EE3810 Epilepsy Detection - With Noisy Source Input

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1 Concepts

Physiology

1. EEG
2. epilepsy

Engineering

1. threshold detection
2. electrical noise
3. op amp comparator
4. hysteresis
5. Schmitt trigger
6. noise margin

2 Background

New technology is being developed to detect and stop epilepsy seizures. What kind of signals and signal features could be utilized to detect seizures? Let's imagine we are recording EEG, x, from an electrode that is able to detect the neural activity from the epileptic focus (or the location of the brain which tends to produce the seizure activity). We process $x(t)$ to obtain $y(t)$ the energy in the eeg signal. We will create a circuit which simulates $y(t)$ using the output of a moisture sensor. We will design and build a circuit which detects "seizures" by determining when the simulated energy in the eeg goes above a threshold.

3 Objectives

In this experiment, you will build a pseudo epileptic seizure detection circuit with the following specifications

1. able to output a TTL signal HIGH when seizures are detected and LOW when not detected.
2. provides an adjustable noise margin, with default setting at 800mV
3. has adjustable thresholds

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You will also

1. gain experience breadboarding
2. learn to use electronic test equipment
3. understand the value of adding hysteresis to a comparator circuit

4 Pre-lab reading / assignment

- D. Gajic, Z. Djurovic, S. Di Gennaro and Fredrik Gustafsson, Classification of EEG signals for detection of epileptic seizures based on wavelets and statistical pattern recognition, 2014, Biomedical Engineering: Applications, Basis and Communications, (26), 2, 1450021.
- Sketch the circuit schematic diagram of a simple comparator circuit.
- Sketch the circuit schematic diagram of a comparator with hysteresis (i.e., a Schmitt trigger) and be sure to calculate all necessary resistor values. The moisture sensor output range is 0 to 3.6V (3.6V when it is completely submerged in water). Suppose you want to provide a noise margin of ±800mV. Assume a power supply of ±5V.

5 Procedure

5.1 Comparator circuit

1. Construct the comparator circuit on the breadboard, according to the schematic you have sketched after the instructor has checked off your work.
2. Use the moisture sensor output as the simulated noisy EEG envelope waveform.
3. Set the threshold level to be 80% of the way between the minimum and maximum input levels (i.e., of the dynamic input range).
4. Test your circuit and show results which validate operation of your circuit.
5. Now, make your threshold level adjustable, and again validate.

5.2 Construct Schmitt trigger

1. Construct the Schmitt trigger circuit on the breadboard, according to the schematic you have sketched after the instructor has checked off your work.
2. Use the moisture sensor output as the simulated noisy EEG envelope waveform.
3. Set the center of the threshold levels to be 50% of the way between the minimum and maximum input levels (i.e., of the dynamic input range).
4. Make a noise margin of 800mV.

5. Test your circuit and show results which validate operation of your circuit.
6. Now, make your noise margin adjustable, and determine the most appropriate settings. Justify your solution.

6 Questions

1. Explain hysteresis and how you observed hysteresis in this lab.
2. How did the Schmitt trigger perform as a seizure detection circuit, compared to the simple comparator? i.e., what were the advantages and disadvantages of using the Schmitt trigger?