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Eye Phone

[1]Ilma banu.W and [2]Archana.S,
[1,2]Department of computer science, St.joseph of college of arts and science for Women, Hosur ,Tamil Nadu, India

Abstract - As smart phones involving researchers are studying new techniques for easy to human interaction. We propose EYE PHONE, a novel "HAND FREE" system capable of driving mobile applications / functions using only the user eye movement and actions Example: wink. Eye phone tracks users eye movement across the phone display using the camera mounted on the front of the phone; more specifically machine learning algorithms are used to:

- Track the eye and position of the mobile phone display as a user views a particular application.
- Detect eye blinks that emulate mouse clicks to activate the target application under view

We present a prototype implementation of eye phone on a Nokia N810 which is capable of tracking the position of eye on the display mapping this positions to an applications that is activated by a wink. At no time does the users have to physically touch the phone display.

Keywords - *Human-phoneinteraction, mobile sensing systems, machine learning, mobile phone*

I. INTRODUCTION

Human computer interaction (HCI) researchers continuously searching for new approaches to reduce the effort users exert when accessing application on mobile phones. The most significant innovation of the past few years in the adoption of touch screen technology introduced with the Apple iPhone and recently followed by all other major vendors, such as Nokia and HTC. The touch screen has changed the way people interact with their mobile phones provides actions using the movement of one or more fingers on the display (example: pinching –photo to zoom in and out,(or) panning to move a map)Several reason research projects demonstrate new people to mobile phone interactions technologies for Example, to infer and detect gestures made by the user, phones use the on board accelerometer, camera, specialized headsets, dedicated sensors or radio features we take a different approach than that found in the literature and propose the Eye Phone system which exploits the eye movement of the user captured using the phone's front facing camera to trigger actions on the phone. HCI research as made remarkable advances over the last decade facilitating the interaction of people with machines.

Figure 1 : The Eye Tribe

The interaction between people and computers in "ideal" environment (i.e) where peoples sit in front of a desktop machine with specialized sensors and cameras centered on them .double tapping the phone to stop an incoming phone call. HPI application the different light conditions and blurred video frames due to mobility make the use of the camera to infer events very challenging.

- HPI technology should be less intrusive
- It should not rely on any external devices
- It should be readily usable with minimum user dependency as possible
- It should be fast in the inference phase
- It should be light weight
- It should be preserve the phone user experience .

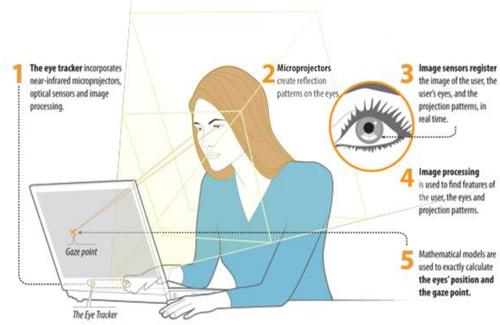

Figure 2: Eye direction

We believe that HPI research advances we produce a leap forward in the way people use their mobile phones by improving peoples safety we propose Eye phone the first system capable of tracking a users eye movement and its current position on the display.

II. HUMANPHONE INTERACTION (HPI)

Human phone interaction represents an extension of the field of HCI since HPI addressed specifically driven by issues of mobility, the form factor of the phone, and its resource limitations Example: energy and computation.

A. Mobility Challenges

A Mobile phones is subject to uncontrolled movement (i.e) people interact with their mobile phones while stationary, on the move, etc .it is almost impossible to predict. one of the immediate products of mobility is that a mobile phone is moved around through unpredicted context (i.e) situations and scenarios that are hard to see or predict during the design phase of a HPI application.HPI application should be able to operate reliably in any encountered condition Example: two HPI applications, one using accelerometer ,the other relying on the phone's camera.

Figure 3: Access granted

B. Hardware challenges

As supposed to HCI applications, any HPI implementation should not rely on any external hardware. Asking people to carry or wear additional hardware in order to use their phone might reduce the penetration of the technology. Moreover, state of the art HCI hardware, such as glass mounted cameras or dedicated helmets are not yet small enough to be conformably worn for long periods of time by people.HPI solutions should adopt lightweight machine learning techniques to run properly and energy efficiently on mobile phones.

Figure 4: Mobility challenge

II. EYE PHONE DESIGN

One question we address in this paper is how useful is a cheap, ubiquitous sensor such as the camera, in building HPI application. We develop eye tracking and blink detection mechanisms based algorithms originally designed for a desktop machines using USB camera. The eye phone algorithmic design breaks down into the following pipeline phases.

- An eye detection phase
- An open eye template creation phase
- An eye tracking phase
- A blink detection phase

A. Eye Detection

By applying a motion analysis techniques which operates on consecutive frames, this phase consist on finding the contour of the eyes. We obtain errors when the algorithm is implemented on the phone due to quality of the N810 camera compared to the one the desktop and the unavoidable movement .

