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1 GETTING STARTED

The Eyegaze Edge allows people to communicate and control their environment with eye movements. The user sits in front of a control screen, which displays a variety of control and communication functions that the Eyegaze Edge is capable of executing. A video camera, mounted under the screen, continually observes the user’s eye, and the system processes those camera images to determine the point on the screen where the user is looking. When the user focuses his gaze on a desired “key” for a predetermined period of time, the Eyegaze Edge executes the associated function, such as verbalizing a phrase, typing a keyboard character, or sending an email.

1.1 Principle of Operation

A video camera mounted below the Eyegaze control screen is focused on one of the user’s eyes. The camera takes 60 pictures per second of the eye and sends those images to the Eyegaze system’s processor for analysis. At the same time, the video image of the eye is displayed in the upper right corner of the screen.

A small infrared light (LED) mounted in the center of the camera lens illuminates the eye and provides a bright image of the pupil and bright spot reflecting off the cornea. The bright corneal reflection is often referred to as the glint spot. Sophisticated image-processing software in the processor continually tracks the center of the pupil and the center of the glint spot. Based on the relative positions of the pupil center and the glint spot, the Eyegaze Edge predicts where on the control screen the user is looking.

![Image: Eye with bright pupil and glint spot](image)

Typically the Eyegaze Edge predicts the user’s gaze point with an accuracy of better than 1/4-inch, enabling the user to activate keys as small as a 5/8-inch square. As feedback to the user, the Edge displays a red dot, called the locator dot, on the screen at the point where the user is looking.

The user operates the Eyegaze Edge by looking at rectangular keys that are displayed on the control screen. To “press” a key visually, the user looks at the key for a specified period of time, called the gaze duration, usually 1/4-second to 2/3-second. When the key is activated it flashes. The system then takes the action associated with that key.

1.2 Requirements for Use

To operate the Eyegaze Edge effectively, a person should have good control of at least one eye. He should be able to move his gaze freely over the full range of the control monitor screen. To select and activate the various keys, he should be able to fix his gaze at any desired position on the screen for a period of about 1/2-second.
1.3 Preparing for Use

*Note: In Section 1.3, “you” is understood to be the person assisting the user.*

On the Eyegaze Edge desktop, click on the Eyegaze icon to bring up the calibration screen.

1.3.1 Positioning the Screen

The Eyegaze Edge screen must be positioned in front of the user in such a way that a) he can comfortably see the entire screen, and b) the camera can clearly “see” one of his eyes. He should be positioned between 16 – 31 inches from the screen, depending on his personal preference. *The screen should always be parallel to his face with the top edge no higher than eye level.* If the user is reclining, angle the top of the screen down so he is facing it. If he is side-lying it is typically easiest to point the camera at the eye which is highest.

![Side-lying position](image)

*Image: Side-lying position*

![Seated position](image)

*Image: Seated position.*

1.3.2 Using the Eye Image Display

The eye image display appears in the upper right corner of the control screen.

![Eye image display on Eyegaze screen](image)

*Image: Eye image display on Eyegaze screen*

![Magnified eye (left) and full camera Image (right)](image)

*Image: Magnified eye (left) and full camera Image (right)*

This display contains:

a) a display of the full camera image (right image)
b) a magnified display of the eye (left image)
c) a focus indicator (between images)

The display of the full camera image provides information about whether the subject’s eye is within the camera’s field of view and is used to position the user for calibration. Until the eye is clearly visible in the image, there will be no magnified image of the eye on the left. Be sure to position the user so his eye appears in the center of the full image on the right. The magnified image on the left is constantly centered by the Eyegaze Edge’s processor, and should not be used for positioning the user.
When the magnified eye display shows the user’s eye, the eye is being “tracked.” You will see a bright tracking indicator dot in the center of the pupil and a dark tracking indicator dot in the center of the glint spot (corneal reflection). Look for these tracking indicators during the process of positioning the user. The user is in good position when the image of the eye is centered and in clear focus, and the tracking indicator dots are present.

A focus indicator is displayed between the two eye images. The focus indicator is a dot that moves up or down showing whether the subject is too close or too far from the camera. If the focus indicator is centered on the reference tick mark, the eye is in perfect focus. If the focus indicator reaches either end of the scale, the eye is approximately 0.75 inch (2 cm) out of focus. As an additional indicator, the video images of the eye turn red or green if the eye moves significantly out of focus. Green indicates that the subject should move (go) forward to restore good focus, and red indicates that he should move backward (retreat).

The eye image display is controlled by the “Toggle Eye Image: key (CTR and F12 simultaneously) on the manual keyboard.

Pressing Control and F12 toggles the display among three states:
1) no eye display in upper right corner
2) display of full camera image and focus indicator
3) display of full camera image, focus indicator, and magnified eye display

1.3.3 Adjusting the Camera

The camera angle and the focus range must be adjusted so a clear image of the user’s eye appears in the center of the eye image display. Typically either eye may be used.

Position the Eyegaze screen a comfortable distance from the user, typically around 20-26 inches away from the screen, with the top of the screen at eye level or lower. Loosen the locking nut on the side of the camera bracket then adjust the camera angle to point the camera toward the user’s eye. Use the full camera image (image to the right) to help locate the eye as you adjust the camera’s focus and angle. Adjust the camera focus by rotating the focus ring until the image is clear. It may be necessary to re-adjust the camera angle in order to get a clear image of the eye. Note: It is usually easier for the user to move his eyes around the screen when it is not too close.
The front ring on the camera lens, the f-stop, controls the amount of light getting into the camera. It is locked in position and should not be rotated.

1.4 Calibrating the Eyegaze Edge

Before the Eyegaze Edge can track the user’s eye movements and respond accurately, it must “learn” several optical characteristics of his particular eye. It calibrates to the user’s eye by observing the eye as he looks at a small yellow circle on the control screen as it moves to various locations. The calibration program determines how to predict the user’s gaze point anywhere on the screen by analyzing the images of the user’s eye when he is looking at these known points.

1.4.1 Calibration Procedure

It is important to notice which eye the camera is focused on, since the Eyegaze Edge will not be able to predict accurately if the user switches eyes without recalibrating. The eye image display is like looking in a mirror: what appears to be the left eye is, in fact, the left eye. What appears to be the right eye is the right eye.

Also pay attention to reflections of light on the eye from sources other than the Eyegaze system’s LED. Ambient infrared light on the surface of the eye can impact the Edge’s ability to predict eye fixations accurately if the reflection sits on top the pupil. (Ambient IR can be seen on the right eye images below, but in this case it will not interfere because it is off to the side of the pupil). If an IR reflection is on the pupil, change the user’s location in the room or eliminate the source of unwanted light by closing window shades, turning off the lamp, etc. The screen should also be positioned so light is not reflecting off of its surface, since screen reflections make it difficult for the user to see the screen displays.

At the beginning of the calibration procedure, the screen displays the message:

CALIBRATION

Look at the Camera to Begin

Or Press F2 to Skip Camera Point

The user directs the Eyegaze Edge to begin the calibration procedure by looking down at the center of the camera lens. Alternatively, a caregiver can press the F2 key to begin the procedure. The system then sounds a beep and places a small yellow calibration circle at the first of 9 locations on the screen. To calibrate, the user looks at the center of each circle when it appears on the screen, then follows it as it moves to a new location. He may relax and take his time. The Edge’s processor will not move the calibration point until the user has looked at it in its current position.
Once the user has looked at the first calibration point on the screen, the camera angle and focus range can no longer be adjusted. Don’t touch the camera after calibration has begun or at any time during Eyegaze use! You can move the screen up or down forward or back after calibration in order to re-position it for Eyegaze use. Adjusting the camera at any time once calibration has begun, or during Eyegaze operation, will prevent the user from running the Eyegaze Edge accurately until he calibrates again.

1.4.2 5-Point Calibration

The 5-point calibration is designed for users who have difficulty controlling their eye fixations, have poor vision, or are young children. If you wish to use the 5-point calibration, click on the 5-Point Calibration icon.

The calibration screen will display:

**5-POINT CALIBRATION**

*Look at the Camera to Begin*

*Or Press F2 to Skip Camera Point*

There are several differences between the 5-point and 9-point calibrations. The 5-point calibration has larger calibration circles and lower requirements for the user to keep his gaze fixed on the calibration points. There are fewer locations to look at, and a more lenient accuracy requirement. Because it is typically not as accurate as the 9-point calibration, it should not be used unless absolutely necessary.

