CYBER-FLUX Innovations

Presents

The Smart Fridge

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Outline

- Background
- System Overview
  - Hardware
    - In fridge
    - Out fridge
- User Interface
  - Website description
- Auto-Generated Grocery List
  - Description
- Nutritional Features
  - Visualization
  - Nutrition profiling model
 - Feature descriptions
- Competition
- Budget
- Summary

Background

- Recent transition from barcodes to RFID tags for tracking of goods through the manufacturing and supply chain
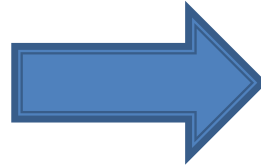
- Utilizing RFID technology, it will soon be possible to conveniently log information regarding the goods that pass in and out of a refrigerator

- Using the information we can provide a suite of features to promote healthy eating and added convenience to grocery shopping

System Overview
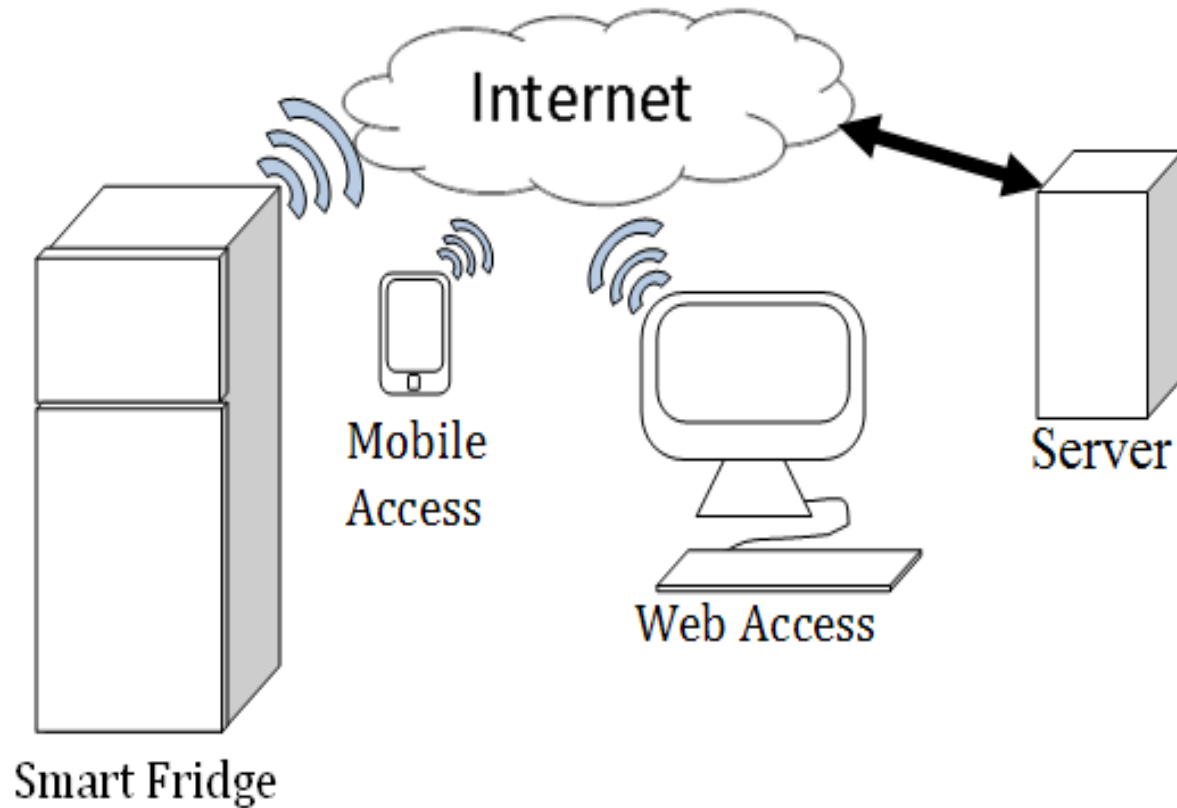
Hardware

- Challenge:

  ◦ Make it work

  ◦ Make it disappear

  ◦ Make it look sexy

Hardware

- Safety
  - Pacemakers
    - Some observations have shown that low frequency RFID technology can interfer with pacemakers
    - For our purposes the higher frequency modules suit the system application better and do not interference with pacemakers
 - Food
    - Studies observing the non-ionizing fields such as those created by RFID readers pose only short-term effects such as heating

