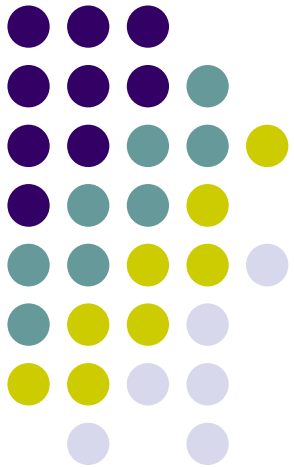
# Mobile and Ubiquitous Computing
# CS 525M:
# Input devices and Mobile HCI

Baoyuan, Xing

*Computer Science Dept.*

*Worcester Polytechnic Institute (WPI)*



# *Human Phone Interaction : EyePhone*

http://www.youtube.com/watch?v=lyBZgfAdNlg

*Human Phone Interaction (HPI) represents an extension of the field of Human Computer Interaction (HCI)*

*Challenging issues in HPI :*

- *Mobility*
- *Resource limitations*

***EyePhone: Interact with the phone via eye***

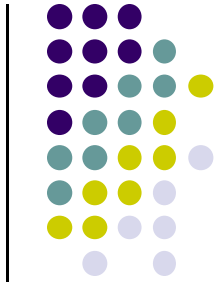
*Advantages :*

*No degrade from noise*

*Kind of interesting*

*Easy to use by disabilities*

# *Related work*



*Lots of developments in HPI using eye interaction over the last several years [5,23,11,13]*

- *The eyeSight technology, simple hand gestures over the camera used to control the phone [5].*
- *The OpenEye relies on an eyeglasses mounted camera to track a person's eyes to realize HCI applications[23].*
- *Fixed cameras in desktop machine picks up eye movement and uses the eye as a mouse in [11], or to enable general HCI applications [13].*

*However, these systems are for static machines, using a specific fixed infrastructure of external sensors and cannot be easily replicated on mobile phones*

# *Designs in EyePhone*

- *Pre-processing for image to locate eyes contour*

  ***Challenge*** *: unavoidable movement in HPI*

  ***Solution :*** *reduce the resolution of image*

  *filter the false eye contour using threshold*

- *Eye Template*

  *Created by users individually, stored in memory*

  *(distance of about 20 cm from the eyes)*

  *Save time & Save energy*

  *(Compared with using online eye template)*

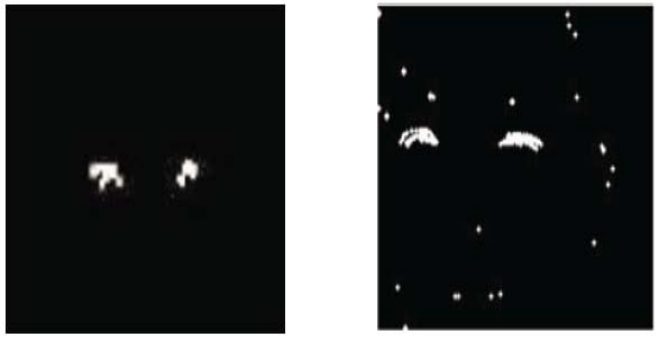
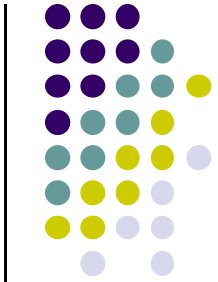


Figure 1: Left figure: example of eye contour pair returned by the original algorithm running on a desktop with a USB camera. The two white clusters identify the eye pair. Right figure: example of number of contours returned by EyePhone on the Nokia N810. The smaller dots are erroneously interpreted as eye contours.

