Night Fox: A Communication Assistant Application for Paralyzed People based on Eye tracking and Sketch Recognition

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Abstract

A communication assistant application for paralyzed people is studied and evaluated. The application is based on normal webcam and totally written in JavaScript, which make this application available for every web user. The WebGazer.js API is applied for data collection. Collected eye-gazing data is processed and recognized to locate the object user want to choose, while using Rubine features and template matching algorithm. This application could help user to achieve certain purpose and the recognition accuracy for the application is about 60% during the evaluation.

Why eye tracking?

- People who could not move below neck are usually caused by trauma reasons or genetic reasons. Different modern technologies are developed to help these people, such as Neural Implant, EEG based BCI, and eye tracking.
- Eye tracking has several advantages, including no need for surgical operation, no requirement for complex supporting system, no demand for long-time training.
- Eye tracking system is widely used in Cognitive Research, Medical Service and many other areas. The system only requires a camera and a computer with certain software, which is easy to install and use.
- Eye tracking has bright business applications.

Why Webcam?

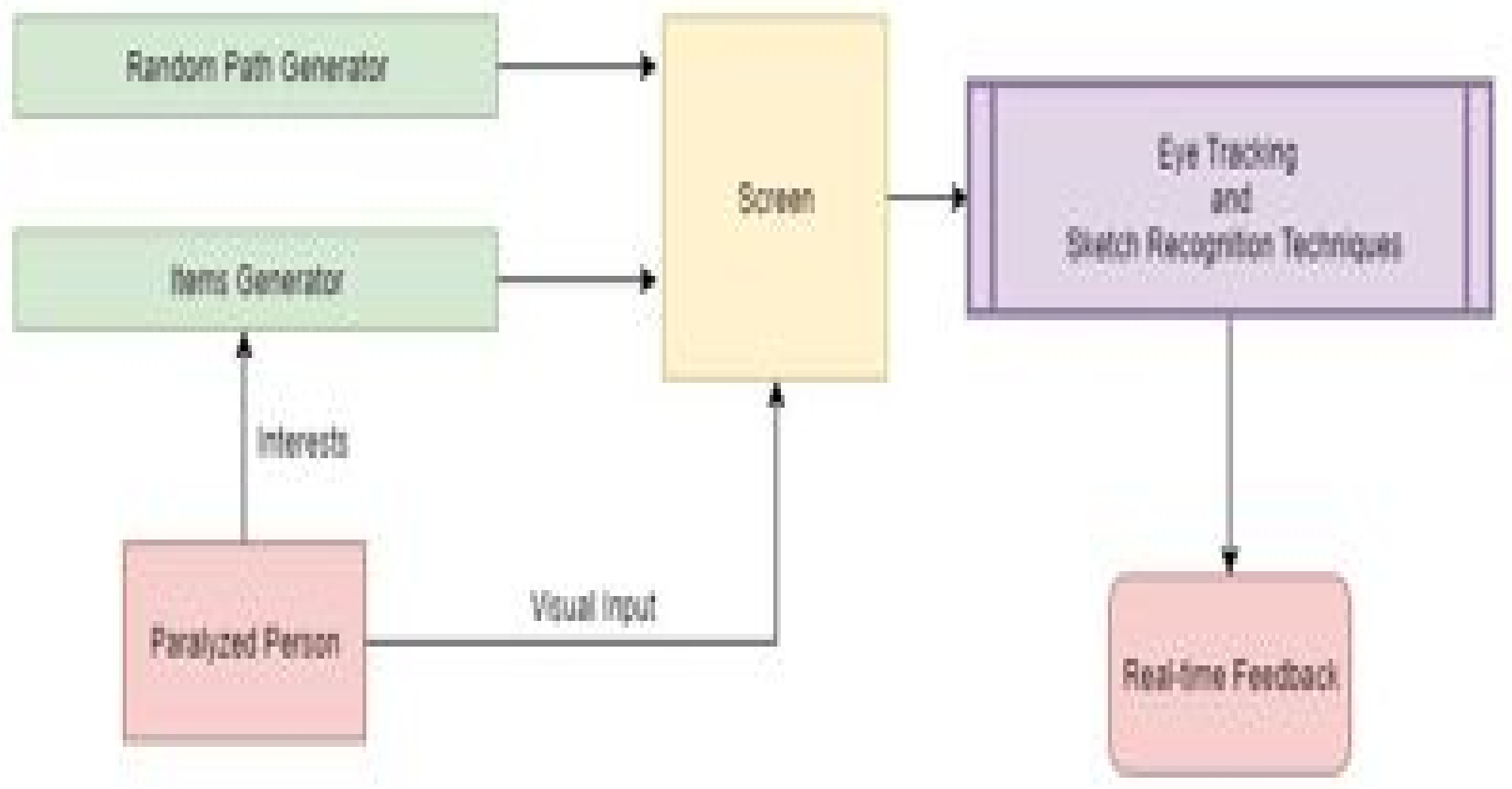
- Most modern eye trackers available on the market utilize near-infrared technology along a high-resolution camera to track the movement of the eyes,
- Near-infrared high-resolution camera is really expensive.
- Computer and software which are used to support the special camera are expensive too, which limit the use of eye-tracking system.
- Web camera is relatively cheap and available in many devices including laptop and cell phones.

