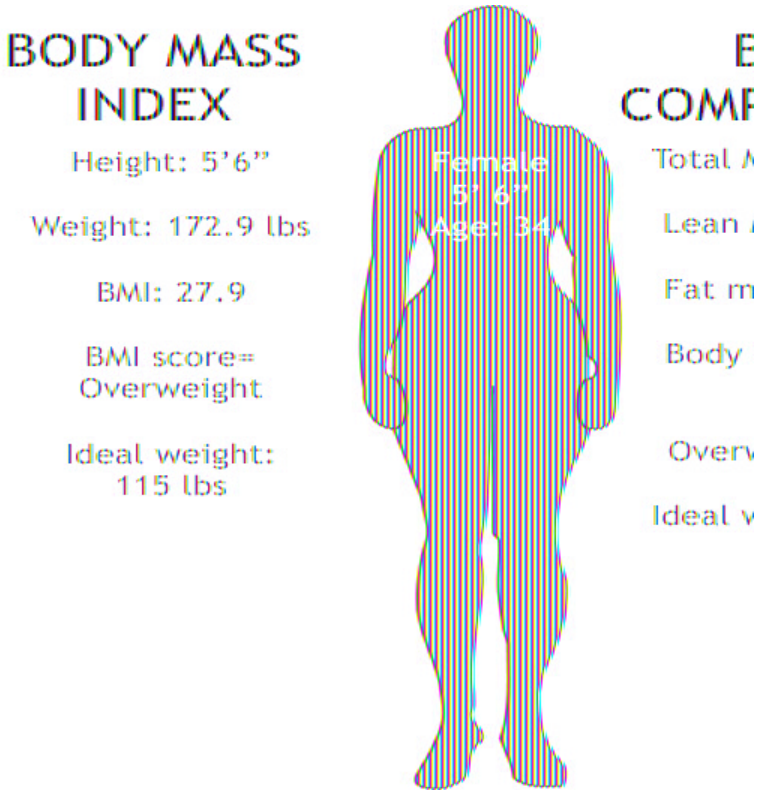
Fat Composition Measurements with Smartphone Integration

Team Quadcopter: Marty Alcala, Brandon Bruen, John Bush (JD), Philip Gordon

ECE 4012 L2A: Professor Bhatti

Initial Motivation



http://news.medill.northwestern.edu/chicago/news.aspx?id=221734&print=1

Motivation

NUTRIENT COMPOSITION

(per 100 grams of cooked lean meat)

CANADIAN BISON

SPECIES	FAT GRAMS	CALORIES KCAL	CHOLESTEROL MG	IRON MG
Bison	2.42	143	82	3.42
Beef	8.09	201	86	2.99
Pork	9.66	212	86	1.10
Chicken	2.00	158	86	0.60
Salmon	12.35	206	63	0.34