Hardware

- In-Fridge module
  - RFID reader/writer unit:
    - APSX 310
  - Microcontroller:
    - Arduino UNO
  - Temperature & humidity sensor:
    - SHT15
  - Door Switch
    - Magnetic Reed switch
  - WiFi Module
    - Asynclabs WiFi Shield
  - Status LEDs and reset button
- Fridge Modifications

In-Fridge Module
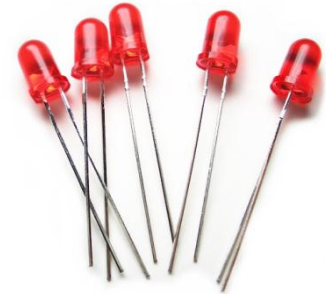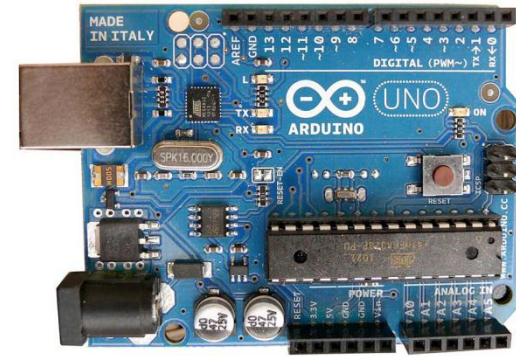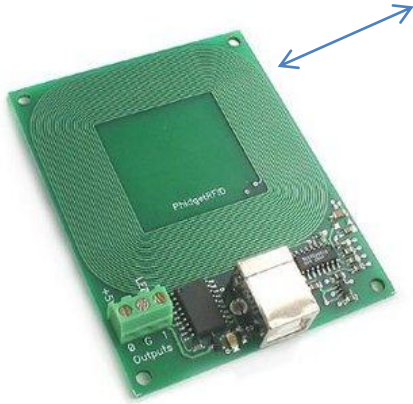
RFID reader

- Challenges:
  - Read multiple tags
  - Read range: covering the entire fridge interior
  - Read tags through water/metal/other materials
  - Communication to other devices
  - Multiple RFID communication protocols
- Approach
  - Select the right frequency
    - 13.56 MHz
  - Increase power and antenna size
    - Right selection of reader hardware
  - Match devices communication protocol
    - Right selection of microcontroller
  - Select ISO RFID protocol
    - ISO 15693

Anti-Collision Algorithm

▸ Most RFID readers include software to deal with multiple tags in reading range.

▸ All ISO 15693 tags have a sleep mode powered by the reader.

Microcontroller

▸ Challenges
- ◦ Physical size
- ◦ Memory
- ◦ Programming Language
- ◦ Debugging and Documentation/Support

▸ Approach
- ◦ Don't care about size that much, fridge is big
- ◦ Pay attention to the code / Think!
- ◦ Select widely used microcontroller/unit

Fridge Modifications

- Challenges
  - Power In-Fridge module
  - Hide RFID reader
  - Place temperature and humidity sensor in an optimal and hidden location
  - Give feedback to the user
    - Power LED
    - Network Connection LED
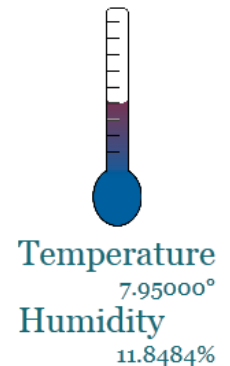   - Data transmission LED
    - Reset button

- Approach...

Wait for the demo!!

User Interface

▸ Users will access the information through a standard website

▸ Displays
  ◦ In fridge Items
  ◦ History of Items
  ◦ Recently Removed Items
  ◦ Expiration Information
  ◦ Manually tracking items
  ◦ fridge temperature
  ◦ fridge humidity
  ◦ Etc.

Vegetable Soup Mix

Shurfine

UPC: 011161133971

Nutritional Metric: 0.329

Quantity: 1

Temperature
7.95000°
Humidity
11.8484%

Items in your fridge have already expired!

