

# *How to Build Your Very Own Sleep Lab: The Execution*

Presented by:

Keith Biddulph & Ne0nRa1n



# *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:

Modular EEG implementation of the [OpenEEG project](#)

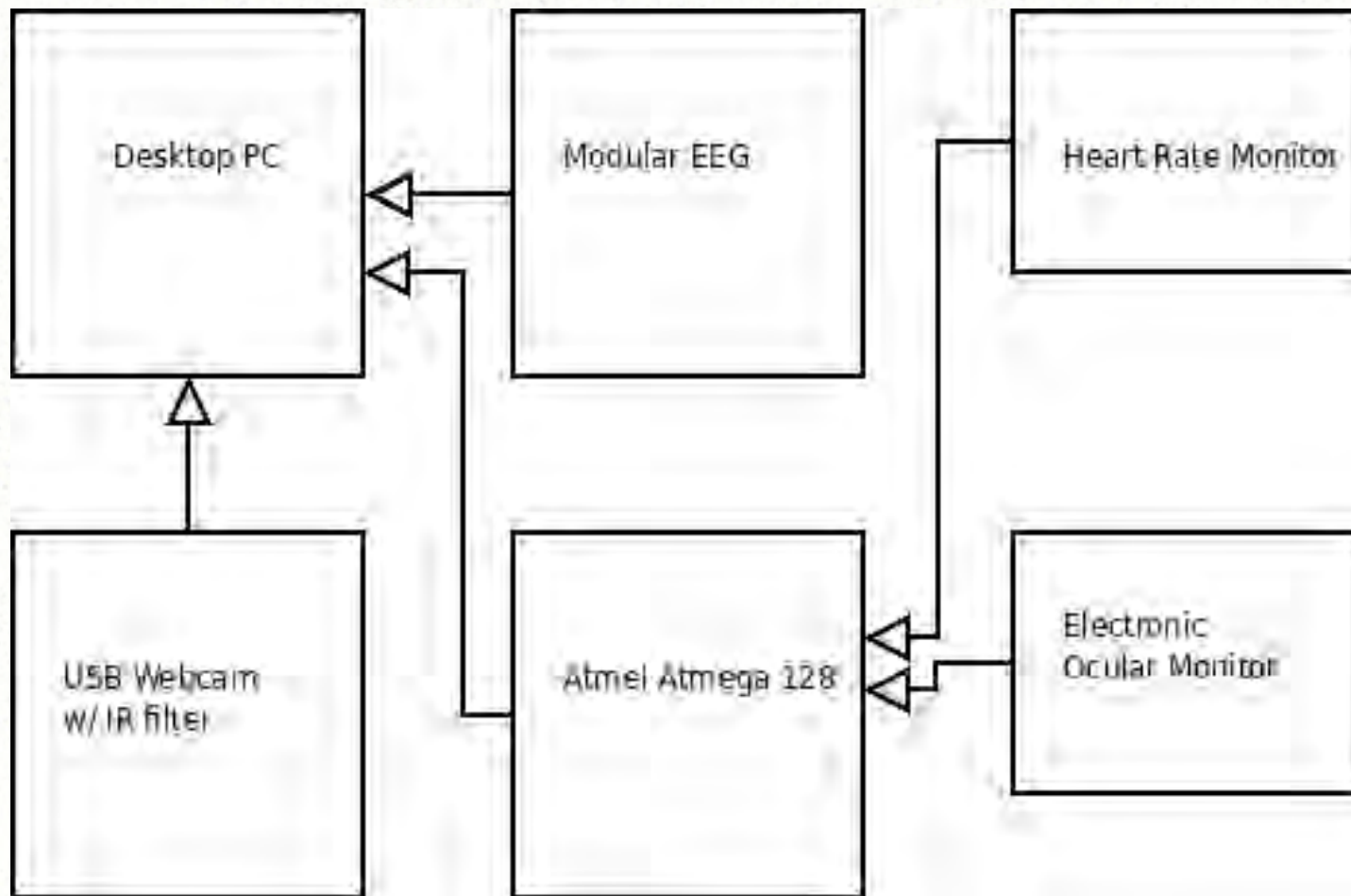
Interfaces with a desktop PC via RS 232 serial port

