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Abstract - The Eyegaze System is a communication and control system for people with complex physical disabilities. You run the system with your eyes. By looking at control keys disabled on a screen, a person can synthesize speech, control his environment (lights, appliances, etc.), type, operate a telephone, run computer software, operate a computer mouse, and access the Internet and e-mail. Eyegaze Systems are being used to write books, attend school and enhance the quality of life of people with disabilities all over the world.

I. INTRODUCTION

Imagine yourself being an intelligent, motivated nad working person in the fiercely competitive market of information technology, but just one problem, you can't use your hands, or you can't speak. How do you do your job? How do you stay employed? You can, because of a very good gift from computer industry: The Eyegaze, a communication and control system you run with your eyes.

The Eyegaze System is a direct-select vision-controlled communication and control system. It was developed in Fairfax, Virginia by LC Technologies.

WHO'S USING THE EYEGAZE SYSTEM?

- This system is mainly developed for those who lack the use of their hands or voice. Only requirements to operate the Eyegaze are control of at least one eye with good vision and ability to keep head fairly still. Eyegaze Systems are in use around the world. Its users are adults and children with cerebral palsy, spinal cord injuries, brain injuries, ALS, multiple sclerosis, brainstem strokes, muscular dystrophy, and Werdnig-Hoffman syndrome. Eyegaze Systems are being used in homes, offices, schools, hospitals, and long-term care facilities.

II. THE SKILLS NEEDED BY THE USER:

Good control of one eye: The user must be able to look up, down, left and right. He must be able to fix his gaze on all areas of a 15-inch screen that is about 24-inches in front of his face. He must be able to focus on one spot for at least ½ second.

Several eye movement problems may interfere with Eyegaze use. They include:

Nystagmus: The user may not be able to fix his gaze long enough to make eyegaze selections.

Alternating strabismus: The Eyegaze System is constantly tracking the same single eye. If, for example, a user with alternating strabismus is operating the Eyegaze System with the right eye, and that eye begins to deviate, the left eye will take over and focus on the screen. The Eyegaze camera, however, will continue to take pictures of the right eye, and the system will not be able to determine where the user's left eye is focussed. When the left eye deviates and the right eye is again fixed on the screen the Eyegaze System will resume predicting the gazepoint. Putting a partial eye over the nasal side of the eye not being observed the camera often solves this tracking problem. Since only the unpatched eye can see the screen, it will continuously focus on the screen.

1. **Adequate vision:** Several common vision problems may affect a user's ability to see the text clearly on the Eyegaze monitor. These include the following:

Inadequate visual acuity: The user must be able to see the text on the screen clearly. If he's over 40 years old and has not had his vision checked recently, he might need reading glasses in order to see the screen clearly.

In most of the cases, eyetracking works well with the glasses. The calibration procedure accommodates for the refractive properties of most lenses. Hard-line bifocals can be a problem if the lens boundary splits the image of the pupil, making it difficult for the system's image processing software to determine the pupil center accurately. Graded bifocals, however, typically do not interfere with eye tracking.

Soft contact lenses that cover all or most of the cornea generally work well with the Eyegaze System.

Diplopia: Diplopia may be the result of an injury to the brain, or a side effect of many commonly prescribed medications, and may make it difficult for the user to fix his gaze on a given point. Partially patching the eye not being tracked may alleviate double vision during Eyegaze System operation.

Blurred vision: Another occurrence associated with some brain injuries, as well as a side effect of medications, a blurred image on the screen decreases the accuracy of eye fixations.

Cataracts; If a cataract has formed on the portion of the lens that covers the pupil, it may prevent light

from passing through the pupil to reflect off the retina. Without a good retinal reflection the Eyegaze System cannot accurately predict the user's eye fixations. Surgical removal of the cataracts will normally solve the problem and make Eyegaze possible.

Homonymous hemianopsia: This may make calibration almost impossible if the user cannot see calibration points on one side of the screen.

2. **Ability to maintain a position in front of the Eyegaze monitor:** It is generally easiest to run the system from an upright, seated position, with the head centered in front of the Eyegaze monitor. However the Eyegaze System can be operated from a semi-reclined position if necessary. Continuous, uncontrolled head movement can make Eyegaze operation difficult, since the Eyegaze System must relocate the eye each time the user moves away from the camera's field of view and then returns. Even though the System's eye search is completed in just a second or two, it will be more tiring for a user with constant head movement to oerate the system.

3. **Memory:** Memory deficits are a particular concern in considering the Eyegaze System for someone with a brain injury. A user who can't remember from one day to the next how to operate the system may find it too difficult to use it effectively.