# *Designs in EyePhone*



- *Eye Tracking*

  *Calculates a normalized correlation score (range : [-1,1])*
  *Greater than 0.4 is viewed as true positive*

  *Search window is limited to a region(twice open eye size)*
  *Reduce computation time*

- *Blink Detection*

  *Two issues compared with HCI :*
  *Quality of the camera is not the same as a good USB camera*
  *Camera is closer, causing iris movements detected (i.e. eyeball rotation)*

  *Fixed four thresholds are used to detect blink based on experiments*

# *Evaluation of EyePhone*

*Phone : Nokia N810 , OS: Maemo 4.1, a Unix based platform*

## Eye tracking and blink detection

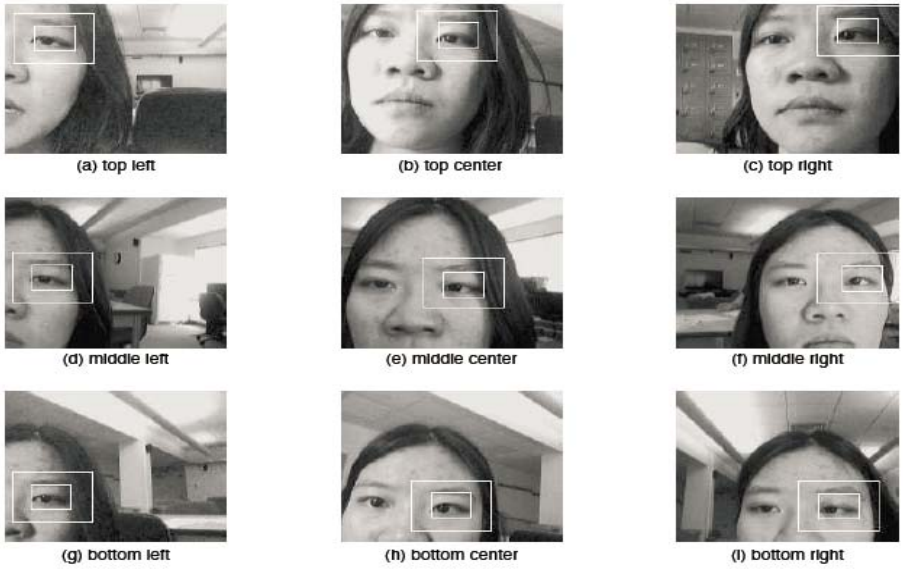
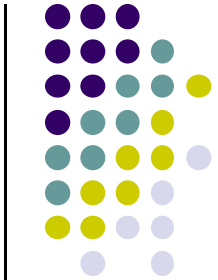



Figure 2: Eye capture using the Nokia N810 front camera running the EyePhone system. The inner white box surrounding the right eye is used to discriminate the nine positions of the eye on the phone's display. The outer box encloses the template matching region.


Figure 4: EyeMenu on the Nokia N900. While looking the display, a button is highlighted if it matches the eye position on the display. The highlighted button is ready to be "clicked" with a blink of the eye. In this example, the user is looking at the SMS button and the SMS keypad is launched by blinking the eye.

# *Evaluation of EyePhone*



## Accuracy of eye tracking and blink detection in different situations

(All experiments are repeated five times and average results are shown)

**DS**: Daylight exposure & stationary

**AS:** Artificial light exposure & stationary

**DM:** Daylight exposure & walking;

**BD :** Blink detection accuracy in daylight

| Eye position | DS | AS | DM | BD |
|---|---|---|---|---|
| Top left | 76.73% | 74.50% | 82.81% | 84.14% |
| Top center | 79.74% | 97.78% | 79.16% | 78.47% |
| Top right | 80.35% | 95.06% | 60% | 82.17% |
| Middle left | 98.46% | 97.19% | 70.99% | 74.72% |
| Middle center | 99.31% | 84.09% | 76.52% | 79.55% |
| Middle right | 99.42% | 75.79% | 65.15% | 80.1% |
| Bottom left | 98.36% | 93.22% | 78.83% | 74.53% |
| Bottom center | 90.76% | 71.46% | 85.26% | 67.41% |
| Bottom right | 84.91% | 93.56% | 78.25% | 72.89% |

## System Measurements

Table 2: Average CPU usage, RAM usage, and computation time for one video frame. The front camera supports up to 15 frames per second. The last column reports the percentage of used battery by EyePhone after a three hour run of the system.

| CPU | RAM | Computation time | Battery used after 3h |
|---|---|---|---|
| 65.4% | 56.51% | ~100 msec | 40% |