Click Here for Details

Auto-Generated Grocery List

- Purpose
  - Removes the inconvenience and difficulties of manually constructing a grocery list
  - Grocery shopping without a list can lead to:
    - Inefficient shopping
   - Forgetting to buy some items
    - Over buying

- Algorithm
  - Monitors numerous parameters to intelligently choose items that should appear on the list
    - "always on list" (user specified)
    - History analysis
      - Purchase frequency
      - Purchase quantity
      - Time since last purchased
    - Expiration date monitoring
    - Predictive consumption

Nutritional Features

▶ Website visualization
  ◦ An experience that satisfies a variety of user types
    • Single number for nutritional value
    • Detailed nutritional information
    • Top 5 most and least nutritious item lists
    • Bar graphs
    • Pie charts
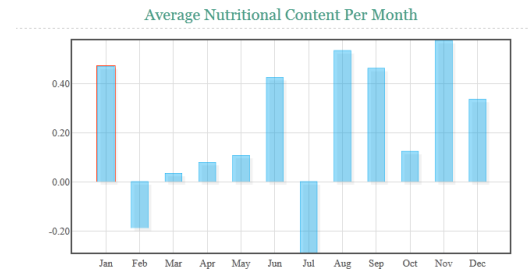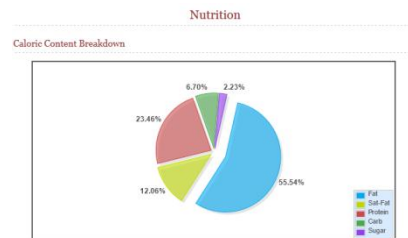
Nutritional Profiling Model

▸ Understanding the nutritional value of food is a complicated issue

▸ The smart fridge system uses a sophisticated nutritional profiling model to simplify the problem to a single nutritional metric

◦ Considers the following information

Fat	Saturated fat	Cholesterol	Sodium
Carbohydrate	Fibre	Sugar	Protein
Vitamin A	Vitamin C	Calcium	Iron

Nutritional Features

- Detailed Nutritional Information

Nutritional Facts

Nutritional Fact	Value
Sodium Per Serving	880 mg
Protein Per Serving	21 g
DVP Sodium	36%
DVP Iron	6%
Sugar Per Serving	5 g
DVP Calcium	2%
Serving Size	85 g
DVP Cholesterol	20%
DVP Saturated Fat	24%
DVP Carbo	2%
Total Fat Per Serving	22 g
DVP Total Fat	34%
Cholesterol Per Serving	60 mg
Carbo Per Serving	5 g