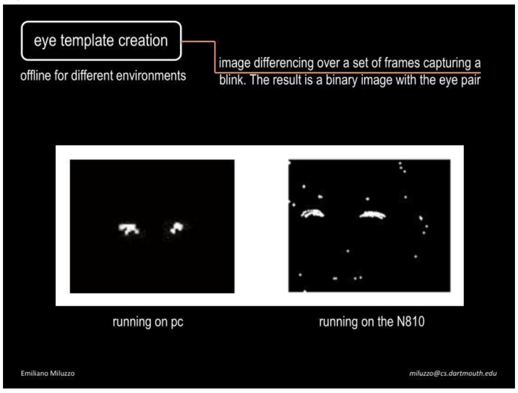

Figure 6 : Template creation

B. Open Eye Template Creation

While the authors in adopt an online open eye template creation by extracting the template every time the eye pair is lost eye phone does not rely on the same strategy.

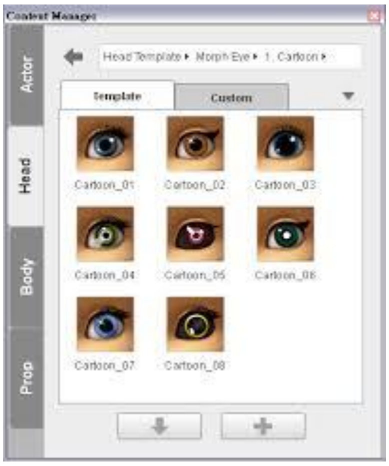

Figure 7 : Eye detection

A. Eye Tracking

The tracking algorithm is based on template matching. The template matching function calculates a correlation score between the open eye template, created the first time the application is used, and a search window. The search window is limited to a region which is twice the size of a box enclosing the eye.

Figure 7 : Eye tracking

B. Blink Detection

To detect blinks we apply a thresholding technique for the normalized correlation returned by the template matching function as suggested in however, our algorithm differs from the one proposed in .In the authors introduce a single threshold T and the eye is deemed to be open if the correlation score is greater than T, and closed vice versa. In the eye phone system, we have two situations to deal with:

- The quality of the camera is not the same as a good USB camera.
- The phone's camera is generally closer to the person's face than is the case of using a desktop and USB camera

Figure 8: Blind detection

C. Legend

- DS =eye tracking accuracy measured in daylight exposure and being steady.
- AS = eye tracking accuracy measured in artificial light.
- Exposure and being steady.

Figure 9 : Legend

- DM=eye tracking accuracy measured in day light exposure and walking.
- BD =blink detection accuracy in day light exposure.

D. Eye Tracking

Eye tracking is a technique that captures eye behavior in response to a visual stimulus (Eg: computer interface, photograph, page in a newspaper, TV commercial). When using eye tracking.

G. Usability Testing

The interaction between the user and the screen is mediated by the eye. We evaluate usability based on visual behavior as well as clicks, errors and interview feedback.

H. Marketing Research

The eye is the window to the mind of the consumer. We use advanced eye tracking technology along with traditional methods to meet your marketing research objectives.

I. Scientific Applications

The potential uses for eye tracking are limitless. As industry leaders, we have applied our technology and expertise in a range of important fields of science

J. Eye Works TM

Eye Works™ is the only eye tracking software developed by researchers for researchers. This powerful package is compatible with more eye trackers than any other platform and includes all the tools you'll need to conduct advanced research in any field.

K. Software

The success of your eye tracking study depends on the effectiveness of your software. We have developed the tools to take your research to the next level.

L. Cognitive workload

The ability to measure mental effort is invaluable. Our patented cognitive workload algorithm captures a direct signal from the brain as it is transmitted through the pupil.

M. Capabilities

The researchers at Eye Tracking, Inc. wear many hats. From marketing and usability to software and science, we have driven innovation in eye tracking for over a decade.

IV. ADVANTAGE OF EYE TRACKING

- Eye movement is faster than other current input media
- No training or particular coordination is required of normal users
- Can determine where the user's interest is focused automatically
- Helpful for usability studies to understand users interact their environments

A. Potential application

- Eye gaze correlation for videoconferencing
- Maximizing controller's efficiency, minimizing dangers in air traffic displays
- Potentially could provide new and more effective methods of computer-human interaction

B. Easy

- Intuitive user interface
- Real-time feedback of eye movement data
- Very quick set up. No complicated hardware to configure, simply install the PCI card in your computer and load the software

C. Flexible

- Select between 30Hz and 60Hz operation methods
- Robust against different lighting conditions
- Pupil-only tracking, glint-only tracking, or choose pupil-glint vector tracking that provides tolerance to head movements
- Choose between Dark Pupil or Bright Pupil tracking
- Visual range +/-44% of visual are horizontal and +/-20%vertical

V. INTERACTION ANALYSIS

The new generation of smart phones has been revolutionized with the introduction of technologies like touch screen accelerometer, gyroscope, photo camera, etc. These innovation in conjunction with the increase in hardware performance, allows a different approach in the use of these devices improving user experience and interaction. Several recent research projects demonstrate how the interaction with mobile phone technologies improved.

