

# Quad Rat Vitals Monitor



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## Abstract

The design and construction of a rat vitals monitoring system is essential for simultaneously monitoring multiple anesthetized rats. Our client currently runs PET scans on four rats simultaneously, and the scans can last up to two hours. During the two hour scans, the rats are under anesthesia and doses of the anesthesia medications must be adjusted based on the rats' vitals. The client desires to have an accurate, reliable, and easy to use rat vital monitoring device to aid in this process. The current design for this monitoring device includes force-sensing resistors (FSR) for monitoring breathing rate, thermistors to monitor rectal temperatures, and pulse oximeters to monitor SpO<sub>2</sub> levels and heart rates. The design also includes an easy-to-read graphical user interface (GUI) that displays live traces of the vitals as well as the current value of those vitals in the form of heart rate, blood oxygen saturation, temperature, and breathing rate.

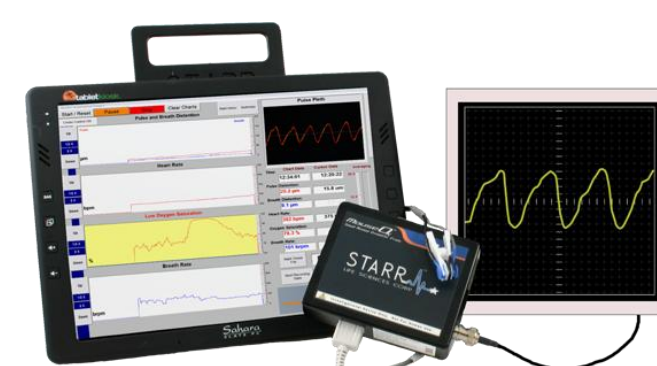
## Motivation

Our client's research required him to monitor vitals of four rats individually. The laboratory assistants must be informed in a timely manner if any of the four vitals enter critical ranges so adjustments to the anesthesia can be made.

## Existing Devices

MouseOx, produced by Starr Life Science™ and the Nellcor N-100  
 - Monitor SpO<sub>2</sub> levels, heart rate, and breathing rate  
 - Not capable of monitoring multiple rats  
 - Four separate units not cost effective

Figure 1. MouseOx: Image taken from [http://www.starrlifesciences.com/images/products/mouse\\_analog.png](http://www.starrlifesciences.com/images/products/mouse_analog.png)



