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RESEARCH ARTICLE OPEN ACCESS

A Revolutionary Way of Aiding People With Severe Neurological Disorder through Information Technology

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ABSTRACT

Information and communication technology can have a key role in helping people with several disabilities and special needs considering both physical and cognitive disabilities the paper describes a input device , based on eye tracking techniques , that allows people with severe motor disabilities even not only for motor disabilities and other several disease like cerebral palsy , spinal cord injuries, brain injuries , ALS , multiple sclerosis, brainstem strokes , and muscular dystrophy , syndrome can use this eye tracking technique for selecting specific areas on the computer screen and the persons who lack the use of their hands or voice can also use this system. Compared to other existing solutions the strong points of this approach are simplicity and consequent affordability of costs. This system can be easily installed to any pc with simple techniques Systems are being used to write books attend school and enhance the quality of life of people with disabilities all over the world.

Keywords:- MNDs, ALS, GAZE,

I. INTRODUCTION

The problem of assisting people with special needs is assuming a central role in our society, and information and communication technologies are asked to have a key role in aiding people with both physical and cognitive disabilities. Assistive technology focuses on the application of ICT to different disabilities, including sensory (hearing and vision), motor (orthopedic), cognitive (learning, speech, mental) and emotional ones. The present paper describes an ICT application in the field of motor disabilities; it consists in an eye-tracking mechanism that can act as an alternative pointing device for a computer screen. With respect to more sophisticated solutions, that will be mentioned in the paper, the main advantage of this approach is the cost-effectiveness that can make this system affordable to a vast number of users. The hardware requirements, in fact, are simply a personal computer and a web cam, and the approach relies on image processing algorithms applied to the captured images of the user. Before going in to the project let us know something about the motor neuron disease.

What is NEURON DISEASE?

The motor neuron disease (MNDs) are a group of progressive neurological disorders that destroy cells that control essential muscle activity such as speaking, walking, breathing, and swallowing. Normally, messages from nerve cells in the brain (called *upper motor neurons)* are transmitted to nerve cells in the brain stem and spinal cord (called *lower motor neurons)* and from them to particular muscles. When there are disruptions in these signals, the result can be gradual muscle weakening, wasting away, and uncontrollable twitching (called fasciculation's).Eventually, the ability to control voluntary movement can be lost. MNDs may be inherited or acquired, and they occur in all age groups. In adults, symptoms often appear after age 40. In children, particularly in inherited or familial forms of the disease, symptoms can be present at birth or appear before the child learns to walk of sporadic (non inherited) MNDs are not known, but environmental, toxic, viral, or genetic factors may be implicated. Common MNDs include amyotrophic lateral sclerosis (ALS), progressive bulbar palsy, primary lateral sclerosis, and progressive muscular atrophy. Other MNDs include the many inherited forms of spinal muscular atrophy and post-polio syndrome, a condition that can strike polio survivors decades after their recovery from poliomyelitis

CAUSES OF MND:

The causes of MND are unknown but worldwide research includes studies on:

- Viruses, toxins, genetic factors and immune factors
- Nerve growth factors and chemicals which control nerve cells

IS THERE ANY TREATMENT:

There is no cure or standard treatment for the MNDs. Symptomatic and supportive treatment can help patients be more comfortable while maintaining their quality of life. The drug riluzole , which as of this date is the only drug approved by the U.S. Food and Drug Administration to treat ALS, prolongs life by 2-3 months but does not relieve symptoms. Other

ALTERNATIVE COMMUNICATION

Since there is no treatment to solve the MND and the cause is also unknown we use a communication system for the affected people. We can bring out their ideas since the physical independence is only lost

medicines that may help reduce symptoms include muscle relaxants such as baclofen, tizanidine, and the benzodiazepines for spasticity; glycopyrrolate and atropine to reduce the flow of saliva; quinine or phenytoin for cramps; anticonvulsants and nonsteroidal anti-inflammatory drugs to relieve pain

SURVEYS ABOUT THE MND

According to the National Institutes of Health, about 400 to 600 people per 100,000 worldwide get MND; some 460,000 people in the world are newly diagnosed with MND each year, and nearly 3,000,000 people residing in the U.S. at any time are living with it. The average age of diagnosis is 55 years with arrange of 40 to 70 years. It is possible, however, to find individuals in their 20s and 30s diagnosed with ALS. Men are 20% more likely to develop ALS than women.