1.4.3 Maintaining Focus During Calibration

To obtain good calibration results, it is desirable to keep the eye in good focus during the calibration procedure. If the user is significantly out of focus during calibration, a circle appears around the calibration dot to alert the user to move into focus. If the circle is green, move forward toward the camera. If the circle is red, move backward. The color code is a little like a traffic light:

Green  Go forward
Red    Retreat (back up)

If the eye is out of focus, the calibration procedure waits for it to return to focus before accepting the calibration point and moving on to the next point. Move the screen until the eye image is again clear, or ask the user to move his head back into position.

1.4.4 By-passing the Camera Point when Calibrating

If the user’s upper eyelid blocks a considerable amount of his pupil when he looks down at the camera, the Eyegaze Edge may not bring up the first calibration point to begin the calibration procedure. You can manually bring up the first calibration point by pressing the “Skip Camera Point” key (F2) on the keyboard.

1.4.5 Compensating for a Pupil Blocked by the Eyelid

If the user’s eyelid extends down over the top of his pupil, the Eyegaze Edge will compensate for the missing piece of the pupil and continue to predict the user’s gaze point accurately. There is no need to change the position of the screen.
If the lower lid is blocking the pupil the screen may not be positioned optimally, e.g. parallel to the face. The lid may be also obscuring the corneal reflection, critical to Eyegaze use.

1.4.6 Bringing up the Calibration Program from Other Screens

If the System is in an Eyegaze program, press the “Re-Calibrate” key (F1) on the manual keyboard to bring up the calibration program. If the user is in a Grid program he must first exit back to Eyegaze before you press F1.

1.4.7 Accuracy Display

At the end of the calibration procedure, the Eyegaze Edge displays the accuracy of the calibration that it just performed. All nine of the yellow calibration points appear on the screen at once, as well as all the locations of the user’s gaze points. Red crosses represent the gaze points. Data displayed on the upper left corner of the screen shows the average accuracy of the gaze point predictions in inches or centimeters. You can freeze the screen with the data displayed by pressing the space bar. Pressing the space bar a second time will resume operation. The average accuracy of the horizontal and vertical components of the gaze points is also displayed. Attaining a calibration accuracy number of .25 inches (.63 cm) or smaller will automatically bring up the Eyegaze Main Menu.

If the user is doing a 5-point calibration, the Eyegaze Edge will automatically bring up the Main Menu when the accuracy is .66 inches (1.45 cm) or smaller. During Eyegaze operation, he may not be able to accurately target all of the Eyegaze keys if the system’s calibration is that “loose.” The 9-point calibration is always preferable, and will provide the user with the highest level of accurate Eyegaze key activation. If the user is able to do a 9-point calibration it should be used.

Simplified 5-Point Calibration vs. Normal 9-Point Calibration

<table>
<thead>
<tr>
<th>Simplified Calibration</th>
<th>Normal Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Point</td>
<td>9 Points</td>
</tr>
<tr>
<td>Larger points</td>
<td>Smaller points</td>
</tr>
<tr>
<td>Must fix gaze for 1/4 second on each point</td>
<td>Must fix gaze for half a second on each point</td>
</tr>
<tr>
<td>Acceptance within .66 inches (1.45cm)</td>
<td>Acceptance within .25 inches (.63cm)</td>
</tr>
<tr>
<td>7 Retakes</td>
<td>5 Retakes</td>
</tr>
</tbody>
</table>

1.4.8 Re-taking Calibration Points

If the user does not get a sufficiently accurate calibration, i.e., if the average error is more than .25 inches (.63cm), or .66 inches (1.45cm) in the 5-point, the calibration program assumes it did not get good readings on one or more of the calibration points. It will automatically repeat the data collection for the worst-case points. The Eyegaze Edge indicates a point it will retake by displaying a purple circle at
that point. The user should prepare to look at that point, as it turns yellow. After the calibration point re-take, the program readjusts the calibration parameters and re-computes the calibration accuracy. If a calibration point re-take is less accurate, the system ignores the re-take, and keeps the previous calibration. It first displays the results of the re-take then the prior better performance is again displayed. If the accuracy is still not good enough, it will again display a purple, then yellow, circle for the user to look at. If the accuracy improves enough during one the re-takes, the calibration procedure is completed, and the Edge automatically displays the Main Menu.

1.4.9 Re-starting the Calibration Procedure

If the calibration procedure is not going well, it can be restarted at any time by pressing the “Re-calibrate” key (F1) on the manual keyboard.

1.4.10 Terminating the Calibration Procedure

The calibration procedure can be terminated at anytime by pressing the Escape key (Esc) on the manual keyboard. If the calibration procedure is terminated with an Escape, the Eyegaze Edge completely ignores any results from that calibration session and returns to the calibration results that existed prior to that session. Escaping from the calibration procedure is useful any time a good calibration already exists, and the user does not wish to recalibrate.

1.4.11 Accepting Calibrations

If the user has limited eye control, which hinders his calibration accuracy, you may press the “Accept Calibration” key (F3) on the manual keyboard to instruct the Edge to accept a calibration of great than .25 inches. You may accept a calibration at any time after the user completes the original calibration points, i.e., either during the re-takes or while the screen again displays its message to begin calibration. It is important to pay attention to the calibration accuracy number being accepted (displayed in the upper left corner of the screen.)

As a rule of thumb, doubling that calibration number will give you an indication of the size of the keys the user will be able to accurately target. For example, a calibration of .75 inches means the user will be able to activate keys 1.5 square inches or larger. In some cases, a user may be able to calibrate more accurately using the 5-point calibration instead of the 9-point. You may want to try both calibration procedures to see which gets better results. It is also wise to try calibration on the opposite eye to see if the results are better.

1.4.12 Retention of the Calibration Results

Once the Eyegaze Edge is calibrated for a given user, the system retains that calibration data until re-calibrated. The user may close his eyes, move his head, or move away from the system. He can resume Eyegaze operation by returning to his position in front of the screen. Once the user’s calibrated eye is in clear focus again the Eyegaze Edge will again accurately predict his gaze point. The Eyegaze Edge may even be turned off and back on without losing the calibration. Note, however, that moving the camera, or changing its focus setting, will invalidate the calibration, in which case the Eyegaze Edge will continue to respond to eye fixations but it will not accurately reflect where the user is looking. Switching to the opposite, un-calibrated eye will cause a similar inaccurate response.
1.4.13 Saving a Calibration for Later Retrieval

**NOTE:** We do not recommend saving a calibration unless it is extremely difficult for the user to calibrate.

One calibration result can be saved for later retrieval. To save the current calibration, press the “Save Calibration” key (F5) on the manual keyboard. Pressing F5 at any time during regular Eyegaze operation can save a calibration, after the user is in the Eyegaze programs. To verify that the calibration data is being saved, “Save Calibration” will be displayed under the eye image. Only save a calibration once the user is in the Eyegaze programs — not from the calibration screen. If you push F5 from the calibration screen you’ll be saving the last completed calibration, not the one you want to save.

When saving a user’s calibrated data, it is necessary to record the camera angle and the focus range settings because these settings must be the same when the calibration data is retrieved to be used again. The camera angle may be noted by marking the camera bracket with a pencil. Returning the bracket to the pencil line at a future time will duplicate the angle used during the saved calibration. Write down the focus ring setting number, the date, time, and which eye was calibrated. By resetting the focus ring to the number used during the calibration that was saved, the focus is duplicated.

1.4.14 Retrieving a Saved Calibration

A saved calibration can only be used if the angle and focus setting of the camera used during that calibration can be duplicated. Once the camera focus and angle have been returned to their correct settings, position the user so that the eye that he had previously calibrated is in clear focus on the eye image display. From the calibration screen press the “Retrieve Calibration” key (F4) on the manual keyboard. Data will appear in the upper left corner of the screen listing: the time, the date, left or right eye, and the calibration accuracy.