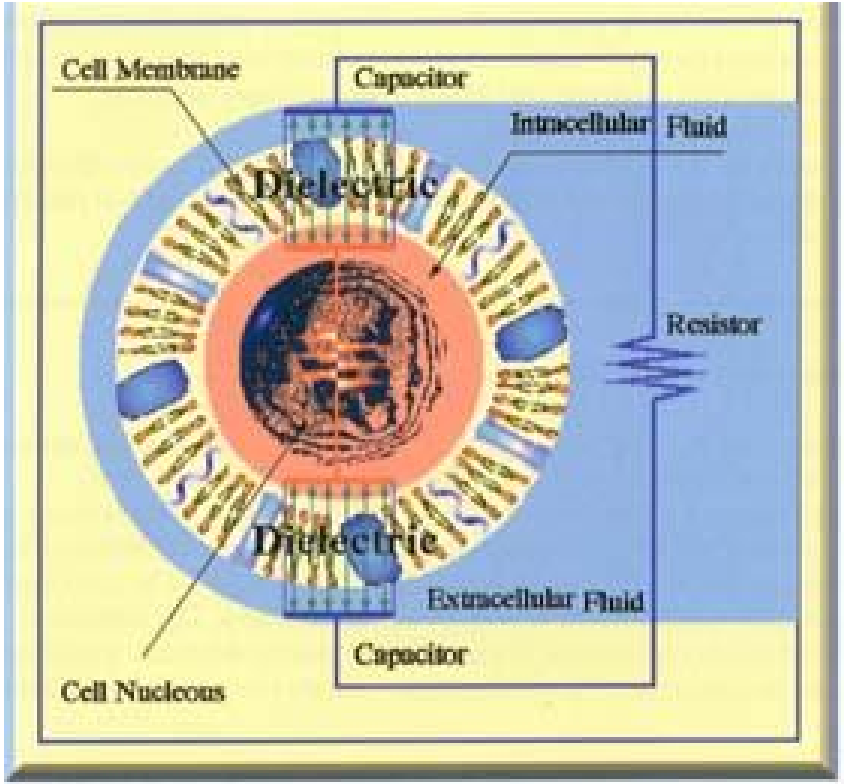
Source: *Canadian Nutrient File, 2001b*

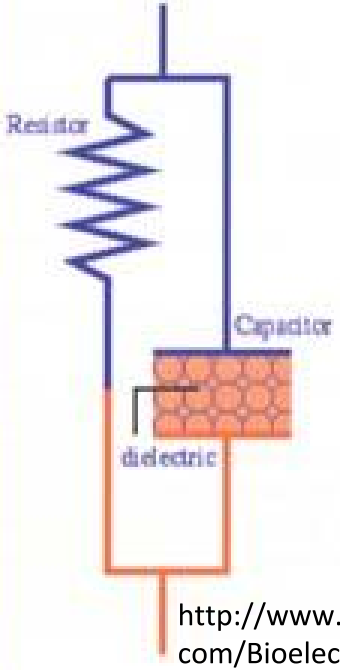
http://www.canadianbison.ca/consumer/Why_Bison/nutrition.htm

Existing Technology

- Dual-Energy X-Ray Absorptiometry
- Hydrostatic Weighing
- Boil testing
- Bioelectrical impedance