Homebrew microcontroller (Atmel Atmega128) device to collect other signals

Also Interfaces with a desktop PC via serial port

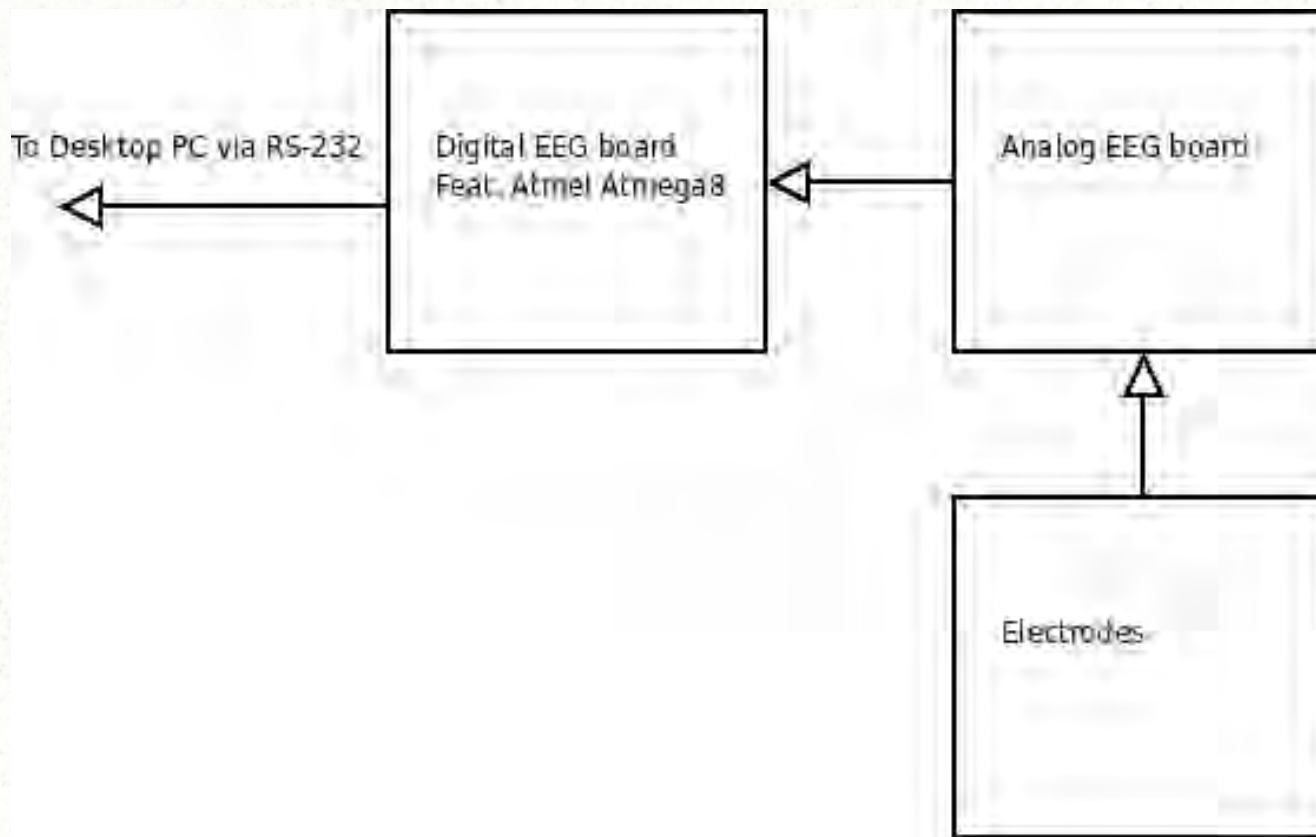
USB Webcam modded to see only IR

