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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 concurrently, 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 SpO₂ levels and heart rates. The design also includes an easy to read graphical user interface (GUI) that displays running averages of the four vitals, history graphs of the four vitals, and live traces of heart rate and breathing rate. Data will be stored for later analysis.

Project Motivation

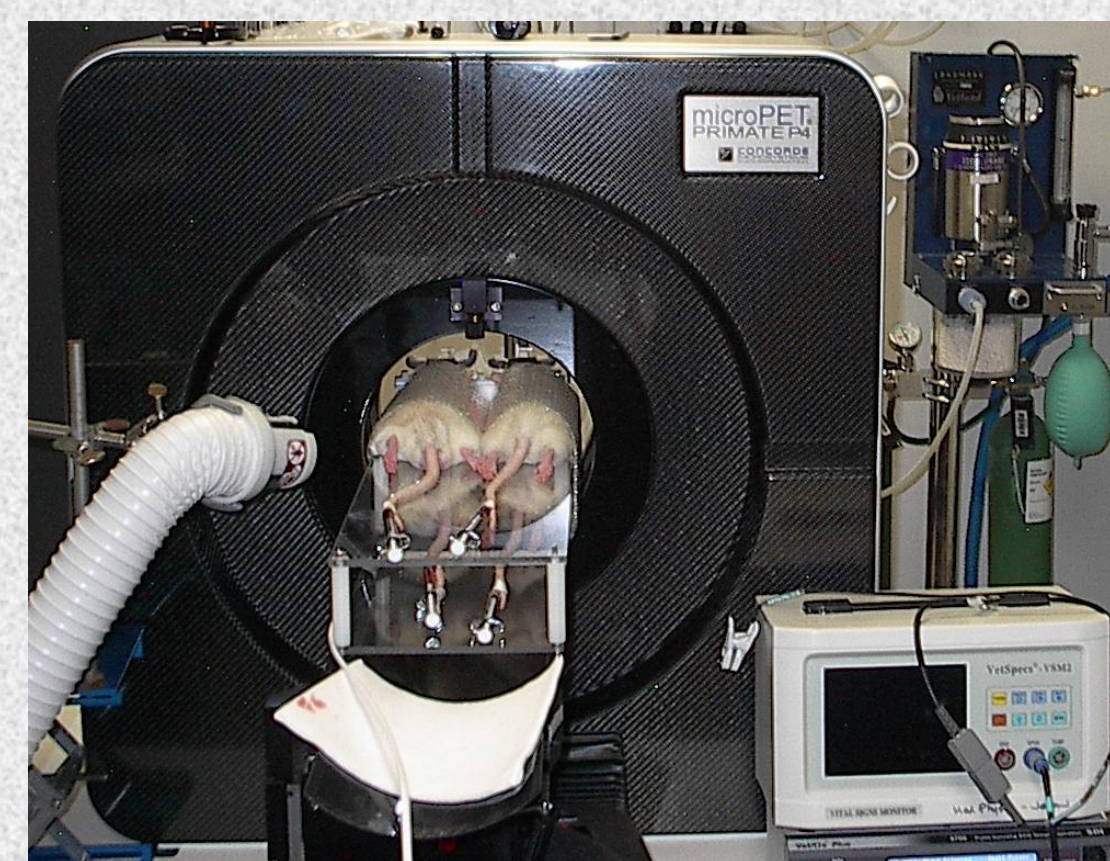


Figure 1. Our client's current setup. Picture taken in spring 2009.

Our client's research requires him to monitor four vitals of each rat 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 SpO₂ levels, heart rate, and breathing rate
 - Not capable of monitoring multiple rats
 - Four separate units not cost effective

