The Development of Human-mobile communication system (E-mobile system) Using EOG (ElectroOculoGraphy)

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Abstract

This paper relates to develop the human-mobile interface system using saccadic eye movements as an aid to the disabled. EOG(ElectroOculoGraphy) method is used to measure the potentials of rapid eye movements because the method is not expensive and the device is simple. But because the resolution and accuracy of this signal are not good, the algorithm to remove the drifting, using ideal velocity shape, is applied to process the signals. The mobile robot (POSTUR-II) used in this system was developed in Robot & Bio-mechatronics laboratory in POSTECH and has the tele-operation system for the tele-communication with a main computer. Our Research is to help the physically disabled except his eye movements to operate some works with the mobile. Our Results about the system's possibility will be showed by some experimental tests giving the point information to the mobile by eye-gaze.

1. Introduction

So far, the researches about human eye movements have been used to diagnose the eye diseases and treat medically. But most recent, for several years, the research to apply the eye movements to the human-life has being progressed by several research groups[2][4][5][6]. Especially because the eye movement has the abilities of remote controller for the disabled, it is an attractive device for the rehabilitation engineering. For an example, it is possible the disabled who can't use the computer mouse to operate the monitor cursor by eye movements [2][4][5][6].

This paper is to extend the above researches and use the basic properties of the eyes and the mobile robot (PosTur-II) by following :

1. The response of the sense of sight naturally is very fast.

2. PosTur-II is the mobile robot can move with the high speed by using the slip of the wheel.

Using the above merits, we can give the efficient communication device using eye movements to the disabled who can hardly response against the sudden situations.

In this paper, we used EOG method to measure the eye signals. This method is very cheap and necessary the simple device. And it does not interfere the sight so that it can be widen the range of the measurements (up(down) : +-25 deg., left(right) : +-35). But, the resolution is very low about 1 degree and it has the disturbances like the face art-effects and drifts. For this demerit, we decided the resolution of 1 degree is small enough to move the mobile. And we reduced the error by removing the drift using Ideal velocity profile algorithm.

We are able to get the blink signal by EOG method and this signal has high cognition rate by only simple algorithm. Therefore we change the task mode using this signal and can perform more various tasks.

The mobile robot(PosTur-II) used in this research is car-like type wheeled mobile robot. This mobile has the various sensors (vision, sonar, gyroscope so on) and fast speed and has the RF frequency module so it is able to communicate with tele-operating device.

The contents of this paper is following :

In section 2., we describe the signal processing algorithm of the signal gotten by EOG method. In section 3., we introduce E-mobile system, and in section 4., we confirm the possibility of this system by simple experiment. Finally in section 5., we introduce the application of E-mobile system and the direction of our research.

2. Signal analysis

The signals to be given by eye movements are the gaze-signal by rapid eye movements and the blink signal by twinkling. The way to get blink signal is very easy. So we don't care it. In this section, we describe the signal processing and algorithm to get the saccadic signal.

The signal by EOG method has very low potentials (μV) and is including the high frequency noise with line frequency (60Hz) noise. To remove this noise, an analog filter cut the signals over 10Hz as static noise, and the signal after filtering was amplified by over 2000 times. Finally the signal was cut over 5Hz after A/D converting.

Ideal Velocity Shape Algorithm for Removing Drift-effects

To detect the saccadic motion, we usually use the velocity profiles or the signal itself [1][3]. We can determine the threshold values and when the signal values are over or under the threshold, we can cognize the saccadic motion. This method is ideal if there is no noise. But in the case having the drift noise like EOG method, it is difficult to determine the critical threshold value, so we can' t get the accurate potential values.

The signals processed in hardware are including the drift noise. This noise is defined as the slow movements having no relation to the eye movements.

We can see the drift effect in the velocity profile of saccadic movements. At first, by the definition of the saccade, we can make the ideal saccadic velocity profile. In other words, the velocity and acceleration at start and end of the saccade is zero, at peak duration(n_p) the acceleration is zero, and the velocity has the peak velocity(V_p). Using the conditions, we can make the ideal polynomial velocity profile by 6 orders.

Now, we can find the range(b) of satisfying the actual signal with the ideal signal. But in the range(a) the actual signal is not following the ideal signal well because of the drift noise. (see the fig. 2.)