1.4.15 Maintaining Eyegaze Accuracy

To maintain accurate Eyegaze operation, the camera must be aimed at the same eye on which the calibration was performed, and the eye must be kept in good focus. The camera angle and focus setting must not be altered after calibration. Re-adjusting the camera angle or focus prevents the system from accurately predicting where the user is looking. If you move the camera or change the focus the user must recalibrate! If the user gets out of focus or out of the camera’s field of view, the focus may be recaptured by moving either the user or the control screen until the correct eye is clearly visible on the eye image display. If the Eyegaze Edge is not responding accurately to the user’s eye and it is suspected that the camera focus or angle was inadvertently changed, recalibrate.

1.5 Visually Pushing Keys

**Note:** In Section 1.4, “you” is understood to be the user.

You activate most Eyegaze Edge operations by visually “pushing” the keys that are displayed on the various screens. When you look at a key and keep your gaze there for about 1/2-second, the Eyegaze Edge responds by taking the action associated with that key.

1.5.1 User Feedback

**Locator Dot**
As you look at a key, a small red dot will appear at the location of your eye gaze. The locator dot may be thought of as a visual cursor that you move around with your eyes. Generally, there is some slight
variation between where a user is looking and where the Eyegaze Edge predicts that he is looking. If your calibration was accurate to 1/4-inch or better, the system’s prediction should put the locator dot within the desired key. If you have moved out of clear camera focus, the locator dot may be higher or lower than where you are looking.

The purpose of displaying the locator dot is to a) provide feedback that the Eyegaze Edge knows you are looking at a key, and b) allow you to make corrections, such as moving back into clear camera focus. The dot changes from red to green when the system is tracking, but you are looking off the screen. Do not look directly at the dot or you will “push” it off the screen!

Key Flashes
When you leave your gaze within a key long enough to trigger it, the Eyegaze Edge responds not only by taking the action indicated by the key but also by briefly flashing the key and making a clicking sound.

1.5.2 Gaze Duration

The length of time that a user must leave his gaze within a key in order to trigger it is called the gaze duration. Typical gaze duration values range between 1/4-second and 2/3-second. As you become a more competent Eyegaze user, you may wish to reduce the gaze duration so that the system responds more quickly. A shorter gaze duration, which increases the speed, may be particularly desirable when typing. Within all the Eyegaze keyboard programs, you may temporarily change the gaze duration by entering the Keyboard Control screen and visually pressing the gaze duration “UP” or “DOWN” keys. The gaze duration will return to the system setting upon exiting the program.

An assistant can temporarily change the gaze duration in any Eyegaze program by pressing “Decrease Gaze Duration” key (F6) or “Increase Gaze Duration” key (F7) on the manual keyboard. F6 decreases (makes it faster) and F7 increases (makes it slower) the gaze duration in 1/10-second increments. When changing the gaze duration, a message appears in the upper right corner of the screen showing the new value for the gaze duration. Again, the gaze duration will return to the system setting upon exiting whatever program the user is in. The default gaze duration may be permanently changed in the ECS Settings program. For instructions on setting the system gaze duration, see Section 6.1 “Setting Gaze Control Parameters.”
2 EYEGAZE PROGRAMS

Note: In Section 2, “you” is understood to be the user.

2.1 Main Menu

Upon completing the calibration procedure, the Eyegaze Edge automatically displays its Main Menu. The Main Menu is the navigational center of the Eyegaze Edge. It presents a list of various Eyegaze programs and permits a user to select the desired program. To call up the program of your choice, visually press the key next to the program name. When you are finished with a program, looking at the “Exit” key for that program restores the Main Menu.

2.2 Phrases

Using a speech synthesizer, the Phrases program allows a person to “speak” regularly used phrases with a single key activation, eliminating the need to type a whole phrase each time he wishes to speak it. The Phrases screens use a simple large-key format with 14 phrases and two control keys on each screen. Looking at a key causes its phrase to be verbalized.

The “Pause” key temporarily deactivated the Phrases keys to avoid inadvertent key activation while reading the screen choices. Gazing at the Pause key a second time re-starts the eyetracking and permits key activation. The “Menu” key returns you to the Phrase Selection Menu.

There are nine Phrases screens to choose from on the Phrases Selection menu screen. An assistant can easily customize both the Phrases screen labels and the spoken phrases to suit your requirements by using the ECS Settings Program. (See Section 6.8 “Editing the Phrases.”)

2.3 Keyboard

The Keyboard program makes it possible to type by looking at keys on a keyboard display. As the keys are activated, the typed characters appear on the screen above the keyboard. The typed text can be
printed, verbalized through a speech synthesizer, or stored as a file for later retrieval. The Keyboard program functions as a simple word processor.

All Eyegaze keyboards function as single-stroke keyboards. While a manual keyboard requires simultaneous keystrokes (e.g., the shift key must be held down while typing a capital letter), the Eyegaze keyboards have a lock feature built into the “shift”, “control” and “alt” keys. Once visually pressed, these keys stay active and work in conjunction with the next key selection. These locking keys may be deactivated by visually pressing them a second time.

The **Alpha** keyboard is a simple, large-key alphabetic keyboard. It has both upper case and lower case options, as well as a third screen, activated from the AltGr key, with numbers and punctuation. The Alpha keyboard key dimensions are 1-1/4 inch by 1-1/2 inch.

The **Qwerty** keyboard has a key layout that is familiar to anyone who has used a standard typewriter or computer keyboard. Its visual keys are 1 inch square. It also has a third layer of keys that include various punctuation and editing keys.

The **abcde** keyboard has all of the keys found on a full function computer keyboard. Its letter keys are in alphabetic order clustered around the space key. The keys on both this keyboard and the Frequency keyboard are 3/4-inch square.

The **Frequency** keyboard has all of the features of the abcde keyboard. To provide maximum typing speed, the letter keys are arranged around a centrally located space key, according to the average frequency of use of each key. The most commonly used letters (e,s,t,a…) are located directly around the space key, and the least frequently used letters (x,j,q,z…) are located slightly farther away.
2.3.1 Special Features in the Keyboard Program

Cursor Positioning
To control the position of the cursor within the displayed text use of the following keys:

<table>
<thead>
<tr>
<th>Key</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrow keys</td>
<td>Moves the cursor right, left, up or down within the text.</td>
</tr>
<tr>
<td>Home (Hom)</td>
<td>Moves the cursor to the beginning of the line. If the Home key is activated twice in succession, the cursor goes to the beginning of the text after the second activation.</td>
</tr>
<tr>
<td>End</td>
<td>Moves the cursor to the end of the line. If the End key is activated twice in succession the cursor goes to the end of the text after the second activation.</td>
</tr>
<tr>
<td>Page Up (PgU)</td>
<td>Moves the cursor to the top display line. If the cursor is already on the top display line it moves the entire display up six lines.</td>
</tr>
<tr>
<td>Page Down (PgD)</td>
<td>Moves the cursor to the bottom display line. If the cursor is already on the bottom display line it moves the entire display down six lines.</td>
</tr>
<tr>
<td>Shift right arrow</td>
<td>Moves the cursor to the beginning of the next word.</td>
</tr>
<tr>
<td>Shift left arrow</td>
<td>Moves the cursor to the beginning of the previous word.</td>
</tr>
<tr>
<td>Alt right arrow</td>
<td>Moves the cursor 10 spaces to the right.</td>
</tr>
<tr>
<td>Alt left arrow</td>
<td>Moves the cursor 10 spaces to the left.</td>
</tr>
</tbody>
</table>

Deleting Characters
To delete characters in the text use the following keys:

<table>
<thead>
<tr>
<th>Key</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backspace (BACK)</td>
<td>Deletes the character prior to the cursor.</td>
</tr>
<tr>
<td>Delete (DEL)</td>
<td>Deletes the character at the cursor.</td>
</tr>
</tbody>
</table>

Paragraph Control
As you are writing or editing text, the Keyboard program’s editor automatically controls the text display so that no more than 80 characters are displayed on a line. When a paragraph contains more than 80 characters, the editor automatically figures out how many words fit on each line. As you edit the text within a paragraph, the editor continually readjusts word locations as necessary.

When the editor decides to start a new display line the action is called a “soft” return. You may insert a “hard” return by looking at the enter key (labeled ENT). The hard return will appear on the screen as the symbol □, and the cursor will move down to the beginning of the next line to start a new paragraph. You may delete the hard return by looking at the delete key while the cursor is under the hard return symbol.

