Utah State University

Mechanical & Aerospace Engineering

MAE 3340 *INSTRUMENTATION SYSTEMS*

Design Final Presentation

Pulse Oximeter Design Presentation

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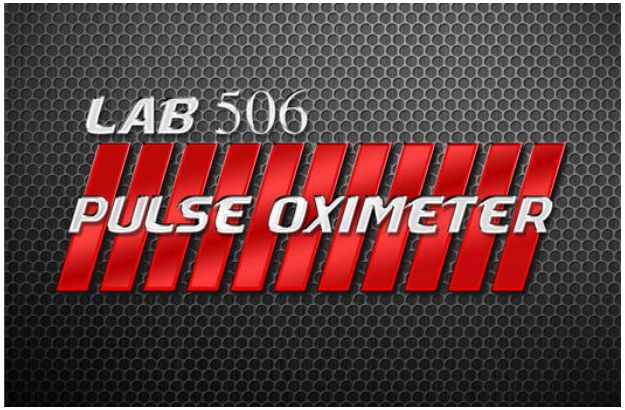
MAE 3340 Lab Section: 506

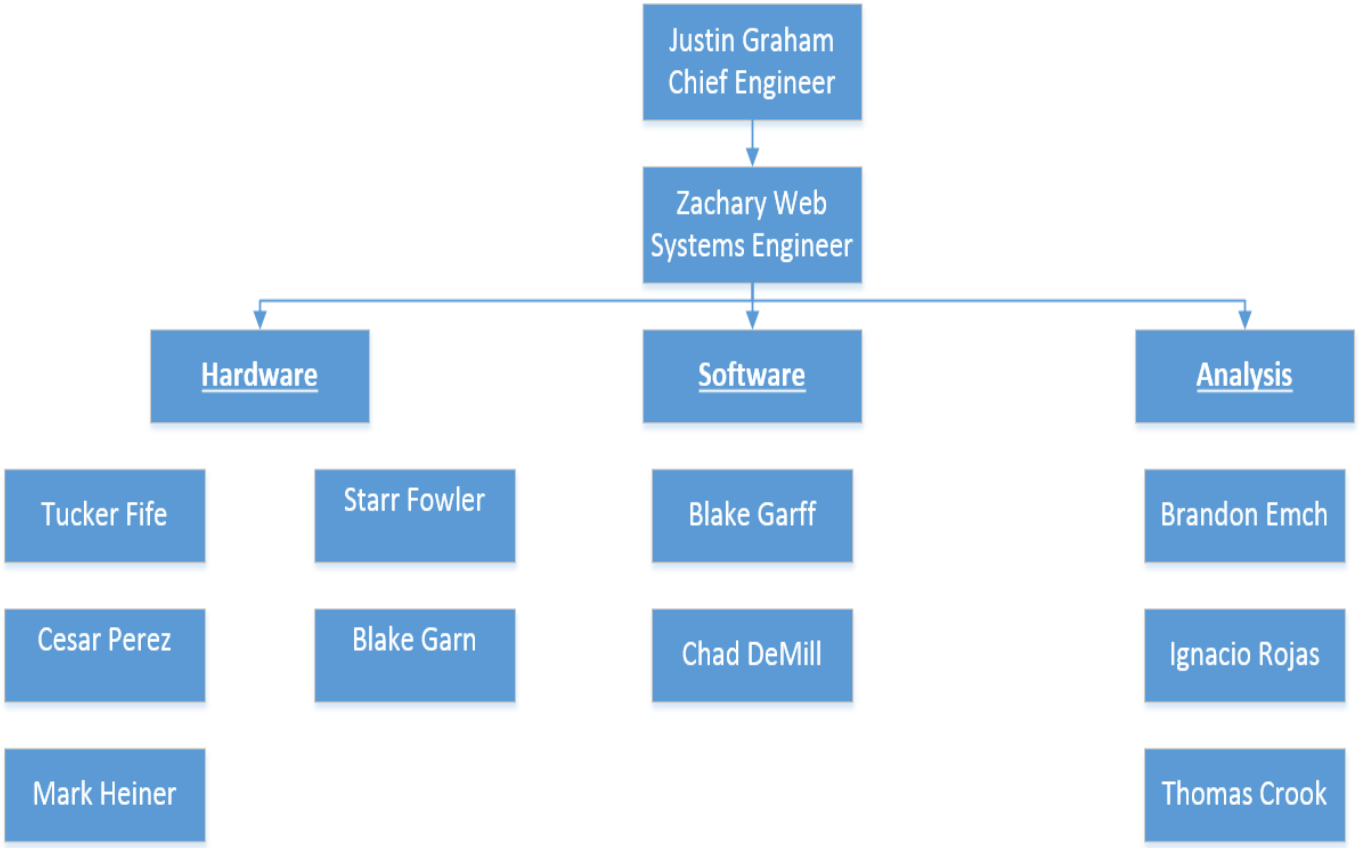
Date, Time, Location: May 2 2014, 9:30 am, USU



