Development of an Electro-Oculography (EOG) Measurement System

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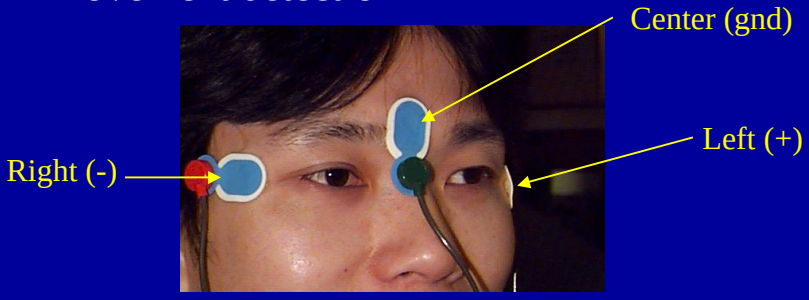
Electro-oculogram

- Measurement of corneal-retinal potential
- Three electrode setup for horizontal eye movement detection



EOG Overview of Function

- Eye position:
  - Left, potential is positive
  - Right, potential is negative
  - Straight, EOG output is zero
- Approximately linear over 30 degree arc
- Accurate to 1 degree

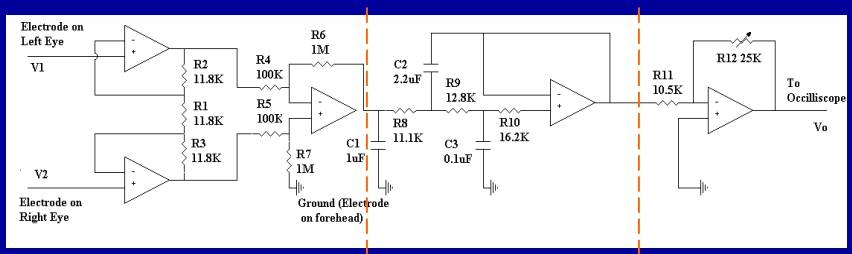
Applications

- Sleep and dream research
- Reading ability and visual fatigue

Applications – Cont'd

- Retinal dysfunction
  - Some disorders of the retina exhibit abnormal or absent changes in the corneal-retinal potential during dark and light adaptation processes.
- Vestibular and balance dysfunction
  - Nystagmus: characteristic slow-phase/fast-phase eye movement measurable by EOG
  - prevent drunk drivers from taking to the road.

