How to Build Your Very Own Sleep Lab: The Execution

Presented by:

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Overview

What does it do?

We're collecting data for later interpretation:
Electroencephalogram (EEG)
Heart rate monitor (HRM)
Electronic Ocular Monitor (EOM)
Infrared pictures
Overview

What does it not do?

Breathing measurements
Skin response on face

Why not?

Restless leg and apnea are obvious to an outside observer
Overview

A series of devices connected to an ordinary desktop PC:

ModularEEG implementation of the OpenEEG project

Interfaces with a desktop PC via RS 232 serial port

Homebrew microcontroller (Atmel Atmega128) device to collect other signals

Also Interfaces with a desktop PC via serial port

USB Webcam modded to see only IR
Hardware overview

- Desktop PC
- Modular EEG
- Heart Rate Monitor
- USB Webcam w/ IR filter
- Atmel Atmega 128
- Electronic Ocular Monitor
OpenEEG overview
Microcontroller data collection device
Sensor choice

ModularEEG from OpenEEG project

Cheap ($<200 to build)
Well tested (Initial release in 2003)
Prebuilt PCBs available
Open Source
Needed to detect stage of sleep
Sensor choice

Wireless heartrate monitor by Oregon Scientific

Super cheap off of eBay ($<20)
Signal to find was relatively simple
Needed to verify that monitored user is calm
Sensor choice

EOM – Fairchild QRB1134

Very cheap
Well documented
Simple
Used to verify REM
Construction pitfalls

ModularEEG – Buy it preassembled!

- Took hours of cramped soldering
- Easy to make solder bridges or short to ground plane
- Easy to put ICs in backwards
- Does not include a power supply
Construction highlights

On the fly construction:

Op-amp for HRM to boost signal from 1Vpp to 5vpp

Adding first-order filters to remove noise from incoming circuits

Finding new and interesting uses for soldering irons
Initial Data

We plugged the EEG in and nothing caught on fire!

EEG capture when subject was asked about their favourite topic
**Initial Data**

HRM and EOM verified to be working:

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Disclaimer:
We are not doctors, nor do we pretend to be.
It is rare, but possible to give yourself an electric shock with this equipment.
There is no warranty – explicit or implied.
We are not responsible for the consequences of anyone attempting to duplicate our efforts.
Initial Data

FIXME: show picture clips of various sleep stages collected here
Analysis

What does this data tell me?

EEG and EOM can verify that user is entering all stages of sleep.
Analysis

What does this data tell me? (cont.)

Camera stills will show fitful sleep, sleepwalking, and restless leg.

Elevated heart rate can indicate stress
Additional info

Flowchart of capture software:

1. BEGIN
2. Spawn thread: capture /dev/ttyS0
3. Spawn thread: capture /dev/ttyS1
4. Capture frame from IR camera
5. Decorate frame w/ captured data
6. Sleep for 60 seconds
7. Exit loop if ctrl-c caught or camera is not capturing data
8. Continue loop
9. Kill background threads
10. END
Additional info

Future expansion:

More sensors:
  Muscle sensors on face
  Volume and temperature of airflow to/from lungs
Automagic identification and categorization of data
Closing

Shoutouts to:

ab3nd, dead addict, lockedindream, lyn, mb, nobodyhere, old grover, psychedelicbike, tottenkoph,

Detailed schematics and source code are available at:

http://defcon17sleeplab.googlepages.com/