Objective

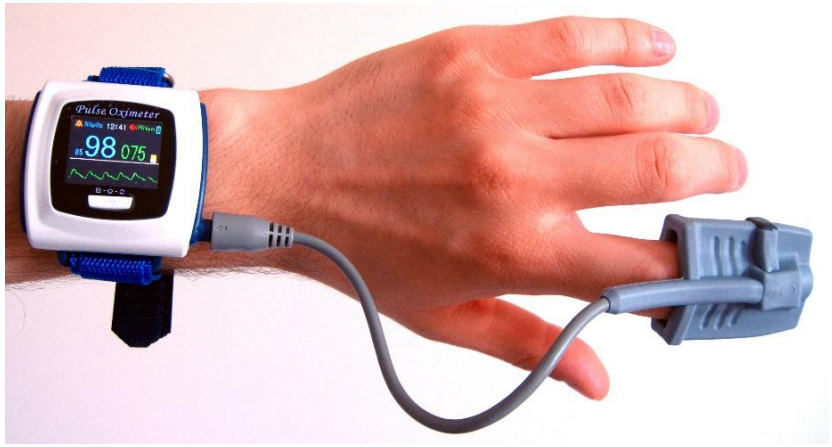
- Fabricate, integrate, and test two pulse oximeter prototypes based upon two configuration circuits:
  1) Photo-Resistive
  2) Photo-Generation
- Evaluate team member heart rates and compare to national average.

Team Member Roles



Pulse Oximetry

- Non-Invasive Method to Obtain Heart Rate and O_2 Saturation.
- Relatively simple concept involving the absorptive characteristics of light.

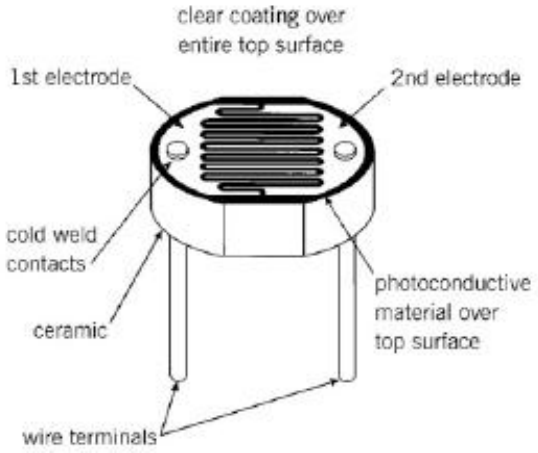


Courtesy of Wikipedia

Theory

1) Photo-Resistor

- Resistance varies depending on the level of exposure to incident light.