# *Hardware overview*

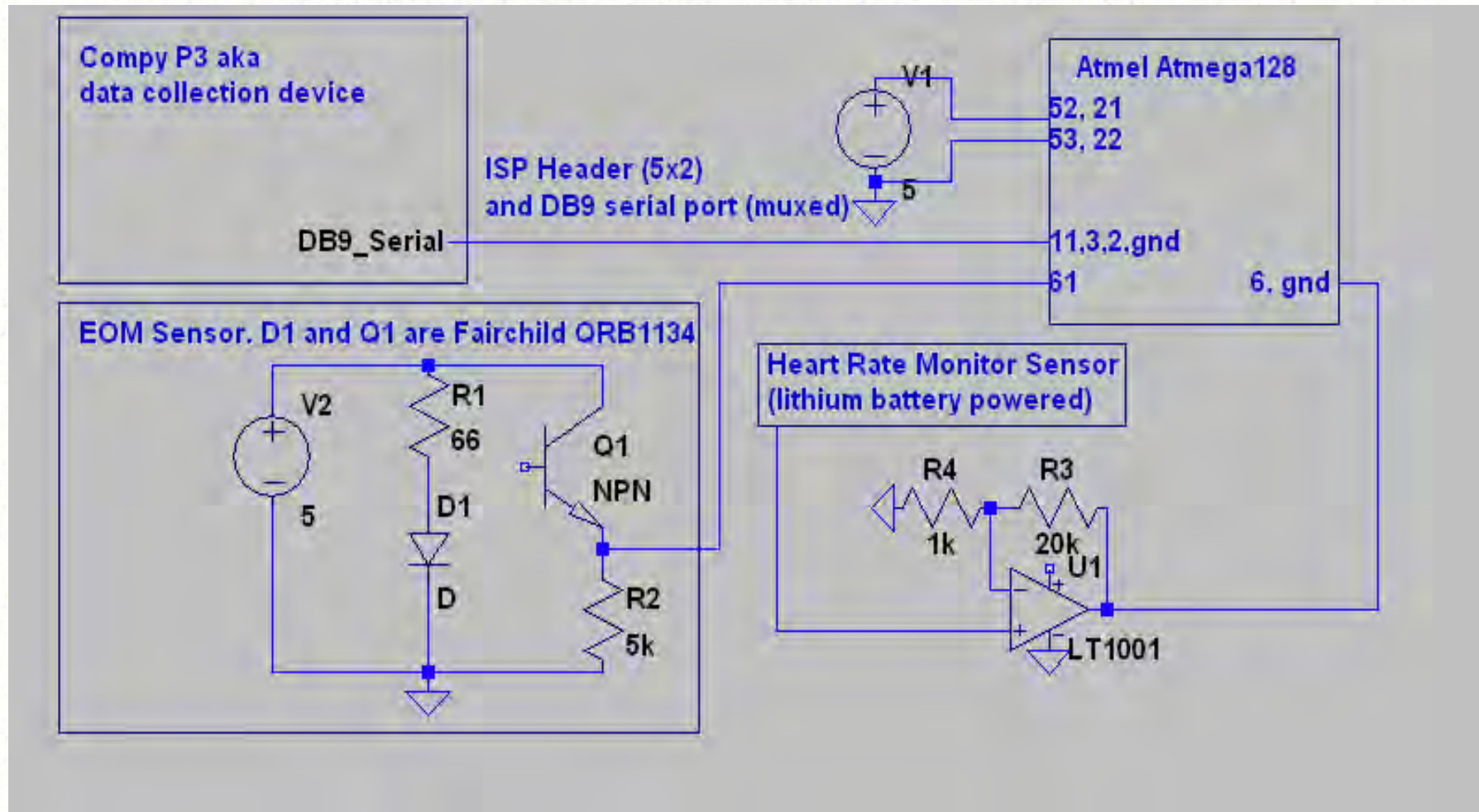




# *OpenEEG overview*



# 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 1V<sub>pp</sub> to 5v<sub>pp</sub>

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!