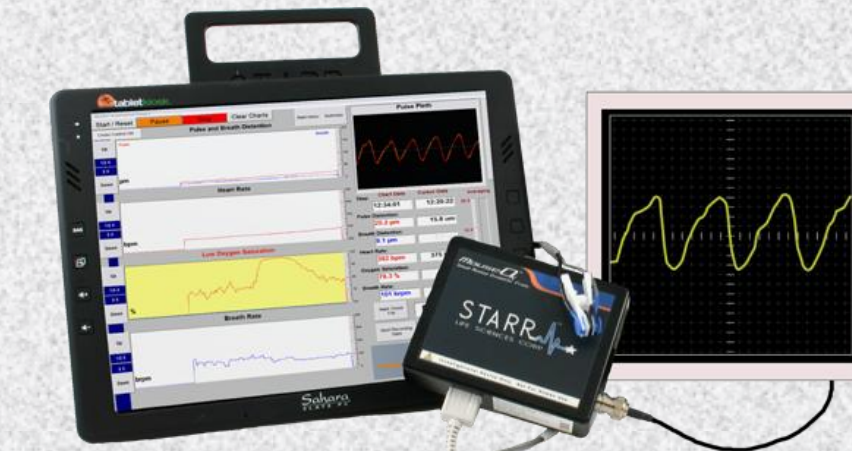


Figure 2. MouseOx: Image taken from http://www.starrlifesciences.com/images/products/mouse_analog.png

Design Criteria

- SpO₂ (± 2%)
- Heart rate (up to 500 beats/min)
- Rectal temperature (33°C - 38°C)
- Respiration rate (20-30 breaths/min)