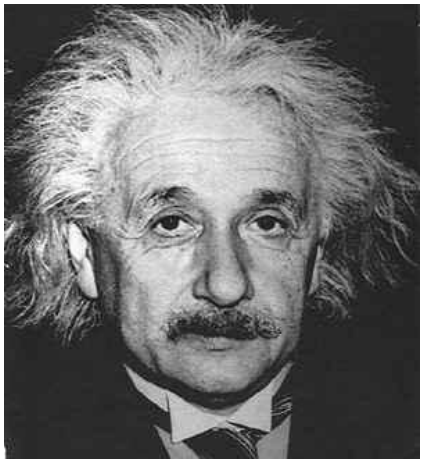


Courtesy of Design Requirements

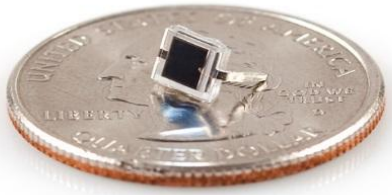
Theory

2) Photo-Diode

- Produces a current proportional to the level of illumination through the inner photoelectric effect.



Courtesy of CASA Guides



Courtesy of Sparkfun

Components

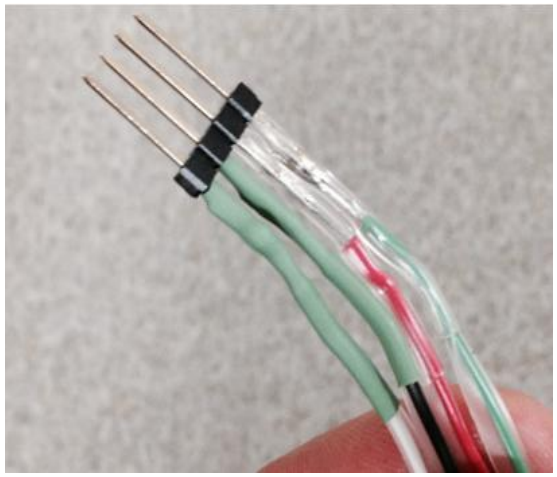
LED		
Company:	**Spark Fun**	**Spark Fun**
Name:	LED - Basic Red 5mm	LED - Basic Blue 5mm
Part # :	COM-09590	COM-11372
Max Current:	20 mA	30 mA
Wave Length:	620 -740 nm	450 - 495 nm
Price:	$0.35	$0.35
Quantity:	1	1

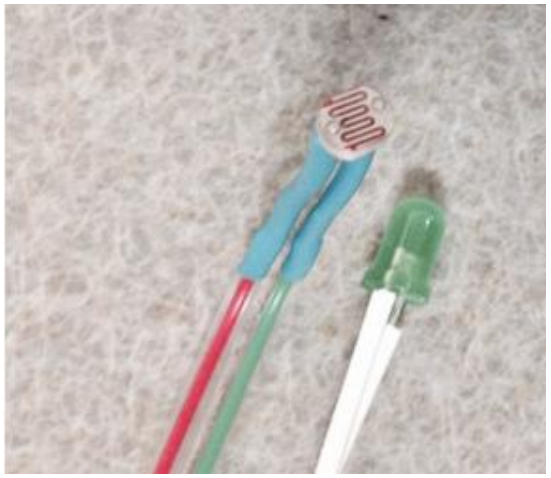
Photodiode	
Company:	**Spark Fun**
Name:	Miniature Solar Cell
Part #:	BPW34
Wave Length:	430 - 1100 nm
Price:	1.5
Quantity:	4
Shipping:	3.93

Photo Resistor	
Company:	**Spark Fun**
Name:	Mini - Photocell
Part #:	SEN-09088
Type:	CdS
Light resistance :	8-20 kOhm
Dark resistance :	~10k Ohm
Max power:	100 mW
Max Voltage:	150 V
Wave Length:	540 nm
Price:	$1.50
Quantity:	4

Assembly

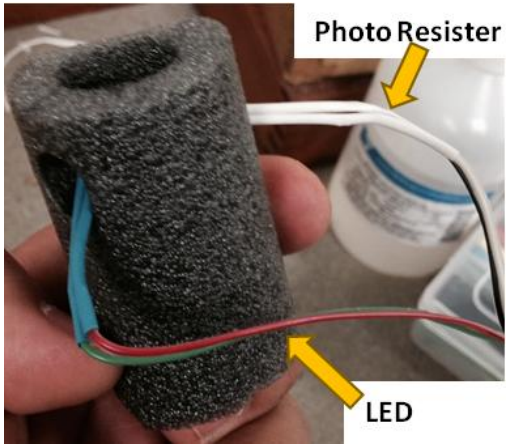
- Used four cord wire distinguishing header from connection ends.
- Soldered header & used heat shrink on connections.





