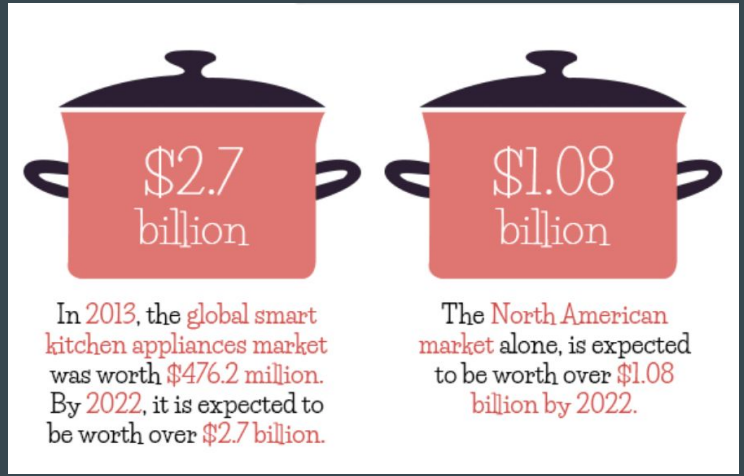
RecipeTop: Group 7

Critical Design Review

Gera Versfeld, EE
Edwin Santiago, EE
Miguel Ramirez, CpE
Jason Portillo, CpE

Motivation

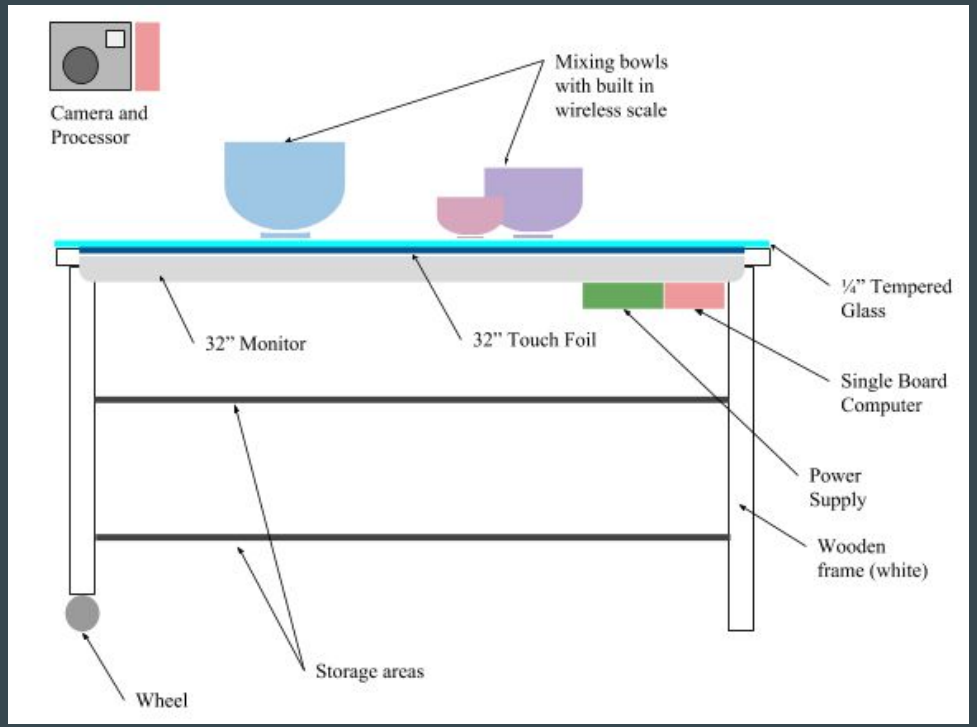
- Create something that helps people learn to cook
- Make cooking a more organized and enjoyable experience
- Make the kitchen a more fully integrated part of a modern smart home



What is RecipeTop?

An interactive countertop and recipe preparation assistant

RecipeTop



Objectives

Core

A multi-touch countertop that will provide users with a unique and helpful experience when cooking.

- Multi-touch enabled display
- Intuitive user interface
- Recipe search, storage, and suggestions
- Recipe guidance with clear steps and useful features like automatic timers

Advanced

Seamlessly interface with other kitchen appliances to make cooking simpler.

