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EYE writer

Under the supervision of

Professor

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Graduation Project for the year
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EYE Writer

The next generation of mouse control tool is real time tracking system based on combined image processing techniques.

Abstract

Most eye trackers based on active IR illumination require distinctive bright pupil effect to work well. How- ever, due to a variety of factors such as eye closure, eye occlusion, and external illuminations interference, pupils are not bright enough for these methods to work well. This tends to significantly limit their scope of application. We present a new real time eye tracking methodology that works under variable and realistic lighting conditions and various face orientations. By combining the conventional appearance based object recognition method (SVM) and object tracking method Kalman filtering based on active IR illumination; our technique is able to benefit from the strengths of different techniques and overcome their respective limitations. Experimental study shows significant improvement of our technique over the existing techniques.

Motivation

Eye writer helps people who born with amyotrophic lateral sclerosis "ALS" to continue their lives.
The computer can be considered as an ideal tool for enabling communication with such people, improving their life and making it more reliable.
1-ALS causes weakness with a wide range of disabilities Eventually, all muscles under voluntary control are affect, and individuals lose their strength and the ability to move their arms, legs, and body.
Sometimes called "Lou Gehrig's disease", is a rapidly progressive, invariably fatal neurological disease that attacks the nerve cells *(neurons)* responsible for controlling voluntary muscles (muscle action we are able to control, such as those in the arms, legs, and face). The disease belongs to a group of disorders known as motor neuron diseases, which are characterized by the gradual degeneration and death of motor neurons.
In USA according to National Institute of Neurological Disorder and Stroke "NINDS" More than 12,000 people in the U.S. have a definite diagnosis of ALS, for a prevalence of 3.9 cases per 100,000 persons in the U.S. general population.
2. People who were injured in an accident not of speech and movement to interact with implement computer applications in a meaningful way that requires minimal effort. We just want to help them to live normal life communicate, doing their work, playing video games, get online using social media Facebook, Twitter.

Methodology

1. **Sensor input**
   the camera captures video stream for eye.
2. **Interlaced image and video detector**
   there are two types of images:
   First image (back ground on + eye light on).
   Second image (back ground on + eye light off).
   -To obtain the desired bright pupil effect, we build an IR illuminator that illuminates person's eye and use an IR sensitive camera to acquire image.
   We can achieve the two types of images by using outer and inner LEDs.
   1. Bright eye.
   -Outer LEDs "off "
   - inner LEDs "on"
   2. Dark eye.
   - outer LEDs " on "
   - inner LEDs " off "

We have developed a circuitry to synchronize the outer ring of LEDs and inner ring of LEDs with the even and odd fields of the interlaced

image respectively so that they can be turned on and off alternately the interlaced input produce the even and odd field.

While both images share the same BG and external illumination pupils in the even image look significantly brighter than the odd image to eliminate the background and reduce external light illumination, the odd image is subtracted from the even image, producing the different.

3. Subtracting image.

Our project method use (eye on + BG off) - To Obtain this image by subtracting previous two image.

(first image – second image) = (eye on + BG off)

4. Smoothing

by using Gaussian bluer smoothing edges by creating an approximating function that attempts to capture important patterns in the data, while leaving out noise or other fine-scale structures/rapid phenomena. In smoothing, the data points of an image are modified so individual points (presumably because of noise) are reduced, and points that are lower than the adjacent points are increased leading to a smoother signal.

5. Adaptive threshold

Convert image to binary image "black & white"

6. Inverse adaptive threshold

convert black to white and white to black.

7. Supporting vector machine

one way to distinguish the pupil's blobs from other noise blobs is to use their geometric shapes. Usually, the pupil is an ellipse-like blob and we can use an ellipse fitting method to extract the shape of each blob and use the shape and size to remove some blobs from further consideration. For example, a blob with a large size or a large major-to-minor axis ratio should not be a pupil. We observe that there are still several non-pupil blobs left after binary blob elimination based on geometric properties because they are geometrically very similar to pupils. Thus we have to use other features. In the dark image, the region surrounding eyes have a unique intensity distribution. They appear different from other parts of the face. The appearance of an eye can therefore be utilized to separate it from non- eyes.

We map the locations of the remaining binary blobs to the dark image and then apply the Support Vector Machine (SVM) automatically identify the binary blobs that corresponding eye correspond to eyes.

*Sequence of erosion& dilation

Sequence of erosion& dilation deals with Gray Scale images only. Erosion shrinks and dilation ⊕expands the shape of image.

A). Dilation:

The opening off set X by structuring element B Is denoted an X⊕B, Is defined.

$X \oplus B = X + b = \{x + b : x \in X \ \& b \in B\}$

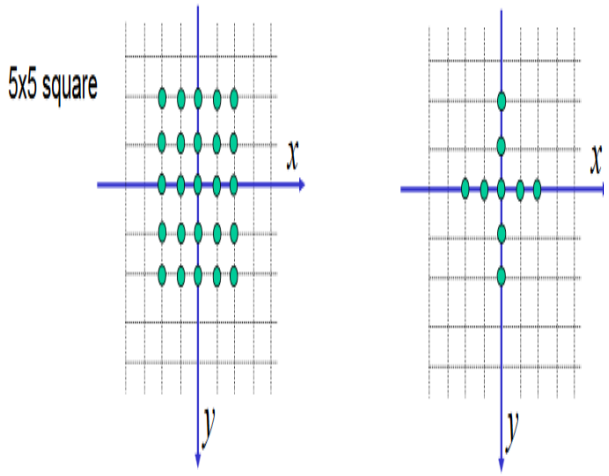
If X is any gray scale shape and B is symmetric structuring element.