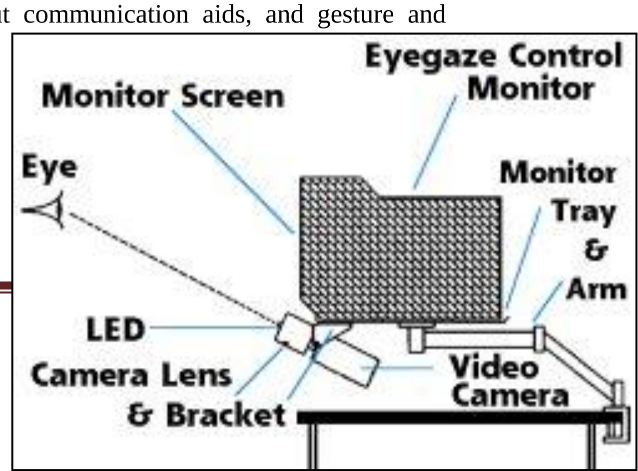
RESULTS OF THE PERSONS AFFECTED BY MND

- Since the ability of speaking gets affected it becomes more difficult to understand the speech of a person with MND
- Since the muscular movements are affected the ability of walking and moving the hands also gets affected

.The senses of eyesight, hearing, taste, smell and touch are still be used

The person affected by MND or other disease do not suffer from any visual problem the present system used to solve the problem for the mentioned disease is EYE GAZE system In this system we use vocalization and speech, communication boards and voice output communication aids, and gesture and sign languages.

As a user sits in front of



the Eye gaze monitor, a specialized video camera mounted below the monitor observes one of the user's eyes. Sophisticated image- processing software in the Eye gaze 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.

HOW DOES THE SYSTEM WORK

In detail the procedure can be described as follows: The Eyegaze System uses the pupil-center/corneal-reflection method to determine where the user is looking on the screen. An infrared-sensitive video camera, mounted beneath the System's monitor, takes 60 pictures per second of the user's eye. A low power, infrared light emitting diode (LED), mounted in the center of the camera's lens illuminates the eye. The LED reflects a small bit of light off the surface of the eye's cornea. The light also shines through the pupil and reflects off of the retina, the back surface of the eye, and causes the 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 Eye gaze System predicts the gaze point with an average accuracy of a quarter inch or better.The system learns properties by performing a calibration procedure. The user calibrates the system by fixing is 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 Eye gaze System and returns later too. So the calibration time can be saved.

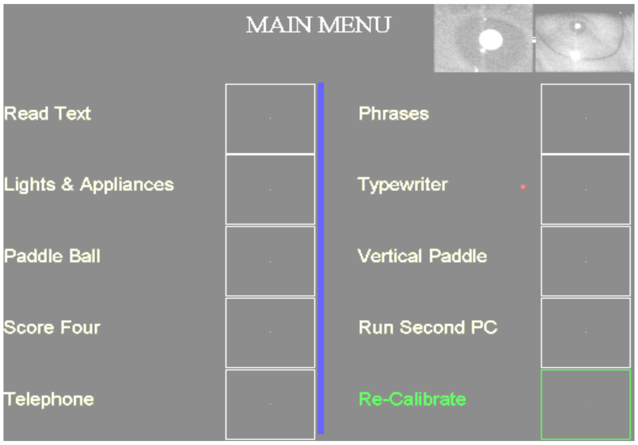
AMBIENT INFRARED LIGHT: The Eye gaze System must be operated in an environment where there is limited ambient infrared light. Common sources of infrared light are sunlight and incandescent light bulbs. The System makes its predictions based on the assumption that the only source of infrared light shining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

OPERATIONS DONE BY EYE GAZE

A user operates the Eye gaze System by looking at rectangular keys that are displayed on the control screen. To "press" an Eye gaze key, the user looks at the key for a specified period 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.