Previous Semester

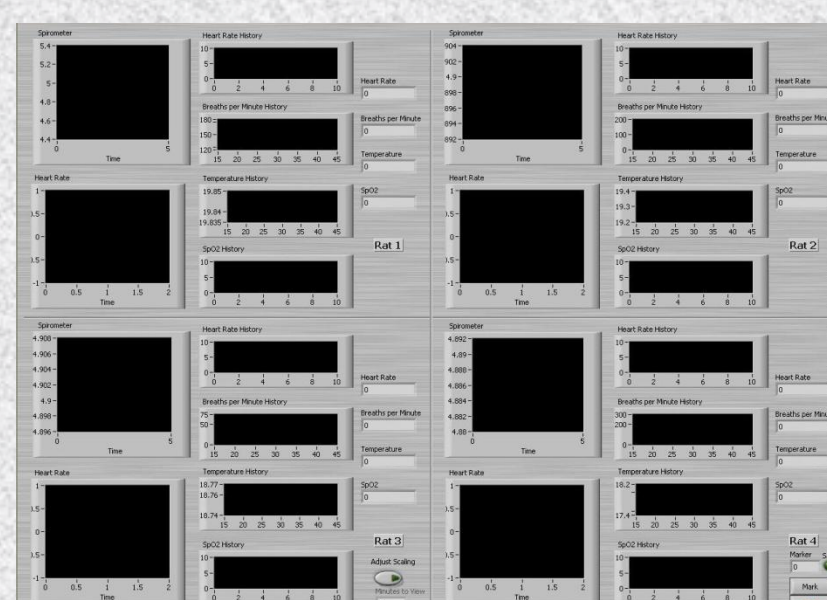


Figure 3. Screenshot of LabVIEW Graphical User Interface

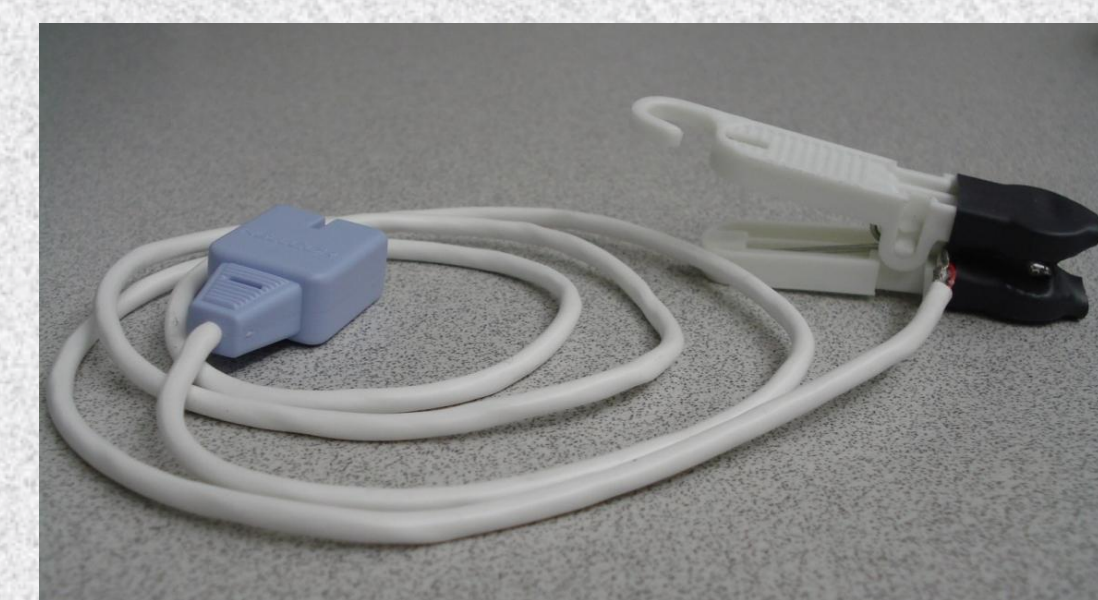


Figure 4. Pulse oximeter probe manufactured from excised NellCor parts



Figure 5. Functioning rectal temperature probe and force sensing resistor

Final Design

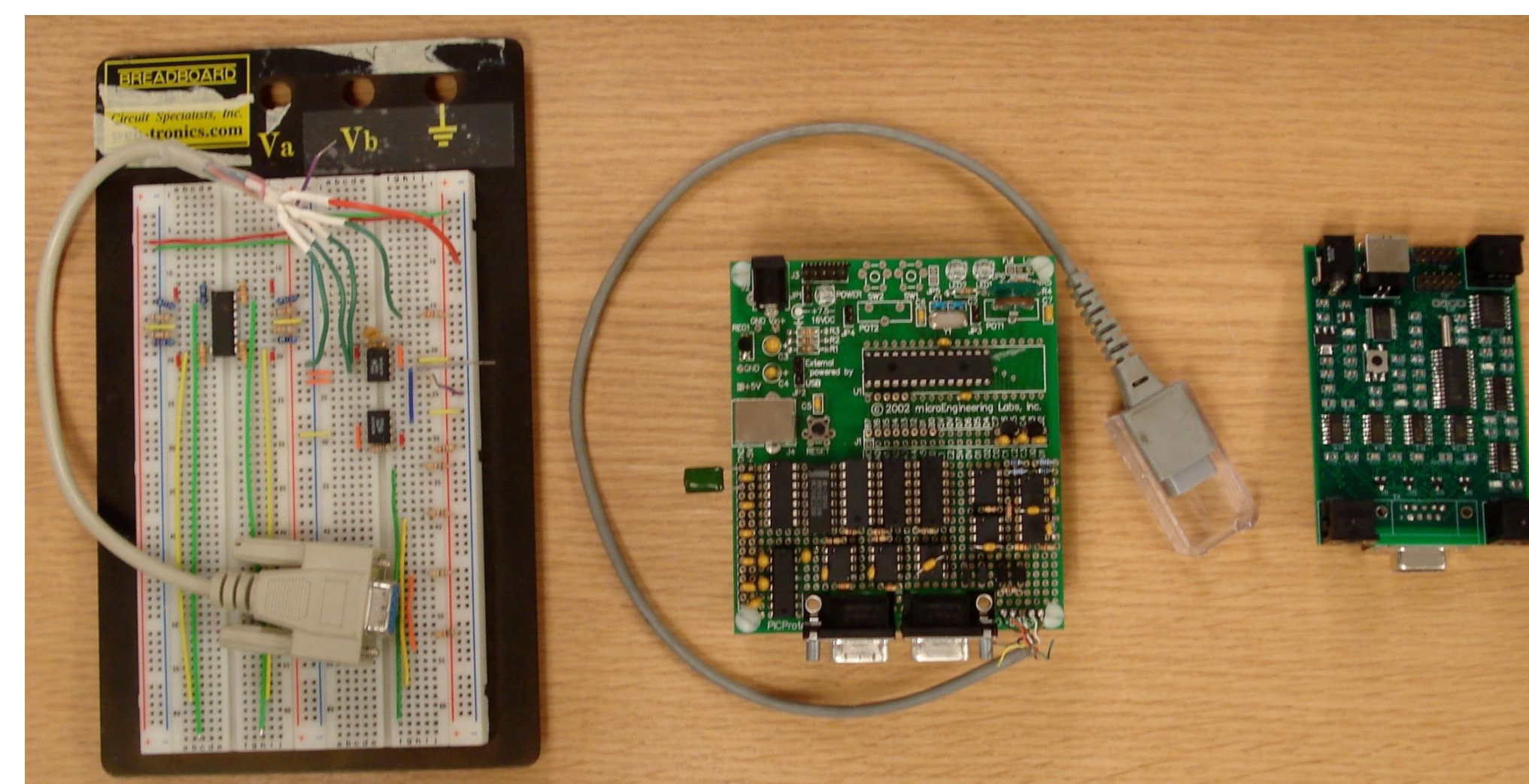


Figure 6. Progression of pulse oximeter circuit development. Bread board prototype containing photoplethysmograph (left), prototype wire-wrap board (middle), and final printed circuit board (right).

