Computer Input Control Based on Eyeball Movement

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ABSTRACT

An innovative method of accessing a computer completely hands-free, is what we intend to present in this paper. The computer shall now be accessible and easily maneuvered through, using merely one's EYES! The paper attempts to present a hands-free method of computer control by adjusting to the individual's pupil movement, simulating the same onto the cursor, and taking inputs that would otherwise be given by a mouse or keyboard that need hands to access. Indeed, one shall not only control a mouse using his eyes, but also access the complete INPUT methodology.
Keywords: Viola-Jones, Adaboost, Kalman filter, tracker.

1. INTRODUCTION

Using a personal computer seems like a piece of cake for us individuals who are fortunate enough to be able to use our hands. But for those differently able individuals born with the case of Amelia (defect of being born without one or more limbs), people undergone accidents leading to loss of limbs, or those suffering from ALS, paralysis or other motor-skill disabling diseases, using a computer becomes a tedious task. An alternate method thus becomes a necessity to make computer access viable. In most such cases of paralysis, the victim's eyes remain mobile. Using this to their advantage, and a technology apt enough to capture the eyes' movements and that of the individual eyeballs, the computer can be spontaneously accessed. This paper aims to introduce simple eye gestures like blinking, winking, and gazing as inputs to control and access a computer. The movements of the eyes shall be detected using basic webcams with resolution enough to capture the slightest eyeball movements and no external devices will be necessary.

The project aims at designing a Software that would be installed into a Desktop or Laptop; the software shall make use of a webcam to capture real time images of the user and then process these images to detect the eye using the Viola Jones eye detection technique [1] combining it with Kalman filter[2] for improved results [3]. Users shall be able to control clicks using blinks and winks along with options concentrating on gaze for selection. There will also be a side bar/tab to allow the user control features like drag, scroll, and multi-select and access the onscreen keyboard with combination keys.

2. LITERATURE REVIEW

2.1 Real Time Face Detection

To develop a system capable enough to detect a feature as minor as the eye, it is first necessary to localize the face and detect as well track it. The initial phase of face detection will make use of the Viola-Jones face detector, which consists of three aspects [1]. The first is the introduction of a new image representation called the "Integral Image" which allows the features used by the detector to be computed very quickly. The second is a simple and efficient classifier, which is built using the AdaBoost learning algorithm [6] to select a small number of critical visual features from a very large set of potential features [1]. The third contribution is a method for combining classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising face-like regions.

We will implement the full Viola-Jones Detector to localize the face in the image. The output of the face detector is an image region containing the face, which is then examined to predict the location of the eye. The facial feature detection method described here uses individual feature patch templates to detect points on the face [6].

2.2 Real Time Eye tracking

Multifarious computational methods can be used to detect and track the eye efficiently. However, of all, the use of Kalman filter algorithm [2] is comparatively advantageous for the dynamic measuring of the eye feature since it provides the following advantages; the Kalman filter being a recursive procedure, requires minimum amount of storage

for the past samples, it also provides an efficient mechanism for modeling slowly time-varying noisy systems. In addition, the accuracy of estimation can be assessed by monitoring the error covariance [5].

We will be using the methods introduced by Wenkai Xu and Eung-Joo Lee using rectangle features for tracking eye in dynamic situations [5] along with the Zhiwei Zhu and Qiang Ji's eye tracking method under variable lighting conditions and face orientations [4] for improved tracking. The reason behind selecting these two methodologies is that they use Viola's conception and add in new rectangle features to construct a cascade classifier for rough eye detection. The results from the classifier usually have some errors, such as eyebrows, mouth, nares, larger or smaller eyes, so geometric features are introduced to detect the eye location accurately. An integrated eye tracker to overcome the effect of eye closure and external illumination by combining Kalman filter with Mean Shift algorithm is presented. This eye tracker can robustly track eyes under variable and realistic lighting conditions and under various face orientations. In addition, this integrated eye tracker is able to handle occlusion, glasses, and simultaneously tracks multiple people with different distances and poses to the camera [5].

3. EXISTING SYSTEMS

3.1 Camera Mouse

The Camera Mouse is an existing software developed by Margrit Betke and Peter Fleming to track the computer user's movements with a video camera and translate them into the movements of the mouse pointer on the screen. Body features such as the tip of the user's nose or finger can be tracked. The visual tracking algorithm is based on cropping an online template of the tracked feature from the current image frame and testing where this template correlates in the subsequent frame. The location of the highest correlation is interpreted as the new location of the feature in the subsequent frame. Various body features are examined for tracking robustness and user convenience [7].

The system is apt enough to try various body features including the eye as a whole, but tracking the pupil and determining gaze direction is not achieved.