## Previous Work

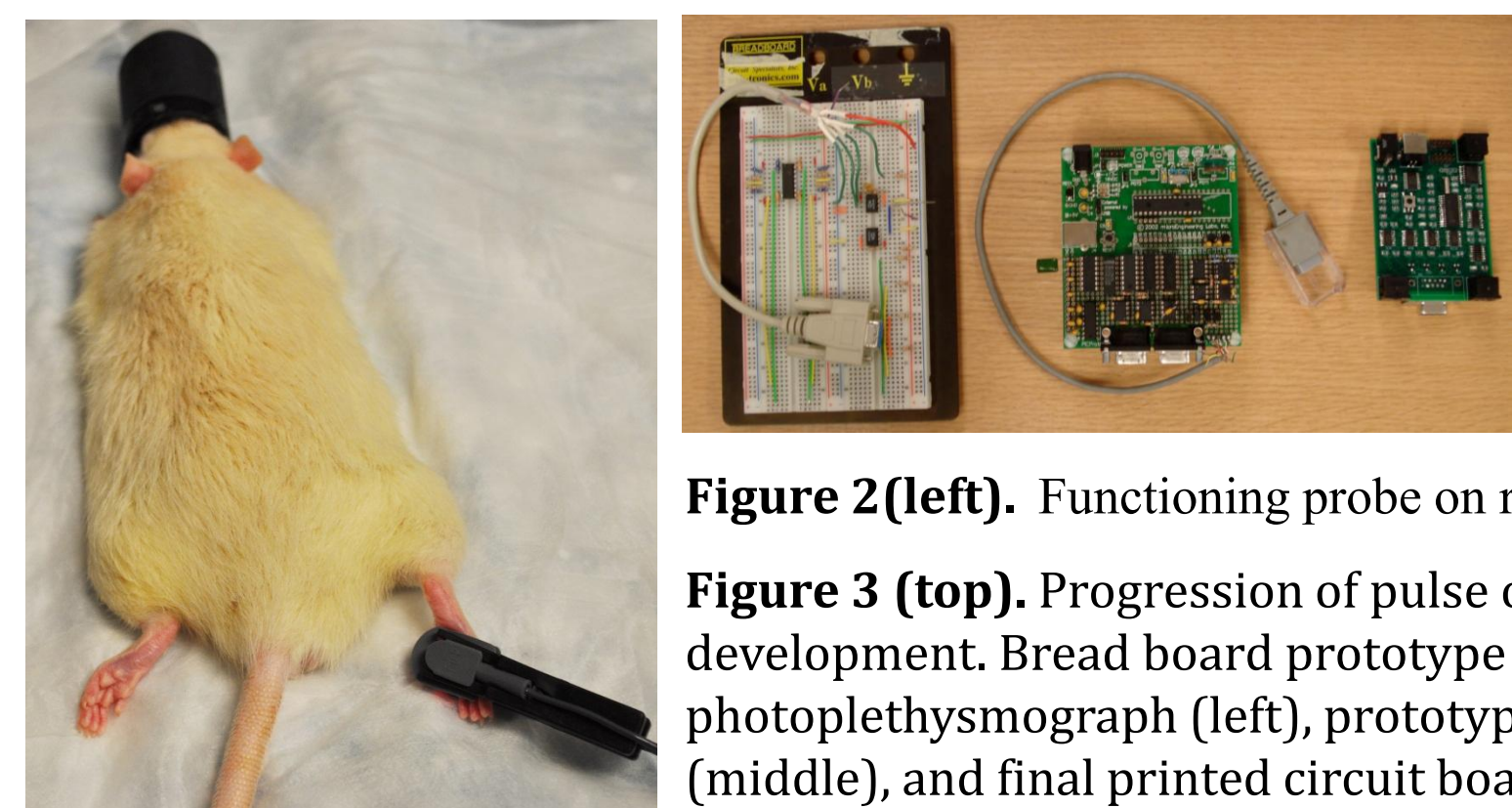


Figure 2(left). Functioning probe on rat under anesthesia.  
 Figure 3 (top). Progression of pulse oximeter circuit development. Bread board prototype containing photoplethysmograph (left), prototype wire-wrap board (middle), and final printed circuit board (right).

## Final Design

### Hardware

- Built 4 working circuit boards
- Boards each contain input for a force sensing resistor, pulse oximeter and thermistor
- Built system controller to manage system
- Data output via USB or Ethernet connection
- Housing contains all four boards, panel mounts, and the system controller
- Housing contains LEDs indicating the power state and status of each board
- Panel mounted components ease connection of sensors