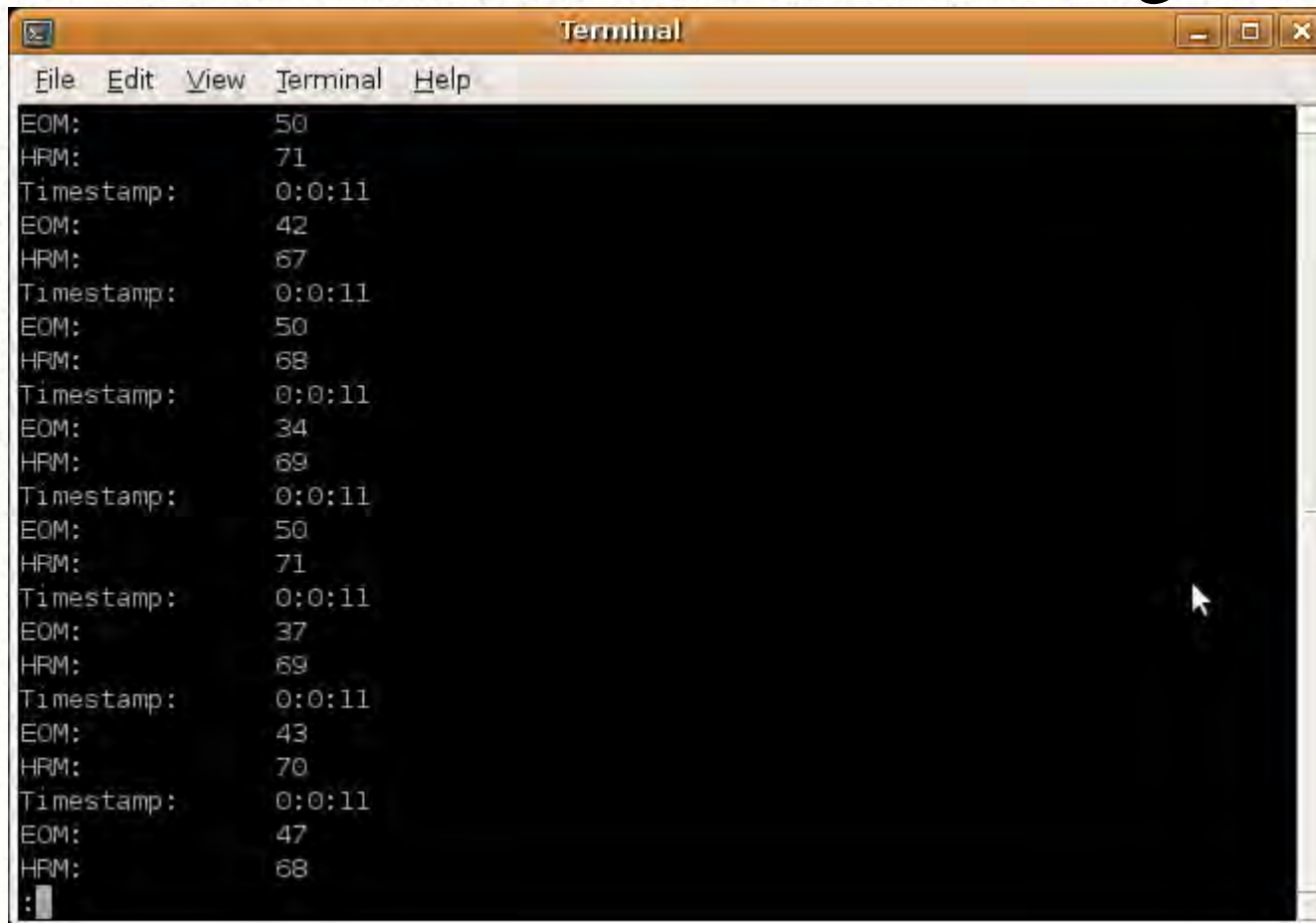
EEG capture when subject was asked about their favourite topic





# *Initial Data*

HRM and EOM verified to be working:



```
Terminal
File Edit View Terminal Help
EOM: 50
HRM: 71
Timestamp: 0:0:11
EOM: 42
HRM: 67
Timestamp: 0:0:11
EOM: 50
HRM: 68
Timestamp: 0:0:11
EOM: 34
HRM: 69
Timestamp: 0:0:11
EOM: 50
HRM: 71
Timestamp: 0:0:11
EOM: 37
HRM: 69
Timestamp: 0:0:11
EOM: 43
HRM: 70
Timestamp: 0:0:11
EOM: 47
HRM: 68
:
```



# *Initial Data*

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*

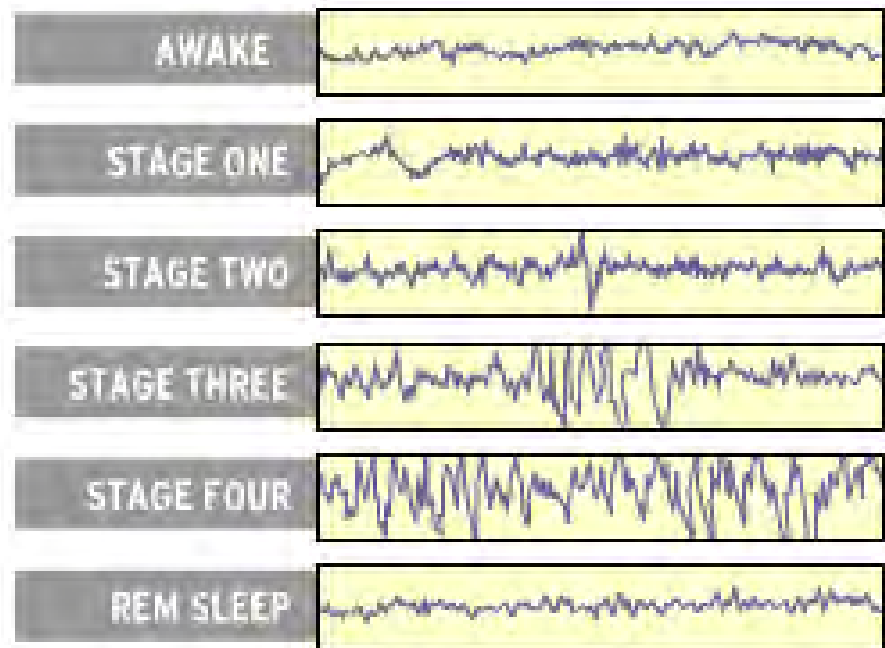
FIXME: show picture clips of various sleep stages collected here