VI. EVALUATION

In this section, we discuss initial results from the evaluation of the eye phone prototype, we implement eye phone on the Nokia N810.The N810 is equipped with a processor(400 MHz),RAM(128 MB),operating (Maemo 4.1, a unit based platform) (open source computer vision).

Figure 10 : Flexible

- Daylight exposure analysis for a stationary subject
- Artificial light exposure for a stationary subject
- Daylight exposure for person walking
- Impact of distance between eye and tablet
- System measurements

A. *Daylight Exposure*

The first experiment shows the performance of Eye-Phone when the person is exposed to bright daylight, i.e., in a bright environment, and the person is stationary. The inner white box in each picture, which is a frame taken from the front camera when the person is looking at the N810 display while holding the device in their hand, represents the eye position on the phone display. It is evident that nine different positions for the eye are identified

B. *Artificial Light*

In this experiment, the person is again not moving but in an artificially lit environment (i.e., a room with very low daylight penetration from the windows). We want to verify if different lighting conditions impact the system's performance. The results, shown in Table 1, are comparable to the daylight scenario in a number of cases. However, the accuracy drops. Given the poorer lighting conditions, the eye tracking algorithm fails to locate the eyes with higher frequency.

VII. IMPACT OF DISTANCE BETWEEN EYE AND TABLETS

Since in the current implementation the open eye template is created once at a fixed distance, we evaluate the eye tracking performance when the distance between the eye and the tablet is varied while using Eye Phone. We carry out the measurements for the middle-center position in the display (similar results are obtained for the remaining eight positions) when the person is steady and walking.

A. *System measurements*

In Table we report the average CPU usage, RAM usage, battery consumption, and computation time of the Eye Phone system when processing one video frame – the N810 camera is able to produce up to 15 frames per second. EyePhone is quite lightweight in terms of CPU and RAM needs. The computation takes 100 msec/frame, which is the delay between two consecutive inference results .In addition, the Eye Phone runs only when the eye pair is detected implying that the phone resources are used only when a person is looking at the phone's display and remain free otherwise. The battery drain of the N810 when running the EyePhone continuously for three hours is shown in the 4th column of Table .

B. *Application*

An example of an EyePhone application is Eye Menu as shown in Figure. Eye Menu is a way to shortcut the access to some of the phone's functions. The set of applications in the menu can be customized by the user.

Figure 12 : Eye menu

The idea is the following:

- The position of a person's eye is mapped to one of the nine buttons.
- A button is highlighted when EyePhone detects the eye in the position mapped to the button.
- If a user blinks their eye, the application associated with the button is lunched.
- Driving the mobile phone user interface with the eyes can be used as a way to facilitate the interaction with mobile phones or in support of people with disabilities.

C. *Car driver safety*

Eye Phone could also be used to detect drivers drowsiness and distraction in cars. While car manufactures are developing technology to improve drivers safety by detecting drowsiness and distraction using dedicated sensors and cameras. Eye Phone could be readily usable for the same purpose even on low-end cars by just clipping the phone on the car dashboard.

Figure 14 : Record

FUTURE WORK

We are currently working on improving the creation of the open eye template and the filtering algorithm for wrong eye contours. The open eye template quality affects the accuracy of the eye tracking and blink detection algorithms. In without needing to either write on paper or type on a computer. A similar project evaluated on the iPhone has recently been proposed [8]. The uWave project [7] exploits a 3-D accelerometer on a Wii remote-based prototype for personalized gesture recognition. Phones can be used as radars as in [10] where proximity based sensing is used to infer speed of surrounding

RELATED WORK

There are a number of developments in HCI related to mobile phones over the last several years [4, 5, 23, 6, 7, 8, 9, 10]. Some of this work exploits accelerometers on the phone in order to infer gestures. The Phone Point Pen project [4] is the firsT example of a phone being transformed into a pen to write in the air in order to quickly take small notes

CONCLUSION

In this paper, we have focused on developing a HPI technology solely using one of the phone's growing number of on board sensors, i.e., the front-facing camera. We presented the implementation and evaluation of the Eye Phone prototype. The Eye Phone relies on eye tracking and blink detection to drive a mobile phone user interface and activate different applications or functions on the phone. Although preliminary, our results indicate that Eye Phone is a promising approach to driving mobile applications in a hand-free manner.

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