Speak Key
You can speak individual paragraphs within the text by activating the “Speak” key (labeled SPK) on the keyboard. The speech synthesizer will then verbalize the entire paragraph where the cursor presently resides. To select a paragraph for speech, move the cursor to any position within the desired paragraph.
**Pause Key**
The “Pause” key (labeled PSE) makes it possible for you to look at the keyboard without activating keys. When you look at the Pause key it will light up. While the Pause key is illuminated, the Eyegaze Edge will not respond to your gaze, allowing you to look around without activating keys. The Pause key will remain lit until you look at it a second time to resume key activation.

### 2.3.2 Keyboard Control Screen

Looking at the “out” key on the keyboard display brings up the Keyboard Control screen. The Control screen can be thought of as the menu screen for the Keyboard program, providing access to all of the functions associated with that program:

#### Keyboard Selection Keys
Look at a Keyboard selection key: “alpha”, “qwerty,” “abcde,” or “freq” to choose a keyboard. Activate the “Type” key to bring up the selected keyboard.

#### Save Key
To save text you have typed activate the “Save” key. A “File save” screen then appears, which contains a keyboard for naming the file you are creating. Type in a file name, then activate the Save or Enter key.

If you have previously retrieved a file, the name of that retrieved file automatically appears on the File Save screen. If you have edited (changed) the text and wish to replace the old file with the newly edited version, activate the Save key without typing in a new file name. If you wish to save the new text in a different file, type in the new file name and then activate the Save key. To exit the Save File screen, look at the Out key. You can exit the screen without saving a file.

#### Retrieve Key
To retrieve a file, activate the “Retrieve” key. A list of all your text files appears. Look at a key next to the name of the file you want to retrieve. After you retrieve a file, the program automatically returns to the Keyboard Control screen. Look at “Type” to bring up the file on a keyboard screen, where you can edit or add to the retrieved text.

It is possible to retrieve a file and add it into text that is already on the screen. While you are on the keyboard screen, place the cursor at the location on your text where you want the retrieved text to be inserted, then:

1) Look at the Out to got to the Keyboard control screen, and activate the Retrieve key.

2) From the Retrieve screen select the file you wish to add into your text. As soon as you make your selection the retrieved text will be inserted just ahead of the cursor you previously placed. The cursor will be under the first character of the inserted text.

Deleting files: To delete a file, first go to the Retrieve File screen, which displays all your saved files. There are three steps involved in deleting a file:

1) Activate the “Delete” key. The key turns red, and the screen is re-labeled “Delete File”.

2) Look at the key next to the file you wish to delete. The file key turns yellow.
3) Activate the Delete key again. The file is now deleted, and the screen reverts to the Retrieve screen.

If you start the delete procedure by mistake, or if at any point during the procedure you decide not to delete a file, you can stop the delete procedure by looking at the exit key. Also, any variation from the above procedure will cause the screen to revert to the Retrieve mode without deleting a file.

Clear/Restore Key
To erase all text from the screen, look at the “Clear” key on the Keyboard Control screen. When the Clear key is activated it will change to “Restore”. If you accidentally clear the text, or if you exit from the Keyboard program without saving the text you just wrote, it is possible to restore that text. Whenever you clear the text or exit the Keyboard program, it automatically saves the text in a special backup file. When the key is in the “Restore” state you can bring back that last unsaved text by looking at the Restore key.

Gaze Duration Keys
To make the speed of key activations faster when you type, look at the “down” key. Each time the key is activated it will decrease the time you must fix your gaze on a key by .03 seconds. To slow the speed of key activations look at the “up” key. Each time it is activated the amount of time you must look at a key to type will increase by .03 seconds. An assistant can permanently change the default gaze duration for the Eyegaze keyboards by using the ECS Settings program. (See “Special Gaze Duration: in Section 6.7 “Setting Up the Keyboards”.)

Type Key
Looking at the “Type: key will bring the selected keyboard up on the screen.

Print Key
If you have a printer connected to your Eyegaze Edge, activating the “Print” key will print out the document you’ve been typing.

Speak Key
Activating the Speak key on the Keyboard Control screen brings up a special speech control screen. Looking at the “Speak full text” key will verbalize the entire text. “Speak paragraph” will verbalize the paragraph where the cursor resides. The arrow keys move the cursor up, down, left, and right. The Home key (labeled Hom) moves the cursor to the start of the paragraph. The “End” key moved the cursor to the end of the paragraph. “Page up” (labeled PgU) and “Page down” (labeled PgD) move the cursor up or down 6 lines.

Speech Mode Key
The Eyegaze keyboards have three Speech Modes: “Off,” “Character,” and “Word”. In the “Off” mode the speech synthesizer remains silent until the Speak key is activated. In “character” mode the synthesizer verbalizes each letter as it is typed. In “Word” mode it speaks each word as it is typed. In the “Word” mode, the speech synthesizer assumes you have finished a word when you type a space or punctuation mark. These settings are rarely used. An assistant may permanently change the Speech Mode by using the ECS Settings Program. (See “Default Keyboard” in Section 6.7 “Setting Up the Keyboards”.)

2.5 Environmental Controls (option)

Household devices, located anywhere in the home, that can be operated with a switch can be controlled from the Eyegaze Edge. The Lights and Appliances program displays a set of switches to
control the various appliances that have been selected for Eyegaze control. Looking at the “On” or “Off” key of the desired switch control each appliance.

The Eyegaze Edge uses the X-10 Home Control Interface to make the electrical connection between the Eyegaze processor and the appliance switches. The X-10 sends signals over existing house wiring to control small modules that plug in between the electrical outlets and the appliance plugs. Most televisions cannot be operated from the X-10, but can be controlled through the optional Grid program (see Section 3).

The House Code settings for all X-10 appliance modules must be set to “L”. The number setting on a given module with an appliance plugged into it should match the Lights and Appliance screen switch location (e.g. according to the diagram above, the module the fan is plugged into should be set at 4).

2.6 Eyegaze Edge Links for Computer Access (option)

The Eyegaze Edge Links allow the Eyegaze Edge to become a wireless keyboard and mouse interface for your Windows-based PC, Mac or Linux system. Two Eyegaze Edge Links, similar in appearance to USB sticks, are used: one is plugged into the Eyegaze Edge and the other into the computer you wish to control. When you type on a Computer Access keyboard, the characters you type will appear at the top of the Eyegaze keyboard screen as well as into your selected program on the computer you are interfacing. As you are writing a document it is not necessary to continuously look at your computer’s monitor to review the text. The last 8 to 10 lines you have typed will appear above the keyboard display on the Eyegaze control screen.

In the Computer Access program, the various special keys (Function, Control, Alt, Command, etc.) on the Eyegaze keyboard will take on the meanings defined by the application program you are running on your computer.

Looking at the “Out” key brings up the Keyboard Control screen, which allows you to select alternative keyboards, adjust the gaze duration for faster or slower key activation, print, clear the screen of text or exit back to the Main Menu. The Keyboard Control screens on the Computer Access program are operated the same as those in the Keyboard program. (See Section 2.3.2 “Keyboard Control Screen”.) The “Clear” key will clear the text off of the Eyegaze screen, but not off of the screen on your computer. The “Print” key will print the text as it appears on the Eyegaze screen, not as it appears on your computer. (Use the print command for the program you are running on your PC or Mac to print its text).

2.6.1 Mouse Control in the Computer Access Program

Visual mouse control of your PC or Mac is done through the Mouse Control screen. The user brings up the Mouse Control screen by activating the “Mou” key on any one of the Eyegaze keyboards in the Computer Access program.
Positioning the Cursor
The cursor on your computer’s monitor is put into motion by selecting one of the eight arrow keys labeled “Move Mouse” on the Eyegaze system’s Mouse Control screen. The direction the cursor will move (up, down, right, left, and four diagonals, which are not labeled) is determined by which key you activate.

There are two ways to control the cursor motion: the Speed and the Step modes. A user switches between the Speed and Step modes by activating the Mode key on the Mouse Control screen. Activating the mode key toggles the mode between Speed and Step modes. The name of the mode that is active at any time is displayed above the Mode key.

Speed Mode
To put your computer’s cursor in motion, look at the Move Mouse key that corresponds to the direction you want the cursor on your computer to go. When the directional key is activated it will turn blue. When it turns blue, look over at your computer’s monitor and watch the cursor until it gets to a point where you want it to stop. Immediately look back at the Eyegaze screen to stop the cursor. The entire Eyegaze screen has become a giant STOP button. The cursor will not move again until you activate another arrow key.