- Single Value Nutritional Metric

Nutritional Metric: 7.295

Nutritional Features

▸ Item Caloric Breakdown
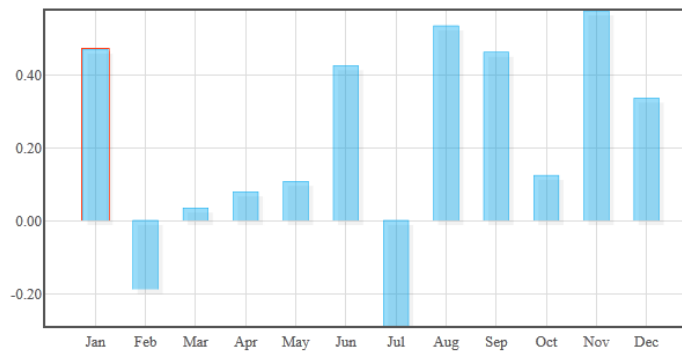
Nutrition

Caloric Content Breakdown
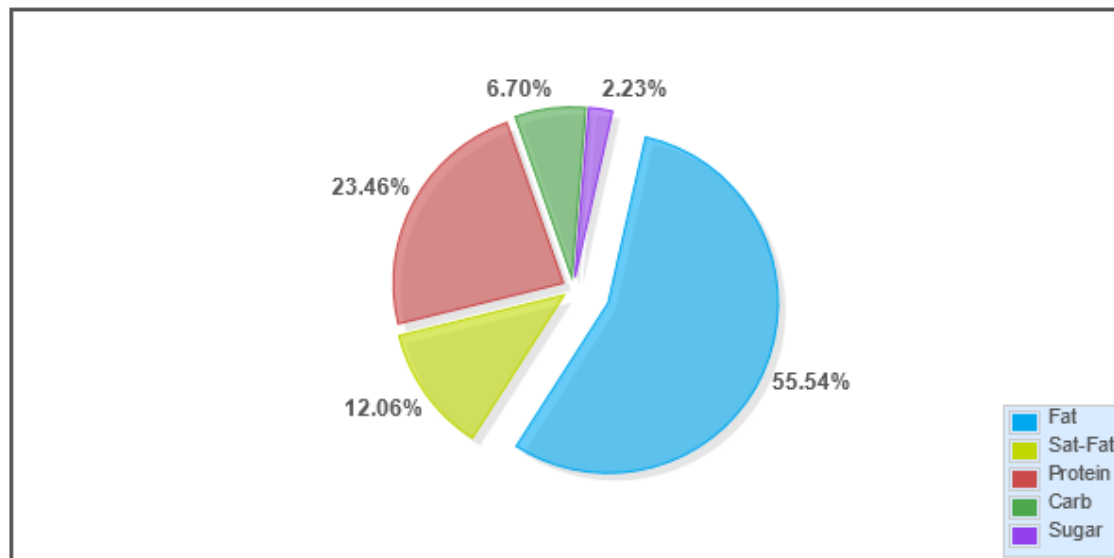
Nutritional Features
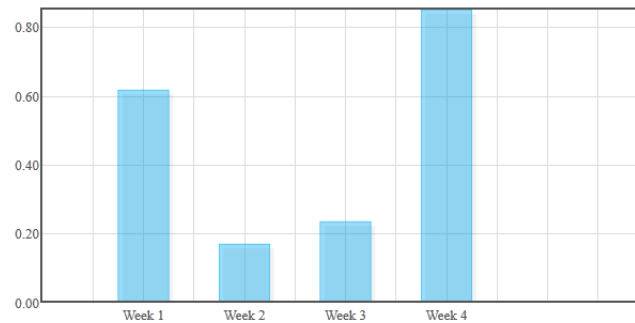
- Nutrition History Monitoring
  - Year long

Average Nutritional Content Per Month

  - Month long

Weekly Breakdown for January

Nutritional Features

▶ Top 5 Lists

Most Nutritious Items of August

100% Fruit Juice Omega Orange

Genesis Today

UPC: 812711010830

Nutritional Metric: 4.339

Quantity: 0

100% Fruit Juice Omega Orange

Genesis Today

UPC: 812711010823

Nutritional Metric: 4.339

Quantity: 0

Salmon w/Honey Dijon Mustard Sauce Meals For 2

Joe's Crab Shack

UPC: 651235291246

Nutritional Metric: 3.543

Quantity: 0

Southwestern Fresca

Michelina's Lean Gourmet

UPC: 717854108744

Nutritional Metric: 3.334

Quantity: 0

Least Nutritious Items in your Fridge

The Original Bratwurst Brat

Kayem

UPC: 030771012315

Nutritional Metric: -2.63

Quantity: 0

Vegetable Pizza For One

Celeste

UPC: 019600045007

Nutritional Metric: -2.43

Quantity: 0

Spicy Chicken Breast Patties

Tyson

UPC: 023700015235

Nutritional Metric: -1.12

Quantity: 0

Milk & Fruit Blend Banana Licuado

Kern's Lactaid Licuado

UPC: 053859090104

Nutritional Metric: 0.023

Quantity: 0

Cottage Cheese Vermont Style Cottage Cheese

Cabot

UPC: 078354124079

Nutritional Metric: 0.229

Quantity: 0

Competition

- LG's Thinq fridge is the most obvious competition to our product
  - Requires users to scan barcode
  - Much less convenient

Budget

- Prototype
  - $700
  - Cost would be heavily reduced with mass production

- Final product
  - Would be sold to manufactures
  - RFID enabled fridge would sell for $5000

What was learned

- Working with new technologies can be a daunting task

- System integration is among the toughest challenges

- Team dynamics issues can raise unforeseen complications

Summary

- RFID is the prominent future technology used to replace barcodes

- By taking advantage of the non-contact identification of RFID tagged items it is convenient to track items entering and exiting a fridge

- Through logging and manipulation of grocery item data we can provide many life improving features

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References

- [1] http://www.rfidnews.org/2010/01/07/u-s-food-and-drug-conduct-study-to-determine-rfid-effects-on-pacemakers-and-implanted-cardiac-devices

- [2] http://www.rfid-in-action.eu/public/rfid-knowledge-platform/all-rfid-documents/communication-strategies-to-inform-consumers-stakeholders/rfid4sme_is-rfid-safe-at-the-workplace

Questions?

Thank you