Why WebGazer.js?

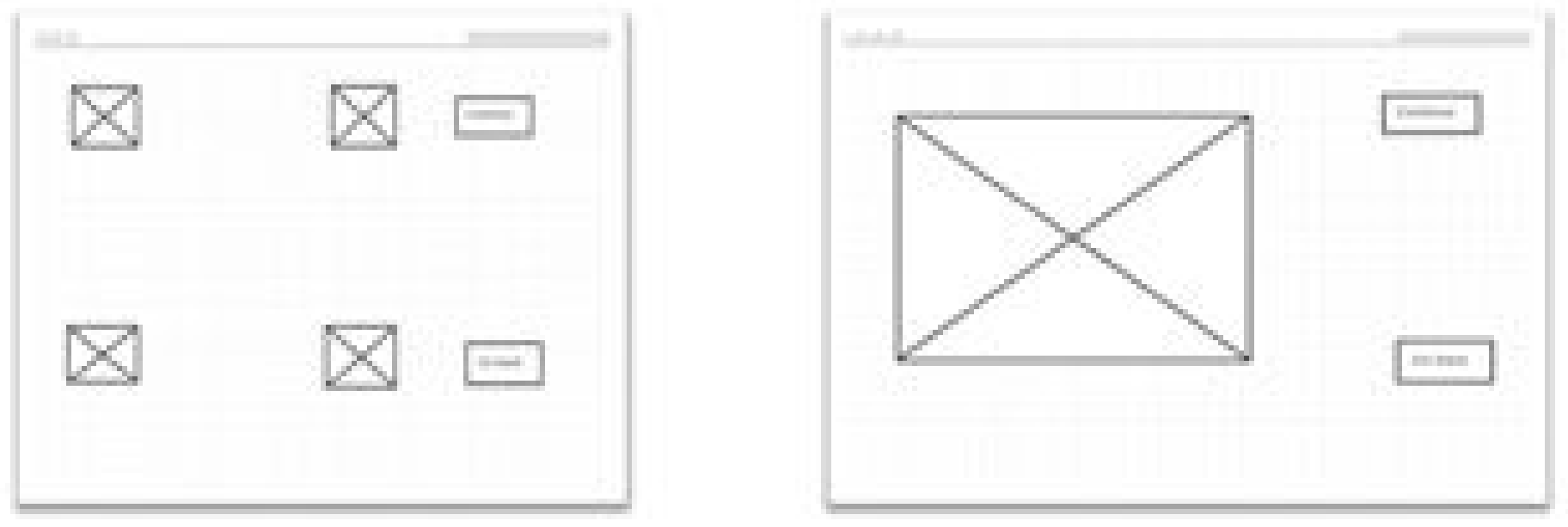
- Web based Eye tracking system written in JavaScript is accessible for every internet user.
- WebGazer that was presented by Alexandra Papoutsaki, 2016. WebGazer is a new approach for scalable and self-calibrated eye tracking on the browser using webcams.

