# Development of Communication Assistant Application with Blinking for Physically Handicapped Children and Elderly People

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## 1. Introduction

Special support schools in Japan need some communication assistant tools especially for physically handicapped children. Their body movements are very limited and many of them also have mental disorders, so they cannot communicate with their families or caregivers. It prevents helpers from understanding what they really need or think. Taking the situation into consideration, we tried to develop a communication support tool operating by blinks for physically handicapped children. We used front cameras on tablets (iPad, iPad mini of Apple Inc. iOS5.0). After several verifications and examination, we have developed a contactless communication assistant application “Eye Talk” and “Eye Tell”. These applications do not malfunction by surroundings, such as brightness or differences of eye shapes. These applications detect only conscious blinks to choose letters and emit them. We have expanded this study to analyze the eye movements and acquire directions of lines of sight. If blinks and directions of lines of sight are detected precisely, we can lighten burdens of users to operate these applications. And also, this system is expected to use for a lot of fields without using expensive equipments if we can simplify and accelerate the process and improve the accuracy of determination. Front cameras of tablets usually have low sensitivity. So if we try to process pictures continuously in real time, it freezes because of the heavy data. Therefore, to increase the accuracy of processing picture data and to detect blinks without freezing are the two most important aims for this study.

## 2. Purposes of the study

- To determine blinks without errors
- To determine only conscious blinks
- To remove unconscious blinks
- To exclude smiling shapes of eyes
- To remove moving of faces
- Not to be influenced by surroundings (lights)
- Not to be influenced by colors of skins
- To react with weak blinks

Processes of improvement of the precision to detect blinks are as follows:

1) To detect an eye area (using OpenCv Haar-like eye-detection)
2) To determine closing of eyes by spiral labeling
3) To determine closing of eyes by brightness
4) To determine closing of eyes by saturation
5) To remove unconscious blinks or moving of eyes (to determine closing of eyes by complexity)
6) To determine closing eyes by afterimage.

We chose OpenCv, a library of programming functions for real time computer vision for image processing. To determine closing of eyes, we used spiral labeling first. Spiral labeling is a method to determine a blink when the size of the iris is lower than the threshold. But many physically handicapped children tend not to be able to open their eyes wide enough and their iris is relatively small, so it is difficult to detect the starting pixels in their pupils.
Next, we determined closing of eyes by using Value in HSV (Hue, Saturation, Value). In this method, we enlarged only necessary parts and executed sizing based on the coordinate information of the eye area detected by the Haar-like classifier. Then we obtain the average brightness of the eye area. When someone closes his/her eyes, the average will rise. We determine it as eye closing. However, the classrooms of most special support schools are relatively dark to avoid giving extra impetuses to children, so we cannot get enough light.
Then we devised a method using saturation. In this method, we calculated the average of saturation of the iris and white area of eyes (0 to 255 in saturation of HSV). If the measured value is lower than the average of saturation, we determine it as closing of eyes. To determine closing of eyes by saturation has extremely good sensitivity, but it detects very small changes such as unconscious blinks and movements of eyes or a face. In order to eliminate false determinations due to unconscious blinks while maintaining a high sensitivity, we used complexity of the image to determine closing of eyes. The complexity of the image is the margin between the edge of the images based on the difference of contours of eyes when they open and close. We determine eyes were closing when the pixel becomes flat. We can control to detect unconscious blinks or movements of irises by using the threshold of complexity. It is possible to prevent malfunctions due to squinting or facial movements with this method.
Some of the subject children cannot blink strongly enough. So we need to detect the unconscious blinks that we excluded. Therefore, it is necessary to increase the processing power. Since the tablet is fixed to the bed, we detect the position of eyes using OpenCV only when we start the application. By the method of using the afterimage, the number of the past frames to compare increases and we can capture changes with high accuracy. As a result, we can quantify the changes of series of movements "eye-opening - eye-closing - eye-opening".

## 3. The purpose to participate SIGGRAPH

We have established the high-accurate determination system of blinks. We distribute the applications using this system free of charge at iTunes Store. We hope someone use this system to produce communication applications in different languages such as English, French, or Chinese. We also expect to improve this system to add the prediction conversion. If we can cooperate to improve this system and use it to develop new software, we believe it will help a lot of handicapped people in the world.


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