Eye Tracking for ALS Patients

Sana Naghipour, Saba Naghipour, Phani Chavali , Ed Richter, and Arye Nehorai
Preston M. Green Department of Electrical and Systems Engineering

Abstract

The Eye tracker project is a research initiative to enable people, who are suffering from Amyotrophic Lateral Sclerosis (ALS), to use prosthetic limbs using their eyes by tracking the movement of the pupil. The project will be implemented in two main phases. The idea is to mount an infrared camera onto a pair of sunglasses and capture the movement of the pupil, and move the limbs using the control signal generated, based on the pupil movements. In this semester, we focused on developing software tools for tracking the motion of the eye. In the next semester, we will build the hardware necessary to control the prosthetic limbs.

Overview

Goal

To track the location of the pupil, in a live video stream using image processing techniques.

Approach

First Phase : development of the software for pupil tracking

Second Phase : building the hardware necessary to capture the images of the eye and transfer the images to a processing unit

Applications

Help ALS patients in various tasks such as communication, writing emails, drawing, making music.

Challenges

The challenges include but are not limited to developing algorithms that are: (i) fast, which obtain good frame rate (ii) robust, that are insensitive to lighting conditions and facial irregularities.

The picture is taken from the website: http://www.eyewritter.org. The image shows pair of infrared cameras mounted on sunglasses to detect the pupil movements of the patient.

Procedure Description

We implement our project in the following steps.

- **Image Acquisition**

We use Labview to capture the video using an infrared camera. There is support for recording of videos with several frame rates, and formats. After obtaining the video, we perform sequential frame by frame processing.

- **Discarding Color information**

We convert the images from all the frames into to their corresponding gray scale images. To do this, we average the pixel values in all the three color channel to obtain a gray scale image.

- **Low pass filtering**

We use low-pass filtering to remove the sharp edges in each image. This also helps to remove the undesired background light in the

- **Scaling**

We scale down the filtered images to obtain lower resolution images. This serves two purposes. First, since the dimension of the image decreases, scaling improves the processing time. Second, the averaging effect removes the undesired background light.

- **Template Matching**

We used a template matching algorithm to segment the darkest region of the image. Since after discarding the color information and, low-pass filtering, the pupil corresponds to the darkest spot in the eye, this method was used. We used a small patch of dark pixels as a template. The matching is done using exhaustive search over the entire image. Once a match is found, the centroid of the this block was determined to the pupil location. For the experiments, we used a block size of 5 x 5 pixels.

- **Determining the search space**

Since the exhaustive search over the entire image to find a match is computationally intensive, we propose an adaptive search method. Using this method, we choose the search space based on the pupil location from earlier frame. In this manner, using the past information, we were able to greatly reduce the complexity of the search. We used a search space of 75 X 75 pixels around the pupil location from the last frame.
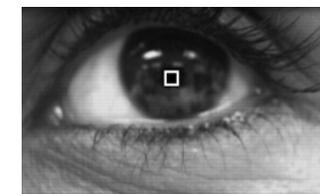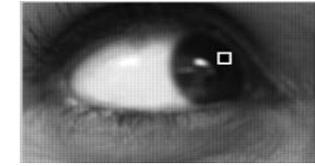
Experimental Setup

a) Experimental Setup
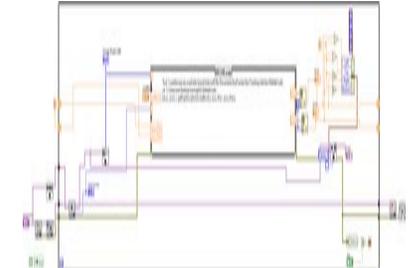
b) Labview instrument

Some Examples

Conclusion

An algorithm for estimating the position and the movement of the pupil is implemented using a template matching method. In the future, we will build the necessary hardware that uses the algorithm for prosthetic limb control.

References

1. http://www.eyewriter.org

2. P. W. Hallinan, Recognizing human eyes, in: SPIE Proceedings,Vol. 1570: Geometric Methods in Computer Vision, 1991, pp. 212{226.