System Overview

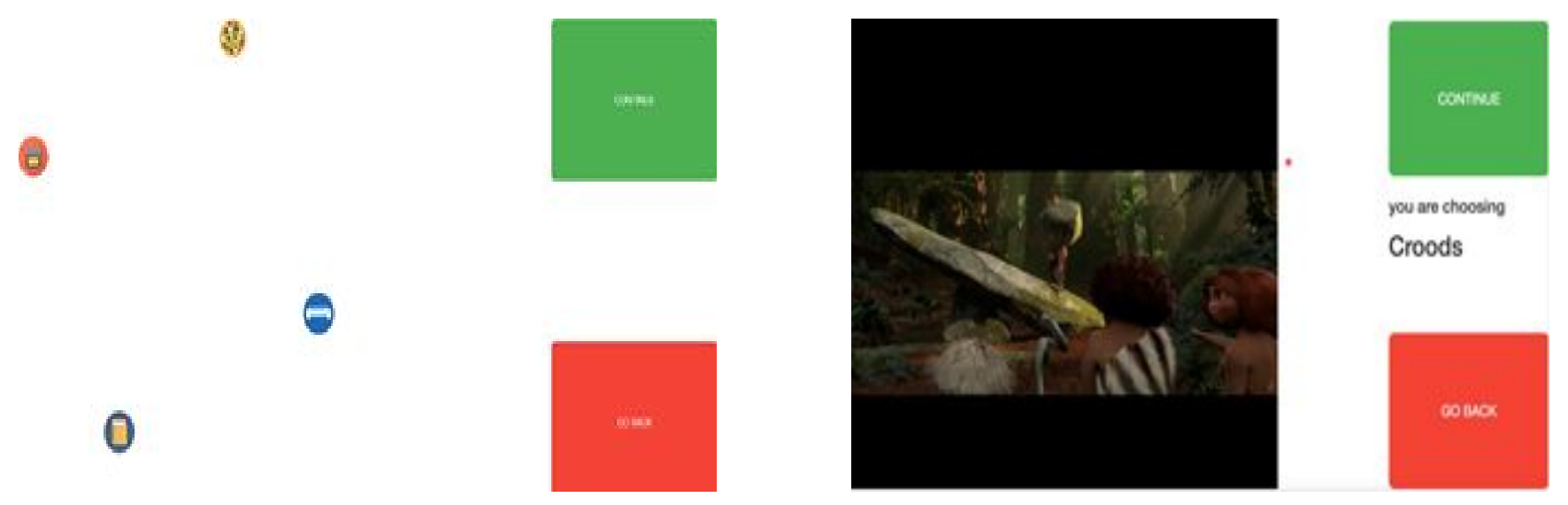
- Gather preliminarily eye movement with regular webcam
- Implement an web-based interface using Node.js
- Applying sketch recognition methods to match the eye movement path with items' movement path