- Circuits printed on 4-Layer boards from PCB Express
- Printed board offers increased speed, reliability, and compact size
- Integrates thermistor and FSR circuits on the same board

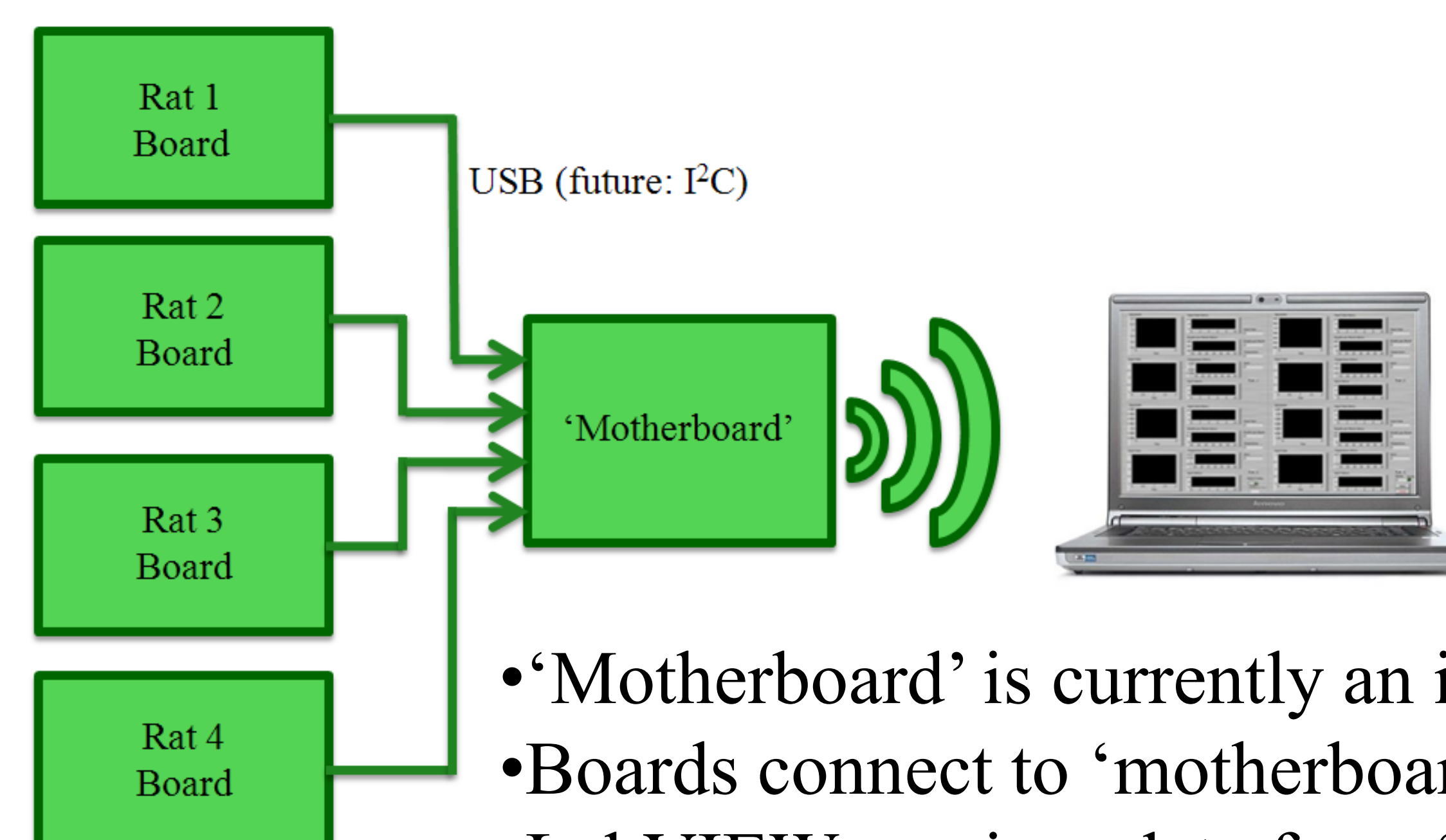


Figure 7. Block diagram of system communication between circuit boards and LabVIEW GUI.

