Laser Speckle in Detecting Seizure Movements

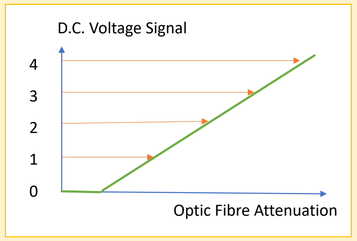
Author: Sabrina Zulkifli Supervisors: Ray Davies, Daniel Roberts

PRIFYSGOL BANGOR UNIVERSITY

academi FFOTONEG PHOTONICS academy

Aim and Objectives

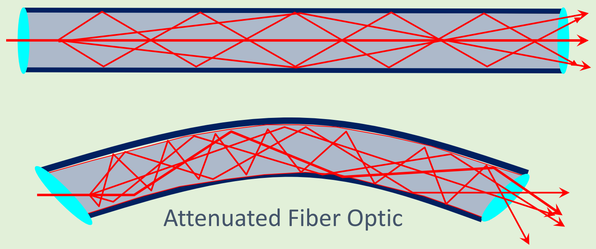
This project utilises laser speckle interference pattern to detect tonic-clonic seizures lasting more than the lethal period. Attenuation of the optical fibre produces a D.C. voltage of value depending on the level of attenuation applied. The voltage signal produced are distinguished into the following movements :



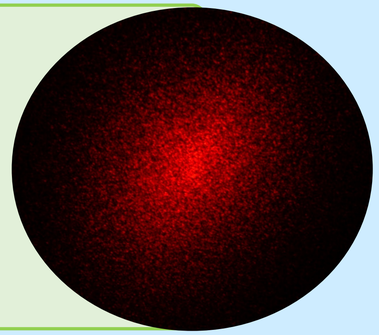
- Normal (~2V)
- Tonic Seizure (<1V)
- Clonic Seizure (>3V)
- Seizure Collapse (4V)

Laser Speckle Concept

Scattered photons emerging from the optical fiber end consist of dark and bright speckle dots due to interference.



Attenuated polymer optical fiber changes the speckle pattern produced and the rate of changing speckles are detected by the photodiode.



Method and Approach

Obtaining the Voltages

A steady D.C. Voltage signal is achieved by using a RC smoothing circuit. Capacitor value is chosen such that attenuation to the optical fibre is sensitive enough to distinguish the different movements.

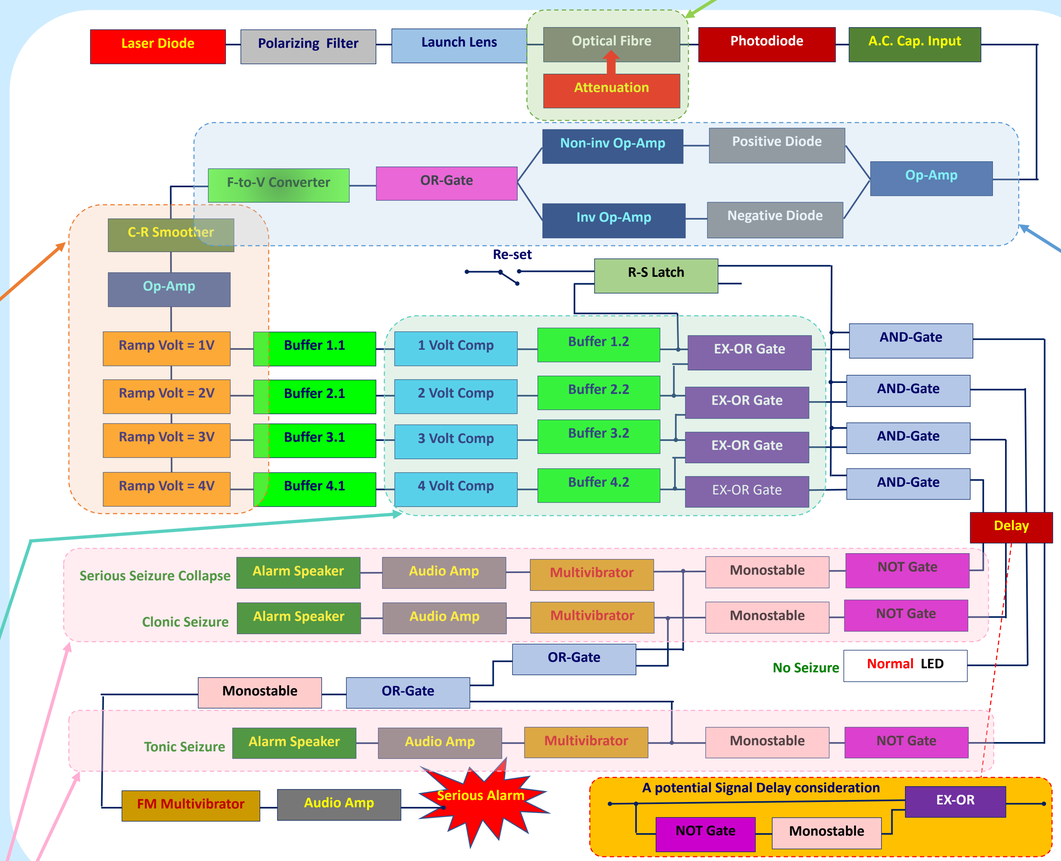
Capacitor Value (**uF**)	Time taken (**s**)	Remarks
47	~ 10	Too sensitive
100	~ 20	Steady decrease
220	~ 40	Too slow

Operating the Voltages

Each of the four Voltage Comparators corresponds to a specific movement, these are then connected to a series of XOR Gates to select only one voltage circuit line to work at a time, avoiding multiple triggers.

Triggering the Alarms

Each of the alarms is triggered by the delay circuit which times the seizure period. An Alarm sound is produced using a Monostable of a desired time together with a Multivibrator and an Audio Amp.



Timing the Seizure

The delay circuit is comprised of a Monostable set to the seizure lethal period together with an XOR Gate. This will implicitly time the duration of the seizure period.

Input	Output
00	0
01	1
10	1
11	0

Figure 1. Table of XOR Gate

Conclusions

With the appropriate processing circuitry, utilisation of Objective Laser Speckle in detecting Seizure movements is attainable, despite the random nature of laser speckle.

Results

The random A.C. of a laser speckle captured by a photodiode is shown on ***Figure 2*** whereas ***Figure 3*** shows the output when an attenuation is applied by a single tap on the optical fibre. In order to obtain a smooth D.C. Voltage signal, the speckle is input into an inverting and non-inverting Op-Amps producing ***Figure 4*** and ***Figure 5***, respectively.

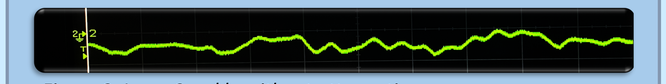


Figure 2. Laser Speckle without attenuation

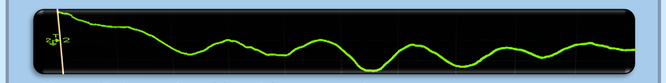


Figure 3. Laser Speckle with attenuation

Figure 4. Output of Inverting Op-Amp

Figure 5. Output of Non-inverting Op-Amp

The OR-Gate of the two Op-Amps effectively enables the voltage signal to be passed to the Frequency-to-Voltage Converter, with an RC Smoothing Circuit average out the random signal into a Smooth D.C. Voltage.

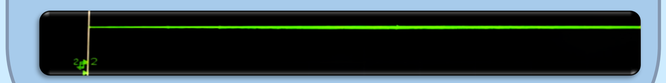


Figure 6. Output of RC Smoothing Circuit with C = 100uF