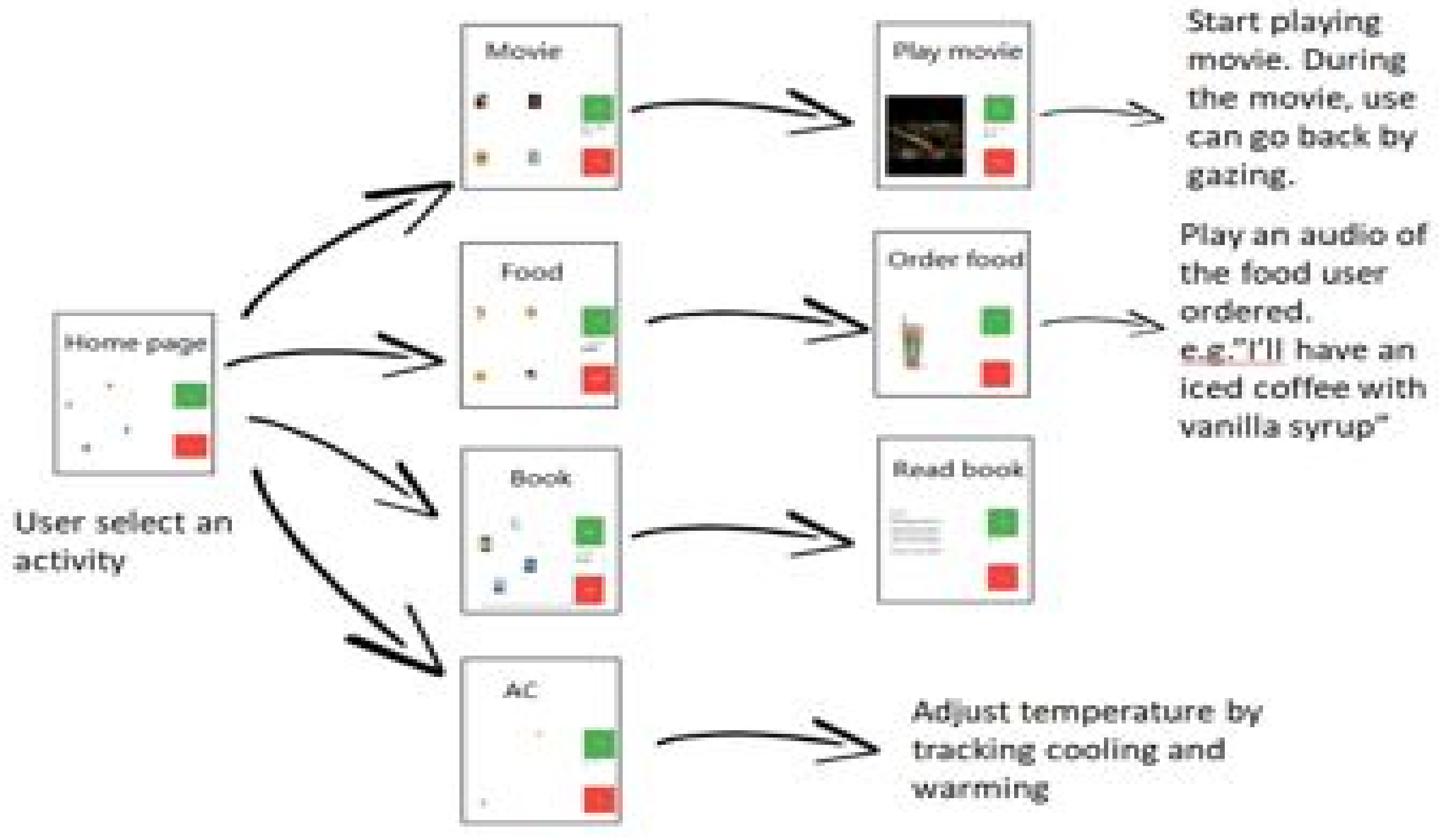
User Interface with heirarichy structure



wireframe of directory UI and final UI



System directory UI and final UI


Home page
User select an activity
Movie
Food
Book
AC
Play movie
Order food
Read book
Start playing movie. During the movie, use can go back by gazing.
Play an audio of the food user ordered. e.g."I'll have an iced coffee with vanilla syrup"
Adjust temperature by tracking cooling and warming