Assembly Continued

- Black Styrofoam casting provides housing.
- Wrapped with aluminum foil and black electrical tape to shield against noise.



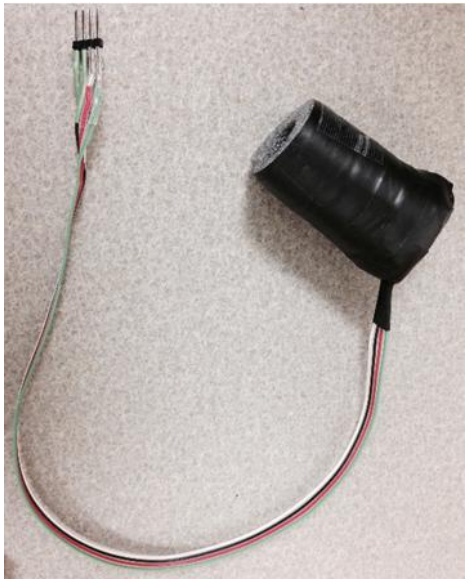


Photo-Resistive Circuit

- Conditioning circuits respond to change in resistance outputting proportional voltage.
- Decided to proceed with Wheatstone Bridge conditioning circuit over Voltage Divider.

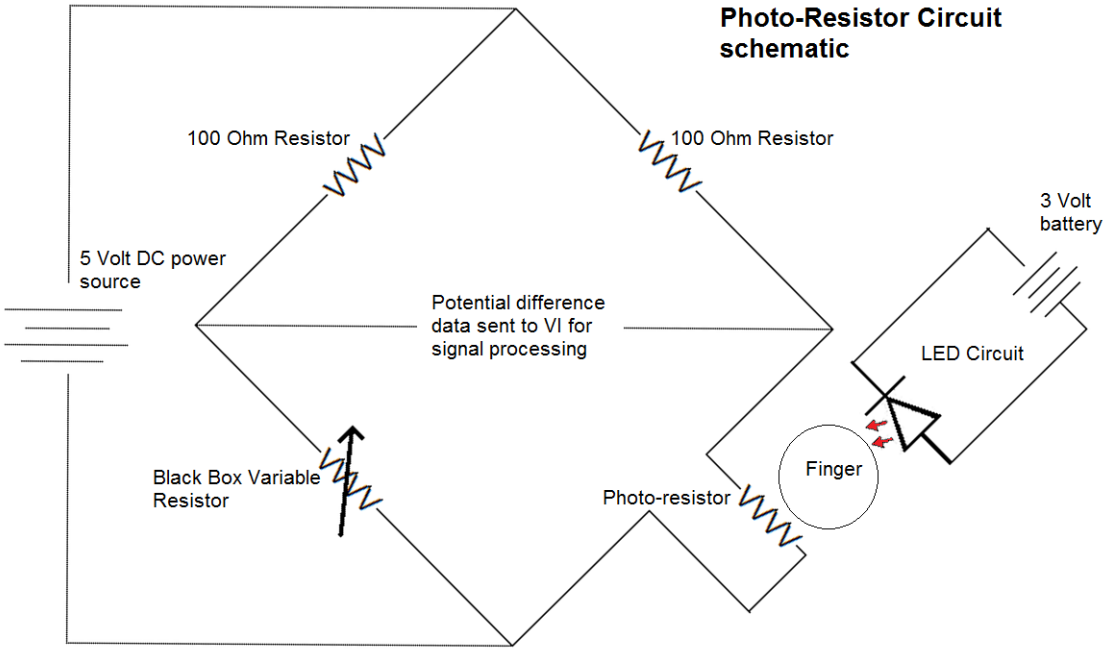
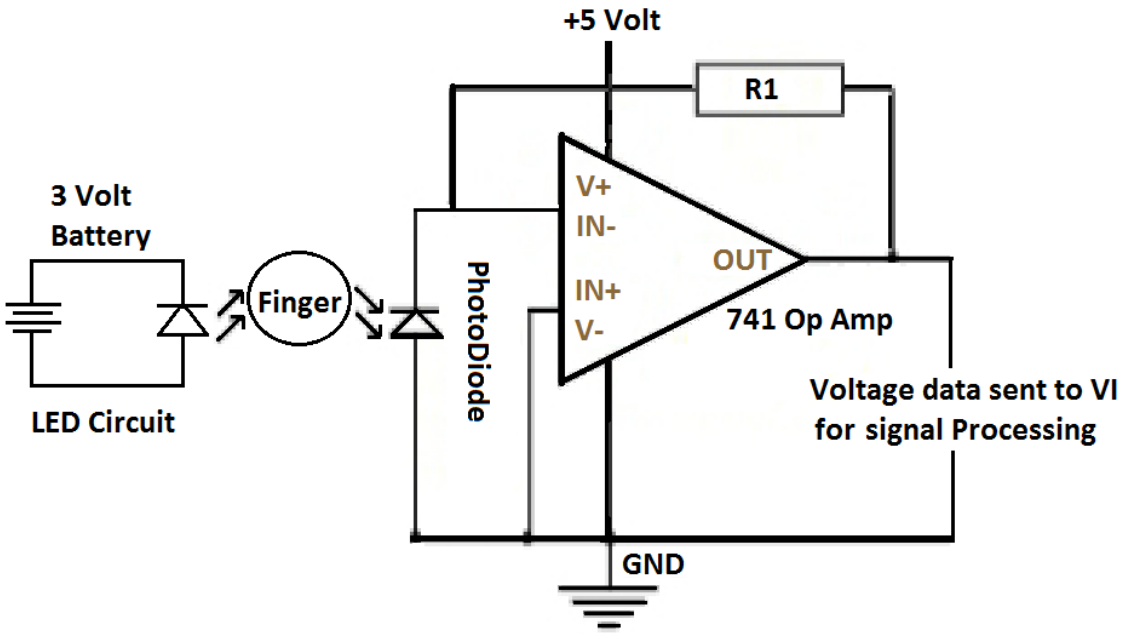