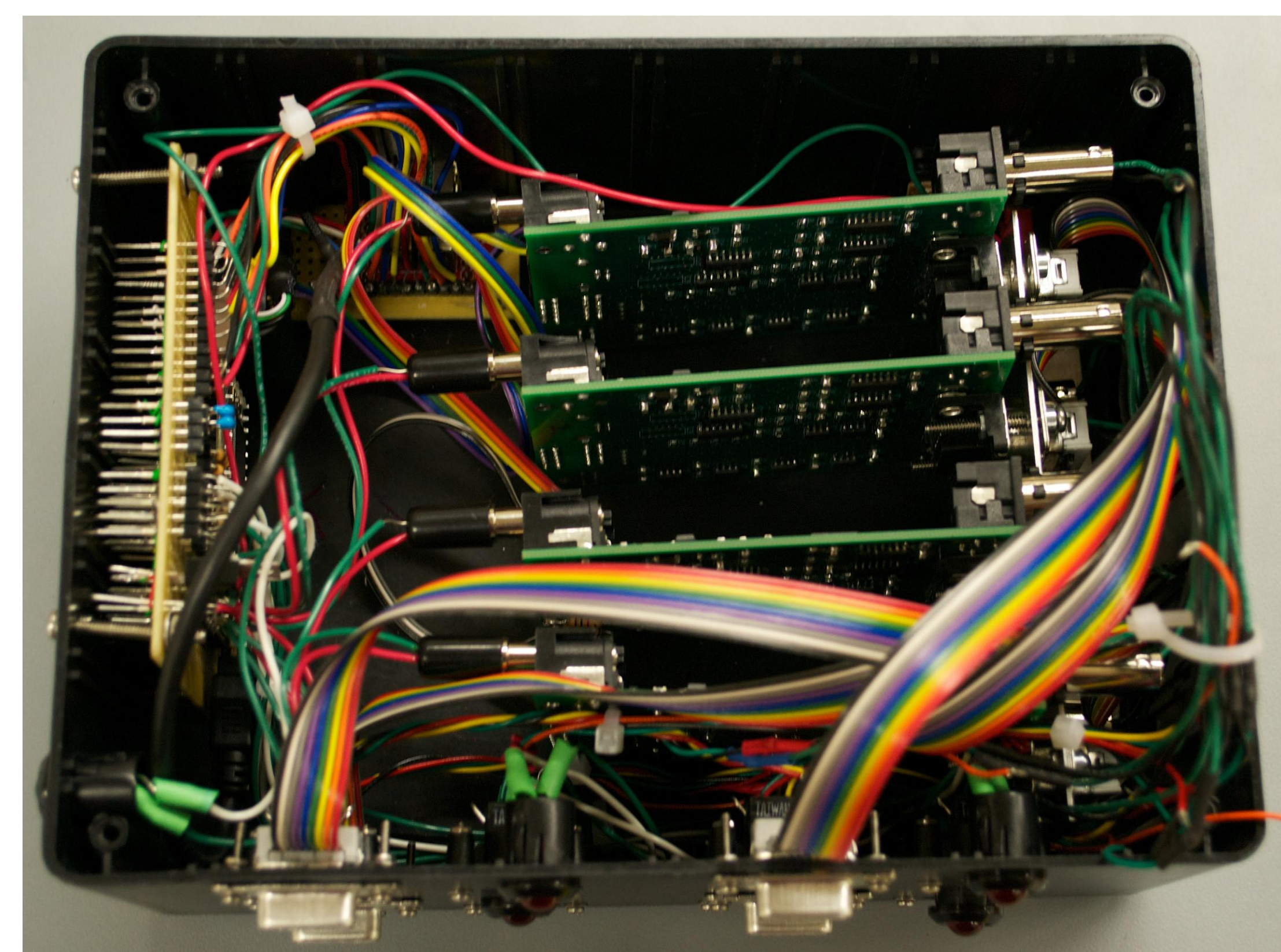


Figure 6. View of the inside of the Quad Rat Vitals Monitor (QRVM). Visible components include the four circuit boards, associated cables, and mBed system control. Sensors are connected to the front (picture, bottom). Ethernet and power connections are made on the side (picture, left).

