large screen.
- All the ports one would expect in a modern laptop such as USB 2.0/3.0, 100/1000mbps wired network, WiFi b/g/n, Bluetooth, etc.
- Two cameras - outward-facing 5.0MP, user-facing 2.0MP
- Solid-State Drive (SSD - the "hard disk": SSD is much faster than the more familiar spinning disk Hard Disk Drive (HDD)).

Con:

- 4:3 ratio screen dimensions.
- Celeron CPU.
- 4GB RAM maximum.
- Small 256GB SSD.

Links:

- <http://www.tobiidynavox.com/en-US/devices/eye-gaze-devices/i-15/#specifications>
- <http://www.tobiidynavox.com/en-US/software/windows-software/communicator-5/>
- <http://en.wikipedia.org/wiki/Celeron>

LC Technologies Eyegaze Edge

LC Technologies is a somewhat minor player in the AAC market. They have technology that is very accurate but they use software called The Grid2 by Smartbox (formerly Sensory Software) which is nice but can be confusing to get to a functional level of understanding. "Grid" means an array of different ways to communicate called "grids". Some grids use symbols and words that allow the user to say words or short phrases while others have keyboard layouts with varying numbers of word prediction slots. Some grids are for environment/entertainment control. You can also just click the "Computer Control" icon and use the OS directly with a small QWERTY keyboard with rudimentary word prediction that types directly into whichever app window is in focus.

The newer Grid 3 is a real improvement but its default word-prediction is also small. It does have a nice feature using technology by Cereproc (the company which made the custom artificial voice for Steve Gleason using his actual voice) where you record words with your own voice and it generates a new artificial voice for you using your real voice. One can either use the environment included in the application or click the "Computer Control" icon to directly use the OS. A menu with mouse operation options (right/left click, drag, and a keyboard option) will appear on the right edge of the screen. The right/left click options are difficult to use, requiring a strange zoom operation to operate.

Pro:

- Accurate eye tracking.
- Large screen.
- Moderate price.
- Customizable.
- Grid 3 software allows generation of your own artificial voice.

Con:

- Can be confusing to get started.
- Sunlight or incandescent lighting can interfere with the infrared camera operation.
- Eyegaze Edge Link second computer operation is better achieved by third-party software.

Links:

- <http://www.eyegaze.com/eye-tracking-assistive-technology-device/>
- <http://thinksmartbox.com/product/the-grid-2/>
- <http://thinksmartbox.com/product/grid-3/>

Forbes Rehab Services (FRS) Comlink LT Enable Eyes

The Comlink is a good system based on an excellent computer. The underlying hardware is the Tablet Kiosk Sahara Slate PC (at time of writing the model i575), a great full PC in a tablet form factor. It boasts an i7 64-bit CPU (not a Celeron, Atom, or AMD equivalent) running at 1.7-2.8GHz

(base-max). This gives great performance while still being easy on battery consumption. The Comlink comes with 4GB RAM but is easily expandable to 16GB. System performance can be further enhanced by swapping the HDD with an SSD. The system comes with a good offering of the usual I/O ports one would expect from a laptop computer: USB 2.0 & 3.0, HDMI for external monitors, WiFi a/b/g/n, Bluetooth, wired gigabit LAN, etc. An optional docking cradle provides 4 more USB 2.0 and VGA ports (note that the side wings of the cradle must be cut off to avoid covering the HDMI and USB 3.0 ports).

The Comlink uses the EyeTech TM5 infrared device and comes with the Grid2 software (Tobii Communicator software optional) with several custom grids provided. The EyeTech TM5 is a robust infrared eyegaze device with good tolerance for head movement and enhanced accuracy for use outdoors. All of these qualities including the solid computer hardware make the FRS Comlink a great (if expensive like the Tobii) choice for an eyegaze communication system.

Pro:

- Excellent computer hardware.
- Robust eyegaze device.
- Expandability with external devices.

Con:

- Expensive.
- A kludge of solutions.

Links:

- http://www.frs-solutions.com/products/comlinks/lt3g_enable_eyes
- <http://thinksmartbox.com/product/the-grid-2/>
- <http://www.eyetechds.com/tm5-mini-assistive-tech.html>
- <http://www.frs-solutions.com/products/software/life-links>

"Roll Yer Own" Solutions

There are a few ways to create your own much less expensive eyegaze speech generating device (SGD) solution. These can include various pieces of equipment and software to make a whole or can include

assembled hardware kits with selected software. These will be indeed considerably less expensive but will come with no technical support for the product as a whole. On top of that, the assembly might not function as

seamlessly as a coherent and integrated product. And Medicare/insurance will not provide 80% of the purchase price like the products previously mentioned which are approved by Medicare as SGDs.