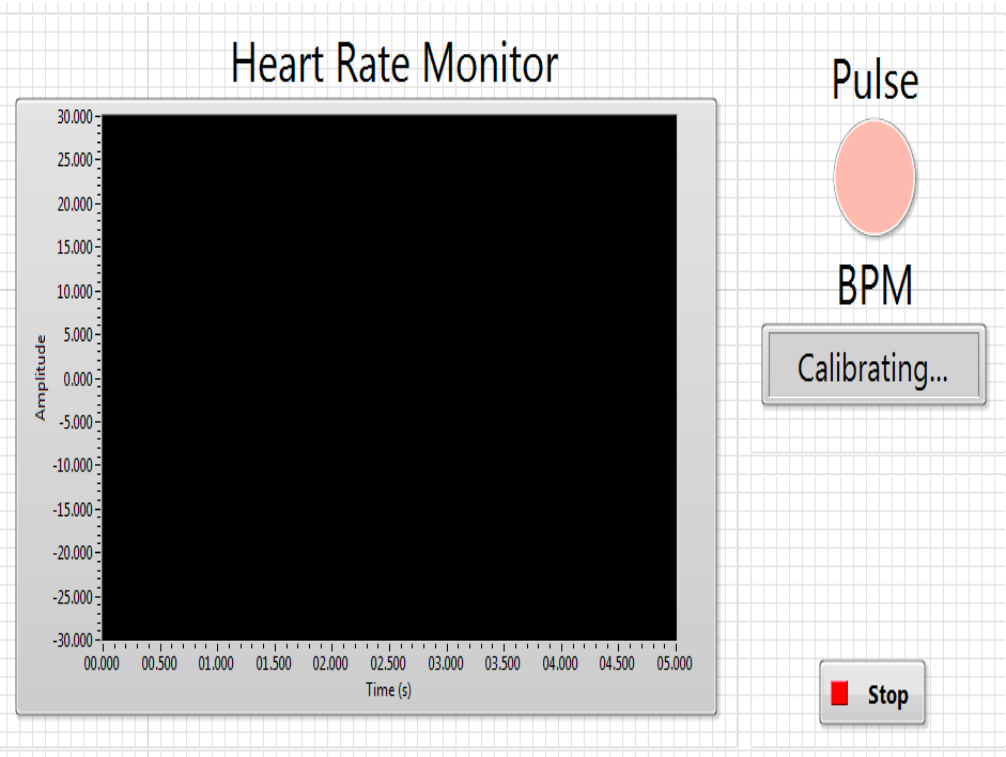
Photo-Generation Circuit

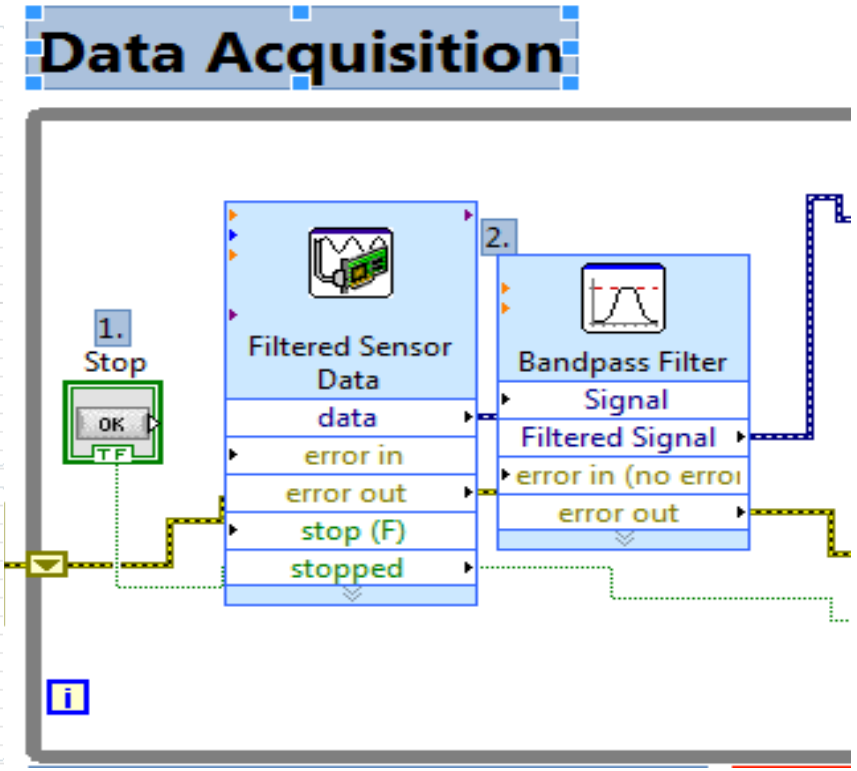
- Uses transimpedance amplifier to convert current from the photodiode into a readable voltage