To adjust the speed of the mouse cursor, select one of the six keys labeled “Cursor Speed / Step Size.” Key 1 gives the slowest speed, allowing the cursor positioning to a single pixel. Key 6 gives the fastest speed, allowing the cursor to traverse the entire screen in little more than a second. After selecting the cursor speed, the value for the speed remains the same until you change it by selecting another Cursor Speed key, or by exiting the Computer Access program. The Eyegaze Edge leaves the selected speed highlighted so you can always see what its present value is.

Step Mode
If you have difficulty moving your eyes quickly from one screen to another, select Step Mode. In the Step Mode, whenever the user activates an arrow key, the mouse cursor on your computer moves a fixed distance and stops automatically. To make the cursor move, you activate the arrow key indicating the direction you want.

The distance the cursor travels is controlled by selecting one of the six keys labeled “Cursor Speed / Step Size” (the same keys used to control the cursor speed when the mouse is in the speed mode). Key 1 gives the smallest step and key 6 the largest.

Clicking Mouse Buttons
Once you have positioned the cursor where you want it on your computer, mouse clicks are implemented by activating one of the six “Click Mouse” keys on the Mouse Control screen.

The left column of Click Mouse keys corresponds to the left button on a hand-controlled mouse, and the right column of keys corresponds to the right button on a hand-controlled mouse.

Double Clicking
To double-click a mouse button (or buttons); activate one of the Eyegaze keys in the second row of the “Click Mouse” keys. A single Eyegaze command causes the mouse to double-click.

Click and Hold Operations
In a manual click-and-hold operation, the user moves the cursor to an object he wants to move, presses a mouse button, moves the cursor while holding the button down, and releases the button when the cursor is at the location where he wishes to drop the object. The Eyegaze System allows the equivalent operation with eye control.
First, move the mouse cursor to the object you wish to move. To initiate the click-and-hold operation, visually activate one of the keys in the bottom row of the “Click Mouse” Keys. At this point the Eyegaze Edge “presses” the mouse button and “holds” it down. To indicate that the button is being held down, the Eyegaze Edge eliminates all the other mouse-button keys from the display. You then move the mouse cursor to the desired location on your computer’s screen, using the arrow keys on the Eyegaze screen. When the mouse cursor is at the location where you wish to release the object, look back to the Eyegaze screen and activate the remaining mouse key. The Eyegaze Edge then “releases” the object. Upon completion of the click-and-hold operation, the Mouse Control screen returns to its normal appearance, i.e. the other mouse keys reappear.

Return to Keyboard
To exit the Mouse Control screen and return to the keyboard, look at the “Type” key.

2.6.2 Assistant Interaction

An assistant can perform keyboard and mouse operations on your PC or MAC by manually operating its keyboard and mouse. Manual keystrokes and mouse operations on your computer can be interspersed with mouse commands from the Eyegaze Edge; your computer will respond to both inputs.

The assistant may exit the Mouse Control screen by manually pressing the Escape key on the Eyegaze Edge keyboard.

2.6.3 Some Cautions

Some computer programs and operating systems have commands that respond to combinations of keyboard and mouse inputs. For example, mouse clicks may evoke different program responses if the SHIFT or ALT key is held down when the mouse button is clicked. It is possible to perform most of these operations on your PC through the Eyegaze Edge. To implement the above example, you would:

a) start in one of the Eyegaze keyboard screens,
b) set the keyboard shift state by visually activating the shift or shift-lock key (the shift key lights up),
c) go into the Mouse Control screen, and
d) activate a mouse-click key.

While it is possible to perform these kinds of operations intentionally, it is also possible to do them unintentionally. To minimize such unintentional operations, it is recommended that you check that no shift states on the keyboard screen are active before entering the Mouse Control screen. If any shift state is active, i.e. if its key is lit up, looking at the key will turn it off.
3 GRID 3 PROGRAM

The optional Grid 3 program from Sensory Software is fully integrated into the Eyegaze Edge. From the Eyegaze Main Menu screen looking at the Grid 3 button will take you into the Grid. EyeWorld 3, our adult Grid program, has training videos accessible within the program so a user can learn the features of operation at his leisure.

The Grid 3 program includes a pack of training cards for caregivers to refer to if they want to create or edit screens.

3.1 Updating the Grid

Sensory Software routinely releases updated versions of the Grid. Keeping your Grid current will minimize the possibility of Grid programs not working correctly.
The Eyegaze Scanning Keyboard is a row-column scanning system that utilizes an eye-motion gesture from the keyboard toward a separate “trigger key” as the mechanism to select a highlighted character. The scanning keyboard is intended for use by people who do not have precise and/or stable enough eye control to select small keys by direct visual fixation.

**Alternative Keyboard/Trigger/Text Configurations**

The relative positions of the keyboard, trigger key, and text display can be configured to meet individual viewing and gesture-direction preferences. The trigger key may be located to the left, right, top or bottom of the keyboard. The text may be displayed above or below the keyboard (if the trigger is right or left of the keyboard), or the text may be positioned to the right or left of the keyboard (if the trigger is above or below the keyboard).

**Alternative Keyboard Layouts**

Two keyboard layouts are available: alphabetic and frequency. In the alphabetic layout, the keys are ordered in a familiar alphabetic sequence. In the frequency layout, the most used keys are in the upper left corner of the keyboard, maximizing typing speed by minimizing the scan time required to reach the most commonly used keys. The user may toggle between the two keyboards by visually activating the "toggle keyboard" key (labeled TKb).

**Scan Speed**

The speed of the automatic scanning sequence is controlled by a parameter called the Scan Duration. The value for the scan duration is displayed adjacent to the keyboard. The user can visually change the scanning speed by activating the “Spd” and “Slw” keys.

The scan durations for the first row, for the first column within each row, and for the first sub-element within each column, are longer than normal. The purpose of these longer initial dwells is to allow the user’s gaze to get back to the keyboard after triggering an entry, but at the same time allow a moderately fast scan rate.

**3-Dimensional Keyboard**

To allow access to more characters than would be normally available on a 6x6 keyboard, there is a “third dimension: to the keyboard. The blue keys on the basic 2-D keyboard bring up a row of hidden keys. It takes three trigger actions (rather than the normal two) to activate these hidden characters.

**Special Keys**

The following list is a summary of the special-action keys (indented entries are “third-dimension” keys located “under” their appropriate heading):
<table>
<thead>
<tr>
<th>N1, N2</th>
<th>Number keys: 0 to 9, -, =</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punct</td>
<td>Punctuation marks: . , ? ; !</td>
</tr>
<tr>
<td>Spc</td>
<td>Space</td>
</tr>
<tr>
<td>Ent</td>
<td>Enter</td>
</tr>
<tr>
<td>Back</td>
<td>Backspace</td>
</tr>
<tr>
<td>Spk</td>
<td>Speak the paragraph that contains the text cursor</td>
</tr>
<tr>
<td>EGC</td>
<td>Special Eyegaze Control Keys</td>
</tr>
<tr>
<td>Clr</td>
<td>Clear the text</td>
</tr>
<tr>
<td>Fst</td>
<td>Speed up the scanning rate</td>
</tr>
<tr>
<td>Slw</td>
<td>Slow down the scanning rate</td>
</tr>
<tr>
<td>Rpt</td>
<td>Repeat last key – useful for cursor controls</td>
</tr>
<tr>
<td>Tkb</td>
<td>Toggle the keyboard between alphabetic and frequency-of-use-layouts</td>
</tr>
<tr>
<td>Save</td>
<td>Save the text buffer to a file called SK</td>
</tr>
<tr>
<td>Exit</td>
<td>Exit the scanning-keyboard program</td>
</tr>
<tr>
<td>C1, C2</td>
<td>Cursor Control Keys</td>
</tr>
<tr>
<td>Lt</td>
<td>Left arrow</td>
</tr>
<tr>
<td>Rt</td>
<td>Right arrow</td>
</tr>
<tr>
<td>Up</td>
<td>Up arrow</td>
</tr>
<tr>
<td>Dn</td>
<td>Down arrow</td>
</tr>
<tr>
<td>Hom</td>
<td>Home</td>
</tr>
<tr>
<td>End</td>
<td>End</td>
</tr>
<tr>
<td>PgU</td>
<td>Page-up</td>
</tr>
<tr>
<td>PgD</td>
<td>Page-down</td>
</tr>
</tbody>
</table>

To adapt the Scanning Keyboard program to individual needs, the values for several parameters may be adjusted in the ECS Settings program. (See Section 6.13, “Setting Up the Scanning Keyboard”.)
5 MANUAL CONTROLS FOR EYEGAZE

NOTE: In Section 5, “you” is understood to be the person assisting the user.