One such solution becoming more popular is the Tobii EyeMobile which is a Microsoft Surface Pro coupled with the Tobii PCEye Mini eyegaze device. The Microsoft Surface is a decent little computer in tablet format, boasting an Intel i5 CPU with 4GB RAM and a 128GB drive. The EyeMobile product is apparently no longer in the Tobii offering, but Surface Pros with superior technical specifications are easily procured from a variety of sources such as Amazon or from Microsoft itself. The lack of multiple USB ports is a limitation - it has just one USB port which the PCEye Mini occupies - and it's unclear whether a hub can be used with the Eyegaze Mini. The relatively small permanent storage in most models can be a problem, although it can contain drives up to 1TB. The Surface Pro can carry a maximum of 16GB RAM and it is recommended to have at least 8.

Of course, this is a minimal system which comes with no text-to-speech (TTS) software, just the Tobii eyegaze software to track the eyes and move the cursor around the screen in coordination with the eye movement. The user can load any preferred TTS software. Options include: Balabolka; Grid2/Grid3; Tobii Communicator; or anything else desired. Further, the Surface Pro is capable of using any other software such as Microsoft Office, any preferred web browser, any preferred email client, or anything else the user requires.

The combination of the Surface Pro with the Eyegaze Mini makes a solid combination of hardware for an eyegaze unit. It is compact, portable, and has good battery life. Given the flexibility in choice of TTS software, the system makes for a great choice of SGD for under \$5,000.

Another DIY option is to purchase a Tablet Kiosk Sahara Slate PC along with either the Tobii EyeMobile, the EyeTech TM5, or any other available eyegaze device. The Sahara Slate is a little more expensive but a

combination would still be in the neighborhood of \$5,000. It must be noted that Medicare will not provide any of the purchase price since these combinations are not currently approved as an SGD. That means neither will private insurance. This should be taken into consideration when choosing an SGD.

Pro:

- Lower cost.
- Flexibility.
- Customized solution.

Con:

- No technical or user support.
- Expense borne by user.

Links:

- <http://www.tobiidynavox.com/en-US/products2/devices/eyemobile-mini/specifications/>
- <http://www.tobiidynavox.com/en-US/software/windows-software/communicator-5/>
- <http://www.tobiidynavox.com/en-US/devices/eye-gaze-devices/pceye-mini/>
- <http://www.microsoft.com/en-us/surface/devices/surface-pro-4/tech-specs>
- <http://www.amazon.com/Microsoft-Surface-Pro-Intel-Core/dp/B01605ZRBK>
- <http://www.eyetechds.com/tm5-mini-1-assistive-tech.html>

Summary:

All infrared eyegaze systems are fundamentally the same. Solutions for Mac platforms do not exist in commercial availability. All commercially available solutions use a computer running Windows and some type of infrared technology. Normal color camera solutions exist but are still tinkering projects without commercial production or support. Those projects lack the tight accuracy of infrared because infrared detects the reflection off

of the cornea ("glint") which the full-color cameras cannot detect. Infrared eyegaze use that glint, along with measurement of the center of the pupil, to mathematically compute where the user is looking.

Software packages range from freely available for download to hundreds of dollars for a commercial product. The range of functions available in the various packages is rather wide. They vary from purely TTS to entertainment and environmental control via infrared transceiver (like the usual remote control devices for televisions and such). Without a consolidated software package, all such functions must be individually addressed with multiple separate applications.

While integrated SGDs are covered by Medicare, they are rather expensive - between \$12,000 \$20,000. Even with Medicare covering 80% of the cost, without supplementary insurance or a grant from something like a foundation, the remainder can still be a little expensive. That makes the case for a DIY or "Roll Yer Own" solution as previously discussed, as the cost of the DIY solution would be about the same as 20% of the commercial one. A commercial solution also provides some amount of technical and user support where the DIY would not. Often that would be worth the expense (or investment) by the user.

Conclusion:

The options presented here are not the only ones available, rather an example of some possibilities. Ultimately, which one to obtain is up to the needs and experience of the user. Hopefully this document can provide some clear guidance ahead of the time when an SGD becomes absolutely necessary. This way the user can perhaps try various options to determine which best suits the requirement rather than being forced to "just get something". The speech pathologist at a multi-disciplinary ALS clinic can help patients obtain systems on a trial basis and assist with evaluation. Since the choice made will be in service for some years, it's important to choose the right one. Future personal situations and requirements must be factored into the choice.

SGDs based on general-purpose computers tend to be the best choice since they can provide much more than just audible speech. Users can

continue to express their graphical or musical artistic talents as well as verbally converse with others in the immediate vicinity. Online communication is now ubiquitous and becoming an essential part of daily life. Such global communication has given back voices back to the severely-disabled and significantly improved their social presence and influence. It also makes possible participation in "telemedicine" which allows more frequent communication with medical professionals, improving care and quality of life.

Communication is an integral part of living and when disease or injury removes typical communication the proper application of technology restores much of that ability. Restoring lost or enhancing normal ability has been the role of technology throughout history. SGDs are a critical technological advancement assisting the severely-disabled, making them able once again.