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 Eye gaze programs. The user calls up a desired program by looking at the Eye gaze key next to his program choice.

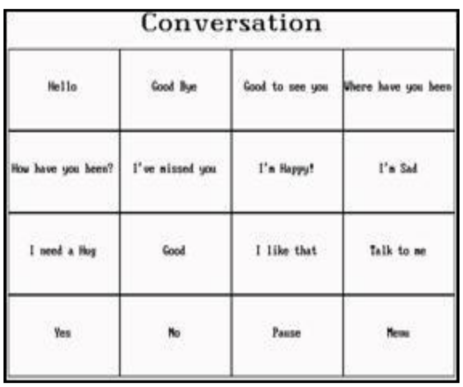


The software used here is NAYN 2.0

THE PHRASE PROGRAM:

The Phrases program, along with the speech synthesizer, provides quick communications for non-verbal 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.

It can effectively communicate with the user



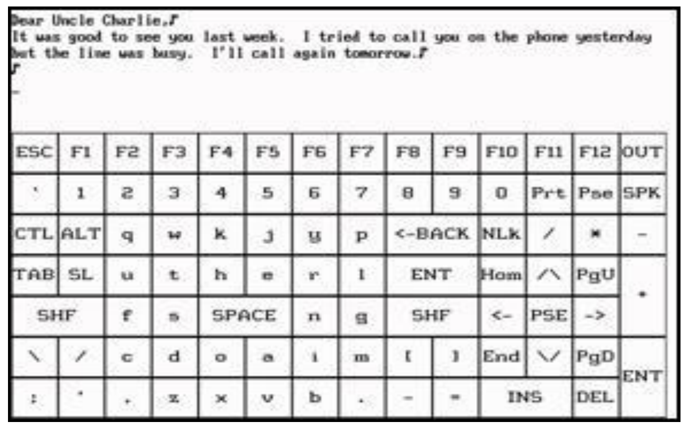
The telephone program:

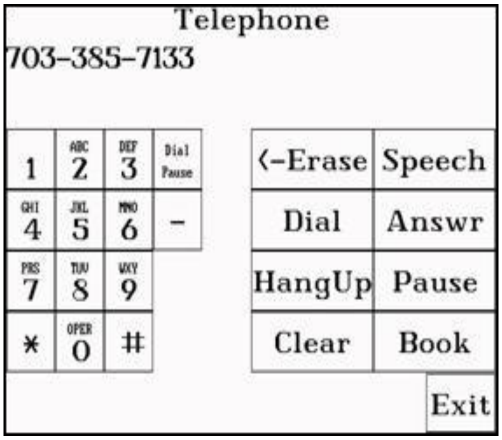
The telephone program allows the user to place and receive calls. Frequently used numbers are stored in a telephone "book". Non-verbal users may access the speech synthesizer to talk on the phone.

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,

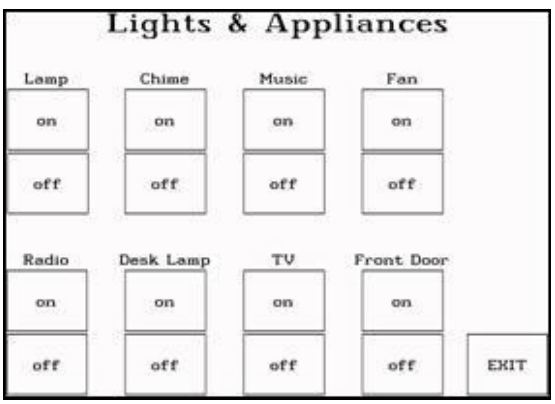
edited





The Lights & appliances Program:

The Lights & appliances Program which includes computer-controlled switching equipment, provides Eye gaze 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



There are several more operations which can be done using eye gaze system

REQUIREMENTS TO USE THE SYSTEM

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 about 24 inches in front of his face. He must be able to focus on one spot for at least 1/2 second.

The persons with the problem of …

1. **Nystagmus** (constant, involuntary movement of the eyeball)
2. **Alternating strabismus** (eyes cannot be directed to the same object, either one deviates)
3. **Homonymous hemianopsia** (blindness or defective vision in the right or left halves of the visual fields of both eyes)
4. **Cataracts** (clouding of the lens of the eye)
5. **Diplopia** (double vision)
6. In most cases, eye tracking works well with 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 Eye gaze System.