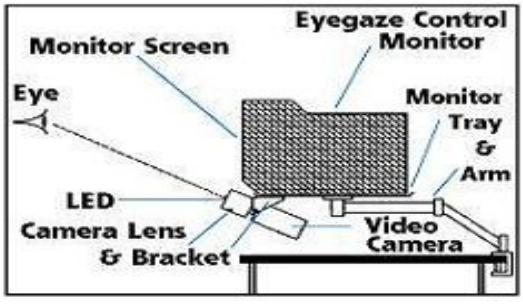
4.

III. MEDICATION SIDE EFFECTS THAT AFFECT EYEGAZE OPERATION

Anticonvulsants can cause: nystagmus, blurred vision, diplopia, drowsiness, headache and confusion. Some antidepressants can cause blurred vision and mydriasis. Mydriasis can be severe enough to block eyetracking.

HOW DOES THE EYEGAZE SYSTEM WORK?

- As a user sits in front of the Eyegaze monitor, a specialized video camera mounted below the monitor observes one of the user's eyes. Sophisticated image-processing software in the Eyegaze System's computer continually analyzes the video image of the eye and determines where the user is looking on the screen. Nothing is attached to the user's head or body.



- reflects off the retina, the back surface of the eye, and causesthe pupil to appear white. The bright-pupil effect enhances the camera's image of the pupil and makes it easier for the image processing functions to locate the center of the pupil. The computer calculates the person's gazepoint, i.e.the coordinates of where he is looking on the screen, based on the relative positions of the pupil center and corneal reflection within the video image of the eye. Typically the Eyegaze System predicts the gazepoint with an average accuracy of a quarter inch or better.
- Prior to operating the eyetracking applications, the Eyegaze System must learn several physiological properties of the user's eye in order to be able to project his gazepoint accurately. The system learns these properties by performing a calibration procedure. The user calibrates the system by fixing his gaze on a small yellow circle displayed on the screen, and following it as it moves around the screen. The calibration procedure usually takes about 15 seconds, and the user does not need to recalibrate if he moves away from the Eyegaze System and returns later.

HOW TO RUN THE EYEGAZE SYSTEM?

A user operates the Eyegaze System by looking at rectangular keys that are displayed on the control screen. To "press" an Eyegaze key, the user looks at the key for a specified perod of time. The gaze duration required to visually activate a key, typically a fraction of a second, is adjustable. An array of menu keys and exit keys allow the user to navigate around the Eyegaze programs independently.

USES OF EYEGAZE

The Basic Eyegaze Can:

I. ADJUST TO A NEW USER in about 15 seconds. (CALIBRATION)
II. TYPE with one of four keyboards, then print or speak.(TYPEWRITER)
III. TURN pages on the computer screen by looking at "up" or"down". (READ TEXT)
IV. TEACH new users with simplified screens. (TEACH SCREENS)

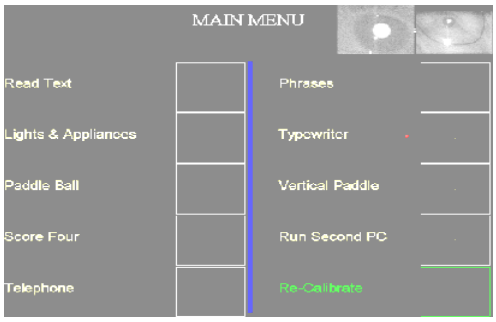
With Options The Eyegaze Can:

1. BE A KEYBOARD to a second computer to run anykeyboard-controlled software, by means of the T-TAMconnector. (Second Computer Mode)
2. SPEAK 100"canned phrases" through a speech synthesizer,with a single glance of the eye. Phrases can be changed bycaregiver or user. (Phrases)

3. CONTROL appliances anywhere in the home or office from one Eyegaze screen. No special wiring. (Lights and Appliances)
4. DIAL and answer a speaker phone from one screen."Phone Book" stores 16 frequently used numbers. (Telephone)

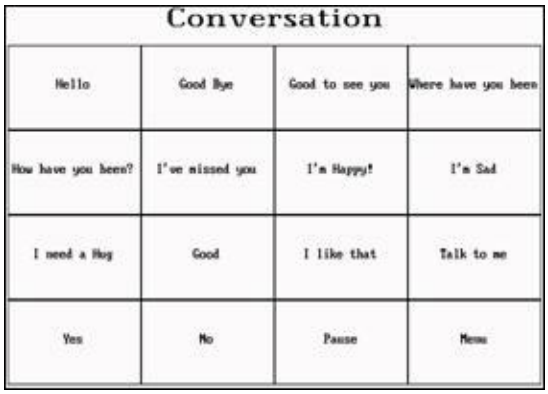
MENUS OF EYEGAZE SYSTEM

The Main Menu: The Main Menu appears on the screen as soon as the user completes a 15-second calibration procedure. The Main Menu presents a list of available Eyegaze programs. The user calls up a desired program by looking at the Eyegaze key next to his program choice.

