Eye Controlled Two-wheel Robot

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Introduction

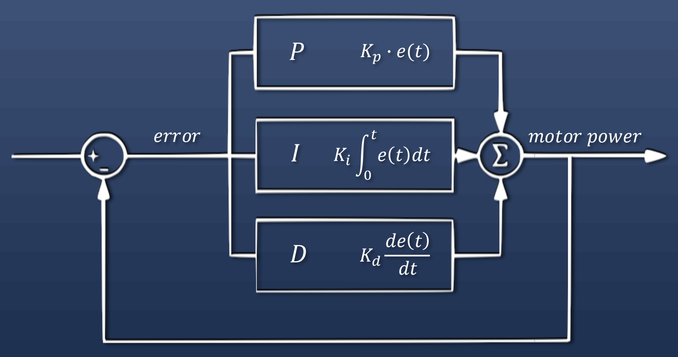
Electrical activity from human body has attracted great interested in past years. Several techniques such as electroencephalography (EEG) and electrooculography (EOG) have been developed to investigate the electrical activity.

Goal

In our project, an EOG, which detects eyeball potential profile, is used as the controller to make the self-balancing robot act. The direction of eyeballs controls the the direction of the robot.

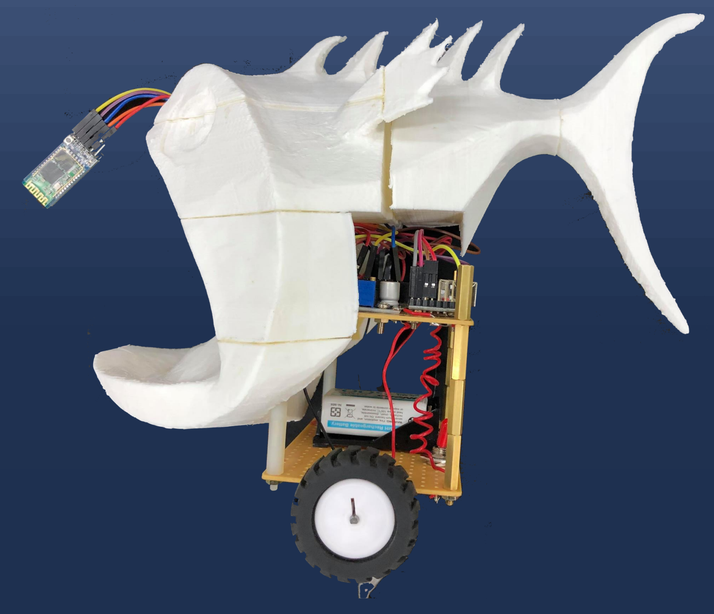
PID Controller

To maintain the balancing of robot, a g sensor and a proportional integral derivative (PID) controller are used. PID controller can detect the error angle of robot.
After PID calculation, the motor power is set to balance the robot.

