Using a Software-Defined Radio to Detect Amplitude Modulated Signals

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Cheap, Portable, Lock-in Detection

Stanford Research Systems' SR530, a lock-in amplifier

Drawbacks:
- Cost: $3,000
- Weight: 16 lbs
- Dimensions: 17” x 5.25” x 17”
- Power: 120 V

Noisy Signal → Lock-in Amplifier → Clean Signal

Reference
When are Lock-ins Used?

Extracting a **weak “modulated” signal from strong random noise**

Examples!

- **Electron Spin Resonance**
  - [www.jeol.co.jp](http://www.jeol.co.jp)

- **Detecting an LED in a Bright Room**
  - [www.robotechbd.com](http://www.robotechbd.com)
Software-Defined Radio ~ A Possible Substitute

Comparison:

Cost 1/14\textsuperscript{th}
Weight 1/23\textsuperscript{rd}
Dimensions 1/60\textsuperscript{th}
Power 1/24\textsuperscript{th}

Radios mostly do what lock-in amplifiers do!

- Detect weak signals
- Wide frequency operation
- Extensive customizability

Photo Courtesy: Valeria Viteri-Pflucker
Unlimited flexibility… but at what cost?
Time Domain

Eye Plots

Frequency Domain

www.wiki.gnuradio.org
Extreme speed ~ Hardware Bottlenecks

Realized **hardware limitation** of USB 2 transfer rate (480Mbps)

Achieved sampling rate 25x faster than conventional audio devices!

Designing and testing a complex signal with function generators and oscilloscope

Photo Courtesy: Valeria Viteri-Pflucker
Future testing plans: Real-time signal averaging

From *noisy* inputs  \[\xrightarrow{\text{Real-time signal averaging}}\]  To *strong* outputs

Possible, but progress is yet to be made in *synchronization* and visualization!
Thank you!

Any Questions?

• Dr. Charles Cheung, Joseph Kopanski and others at NIST for their guidance
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