Circuit Design of EOG

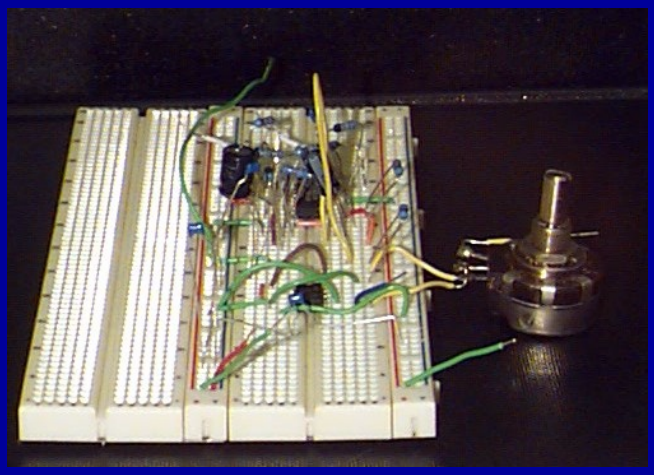


3-op-amp differential amplifier

3-pole Butterworth lowpass filter

Inverting amplifier

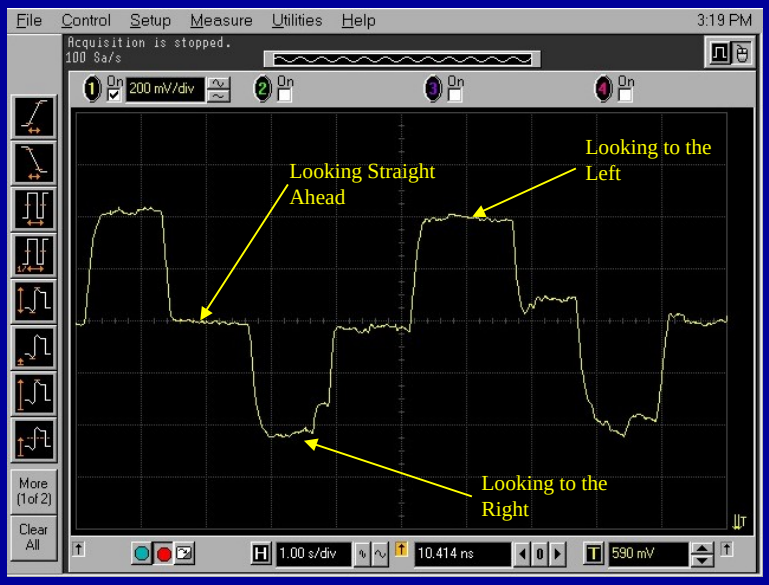
Actual EOG Circuit



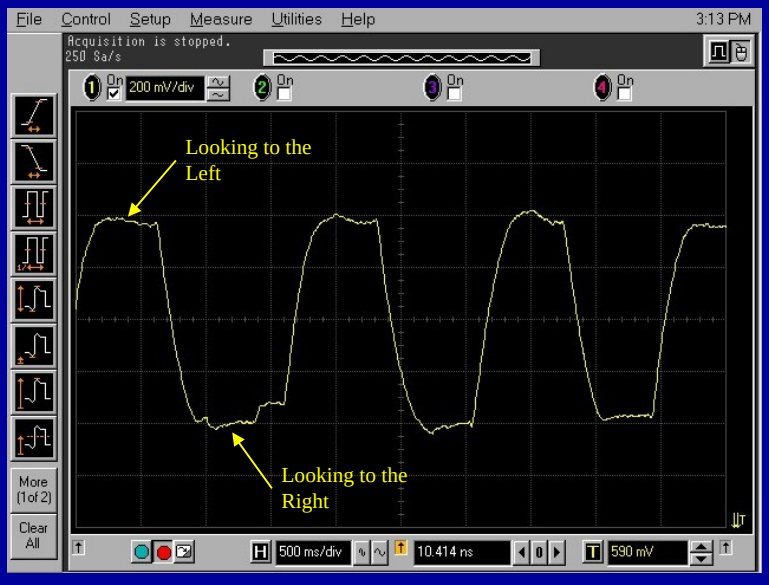
Testing

- Left, right, left, right
- Left, center, right, center
- Visual pursuit
  - Sinusoid @ 0.1 Hz
  - Sinusoid @ 0.4 Hz
- Optokinetics
  - Rotating light bars
  - Evokes nystagmus

Left, Center, Right, Center

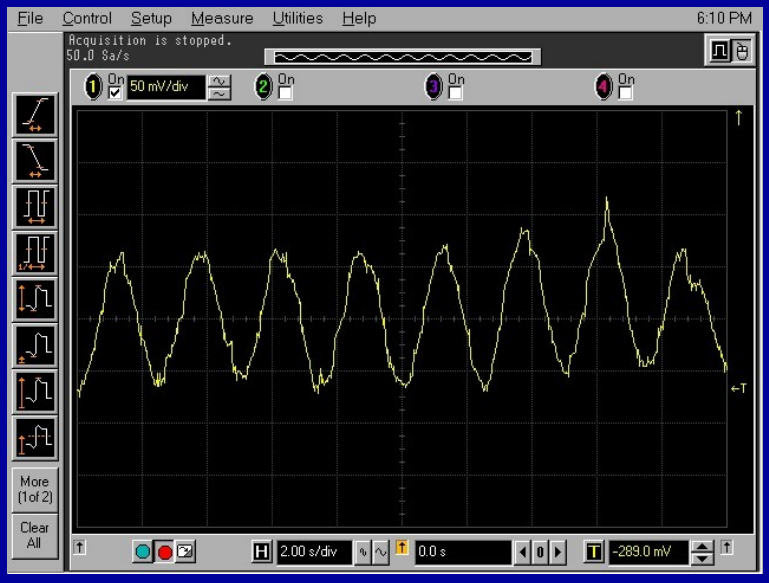


Left, Right, Left, Right



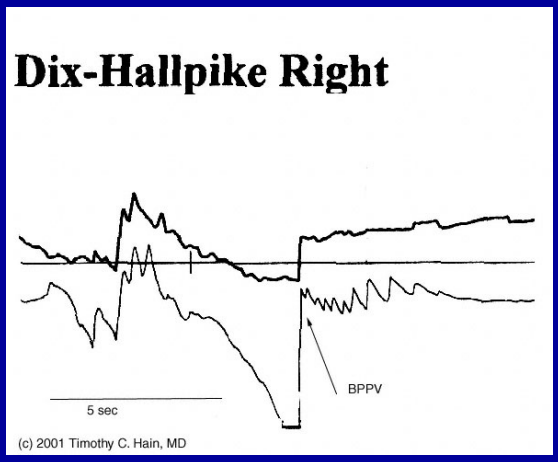
Visual Pursuit @ 0.1 Hz

Visual Pursuit @ 0.4 Hz



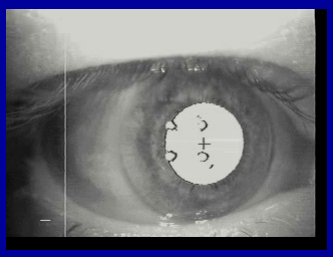
Brief Description of Nystagmus

Nystagmus is an involuntary eye movement characterized by a slow-phase and fast-phase.



Nystagmus – Cont'd

- ENG can be used to diagnose balance and dizziness problems
- Possible causes of nystagmus:
  - Vestibular-ocular reflex
  - Nervous system dysfunction (e.g. alcohol)
  - Visual Field stimulus
    - Optokinetics



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Optokinetics

Optokinetics – Cont'd

Test Result Summary

- Overall, worked very well!
- Measurement system exhibited linear behavior within the ±30° range of motion
- Drift was an issue, but resolved with periodic calibration
- Noise reduced while preserving required bandwidth

Cleaning up the Signal

- Calibration
  - The corneo-retinal potential is not stable and varies with a number of factors, in particular the level of light. Light source should be adjustable by the use of filters or other means.
- Anti-drift
  - DSP, calibration procedure, etc.

Cleaning up the Signal – Cont'd

- A masking cone
  - May be used to reduce electrical interference (actually provided by some manufacturers).
- Artifact rejection
  - Eliminates some of the obvious peaks or drifts in the distorted recorded waveforms due to blinks and other movement.

Making It Clinically Usable

- This simple design provides virtually good results, so there is not much left to do with the circuit itself.
- A/D conversion Ł Computer Program:
  - Artifact rejection
  - Robust control of lights.
    - Usually alternately illuminated for 1 second each, ten times per minute.
  - Waveform display & user interface
  - Data analysis
  - Decision-making procedures

DISCLAIMER:

No group members were (irreparably)

harmed during the “testing” of this “device.”

Acknowledgment

We would like to thank Jorge Gonzalez, M.S.
of the
UVA Vestibular and Balance Center
for his assistance in the testing of our instrument.

Questions?