5.1 ESC (Escape)

From the Main Menu, touching the words “Main Menu” at the top of the screen will escape back to the desktop.

5.2 Function Key Manual Controls

In the Eyegaze programs, the Function Keys on the manual keyboard have specific Eyegaze functions. The functions are labeled on the keyboard.

Note: new keyboards require you to press the “fn” key along with the function key in order to make a selection.

F1 Re-Calibrate
Pressing the F1 function key from an Eyegaze menu screen causes the System to return to the calibration procedure. Manually using the F1 key has exactly the same effect as visually pressing the “Re-calibrate” key from the Main Menu. After the re-calibration procedure is complete, the Eyegaze System returns to the same screen from which the F1 key was pressed.

F2 Skip Calibration Point
Pressing the F2 function key during the calibration procedure causes the calibration program to skip the present point. Pressing F2 is particularly useful if the System does not respond when the user looks down at the camera to begin the calibration procedure.

F3 Accept Calibration
If the user did not get a sufficiently accurate calibration to be accepted automatically, (.25 inches [.63cm] or less) you can manually accept the calibration by pressing the F3 function key. It can be pressed during the calibration point re-takes or while the screen displays its message to restart the calibration. The Eyegaze Edge then accepts that calibration and moves into the Main Menu. Using the F3 key enables users with limited eye control to get into the Eyegaze Edge. Using the “looser” calibration, however, decreases the accuracy of the System’s response, and will make programs with smaller keys, such as the Keyboard program, difficult of the user to operate. (See Section 1.3.14 “Accepting Calibrations.”)

F4 Retrieve Saved Calibration
The F4 function key can be pressed at the beginning of the calibration procedure to recall the calibration that was previously saved. The F4 key, in combination with the F5 key (Save Calibration), makes it possible to bring back a stored calibration for use. Remember, however, that the camera angle and focus right must be adjusted to match the position and focus setting used when the calibration was originally saved. For more information on setting the focus right and camera position, see Section 1.3.16 “Saving a Calibration for Later Retrieval.”

F5 Save Calibration
Pressing the F5 function key during the operation of any Eyegaze program saves the current calibration for later recall. As discussed in Section 1.3.16 “Saving a Calibration for Later Retrieval,” it is necessary when saving a calibration to note the camera angle and focus setting so these can be restored when the calibration is retrieved. The calibration is saved in a separate file and can be recalled from the calibration procedure by pressing the F4 key.
F6 Decrease Gaze Duration
Each manual press of the F6 function key decreases the amount of time necessary for the user to activate a key by 1/10-second, making the keys respond faster to the user’s gaze. When changing the gaze duration with either F6 or F7 keys, the adjusted value is briefly displayed in the upper right corner of the Control screen. Changing to another Eyegaze program reverts the gaze duration back to its original setting.

F7 Increase Gaze Duration
Each manual press of the F7 function key increases the amount of time necessary to activate a key by 1/10-second, causing the keys to respond more slowly to the user’s gaze. When the user exits the program he is in, the gaze duration will return to its default setting. Changing to another Eyegaze program reverts the gaze duration back to its original setting.

F9 Toggle Locator Dot
Pressing the F9 function key switches the display of the locator dot on the control screen between three different modes:

- In-key: the dot is displayed only when the user is looking within a key
- Never-on: the dot is never displayed
- Always-on: the dot is always displayed

Users generally prefer to use the in-key mode so that the dot does not appear when they are looking at inactive regions of the screen, but does appear when their eye position is about to initiate an Eyegaze action. With the locator dot always on, you can see where the user is looking whether or not he is looking within a key. Turning the dot off is occasionally useful for people who are distracted by the dot, but without its visual feedback Eyegaze operation will be more difficult for the user. The F9 key acts as a toggle switch, switching the display mode between its three different states. Upon pressing the F9 key, a brief message appears in the upper right corner of the screen to indicate the new dot display mode.

Control + F12 Toggle Eye Image
The eye image displays appear in the upper right corner of the control screen, and are controlled by CONTROL (CTL) plus the “Toggle Eye Image” function key (F12) on the manual keyboard. The Eyegaze Edge can be set to display or not display eye images.

Typically the eye images are always displayed. It is useful to the user to be able to see what the Eyegaze Edge “sees”. Changing the toggle to display images should only be done when a separate tabletop image monitor is being used, occasionally necessary for young children who may be distracted by the eye image display.

5.3 Manual Controls for the Eyegaze Edge Links Computer Access Program
In the Computer Access program, the user’s PC or Mac accepts keyboard inputs from either the manual keyboard and mouse or from the Eyegaze Edge visual keyboard and mouse. Thus, a program running on the user’s computer can be controlled from either place.
6 USING THE ECS SETTINGS PROGRAM

Note: In Section 6, “you” is understood to be the person assisting the user.

Many of the Eyegaze programs have parameters, data and information that can be changed by an assistant. The phrases and appliance names, for example, can all be easily modified. You edit the Eyegaze text or change the Eyegaze data values by running a program called “ECS Settings”. To get into the ECS Settings program, double-click on the ECS Settings icon on the Windows desktop.

ECS Settings uses standard Windows interaction methods, such as click boxes, radio buttons, and dialog boxes, to allow you to select and modify the items you want. To select an item, first click on one of the tabs at the top of the window to select the category you want. Then click on the item you want.

To switch between categories, simply click the appropriate tab.

Factory Setting Default Values
Each parameter in the ECS Settings program has a “default” value that is set at the factory. The default value is a standard setting considered most useful for most people. To see which parameters differ from the default values, click on the “Highlight Non-Default Values” button. Any non-default (customized) values will then be highlighted in red for easy recognition.

It is also possible to set all the values on a page to their factory setting defaults by clicking the “Set Values to Defaults on this Page” button. To prevent setting defaults accidentally, a dialog box will prompt you to confirm before resetting all the values.

Saving and Restoring Parameter Values
Old sets of parameter values may be saved for later recall. When you click on the “Save Restore” tab, the ECS Settings program gives you the options of backing up the existing settings and/or reverting to previously saved settings.

When you back up the existing settings, the program normally names the saved file: “ECS Settings_On_monthday_year.ecs”, where month, day, and year are the present date, so it is easy to recall when you saved the file. You may, however, edit the file name as you wish (e.g. when an Eyegaze Edge is used by various people, settings files may be saved for each individual user, according to the user’s name).

When you retrieve old settings, the program lists all the file names of all the prior settings you have saved and allows you to select the one you wish to retrieve.

Leaving the ECS Settings Program
After you have edited the parameters you wish to change, click the “OK” button at the bottom of the ECS Settings program window. If you wish to ignore all changes you have just made, click on “Cancel.” If you wish to save parameters you have already edited, but you do not yet wish to leave the ECS Settings program, click the “Apply” button. Since clicking on “Cancel” exits the ECS Settings program, it is advisable to click “Apply” after making any changes you wish to keep.
The following sections describe the various categories of parameters that you can set.

### 6.1 Setting Gaze Control Parameters

The Gaze Control parameters include those variables that affect the user’s gaze interaction with the Eyegaze programs. To edit the Gaze Control parameters, click on the “Gaze Control” tab.