# *Evaluation of EyePhone*

## Impact of Distance Between Eye and Phone

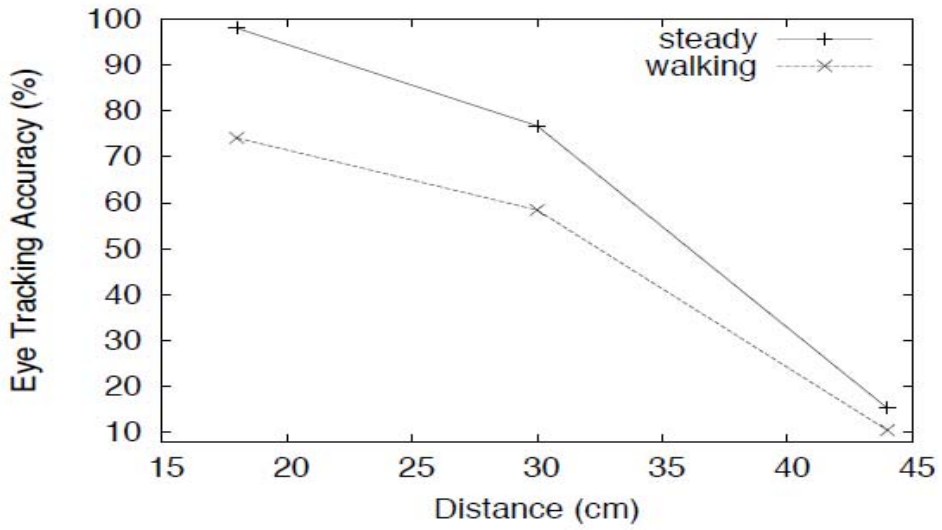
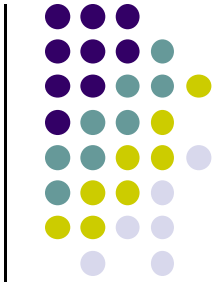



**Figure 3: Eye tracking accuracy for the middle-center position as a function of different distances between the N810 and the eyes when the person is steady and walking.**

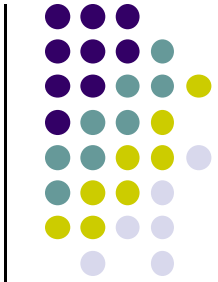
*Accuracy degrades if distance more than18-20 cm, as expected*

# *Conclusion*



- Design and implement a HPI called EyePhone using front camera.
- EyePhone relies on eye tracking and blink detection, to allow users activate the apps on the phone by eye blink
- Although preliminary (yes, it is quite preliminary), results indicate that EyePhone is a promising approach to driving mobile applications in a hand-free manner.

# *Future work and some apps*



*Two issues :*

- ***Creation of the open eye template***

  One-time template might not match the eye in other environments

  i.e. Template created in daylight does not match the eye in darker setting

- ***Filtering algorithm for wrong eye contours***

  Fixed threshold policy is not perfect.

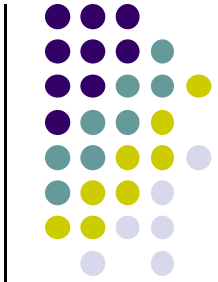
  Adaptive filter with machine Learning is better

*Simple Applications :*

- ***EyeMenu:*** *Launch apps using eye blink, used by disabilities.*

- ***Car Driver Safety:*** *Detecting drowsiness and distraction*

# *Discussion*



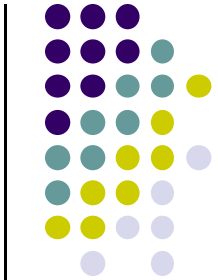
***Questions:***

- *How to know if the eye blink is to interact with phone or just for blinking*

- *In the video, the phone is exactly in front of the face. What is the tolerance of phone with some angle towards the eye.*

*Thank you !!!*

# *References*




[5] eyeSight. http://www.eyesight-tech.com/.

[11] The Eye Mouse project. http://www.arts.ac.uk/research/eyemouse/index.htm.

[13] M. Chau and M. Betke. Real Time Eye Tracking and Blink Detection with USB Cameras. In Boston University Computer Science Technical Report No. 2005-12, 2005.

[23] D. Li, J. Babcock, and D.J. Parkhurst. openEyes: a Low-Cost Head-Mounted Eye-Tracking Solution. In2006 Symposium on Eye Tracking Research & Applications, page 100. ACM, 2006.