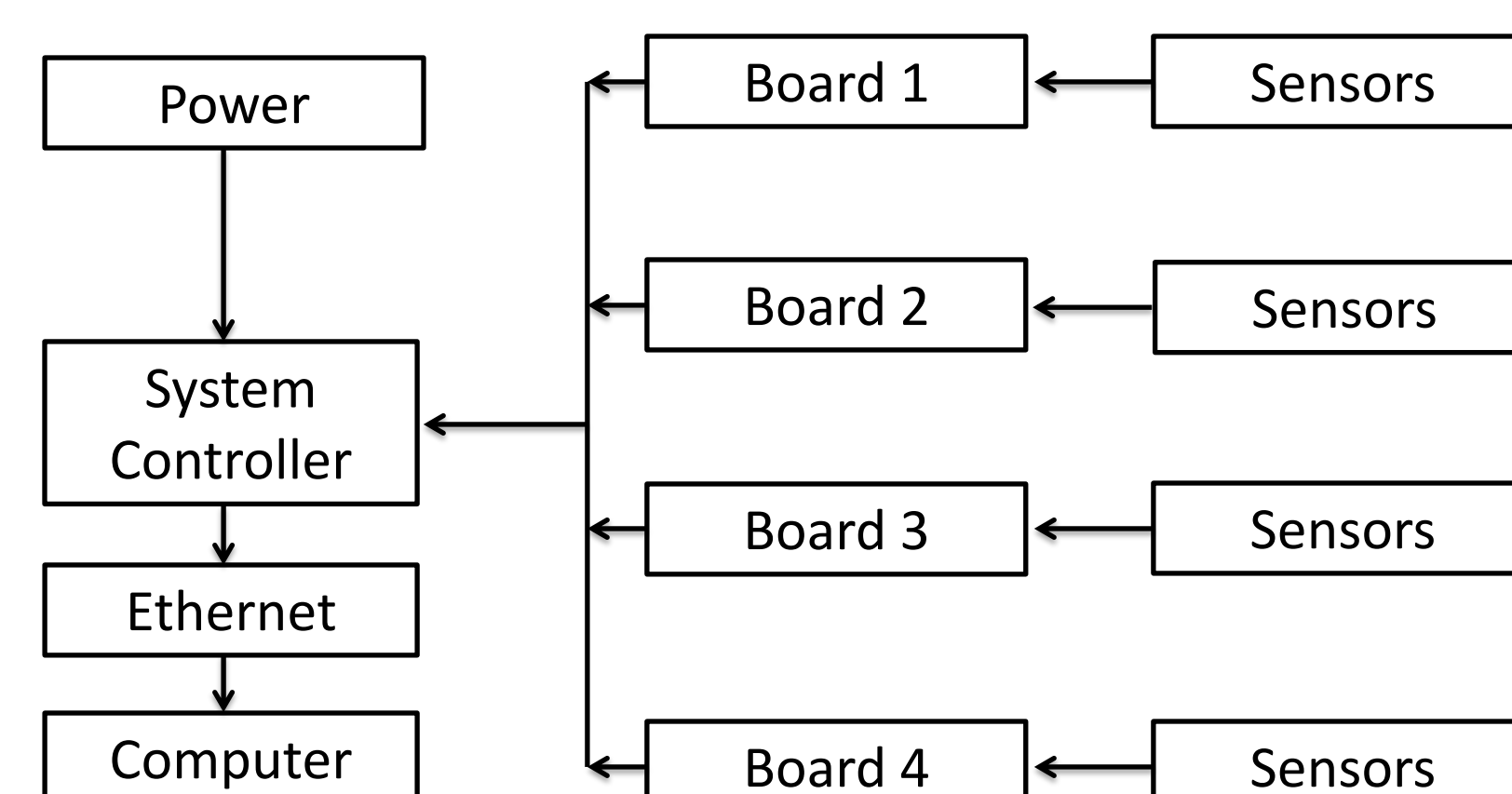


Figure 4. Flow chart of the final design. The System Controller passes the information (voltage values) from all four boards to the Java program on a computer using an ethernet connection.