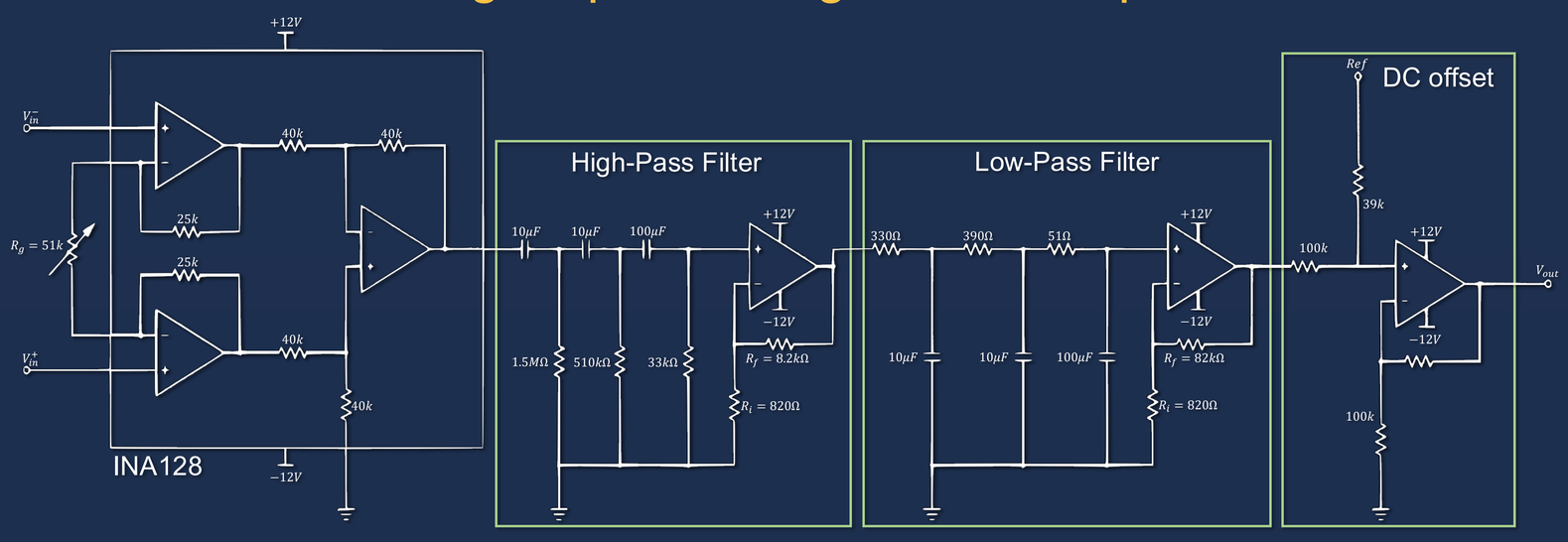


Self-balancing Robot Controlling

To control the robot, the Arduino board and Bluetooth module (HC-05) are used. When the computer receives the data from EOG, it will distinguish if the data is the instruction. Then, the computer send it to Bluetooth and make the robot acts as instructions.



