

An Artificial Variable Star Simulator

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Why Simulate?

- Laboratory exercises
- Training
- Ground truth for KBO occultation studies
- Control studies
 - Observer differences
 - Biases
 - Temporal
 - Color
 - Scintillation
- Exhibits

Prior Art

“Observing simulated Cepheid variable stars in an introductory astronomy lab”

Flesch, TR 1979, Am J Phys, 47(3), 232

- Telescope + photomultiplier tube!
- Incandescent bulb + function generator
- Single star (source)
- One pulsation cycle, two filters

Prior Art

“Observing variable stars indoors with a microcomputer and phototransistor”

Rafert, JB, and Nicklin RC 1983,
Am J Phys, 51(7), 668

- “Telescope” + phototransistor
- Incandescent bulb + Nerf ball!
- Incandescent bulb @ 120 Hz = pulsar! ☺
- Single system (source)
- Oscilloscope output

Gene Hanson's Variable Star Light Board

<http://www.genehanson.com/lightbd.htm>

- 14.4V incandescent bulbs
- Large board
- SS Cyg field
- Manual



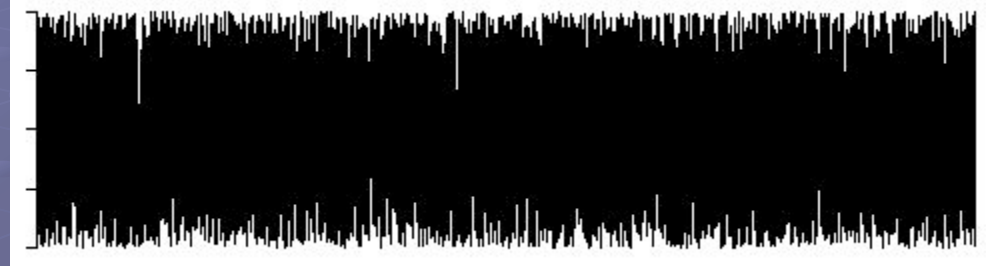
<http://www.genehanson.com/images/brdftrg6.jpg>

Developments

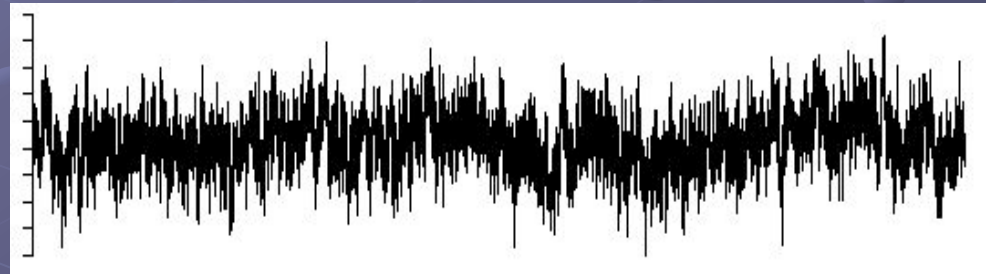
- Small, efficient white LEDs
 - Only prior choice were incandescent bulbs
 - “Color temperature” now similar to stars
 - Roscolux filters for cooler stars
- Fast microcontroller clocks
 - 40 MHz = 10 million instructions per second
- Decent amount of microcontroller memory
 - 24 to 32k instructions/lookup tables

Scintillation (1/f noise)

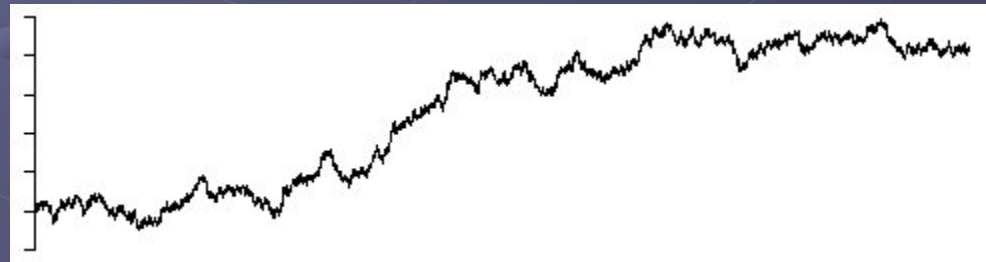
Gaussian (“white”)



1/f (“flicker”)



1/f² (“Brownian”)



Time series from: <http://ozviz.wasp.uwa.edu.au/~pbourke/fractals/noise/>

Hardware

- PIC 18F4525 or 18F4620 MCU
- MAX 233 serial interface chip
- 4-to-16 decoder
- ULN2803 driver
- Use of In-circuit Serial Programming

Future Plans

- Increase number of LEDs to 128
- Self-calibration with TSL237
 - Individual LED current-to-flux correction
- Display time for use with labs
- Analog generation of scintillation noise?
- Substitute computer+ethernet control for dedicated microcontroller?

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