3.2 Eye Tracking device by Tobii Technologies

Tobii Technology sells commercial eye-trackers that are used by a number of people for basic human-computer interaction as well as gaming. Tobii Technology offers camera-based eye tracker systems where the light source and camera are permanently affixed to a monitor. Tobii currently offers two lines of such systems, the new T/X-series line and the existing 50-series line. Of the two lines, the model T60 and the model 1750 are the most directly comparable systems. Tobii trackers utilize near-infrared pupil-center/corneal-reflection eye tracking. All Tobii eye trackers communicate via a Tobii Eye Tracker (TET) server. The TET server is responsible for performing image processing on the camera video feeds and for mapping from image parameters to screen coordinates. The TET server communicates over TCP/IP allowing the server to run separately from the PC receiving the tracker reports [8].

3.2.1   Tobii PCeye Go

The PCeye Go is a peripheral eye tracker that runs on standard desktops and laptops using Windows, allowing the user to work with any application that is controlled by a standard computer mouse. Accompanying PCEye Go is the Tobii Gaze Interaction Software, which eliminates the need for a physical mouse, switch or keyboard. The Control software has two components, Mouse emulation, which replaces the traditional mouse cursor with the user's gaze, and Tobii Gaze Selection. Gaze Selection makes it possible to control your desktop, or any other application, through an intuitive two-step process that reduces the risk of unwanted clicks [9].

In the working mode, the PCeye Go provides a task bar on one side of the screen with the options hover, gaze scroll, click, double click, right click, drag and keyboard. Having a separate taskbar helps with avoiding unwanted clicks. Also not having blink detection helps with avoiding clicks from casual behavioral blinks and blinks from sneezes as well.

4. PROPOSED SYSTEM

The system we intend to introduce shall be able to track even minor variations in pupil movements by comparing current frames with previous frames using images captured by webcams having minimum 1.3 Mega Pixels resolution. Kalman filters will be used here too for improved results in capturing movements.

4.1 Calibration

The initial step of the system will be calibrating the position of the eye in order to make sure the webcam can detect the eye effectively. The user must not be more than 2 feet away from the webcam for proper working of the system. The system shall first identify the user's face, detect it and then detect the eyes. Once done, the system shall concentrate merely on the movements of the pupils; this movement shall not be disturbed by external features like the movement of the eye or the head as a whole.

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To ensure proper working the system will ask the user to calibrate the tracker by gazing at 9 points on the screen. These points being scattered on the screen in the form of a 2D array in a 3 by 3 square, capturing the entire screen from corner to corner. Once calibration is achieved, the system shall move into the working stage. If due to the movement of the head, the calibration is lost, the system shall request for recalibration.

4.2 Working mode

Once the calibration is done, the system shall the provide the user with the usual desktop screen along with a taskbar on either sides of the screen. The user may choose the position of this task bar from the settings menu.
Our system shall read the click, double click and right click inputs by reading the movement of the eye.

4.2.1 Click (blink)

To use the click or select function of the generic mouse, the user will have to blink both his/her. We will be using the blink detection techniques in [3]. To avoid unintentional inputs from motions likes sneezing and occasional blinking, the blink duration for a left-click shall be at least 1 second. The user may also choose to vary this duration according to convenience. Any blink that is shorter or longer than the intended set duration by more than 0.2 seconds shall be ignored.

4.2.2 Double Click (blink twice)

In order to double click, the user will have to blink twice, each blink being of the same length as the set duration. The interval between the two blinks shall be less than 0.2 seconds too.

4.2.3 Right Click (wink)

In order to right click, the user will have to wink using either eye [3]. The wink duration shall work similar to the mechanism followed by blink for single clicking. Winking shall open any properties of the selected or hovered over area, just like the function of a generic mouse at its right click.

4.2.4 The Task Bar

The task bar on the screen shall look as in Figure 1 and shall have the following functions:

Figure 1 Taskbar, as will be seen on the screen.

a. Scroll

The user shall be able scroll through the pages after using this option from the task bar.

b. Drag

The user will be able to drag and drop items with the option on the task bar. The will be able to drag and drop even multiple items that have been selected.

c. Multi-select

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This function is analogous to the drag function when used with a generic physical mouse; but the reason for having a separate option here is to avoid discrepancies where the user accidently drags any multi-selected items unintentionally.

d. Keyboard

By selecting this option, the user will be provided with an onscreen keyboard, which will have the Swype feature for quick typing of words [10]. The Swype technique is used for touchscreen devices for fast typing and this feature shall prove extremely effective with gazing.

When using this option, the user will still have access to other taskbar options without hiding the keyboard. The user will have to gaze back at the keyboard in order to hide it from view.

e. Multi-Key

This option will only appear in the taskbar when the onscreen keyboard is selected. It will allow the user to select combination keys, e.g. Alt+F4.

In order to access any of these features from the taskbar, the user will have to first gaze at the selected area on the screen, then gaze at the option on the task bar and then back at the selected icon or area; except with the keyboard.

5. SCOPE

The project has immense number of applications in all kinds of fields including research and commercial sectors. After future advances in gaze technology, the generic mouse and touch screen could be completely replaced with the eye tracker for absolute computer access. It cannot be used by people with disabilities but also by people who prefer to access their computers visually.

After future advance, the similar functions could be migrated to more complex devices and gadgets like mobiles as well gaming consoles.

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