- Wirelessly connected scale
- Wirelessly connected and controlled toaster oven
- Compact design with storage space built in

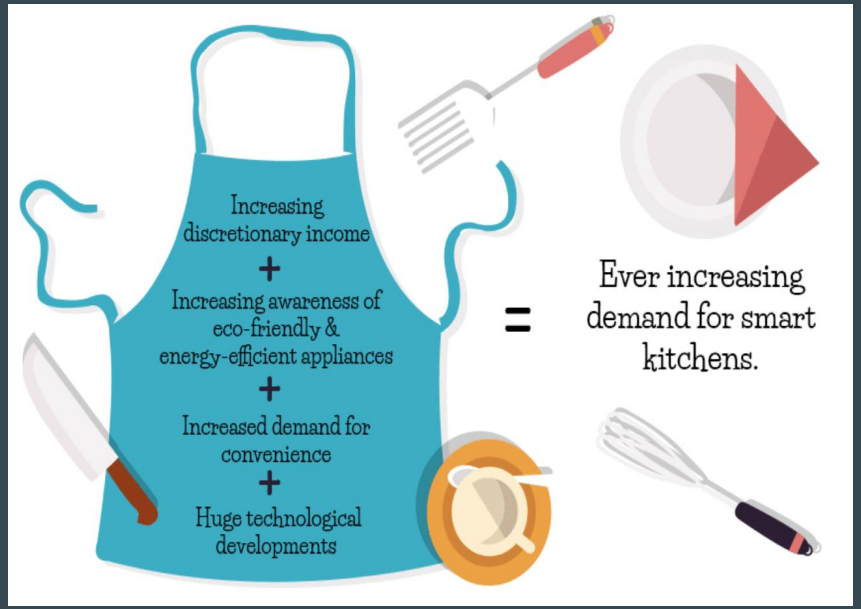
Stretch

We hope to integrate computer vision and ML to for more interactivity and better recipe suggestions.

- Companion mobile application
- Recipe search and suggestion based on ingredients on counter
- Integration with smart home products like Alexa or Google Assistant

Marketing Goals

Letter	Marketing Goal
a	Low cost
b	User Friendly
c	Durable, Kitchen Safe
d	Food safe
e	Help you learn to cook
f	Easy to clean



Engineering Specifications

#	Specification	Quantity	MG
1	Diagonal Display Size	30 in	a,b,e
3	Display Refresh Rate	≥ 20Hz	b
4	UI Response Time	≤ 200ms	b

#	Specification	Quantity	MG
8	Scale Accuracy	≤ 1g	b
10	Counter Height	≥ 30 in	b,c,f
11	Countertop Diagonal	≥ 35in	a,b,c,f
12	Total Prototype Cost	≤ $2000	a
13	Touchscreen Multi-touch Capability	≥ 2 touch points	b,e

Design Constraints

Economic and Time Constraints

- Overall budget for senior design: $2000
- Two semesters to complete project

Environmental, Social, and Political Constraints

- Sustainably manufactured components
- Proper disposal of electronic waste

Ethical, Health, and Safety Constraints

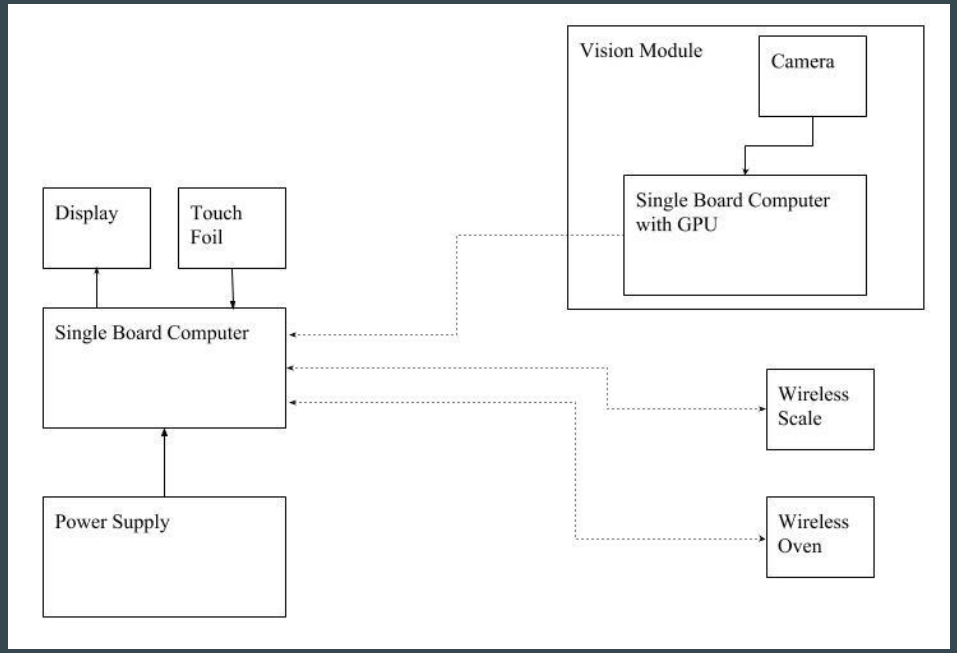
- Smooth, non-porous surface important for safe food handling
- non-toxic, durable
- appropriate working height
- prevent risk of fire or shock, properly insulate and waterproof electronic components
- electronics need heat management systems