DISADVANTAGES:

- The disadvantage of this type of graphical systems, however, is the fact that the partner has to pay attention to the communication board when the subject is using it, and not to the subject; likewise, the subject has to look at the board, too instead of the partner's face. In addition, the subject must use another method to obtain the attention of someone who is not close by and attending.
- They are typically used by children with severe motor disabilities
- One of the main disadvantages of eye gaze techniques, however, are their dependence on the sensitivity of the person

who constantly pays attention to what the child is looking at.

- Eye gaze System must be operated in an environment where there is limited ambient infrared light
- Therefore, stray sources of infrared may degrade the accuracy or prevent Eye gaze operation
- the alternative method which are tried and implemented to solve the problems found in eye gaze technique is provided below

ALTERNATIVE METHODS TRIED:

The alternative method which can be implemented to solve the problems found in eye gaze technique is provided below One of the least expensive and simplest eye tracking technology is recording from skin electrodes, like those used for making ECG or EEG measurements. Because the retina is electrically active compared to the rest of the eyeball, there is a measurable potential difference between it and the cornea Electrodes are placed on the skin around the eye socket, and can measure changes in the orientation of this potential difference. However, this method is more useful for measuring eye movements than absolute position . It can cover wider range of movement than other tracking technology

FAILURE: less accuracy than other techniques

The most accurate, but least user-friendly technology uses a physical attachment to the front of the eye. A non-slipping contact lens is ground to fit precisely over the corneal bulge, and then slight suction is applied (mechanically or chemically) to hold the lens in place. Once the contact lens is attached, the eye tracking problem reduces to tracking something affixed to the lens, and a variety of means can be used. This method is obviously practical only for laboratory studies.

FAILURE: Very uncomfortable for the user to use so practically not possible

THE SYSTEM TRIED IN THE PAPER:

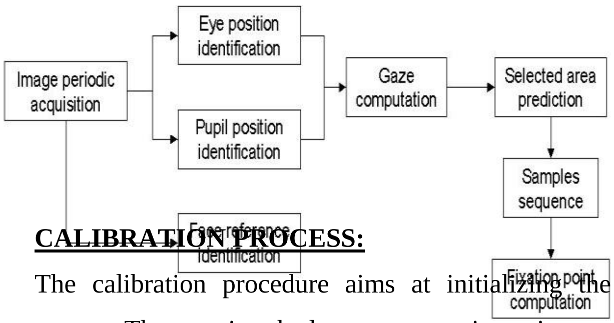
The approach described in this paper goes in the opposite direction, i.e. here the design tried is a very affordable eye gaze tool, whose hardware requirements are simply a personal computer and a cheap web cam. Performance, of course cannot be compared with the one of the most sophisticated systems, but our main goal was to demonstrate that acceptable results may be achieved with little investments.

SYSTEM DESIGN:

The system design refers to the software level, and consists in designing and implementing a set of algorithms to translate the eye movements into computer commands. Hardware requirements are simply a web cam connected to the computer USB port.

OPERATIONS:

The designed algorithms are based on geometric elements, and on image processing. This prototype aims at an accuracy level that does not identify the exact point in the screen, but the screen area on which gaze is directed. The practical goal of our system was to identify which part of the computer screen the user is looking at, where the screen is divided in a matrix of rectangular cells of the same size. This is meant to be applied to graphical communication boards. Some system parameters have to be customized according to the user, and therefore the system has to undergo a calibration procedure every time a new subject uses it. The web cam image is periodically acquired, and the implemented software computes the user’s gaze from these images. From the logical point of view, the system follows a list of steps:



CALIBRATION PROCESS:

The calibration procedure aims at initializing the system. The user is asked to gaze at series points on the screen, starting from the upper right corner and proceeding counterclockwise This procedure give rise to a sequence of points that will be used by the algorithm that computes the fixation points.