# *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.)

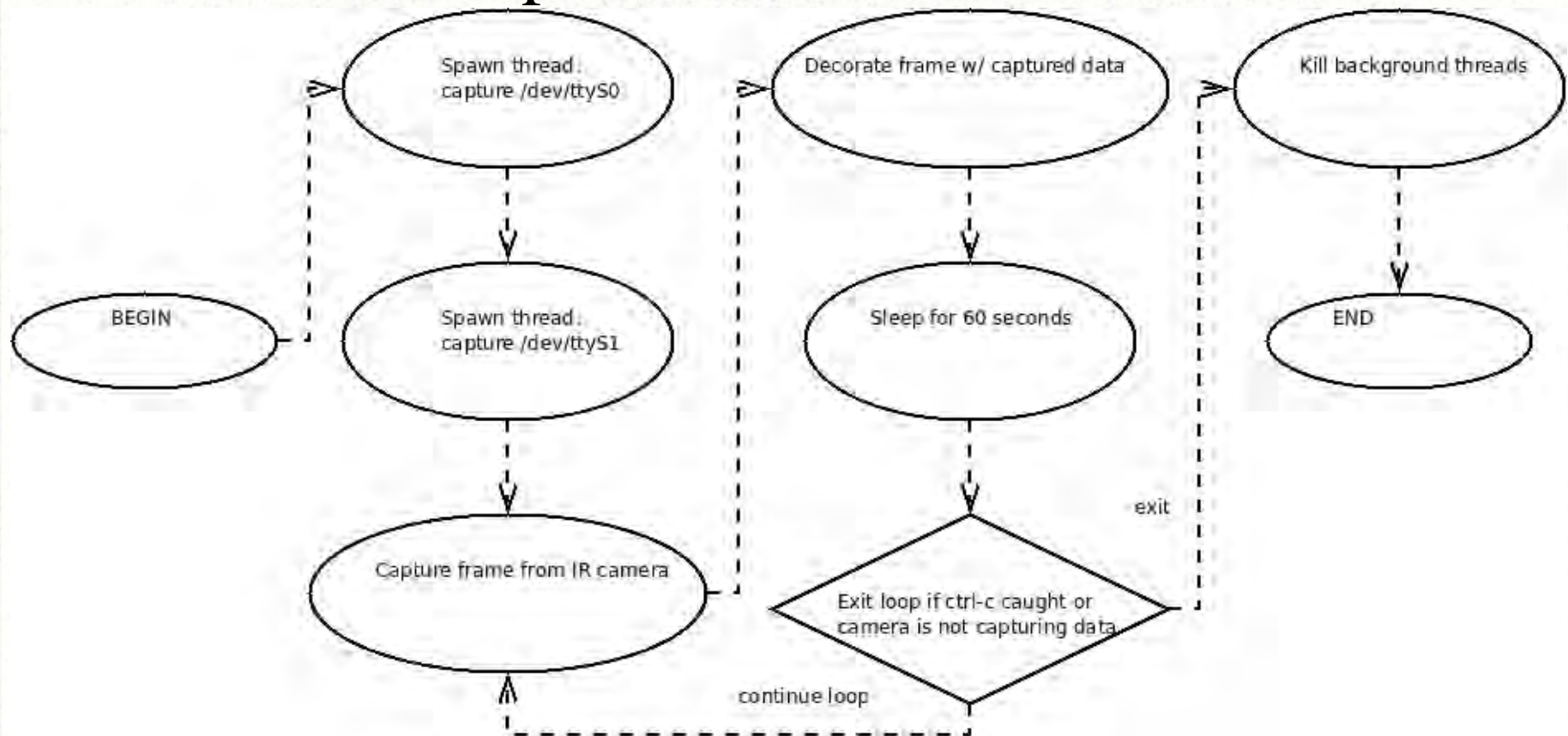
Camera stills will show fitful sleep, sleepwalking, and restless leg.

Elevated heart rate can indicate stress



# *Additional info*

Flowchart of capture software:





## *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/>