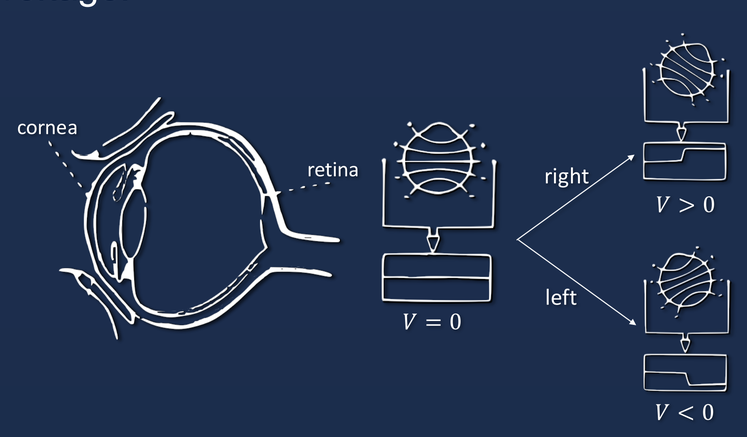
Signal processing circuit setup



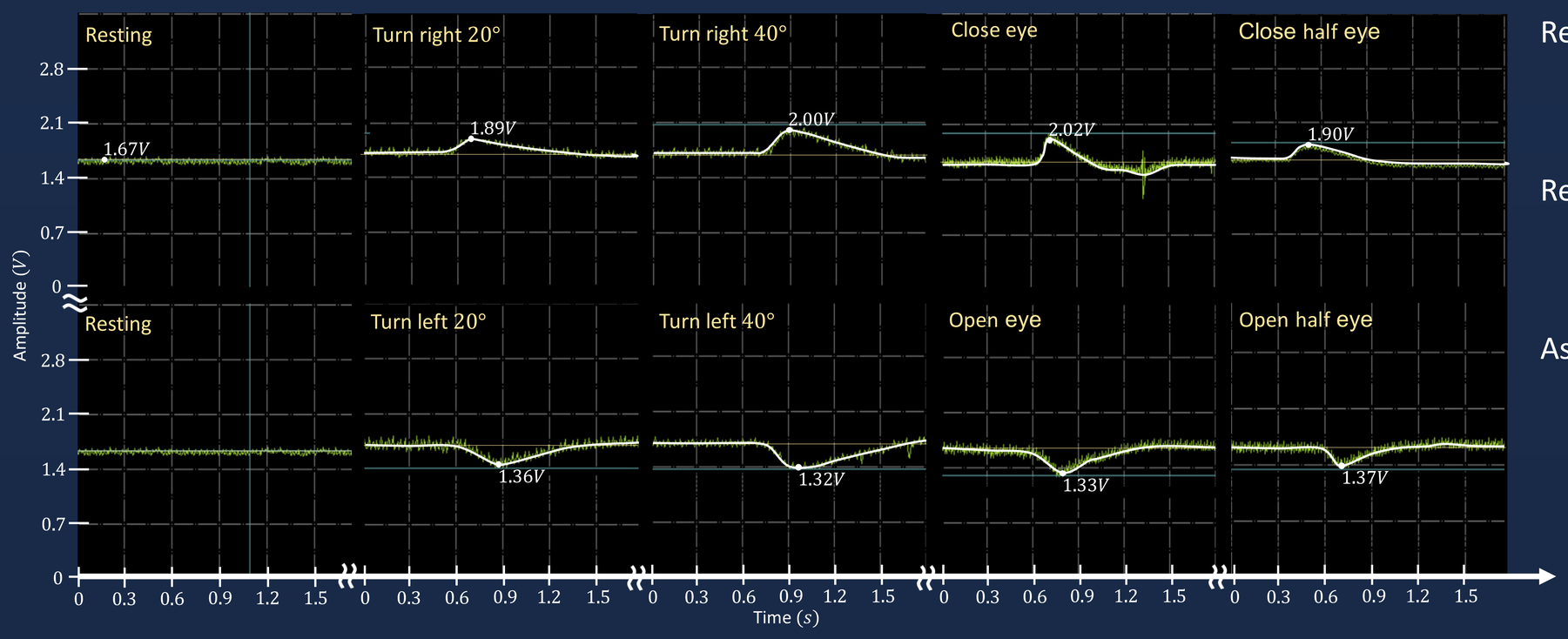
Electrooculography (EOG)

Electrooculography (EOG) can be used to detect the cornea-retinal potential difference of eyeballs. The amplitude of potential difference is determined by the rotating angle of the eyeballs. When eyeballs rotate, it will produce a pulse and back to resting voltage.

The signal of eyeballs passing through the instrumentation amplifier (INA128) which can not only amplifier the two V_{in} from our eyeballs but also output the voltage difference between them. The gain of INA128 is $G_{ina} = 1 + \frac{50k}{R_g}$. Therefore, when the signal will be amplified G_{ina} times. Next, the cutoff frequency (F_0) of a RC filter is $\frac{1}{2\pi RC}$. If the frequency of the received surpasses the boundary of F_0, its energy will decay rapidly. i.e. High-pass filter and low-pass filter in this circuit can limit the frequency of signals from eyeballs in the range of 1∼35 Hz. Last, using UA741 to offset the signal, which let Arduino can read its value. The full circuit's reference voltage (GND) is the signal of on our body.



Eyeball potential profile



Result 1: Eyeballs rotating or blinking
→ a pulse
→ back to resting voltage

Result 2: The degree of rotations or blinking decides the amplitude of voltage.

Assume1: The total area under the voltage line would have the same value when we turn right (left). Therefore, no matter how low our eyeball rotate, we can also detect the angle of our eyes.

Conclusion

When the user put on the device which can detect the eyeball's rotation, the signal would pass the processing circuit to filter the noise, amplify the signal and offset it. Next, the code judge the amplitude magnitude and pass the direction instruction by Bluetooth module to the self-balancing robot. Therefore, the car robot's direction is controlled by our eyeballs.

Reference

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