Bioelectrical Impedance





http://www.betterhealththruresearch.com/BioelectricImpedanceAnalysis.htm

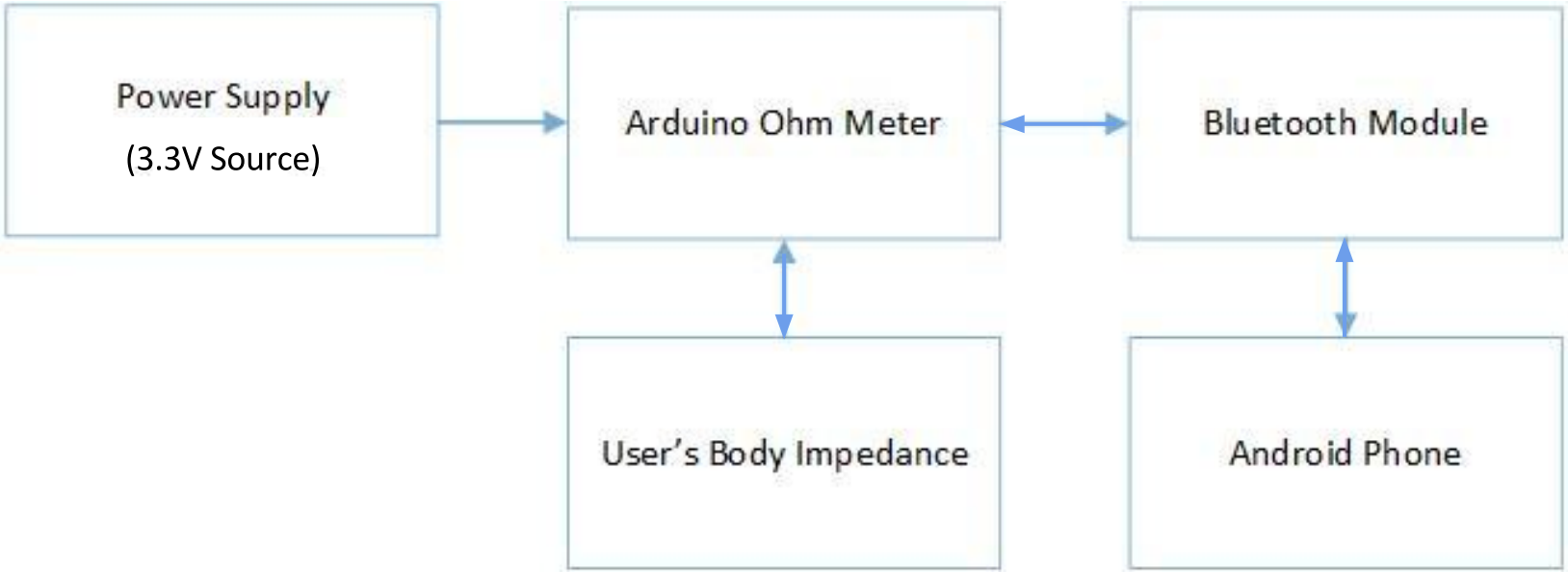
Qualitative Goals

- Determine fat percentage using AC small signal analysis
- Combine resistive and reactive measurements for data acquisition
- Upload data to mobile devices using Bluetooth
- Create user friendly application for data management

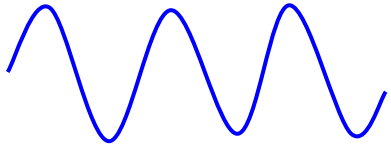
Specifications

Target Subject	Cuts of Meat
Meat Fat % Accuracy	10-20%
Test Duration	<10 Seconds
Device Weight	<3 lbs
Signal Voltage	3.3 - 5 V
Number of Probes	2 - 4

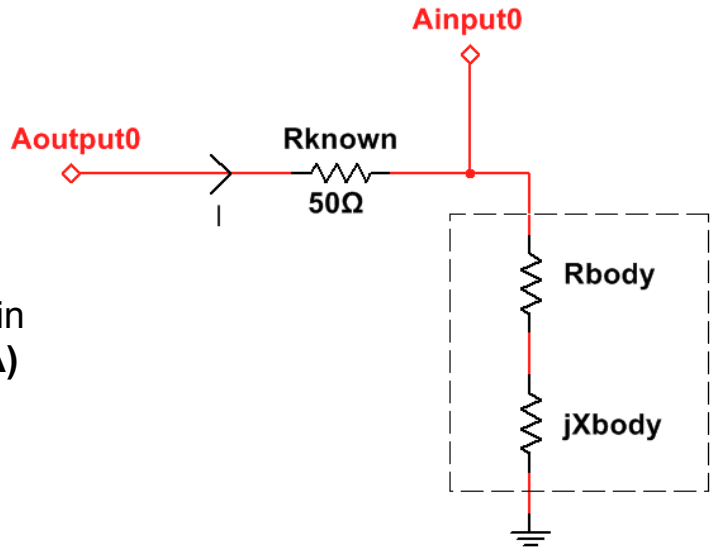
Design Approach



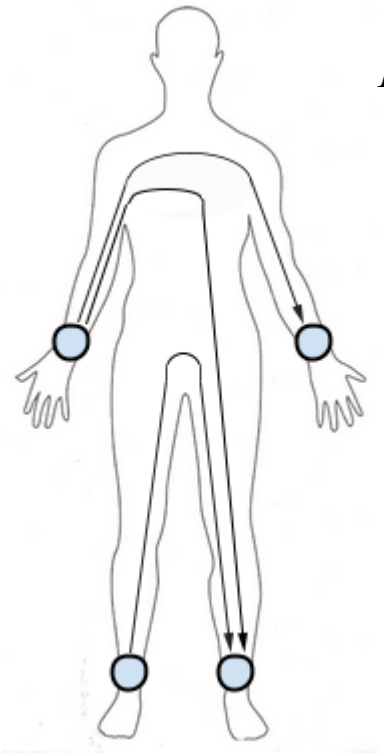
Arduino Ohm Meter



Input signal from Arduino Pin
Aoutput0 **(high kHz, 400uA)**



Regression Model



$$FFM\ (kg) = 0.7 * (\mathbf{Ht^2}/\mathbf{R_{body}}) + .18 * \mathbf{BW} - .18 * \mathbf{Age} + .12 * \mathbf{X_{body}} - 2.5 \quad [1]$$