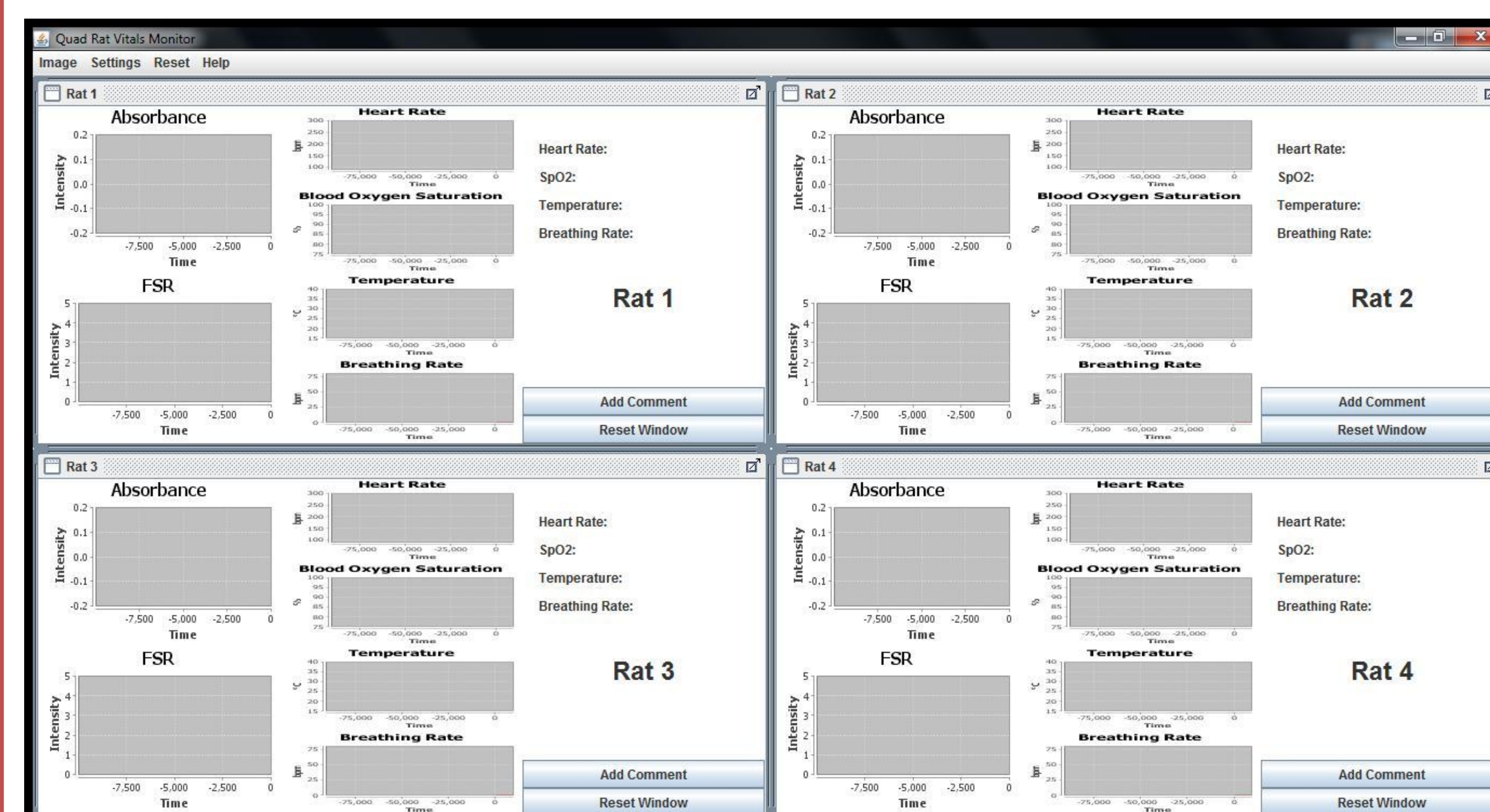


Figure 5. Graphical user interface of final product made in Java. Long term graphs for Heart Rate, SpO<sub>2</sub>, Breathing Rate, and Temperature are displayed. Short term graphs for breathing rate and heart rate are also displayed. Graphs for four separate rats are shown. Menu options include image saving, data saving, and program termination.

### Interface

- Written in Java, an open source program language
- Handles data acquisition, real-time signal processing and user interface
- Signal processing includes filtering and peak detection
- Includes 4 long term graphs (~10 minutes) and two short term graphs(~10 seconds)
- Framework extensible; more than four rats may be monitored
- Automatically saves all data to a Microsoft Excel document during the experiment
- Dynamic resizing of individual panes
- Snapshots enabled for documenting important events

## Testing

- Vital measurements on one rat under anesthetic
- Testing of four rats simultaneously difficult due to experimental protocols; data from one rat set to populate all graphs
- All four vital signals are being monitored