The output of dilation is the set of translated points such that translate of the reflected structuring element has a non-empty intersection with X.

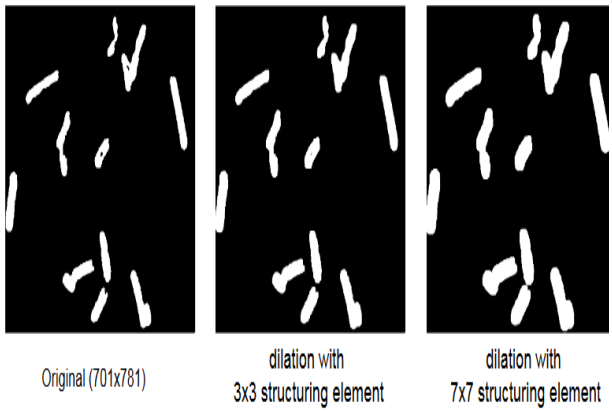
This equation is based on obtaining the reflection of B about its origin and shifting this reflection by b.

This dilation of X by B then is the set of all displacements, b, such that x and b overlap by at least one element. One of the simplest applications of dilation is for bridging gaps. The structuring element has used for repairing the gaps. The gaps have been bridged.

- **Example structuring elements:**



- **Binary dilation with square structuring element:**

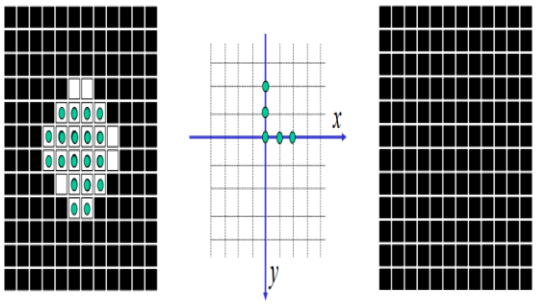


1. Expands the size of 1-valued objects.
2. Smoothed object boundaries.
3. Closes holes and gaps.

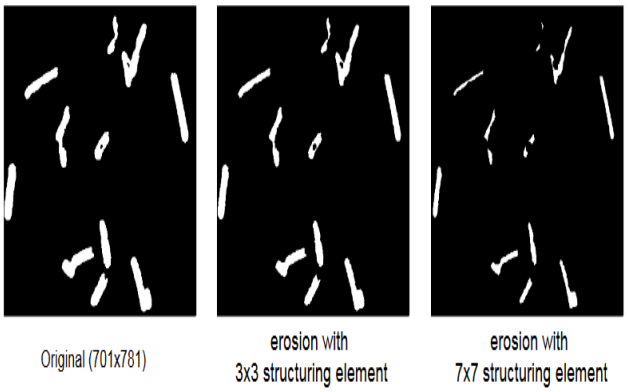
b) Erosion:

The opening off set X by structuring element B is denoted a XΘB, is defined. XΘB= X–b= {z: (B+ z) ⊆X}
If X is any gray scale shape and B is symmetric structuring element.
The output of erosion is the set of translation points such that the translated structuring element is contained in the input set X.
This equation indicates that the erosion of X by B is the set of all points b such that B, translated by b ,is contain X. e of the simplest uses of erosion is for eliminating irrelevant detail sin terms of size from the gray scale image .

- **Example structuring elements:**



- **Binary erosion with square structuring element**



1. Shrinks the size of 1-valued objects.
2. Smoothed object boundaries.
3. Removes peninsulas, fingers, and small objects.

8. Iris localization & momentum

by using this technique we defined a small area using to scan the whole frame to obtain maximum momentum.

9. Pupil detect

get the right position of the pupil).

10. Pupil tracking

using kalman filter to track, predict and correct pupil coordinates.

11. Desk top Mapping

convert pupil coordinates in the frame to coordinate in desktop Windows OS

12. Mouse events (movements& clicking)

using mouse events to write with on-screen keyboard and all Windows applications.

Results

1. Inexpensive Prototype cost about 300 LE (30$).
2. Accuracy of pupil detection 93% 28 fps of 30 fps.
3. Accuracy of pupil tracking 68% up to 96% depending on prototype calibration (focus and position) pupil in input frames.

Limitations

1. Camera Resolution (640*480 pixel_.
2. Frames captured per second (30 fps).
3. Improper usage may lead to wrong action**.**

Conclusion

In this project "EYE Writer" we help disabled people to use current technology.
We achieve low cost, high performance technology.
We reach to 90% of accurate tracking.

Future work

We will develop the project to work with:

1. Wireless connection and don't make the patient complain with lap top.
2. Compatible program self-install driver to make any one can use it.
3. Use small camera with 16 mega pixels embedded in the glasses to enhance images.
4. Not only for patients but Eye writer will be the next generation of mouse control tool.

Prepared by

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