No.

Construction of Assistant System for Disabled People Based on Eye Tracking

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Introduction

In this paper, we present an assistant system for disabled people based on eye tracking by using humanoid robot.

The aim of this research is to get human being's purpose by tracking gaze characteristics and guide a humanoid robot to perform a related tasks.

We addressed the problem of recognizing the operation intentions of disabled people to a head mounted device with eye tracking function. Neural network has been employed in the calibration and tracking process for improving the accuracy and flexibility of the system.

Overall Procedure

The system consists of three components for estimating of user's gaze position, establishing the initial set of objects and guiding humanoid robot assist with a task respectively.

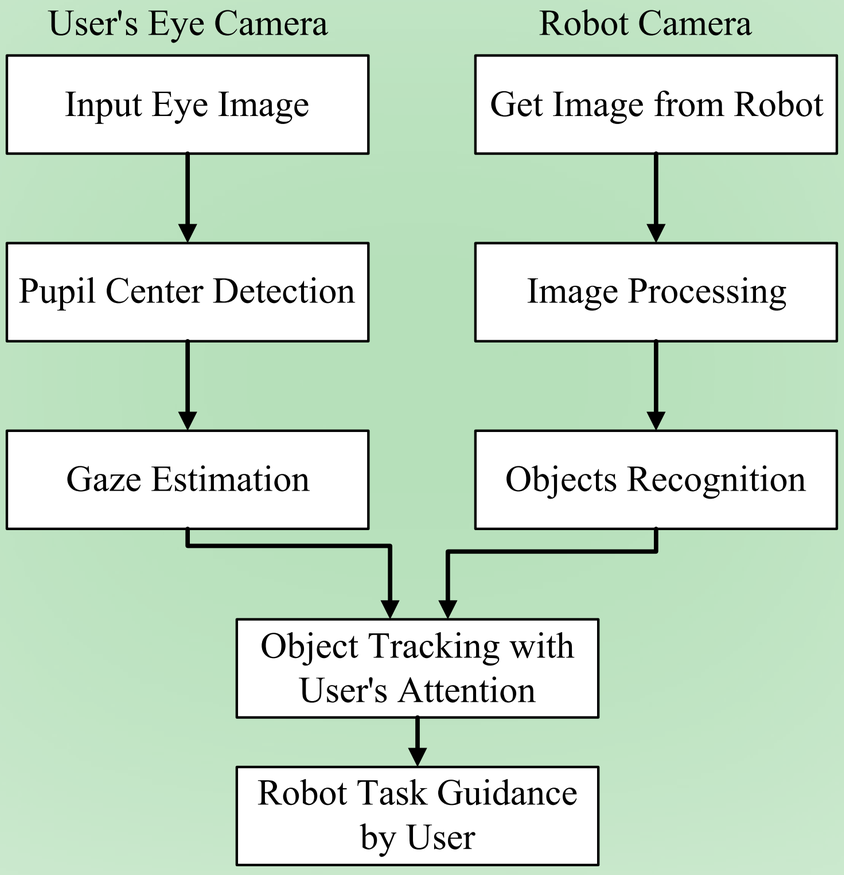

Fig.1 Overall Procedure for Proposed System

Eye Tracking Device and Pupil Center Detection

The eye tracking prototype hardware is made by ourselves. It is a wearable device including an eye capture camera attachedwith NIR LED.

The pupil center detection is the a part of getting pupil center by image processing[1].

Fig.2 Proposed Eye Tracking Device

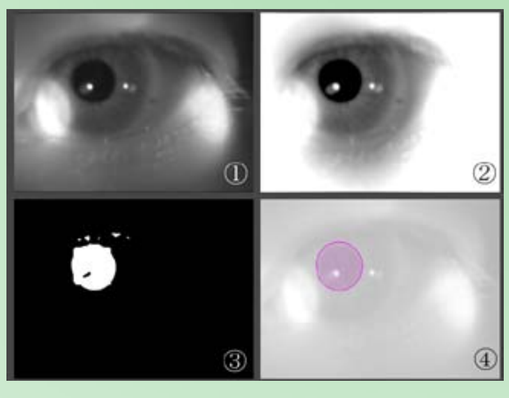

Fig.3 Eye Image Capturing and Pupil Center

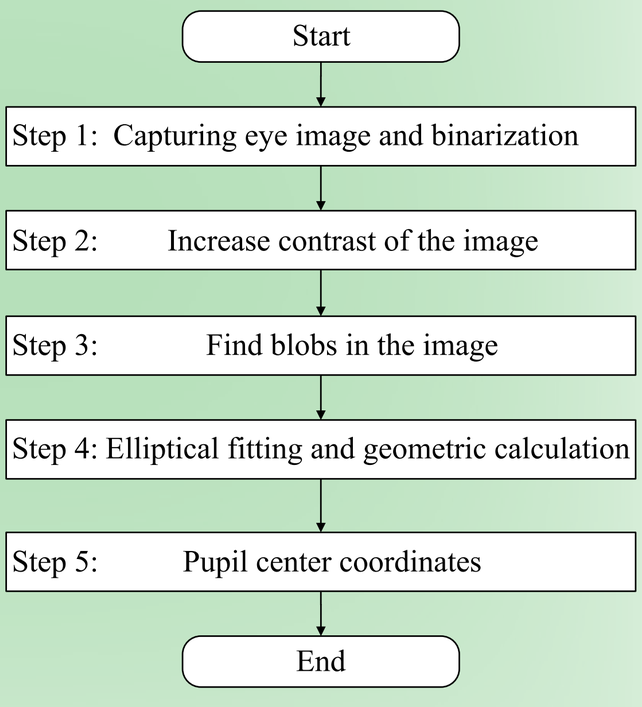

Fig.4 Pupil Center Detection Flow

Gaze Estimation

In this research, the gaze estimation has been achieved by using neural network (NN) to improve the robustness and adaptability of the system.