Ht^2 - Height of the subject squared

R_{body} - Real resistance of subject's body

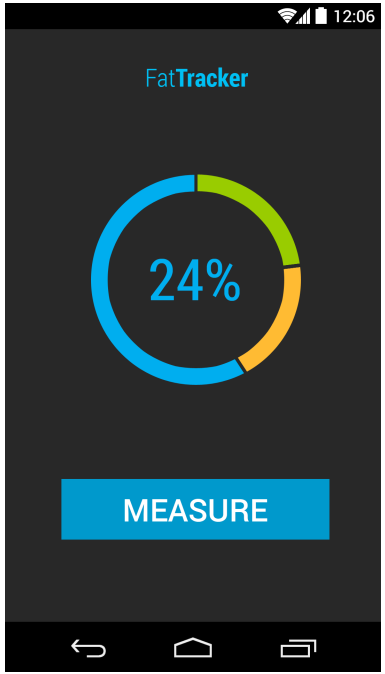
BW - Bodyweight of subject

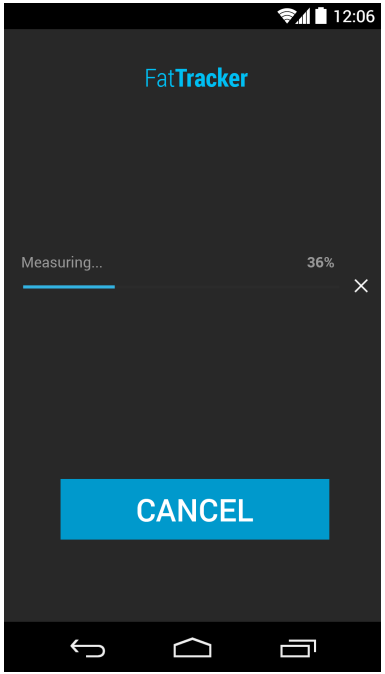
Age - Age of subject

X_{body} - Imaginary reactance of subject's body

Mobile App Interface

Display of latest measurement





Measurement in progress

Benchmarking Data Sets

- Temperature
- Meat Type
- Age
- Density
- Combination of types

Benchmarking Method

1. Weigh meat
2. Run small AC signal test and collect data
3. Put meat in water to calculate density
4. Boil meat until all fat is collected on top
5. Weigh fat and meat again
6. Calculate overall fat content
7. Add to existing model

Benchmarking Method

Upper and lower limits also need to be added

- Upper limit will be measured through a brick of suet (100% fat)
- Lower limit will be an average of the AC signal test on the post cooked meats

Design Expo

- Logistics:
  - Impractical for frequent demonstration
  - Scheduled times for several demonstrations throughout the expo
- Demonstration:
  - We will bring meat and store it in a cooler
  - Show our product by using our device and accompanying smartphone application

Current Status

- Right Now:
  - Ready to order parts and begin assembling, programming, and developing model
- Anticipated Challenges:
  - Data points: accuracy of model is dependent on our testing
  - Limits on meat subjects: to much variation between types of animals?

Schedule

- Phase 1: (8/28 - 9/30)
  - Philip, Brandon: Hardware Development, Baseline Testing, Beginning of Model Development
  - Marty, JD: Arduino Programming, Application Development
- Phase 2: (10/1 - 10/31)
  - All: Model Development, U/I Improvements
- Phase 3: (11/1 - 11/21)
  - All: Improvements, Preparing Demonstration

References

[1] N. Macias. (2007, Aug. 15). *Body fat measurement by bioelectrical impedance and air displacement plethysmography: a cross-validation study to design bioelectrical impedance equations in Mexican adults* [Online]. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2020472/#!po=3.12500

[2] Y. Hui. (2012) *Handbook of Meat and Meat Processing, 2nd Edition*, Boca Raton

[3] S. Nielsen. (2003) *Food Analysis Vol. 1,* New York

[4] Y. Hui. (2001) *Meat Science and Applications*. New York