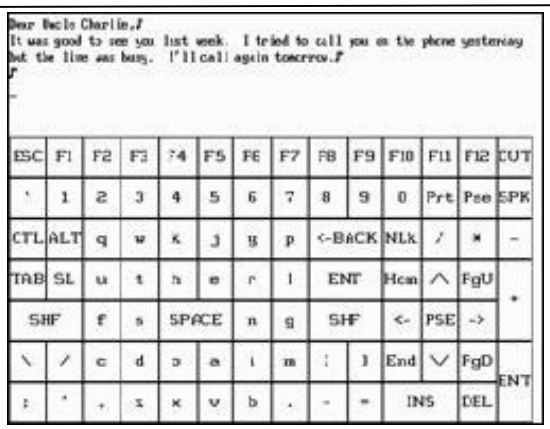


Main Menu Options:

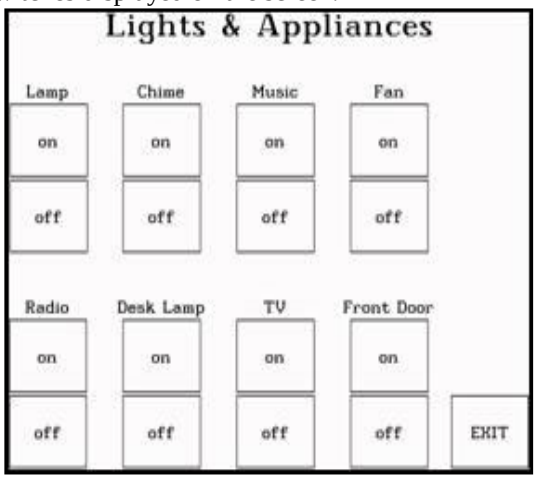
A. The Phrase Program: The Phrases program, along with thespeech synthesizer, provides quick communications for nonverbal users. Looking at a key causes a preprogrammed message to be spoken. The Phrases program stores up to 126 messages, which can be composed and easily changed to suit the user.



B. Typewriter program: Simple word processing can be done using the Typewriter Program. The user types by looking at keys on visual keyboards. Four keyboard configurations, simple to complex, are available. Typed text appears on the screen above the keyboard display. The user may "speak" or print what he has typed. He may also store typed text in a file to be retrieved at a later time. The retrieved text may be verbalized, edited or printed.



C. The Lights & Appliances Program: The Light & Appliances Program which includes computer-controlled switching equipment, provides Eyegaze control of lights and appliances anywhere in the home or office. No special house wiring is necessary. The user turns appliances on and off by looking at a bank of switches displayed on the screen.



ENVIRONMENT REQUIRED FOR AN EYEGAZE SYSTEM

Because eyetracking is one using infrared light, Eyegaze system must take care of light sources in the room in order to ensure the best accuracy. The Eyegaze System must be operated in an environment where there is limited of ambient infrared light. Common sources of infrared light are sunlight and incandescent light bulbs. The system makes its predictions based on the assumption that the only source of infrared light shining on the user's eye is coming from the center of the camera. Therefore, stray sources of infrared may degrade the accuracy or prevent Eyegaze operation altogether. The System works best away from windows, and in a room lit with fluorescent or mercury-vapor lights, which are low infrared.

NEW PORATABLE EYEGAZE SYSTEM

The portable Eyegaze System can be mounted on a wheelchair and run from a 12-volt battery or wall outlet. It weighs only 6 lbs (2.7kg) and its dimensions

are 2.5”x8”x9” (6.5cm x20cm x23cm). The Portable Eyegaze System comes with a flat screen and a table mount for its monitor. The monitor can be lifted off the table mount and slipped into a wheelchair mount.

V. CONCLUSION

Today, the human eyegaze can be recorded by relatively unremarkable techniques. This paper argues that it is possible to use the eyegaze of a computer use rin the interface to aid the control of the application. Care must be taken, though, that eyegaze tracking data is used in a sensible way, since the nature of human eye movements is a combination of several voluntary and involuntary cognitive processes. The main reason for eyegaze based user interfaces being attractive is that the direction of the eyegaze can express the interests of the user-it is a potential porthole into the current cognitive processes and communication through the direction of the eyes is faster than any other mode of human communication. It is argued that eyegaze tracking data is burst used in multimodal interfaces where the user interacts with the data instead of the interface, in so-called non-comman user interfaces.

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