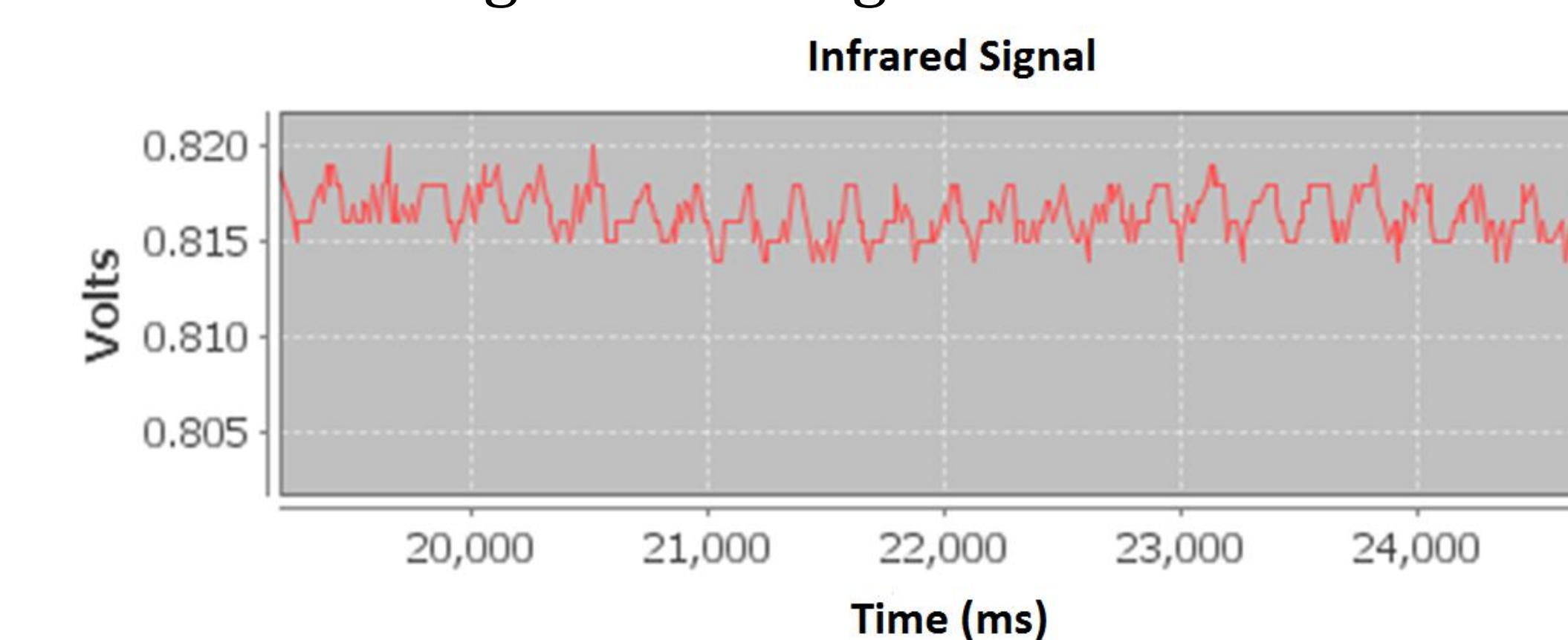


Figure 7. The Infrared signal detected from an anesthetized rat during testing. DC offset has since been corrected.

## Budget

- Spring 2011
  - Digi-key- Housing Components - \$201.69
  - Newark Element 14- Power Supply- \$27.00
- Fall 2010
  - Mouser - Circuit Components - \$97.29
  - Digi-Key - Circuit Components - \$61.00
- Spring 2010
  - Mouser - Circuit Components - \$26.40
  - Digi-Key - Circuit Components - \$371.14
  - PCB Express - Circuit Boards - \$548.00
  - RadioShack - Power Supply - \$30.55
- Fall 2008- Fall 2009
  - Client - Lenovo Laptop - \$660.00
  - Misc. hardware Components: - \$409.00

**Total: \$2,432.07**

## Future Work

- Conduct full system test during client's research
- Improve quality of signal processing and recognition

**Acknowledgments:** We would especially like to thank Peter Klomberg, Dr. Alex Converse, Liz Ahlers, Amit Nimunkar, Ph. D.,

**References:** Webster, J. G., Design of Pulse Oximeters. IOP Publishing Ltd 1997.  
 Starr Life Sciences™ Corp. © 2009  
 Nellcor Puritan Bennett LLC. © 2009