The following table explains the Gaze Control parameters in detail:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaze Duration</td>
<td>0.1 to 1.0 seconds</td>
<td>The length of time that a user must look at a key to visually press it. (Normal range is 0.25 to 0.67 sec)</td>
</tr>
<tr>
<td>Double Key-Press Delay</td>
<td>0.0 to 2.0 seconds</td>
<td>Used to reduce inadvertent double key presses. It is the additional length of time beyond the gaze duration that a user must leave his gaze on a key to press it a second time. (Most useful in typing keyboards.)</td>
</tr>
<tr>
<td>Menu Keys Centered on Screen</td>
<td>Yes or No</td>
<td>For some users it is easier to access keys in the center of the screen rather than on the far right. Centering the keys on the menu screens causes the right hand column of keys to appear toward the center of the screen. (Normal condition is OFF, i.e. no check in the box.)</td>
</tr>
<tr>
<td>Eyegaze Locator Dot</td>
<td>Always On, In-Key, or Never On</td>
<td>Initial display mode for the locator dot on the control monitor screen. Click desired radio button. (Generally set to In-Key.)</td>
</tr>
<tr>
<td>Locator Dot Size</td>
<td>1 to 5</td>
<td>Ranges from smallest (1) to largest (5). Size 1 or 2 is comfortable for most people.</td>
</tr>
<tr>
<td>Locator Dot Color</td>
<td>15 color choices</td>
<td>Select a new color by using the drop-sown and clicking on the desired color. Not all colors can be seen clearly on all Eyegaze screens. In general, reds are best.</td>
</tr>
<tr>
<td>Locator Dot Response Time</td>
<td>7 to 15</td>
<td>Controls how rapidly the locator dot moves when the user moves his eyes from one fixation point to the next. Locator dot response times may be set to values between 7 and 14. A low value of 7 means that the dot moves from one fixation point to the next very quickly, in about a tenth of a second (7/60ths of a second). A high value of 15 means that the dot moves more slowly and fluidly, taking about a quarter of a second to completely follow the eye motion (15/60ths of a second)</td>
</tr>
</tbody>
</table>

Note: the Locator Dot Response Time is not directly related to the Gaze Duration required to activate a key. Both Gaze Duration and Dot Response Time affect the overall response time of the Eyegaze Edge, but they do it in different ways. The user may experiment with different combinations to obtain an optimum “feel”.

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6.2 Setting Image Processing Characteristics

Image Processing parameters control how the eyetracking software analyzes the camera's images of the eye. To edit the Image Processing parameters, click on the “Image Proc” tab.

The following table provides detailed explanation of the image processing parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Droopy Eyelid Compensation</td>
<td>Always On</td>
<td>Droopy Eyelid Compensation is now automated. No action is necessary.</td>
</tr>
<tr>
<td>Focus Range Compensation</td>
<td>On or Off</td>
<td>Focus Range Compensation corrects gaze point measurements as the user moves his head forward and backward. This function should be turned off only if the user has goopy or dry eyes, which results primarily in poor blink reflex. Goop on the cornea distorts the image of the corneal reflection and interferes with the focus range measurement. (Normal condition is ON, i.e. check in the box.)</td>
</tr>
<tr>
<td>Pupil Non-Concentricity Compensation</td>
<td>On or Off</td>
<td>Pupil Non-Concentricity Compensation is intended to accommodate drifting of the pupil center within the iris, which occurs in some people with ALS. This function, normally turned off, is under experimental development and should be turned on only in consultation with LC Technologies. (Normal condition is OFF, i.e. no check in box.)</td>
</tr>
</tbody>
</table>

6.3 Setting Calibration Parameters

The Calibration Parameters control the operation of the Eyegaze calibration procedure. To edit the Calibration control parameters, click on the “Calibration” tab.

**Screen Background Color**
The Screen Background Color may be set to either “Dark” (black) or “Bright” (white). Setting the calibration color also sets the background color for the other Eyegaze control screens. Black screens are recommended and should always be used if possible.

In cases of exceptionally large or small pupils, however, eyetracking performance may be affected by screen background color. If a person has large, bright pupils, a bright screen background can help reduce the pupil size and pupil brightness. Conversely, if a person has small, dark pupils, a dark screen background may help dilate the pupils and increase its brightness.
Displaying Diagnostic Messages
Typically diagnostic messages are not displayed, since they can be distracting for the user. For cases where a user is having difficulty getting through the calibration procedure, the calibration program has an option to display the reason that it is not accepting the present calibration point. To activate these diagnostic messages, check the “Display Diagnostic Messages” box. With the diagnostic messages activated, one or more of the following messages appear when the calibration procedure does not accept a point within a few seconds:

<table>
<thead>
<tr>
<th>Inconsistent tracking</th>
<th>The Eyegaze Edge is occasionally missing, i.e. not finding, the eye during the calibration-point acceptance period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaze not still</td>
<td>The measured gaze is not sufficiently still, i.e. fixated, to accept the calibration point</td>
</tr>
<tr>
<td>Gaze not on point</td>
<td>The user’s gaze is not sufficiently close to the calibration point</td>
</tr>
<tr>
<td>Gaze hasn’t moved</td>
<td>The user’s gaze has not moved from the prior calibration point</td>
</tr>
<tr>
<td>Out of focus</td>
<td>The eye is not in sufficient focus for calibration</td>
</tr>
</tbody>
</table>

Calibration Types
To best suit the user, the calibration procedure may be controlled to perform one of three Calibration Types:

- **Normal**: 9 calibration points, small dots
- **Simple**: 5 calibration points, larger dots, easier for the eye to track
- **High Resolution**: 13 calibration points, small dots (not necessary!)

The normal 9-point calibration is optimum for most users.

The simple 5-point calibration is easier for a user to get through, so it may be preferable for people with limited eye control. On the other hand, the 5-point calibration typically results in poorer eyetracking accuracy than would be obtained if the user were able to get through the normal 9-point calibration.

The high-resolution 13-point calibration may provide slightly more accurate eyetracking for some people than the normal 9-point calibration, but are typically not used.

Changing Calibration Dot Locations
There is rarely any reason to change the locations of the calibration dots. If, however, it is desired to move one or more points on the screen, the ECS Settings program allows you to edit the point coordinates. To move a calibration point, first select the desired “Point Num.” The program highlights the location of the selected point in red. Then edit the x and y coordinates as desired. Coordinate values are expressed in terms of full screen width and height. The values may not be less than 0.00 or greater than 1.00. When you finish editing a coordinate value, the program moves the calibration point on the display, so you can see where it will be on the real calibration screen.

6.4 Changing the Language Setting
The language setting determines the language in which words appear on the Eyegaze screens and which letters are available in the Eyegaze keyboards. To change the language setting, click on the “Language” tab.

Each language has set of system settings associated with it, initially using the default parameters. When you switch to another language, it is possible to save the settings in the previously
selected language as an entire set of settings (e.g. your US English language settings may have an English speech synthesizer, a 0.3 second gaze duration and a set of English phrases, but your “Spanish” settings have a Spanish speech synthesizer, a 0.5 gaze duration and a set of different phrases in Spanish).

To set the language, select the language that you wish to use. A window comes up to ask if you would like to save the settings, with three options: “Yes”, “No” or “Cancel”. If you choose “Cancel” in this window, no changes will be made. If you choose “No”, the System will switch to the selected language but will not back up any of the setting you had set in the previous language. If you choose “Yes” (recommended), the System will save your settings associated with the previous language, enabling you to return to that language in the future without losing those changes. The most useful aspect of saving those changes is that the speech synthesizer saved with each language can correspond to the selected language (e.g. The US English language setting uses English speech and the German language setting users German speech). See “Selecting a Voice” in Section 6.5 “Changing Speech Synthesizer Characteristics”.

6.5 Changing Speech Synthesizer Characteristics

To change the speech synthesizer parameters, click on the “Speech” tab. The type of speech synthesizer that exists on your Eyegaze Edge is displayed on the upper right.

Selecting a Voice
To select a voice, pull down the “Voice Selection” menu and a list of available voices appear. Click on the desired voice.

Setting Voice Synthesis Speed
To edit the voice synthesis speed, click anywhere in the “Speed” box and edit the speed number. The normal speed value is 260.

To listen to a sample speech for the voice and speed you have selected, click the “Speak the test Phrase” key. (You may edit the test phrase if you wish.)

6.6 Changing the Eyegaze Fonts

To change the size of the various fonts used on the Eyegaze screens, click on the “Fonts” tab.

The Eyegaze programs use four fonts:
1) “Keyboard Text Display” – used to display text typed on any of the keyboards.
2) “Small Font” – used in the Phrases and Read Text programs
3) “Medium Font” – used for most key labels (other than Phrases)
4) “Large Font” – used for screen titles
To change one of the four fonts, click the appropriate “Set Font” button. A “Font” dialog box appears:

You may select the font type, font style and font size. A sample of the font you have selected is shown in the “Sample” box. (Note: Changing the “Color” and “Script” settings in the font dialog boxes has no effect on Eyegaze operation.)