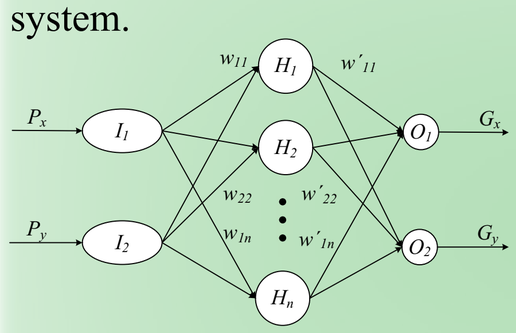

Fig.5 Neural Network for Gaze Estimating

P_x, P_y : pupil center coordinates;
G_x, G_y : gaze position coordinates;
I_x, I_y : input nodes;
O_x,O_y : output nodes;
w_{1i} : weight value;
H_i : hidden node.

For example, the output value G_x of NN can be calculated as follows:

$$G_x = \frac{1}{(1+exp(-\sum_{i=1}^{n} \frac{1}{(1+exp(-\sum_{j=1}^{2} I_j w_{ji}))} w_{ij}))} \quad (1)$$

Object Recognition with Humanoid Robot

After learning object recognition [2], when an object appeared in the view field of NAO, we can get the position of object in NAO's coordinate system. This process is achieved by using the ALVisionRecognition module from NAO SDK.

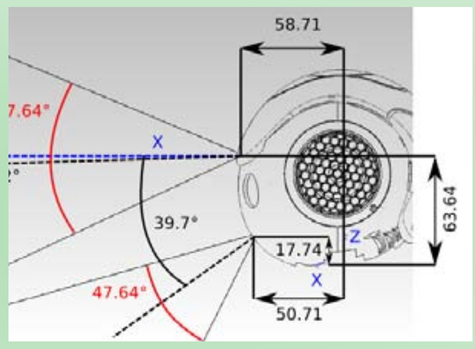

Fig.6 Field View of NAO

Experimental Results

The first part is calibration of eye tracking system. In the second part we asked user to control NAO by gaze. When an object is found and user blinked his eye, the robot will get the object by using its hands.

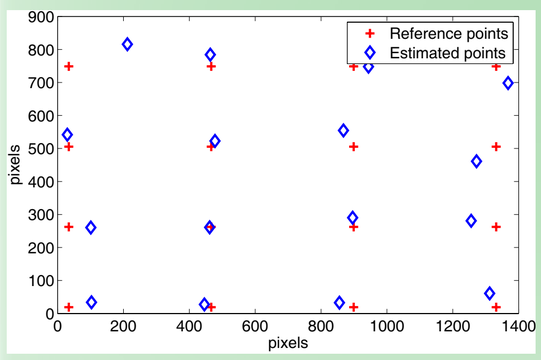

Fig.7 Reference and Estimated Gaze Position

Table.1 Accuracy of Gaze Estimation

	X-axis	Y-axis
Distance(cm)	0.9204	0.7841
Direction(deg)	1.172	0.998

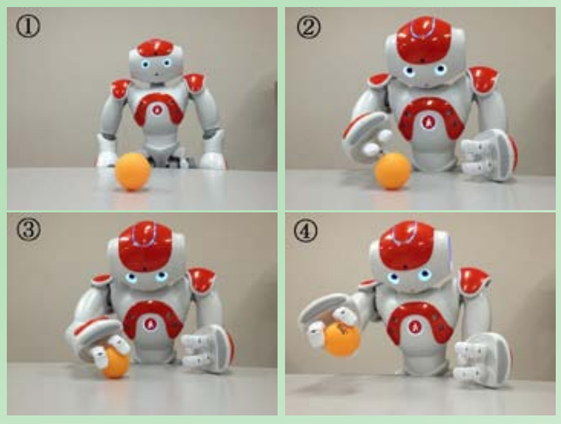

Fig.8 Experiment Scenes of Getting Object by NAO

Conclusions

In this paper, we designed a low cost, wearable eye tracking system and proposed a new calibration method by using random calibration points and using neural network. Then, the NAO humanoid robot assists user to get object by using object recognition worked with gaze estimation.

In future work, we would decrease the calibration process time and try to get object's 3D coordinates by using depth estimation through image processing.

References

[1] D.W.Hansen and Q.Ji, "In the Eye of the Beholder: A Survey of Models for Eyes and Gaze," IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.32, No.3, pp.478-500, 2010.

[2] Documentation of Aldebaran Nao from Aldebaran Robotics -Documentation Version, 1.14.3.