Storyboard of the system

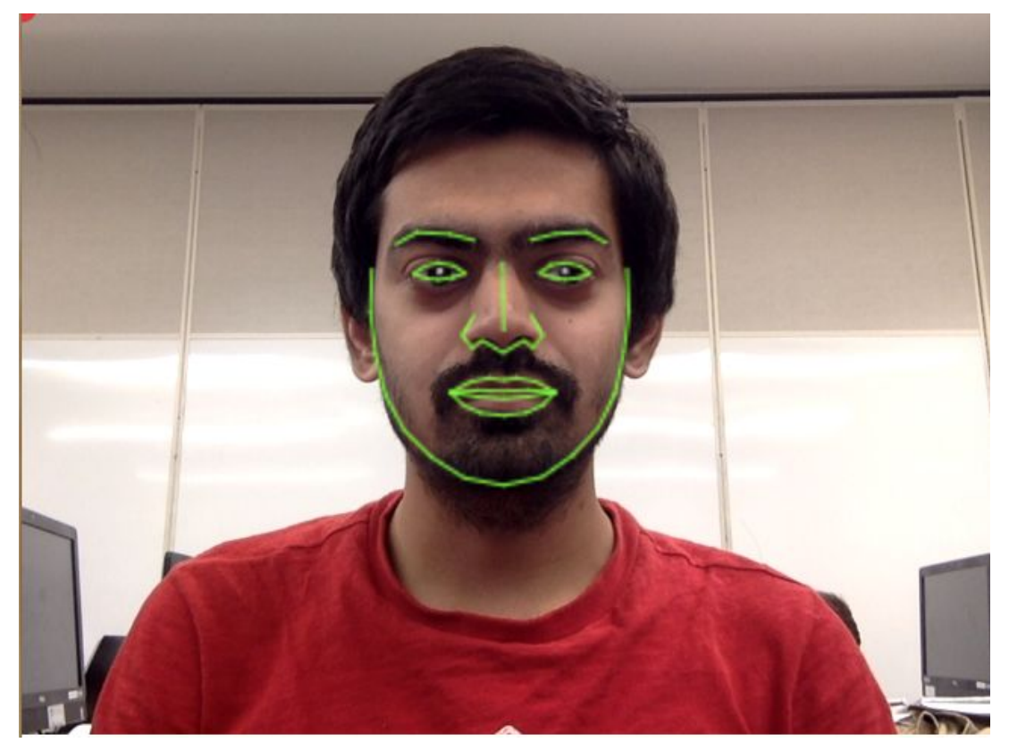
Sketch Recognition

Data Collection and Pre-process:

- Data is continually collected by WebGazer every 10 milliseconds.
- Collected data are considered as stroke points for about 1.5 seconds.

Features:

- Cosine between the start and end points
- Sine between the start and end points
- Counter for hitting Button areas "Yes"&"No"



Stroke Recognition:

- Five strokes form one sketch for recognition
  - R - Moving right L - Moving left U - Moving Up D - Moving Down
  - N - Hitting "No" more than "Yes" Y - Hitting "Yes" more than "No"
- Template Matching is applied for sketches

Evaluation

- Stroke recognition part is tested independently
- 10 participants are randomly chosen for system test
- System is tested individually in ideal and noisy environment
- No pre-trained data was used.
- Alert information are inserted after each phase, so the results could be documented.
- Stroke recognition accuracy is calculated manually
- Evaluation 1: Sketch Recognition