- 'Motherboard' is currently an intermediate computer
- Boards connect to 'motherboard' via USB
- LabVIEW receives data from 'motherboard' via WiFi

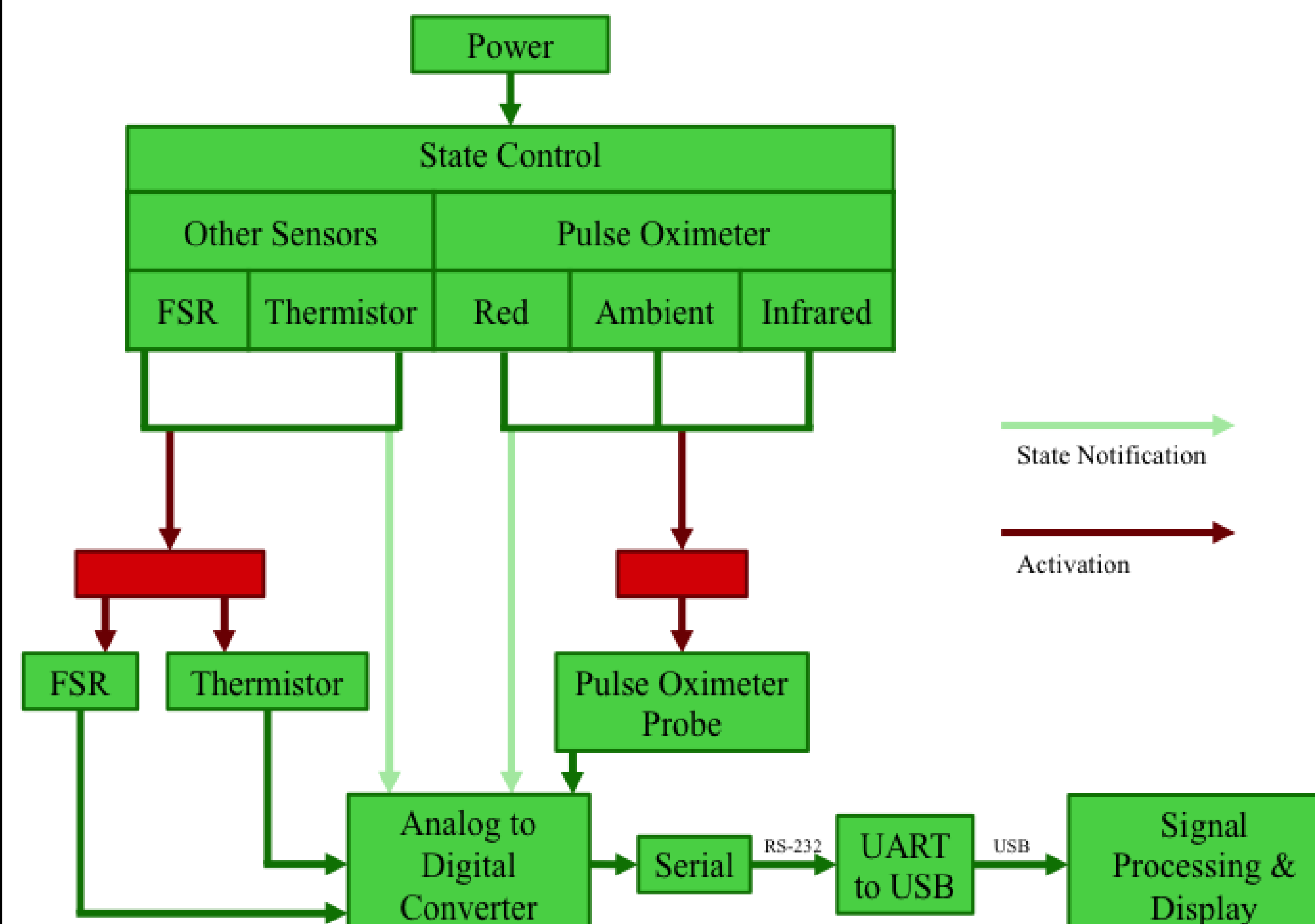


Figure 8. Project block diagram

Testing

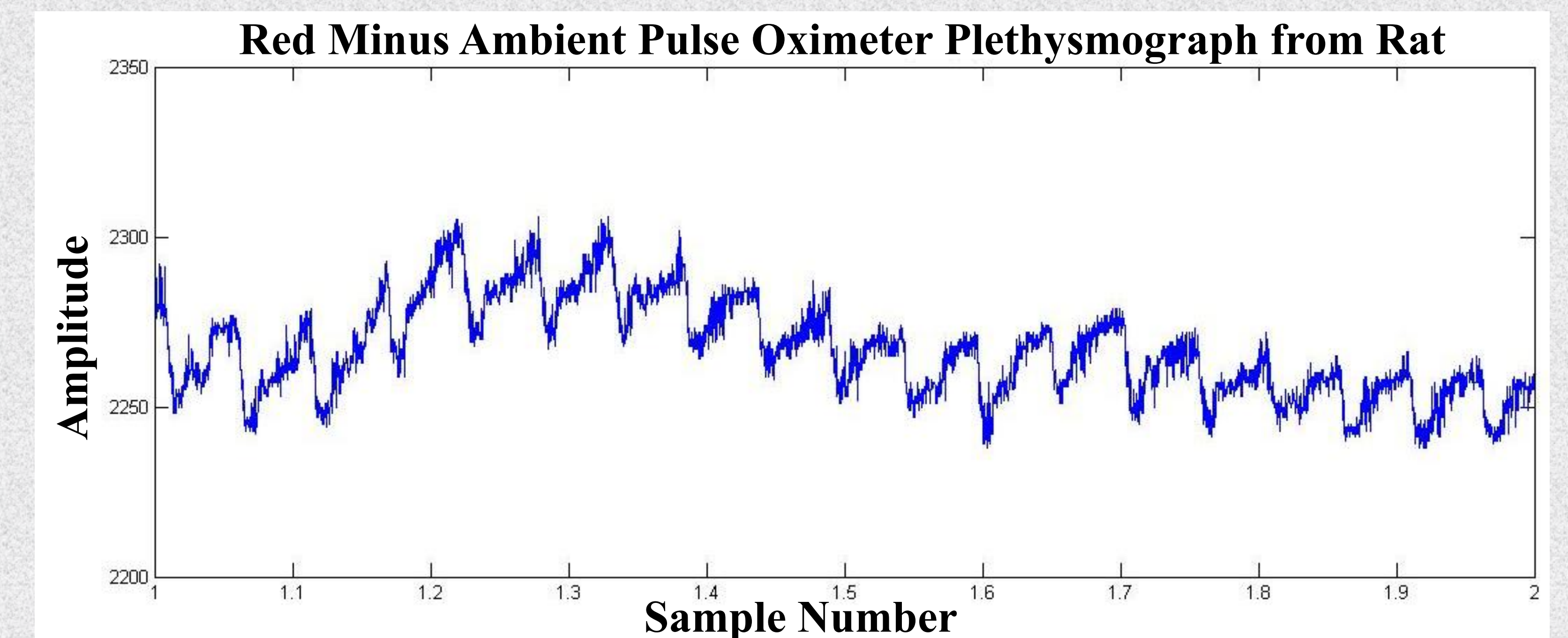


Figure 9. Rat pulse waveform obtained with newly designed probe and printed circuit board. 250 sample points equates to 1 second.

- Shows a rat heart rate of 285 beats per minute
- Raw data displayed using MATLAB
- Filters could be used to eliminate drift and attenuate noise

Budget Analysis

Table 1. Analysis of semester costs

Vendor	Item	Cost
Mouser	Circuit Components	\$26.40
Digi-Key®	Circuit Components	\$371.14
PCB Express	Circuit Boards	\$538.00
RadioShack®	Power Supply	\$30.55
Client	Lenovo® Laptop	\$660.00
Total		\$1626.09

Future Work

- Design motherboard for system
- Switch to using I²C for system communication
- Integrate single board computer
- Fabricate housing
- Test device during PET scan

Acknowledgements

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References

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 Nellcor Puritan Bennett LLC. © 2009