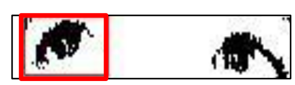
IMAGE ACQUISITION:

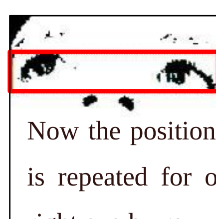
The web cam image acquisition is implemented via the functions of the AviCap window class, that is part of the Video for Windows (VFW) functions The web cam position is below the PC monitor; if it were above, in fact, when the user looks at the bottom of the screen the iris would be partially covered by the eyelid, making the identification of the pupil very difficult. The user should not be distant from the web cam, so that the image does not contain much besides his/her face. The algorithms that respectively identify the face, the eye and the pupil, in fact, are based on scanning the image to find the black pixel concentration: the more complex the image is, the slowest the algorithm is too. Besides, the image resolution will be lower. The suggested distance is about 30 cm

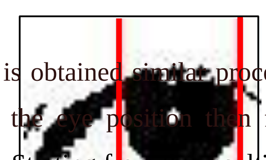
IDENTIFICATION OF PUPIL:

Here we are going to perform the series of operation which helps us to calculate the pupil position. The chosen process work on a binary (black and white) image, and are based on extracting the concentration of black pixels. Three steps are applied to the first acquired image, while from the second image on only the third one is applied.

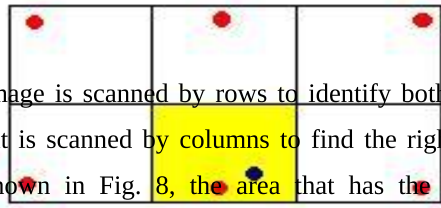
The first st... whose goal ...ntify the face position, is ...ed only t... mage, and the result will ...sed for ... the successive images, in order to speed up the process. This choice is acceptable since the user is supposed only to make minor movements. The image processing converts the image in black and white, and zooms. It to obtain an image that contains only the user's face. This is done by scanning the original image and identifying the top, bottom, left and right borders of the face. A graph is ploted between the black pixel vs Concentration







Now the position of face is obtained similar process is repeated for obtaining the eye position then for right eye by row operation Starting from the resulting image, the second algorithm extracts the information about the right eye position. Our system considers only the movement of one eye, that is suitable except in case of strabismus. This is done in two stages: first



the image is scanned by rows to identify both eyes, then it is scanned by columns to find the right one. As shown in Fig. 8, the area that has the higher concentration of black pixels is the one that contains the eyes. The algorithm uses this information to determine the top and bottom borders of the eyes area.

the data related to the right eye position are stored in a buffer and used also for the following images. This is done to speed up the process, and is acceptable so by repeating the process to obtain from larger area to smaller by similar methods. The method is as mentioned a graph is plotted between black pixels and concentration the pupil is focused by repetation of the process

FIXATION POINT:

This process starts from a given number of samples to calculate the coordinates of the fixation point, that will be used to determine the user's selected area on the screen. It is based on the concentration of gaze samples taken from consecutive images. Figure shows the gaze samples taken from 10 consecutive images: it is evident that most of the points are concentrated within a given area. The fixation point coordinates are then determined by the average of the points in that area.

The algorithm computes a new gaze sample from every image, and as a consequence it calculates a new fixation point. If it is inside the identified area it is assumed that it belongs to the same fixation (i.e. the user keeps looking at the same part of the screen). If the new fixation point is localized outside the area, two interpretations are possible. The first one is a momentary distraction of the user: if the next sample belongs again to the given area, that the previous one is discarded and the fixation is not considered to be changed. Otherwise a new fixation is hypothesized, and samples start to be collected to find its coordinates. A fixation is considered to be completed as soon as a suitable number of samples has been collected for computing the fixation point coordinates.