Recognition accuracy for eye movement

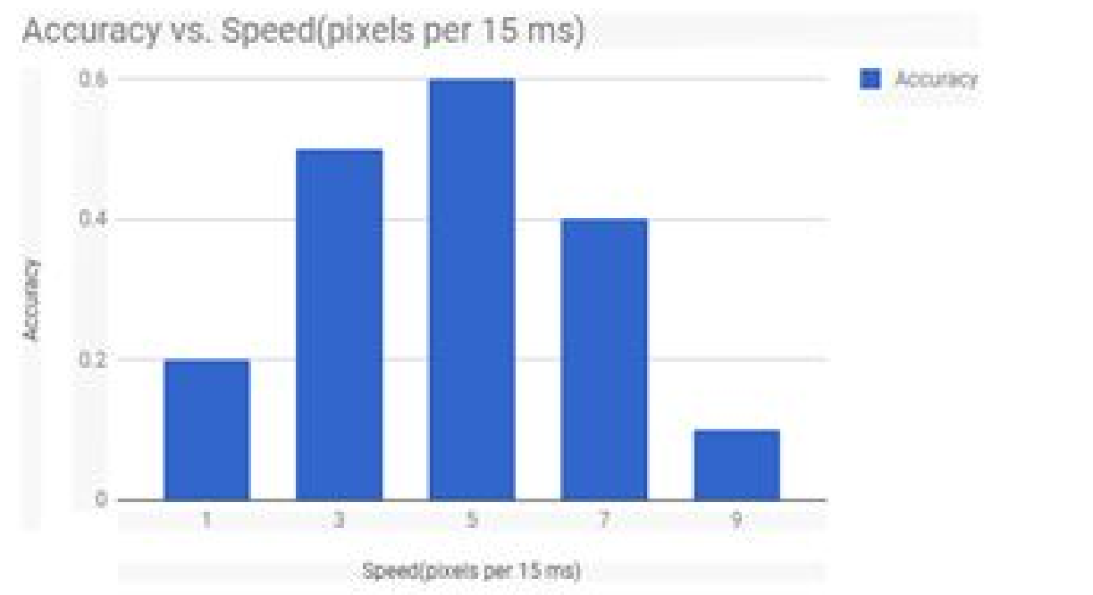
Direction	Accuracy
Left	76%
Right	72%
Up	60%
Down	70%

Recognition accuracy for Gazing

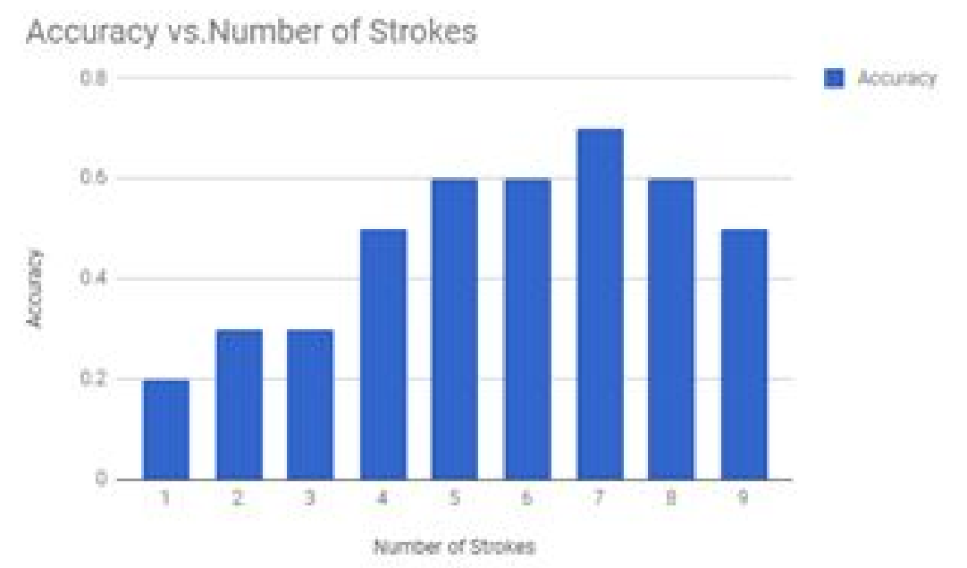
Gaze	Accuracy
Continue	82%
Go back	64%

- Evaluation 2 : System Performance

Total accuracy at different speed



Total accuracy of different strokes



Environment

Experiment	Accuracy
Noisy	50%
Ideal	70%

References

[1] Papoutsaki, Alexandra et al. "WebGazer: Scalable Webcam Eye Tracking Using User Interactions." Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence - IJCAI 2016 (2016): n. pag. Web.

[2] Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. Behavior Research Methods, 44(2), 314– 324. doi:10.3758/s13428-011-0168-7