Software: LabVIEW VI

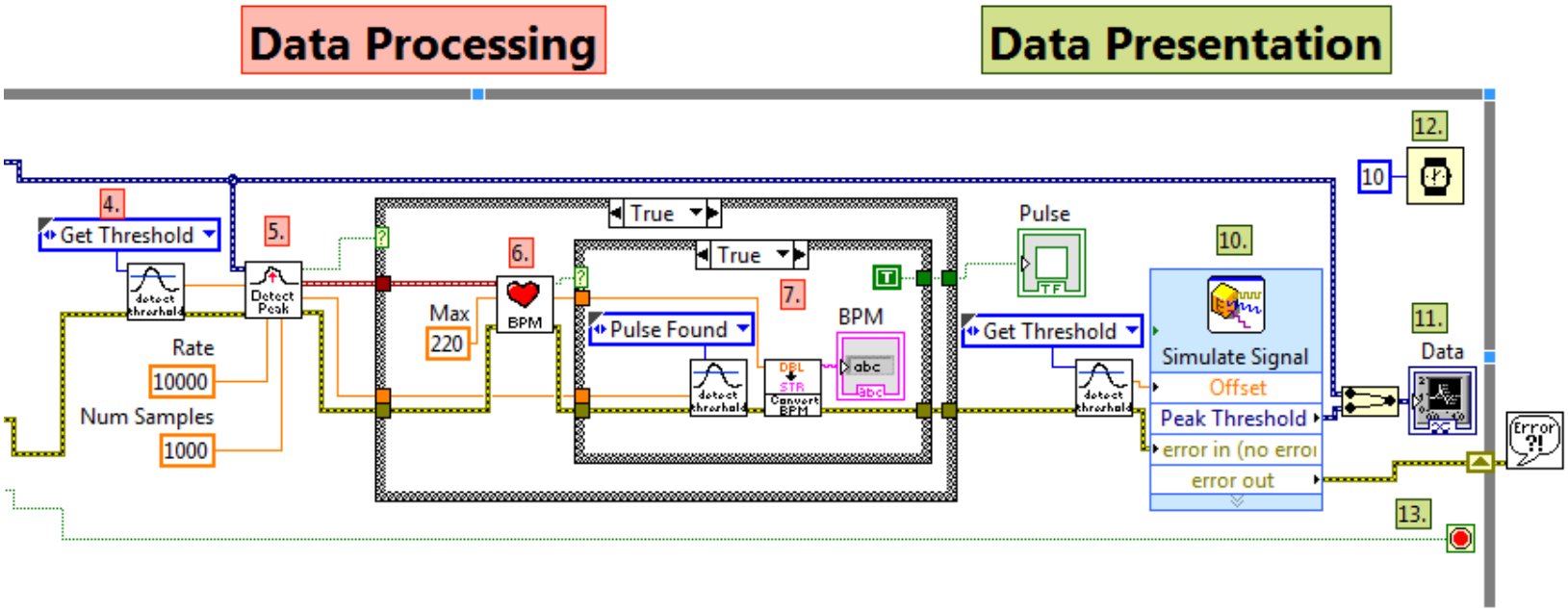
- Changes made





Software: LabVIEW VI

- Features kept



Results

- Due to inconsistent results the team proceeded with Photo-Diode Prototype for Recovery Rates.

Student	Resting Resistor	Resting Diode	Maximum	Recovered	Recovery
1	72	76	114	84	30
2	65	89	115	97	18
3	70	81	105	91	14
4	74	79	168	129	39
5	88	84	88	82	6
6	65	71	88	79	9
7	74	82	147	87	60
8	63	65	97	77	20
9	65	75	172	108	64
10	66	85	141	93	48
11	73	75			

Confidence Interval

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = 78.364 \qquad S_x = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}} = 6.860 \qquad DOF = n - 1 = 10$$

$$\bar{x} - t \times \frac{S_x}{\sqrt{n}} \leq \mu_x \leq \bar{x} + t \times \frac{S_x}{\sqrt{n}}$$

Value	Resting Resistor	Resting Diode	Recovery
Mean	70.455	78.364	30.80
Standard Deviation	7.451	6.86	19.93
Degrees of Freedom	10	10	9
t	2.228	2.228	2.262
Confidence Interval	5.005	4.608	15.026
v	10	10	9
t_{max}	2.228	2.228	2.262
t	-0.154	2.431	0.183

Statistical Significance

$$v = \frac{[(S_1^2/n) + (S_2^2/n)]^2}{\frac{(S_1^2/n)^2}{n_1 - 1} + \frac{(S_2^2/n)^2}{n_2 - 1}} = 10$$

$$t_{max} = 2.228$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(S_1^2/n) + (S_2^2/n)}} = 2.431$$

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Since $t > t_{max}$ the differences in our data and the national data are statistically significant for a 95% confidence interval. Taking this data as a model for the entire engineering population of USU would mean that the average heart rate of engineers at USU are higher than the average American.

Questions??