IDENTIFICATION OF AREA:

The selected area is identified (and the corresponding area on the computer screen changes color) thanks to the fixation coordinates and to the calibration procedure that the user has to undergo before starting to use the system. It consists in building a correspondence between some specific points on the screen (one for each of the areas that can be discriminated by the system) and the fixation points extracted by the algorithms. Each computed fixation point is compared to the "map" resulted from the calibration procedure, and based on this the algorithm determines the area the fixation point belongs to. for example, the black dot represents the computed fixation point, while the light dots are the results of the calibration procedure and constitute the "map". In this case it is evident that the fixation point belongs to the bottom-central area. This simple algorithm compares the coordinates of the fixation point and the calibration points, and selects the area corresponding to the minimum distance

Up until now, a small number of different users tested the system. The user could choose among six areas on the screen (two rows, three columns).
The minimum number of gaze samples to calculate a fixation point is three, and this causes a delay in the illumination of the selected screen area that is equal to the acquisition of three images. Careful illumination of the environment was necessary, in order to have good results.

ADVANTAGES:

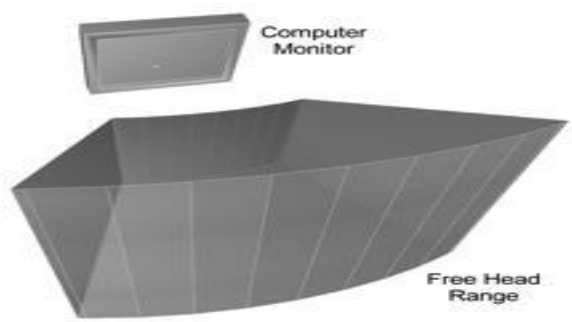
- This main advantage is this system is cost less the hardware requirement comes around 1500.
- Simple hardware requirements
- IR rays are replaced by simple image capturisation technique so non hazardous and can be carried anywhere
- Calibration takes place within 2-3 s
- All the process takes place are repeated several no of times and average is taken so it is accurate
- This new technology solves eyetracking's tolerance-to-head-motion challenge once and for all. The Eyegaze System accommodates all natural head motions during normal computer operation. The user can sit back, sit up, slouch down, move side to side, reach over to the mouse, operate the keyboard, and move close to the screen to examine a display at close range.
- The eyegaze system automatically acquires the eyes when the user enters the workspace, and it rapidly re-acquires the eyes when he returns his attention to the screen after turning his head away.

SYSTEM SPECIFICATION

Head	Motion	Volume:
Side to side	20 inches	(51 cm)
Up and down	12 inches	(30 cm)
Back and forth	15 inches	(38 cm)

Head Speed: 8 inches/sec (20 cm/sec)

Head Accelerations: 20 inches/sec-sq (50 cm/sec-sq)



CONLUSION:

- The solution presented in this paper has been thought for the Motor Neuron Diseases case study and some other disease . The approach, however, can be useful also for other disabilities that cause analogous communication impairments. The system shows that acceptable results can be obtained with few hardware requirements and simple image processing algorithms. The use of better image processing techniques, based on motion recognition, and eventually of more sophisticated cameras have the potentiality of highly improving performance without a substantial change in the followed approach.

- If this system is further improved with better image processing and other techniques makes the system more successful.

FUTURE ENHANCEMENTS:

- One of their primary objectives was to aid pilots in their weapons control. A pilot's hands are typically busy flying the plane, so the task of operating weapons systems at the same time can be quite difficult, particularly if flying in one direction and shooting in another. Eyetracking systems allow the pilots to observe and select targets with their eyes while flying the plane and firing the weapons with their hands.
- It is difficult for tank crews to operate computers while traversing rough terrain. Eyetracking allows an operator to focus on screen icons and, coupled with voice commands, effectively operate computers under battle conditions.
- A GUI interface gaming facilities can also be developed by this technique.
- These futuristic scenarios suggest that information on eye gazes--the way people look at an object--can be put to use to determine a person's mental work load and level of fatigue, to guide the design of computer displays to speed human processing of information, and to control computers. Other applications include controlling camera positions on robots and guiding an artificial intelligence system in recognizing enemy targets.

The performance of the system as follows:

• To allow the system to compute the fixation, the user has to gaze the selected area for 1-2 seconds;

• during this period, the average number of points considered as part of a fixation is 8;

• as a consequence, the computed samples per second are 1.67;

• since the number of samples necessary to compute a fixation is three, the consequent delay is slightly less than one second (0.12 seconds);

The perceived usability was good, even if the extension of the test to a larger number of users will give a better feedback.

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