6.7 Setting Up the Keyboards

The ECS Settings program lets you specify several initial conditions for the Eyegaze Keyboard and Computer Access programs. To change the keyboard’s initial conditions, click the “Keyboard” tab.

Keyboard vs Computer Access Keyboards
You may specify different initial conditions for the keyboards used in the Keyboard and Computer Access programs.

Default Keyboard
First, you may use the “Default Keyboard” drop-down menu to select which of the four keyboards the program will come up in, i.e. “Alpha”, “Qwerty”, “Abcde” or “Frequency”.

Special Gaze Duration
The keyboards may also be set to come up with gaze durations that are different from the Eyegaze Edge’s normal Gaze Duration, (which is set from the Gaze Control screen of the ECS Setting program). Select the “system” setting or the “separate” setting by clicking the appropriate radio button. For reference purposes, the system setting is displayed in the “grayed-out box”. If you select the “separate gaze duration,” a value appears in the adjacent “white” box where you can edit it. (The range of permissible Gaze Duration values is 0.1 to 1.0 seconds.)

Default Speech Mode
You may specify the default speech mode for the regular Keyboard program. The speech mode options are: “Off”, “Character” or “Word”, which may be changed by clicking on the drop-down button. For descriptions of the speech modes, see “Speech Mode Key” in Section 2.3.2 “Keyboard Control Screen.”

6.8 Editing the Phrases

To change the phrases, click on the “Phrases” tab.

When editing the Phrases, first select the “Screen #” of phrases that you wish to modify. To edit the screen title, click anywhere in the “Screen Title” box and type the text you want.
The Phrases keys are numbered 1 through 14, and are presented as a continuous list. To edit a phrase, click on the line of text corresponding to the phrase you wish to edit. The following dialog box appears:

Each phrase has two entries. The “Label” entry contains the text that is displayed on the screen. The “Speech” entry contains the text that the speech synthesizer verbalizes when the phrase key is activated. Type what you wish to add or change in the space provided. The editor does not allow you to type any more characters in the label than will fit in the on-screen key (18 characters). (Note: If you have selected a font larger than the default font size for the “Small Font,” not all 18 characters will fit on the displays.) The speech text may contain up to 78 characters.

6.9 Changing the Paddle Game

To change the settings in the Paddle game, click the “Paddle” tab.

The Paddle Width may be varied between 0.5 and 5.0 inches.

The length of time that the user must look at the camera to bring up the Paddle Game control screen is called the Control Activation Threshold. Its time may be set to a different value than the Gaze Duration. (The permissible range for the Control Activation Threshold is 0.25 to 2.0 seconds.)

6.10 Setting the Eyegaze Edge Links hardware for Computer Access

The Eyegaze Edge communicates with a user’s PC or Mac via the Eyegaze Edge Link. To select the setting for the Edge Link select the “PC Access” tab.

Pull down the “Comm Link” menu and select the “Eyegaze Edge Link.” Apply the change and close the settings window.
6.11 Changing the Environmental Control Settings

To edit the Lights and Appliances screen, click on the “Lights_Appl” tab (image to the right).

The ECS Settings program displays the labels and switch-types for each of the switches. To select a switch to edit, click on the line of text corresponding to that switch. The following “Edit Light / Appliance” dialog box appears:

![Edit Light / Appliance dialog box]

**Editing Switch Labels**
The label for a button on the Lights and Appliances screen may be displayed on up to two lines. Type the entry for the top line in the “Top Label” box, and type the entry for the lower line in the “Bottom Label” box. If the full entry fits on one line, it should be placed on the lower line so it appears closer to the key.

**Setting Switch Types**
The switch type for each key specifies whether the appliance module switch attached to the appliance is normal or momentary. Momentary switches automatically turn off shortly after being turned on. Momentary switches are useful for appliances such as the chime that comes with the Lights and Appliances option.

**Setting the Environmental Controller Hardware**
To tell the Lights and Appliances program which type of environmental control device you have with your Eye gaze System, click the “Edit Controller Settings” button. The following dialog box appears.

Next, pull down the “Device Name” menu and click on the correct device. The options are: “None” (if there is no environmental controller on the Eye gaze Edge), “X10” (for the older model X-10s), “Switch Box”, and “X10 CM11a” in Europe, and “X10 Firecracker” (for newer model X-10s).

Then type in the appropriate values for the “COMn Port” (e.g. “COM1” or “COM2”) and the “port Speed” (e.g. “4800” or “9600”).

The House Code setting on all X-10 appliance modules must be set to “L.”
6.13 Setting Up the Scanning Keyboard

To edit the characteristics of the Scanning Keyboard, click on the “Scan Keybrd” tab.

The “Default Keyboard Layout” menu allows you to select the keyboard that comes up when the Scanning Keyboard program first starts. There are two options: “Alphabetic” and Frequency”

The Default Scan Duration defines the length of time that the highlight remains on a key during the scanning process. It may be adjusted between 0.4 and 4.0 seconds.

The “% Time Added” parameters control the additional time that the scanner dwells on the first row, the first column within a row, and the first element within a column. A value of 0.7 means that the first dwell will be 70% longer than the default scan dwell. (If you change the default Scan Duration, all the “first” dwells automatically change proportionately.)

The “Gaze Border Width” controls the width of boundary regions around the keyboard and trigger. The purpose of the border is to keep gazepoint measurements at the edges of the keyboard or trigger regions from falsely transitioning between scan and trigger modes. The distance between the keyboard and the trigger is twice the border width. You can control the keyboard/trigger separation by adjusting the gaze border width. The border width is expressed as a percentage of the full screen width. The value of 0.08 means that the border is 8% of the full screen width, and that the distance between the keyboard and trigger is 16% of the screen width.

The “Gazepoint Smoothing Time Constant”, expressed in seconds, controls how fast the gazepoint locator dot moves in response to your eye motion.

The “Keyboard Font” and “Text Font” menus allow the selection of alternative font sizes. The font choices include any of the four fonts selected under the “Fonts” tab.

The “Locator Dot Control” permits the gazepoint locator dot to be displayed in three different modes: “Always On,” “In Key,” and “Never On.” In the “In Key” mode, the locator dot is on whenever the gaze is within either the keyboard or trigger regions, and the keyboard and trigger regions include the Gaze Border Width surrounding the keyboard and trigger, so the dot is displayed on a large majority of the screen.

Depending on user preference, the trigger key may be positioned to the left, right, top or bottom of the keyboard. The location of the text display may also be controlled. If the trigger is placed to the left or right of the keyboard, the text may be positioned above or below the keyboard. If the trigger is placed above or below the keyboard, the text may be positioned on the left or right of the keyboard.
7 ASSEMBLING THE EYEGAZE EDGE

7.1 Select a Site for the Eyegaze Edge

1. Choose a site away from uncovered windows and sources of bright incandescent light.

2. Choose a sturdy table, desk, or over-bed table to put the Eyegaze Edge on. A hospital over-bed table works well.

3. Choose a position on the table to attach the clamp. The clamp should be located in a position such that the monitor will be in a comfortable position for the user and such that there is freedom in the swing of the arm both right-to-left and forward-to-back. For over-bed tables, make sure the clamp is close to the table’s support leg for stability.

7.2 Mount the Clamp and Arm for the Monitor

1. Attach the arm clamp to the table, following the instructions in the included table mount brochure.

2. Slide the arm into the clamp. Test stability.

3. Remount the clamp if necessary. If the monitor cannot be swung easily to a comfortable position for the user, the clamp should be remounted.
7.3 Assembling Eyegaze Edge Tablet

Mount the arm base onto a sturdy surface (see Section 7 of the User’s Manual for more detail). Place arm into the base.

Plug the USB Cable into the HUB as shown above. Slide the tilter into the rail until it clicks into position.

Slide the Camera into the rail until it clicks into position. Plug the camera cable into the camera and the bottom USB connection on the hub.

Mount the tablet by placing the tilter into the arm

To turn the system on: Push the Silver Bar on the top right of the Tablet
To turn the system off:
Hit the “Windows” key on the keyboard (bottom row left side)
Click on the “Power Options” icon (top right of the screen)
Or
Swipe your finger inward from the right side of the screen touch the “Setting” icon then “Power”
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