Relevant Standards

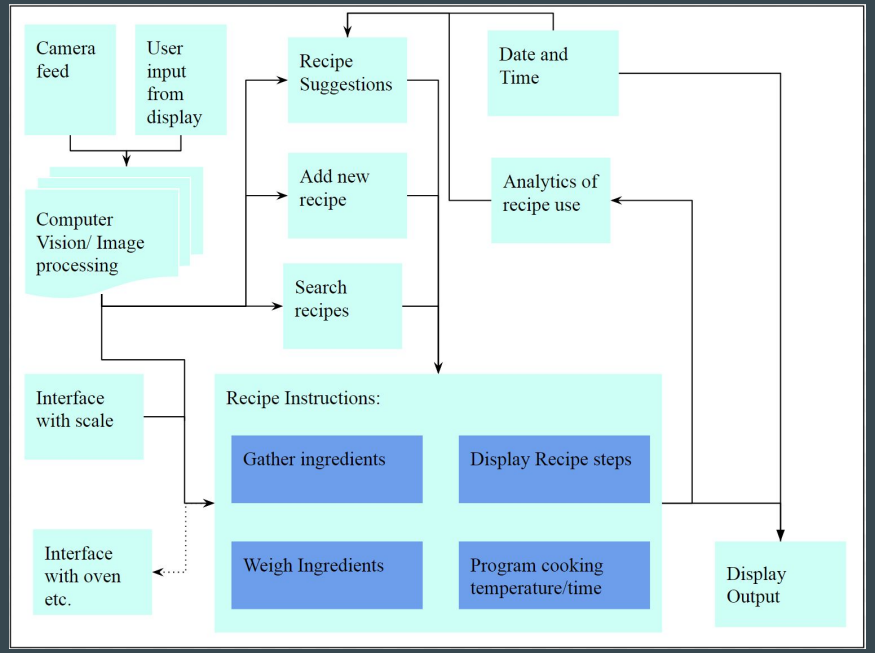
- NEMA 250
  - Provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).
- HTML/CSS W3C
  - CSS Files
  - Code efficiency
  - Device compatibility
  - User accessibility
  - Will not follow internet search optimization guidelines since application will function locally
- NASA TECHNICAL STANDARD: SOLDERED ELECTRICAL CONNECTIONS
  - Fillet - smooth concave buildup of material between two surfaces
  - Soldering environment ventilation system shall comply with OSHA requirements, 29CFR
- Javascript Standards
  - Uniform and consistent coding style
  - Naming convention
  - Commenting and semicolon use

Overall System Block Diagrams

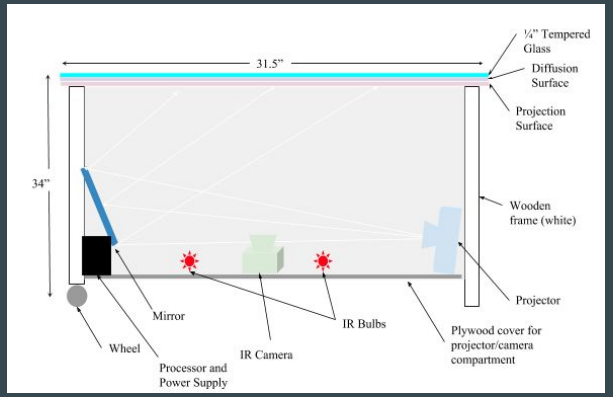
Hardware

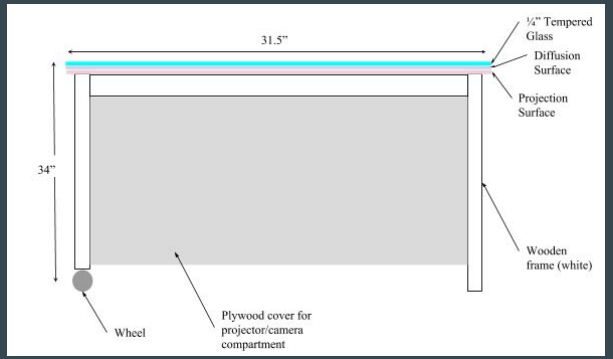


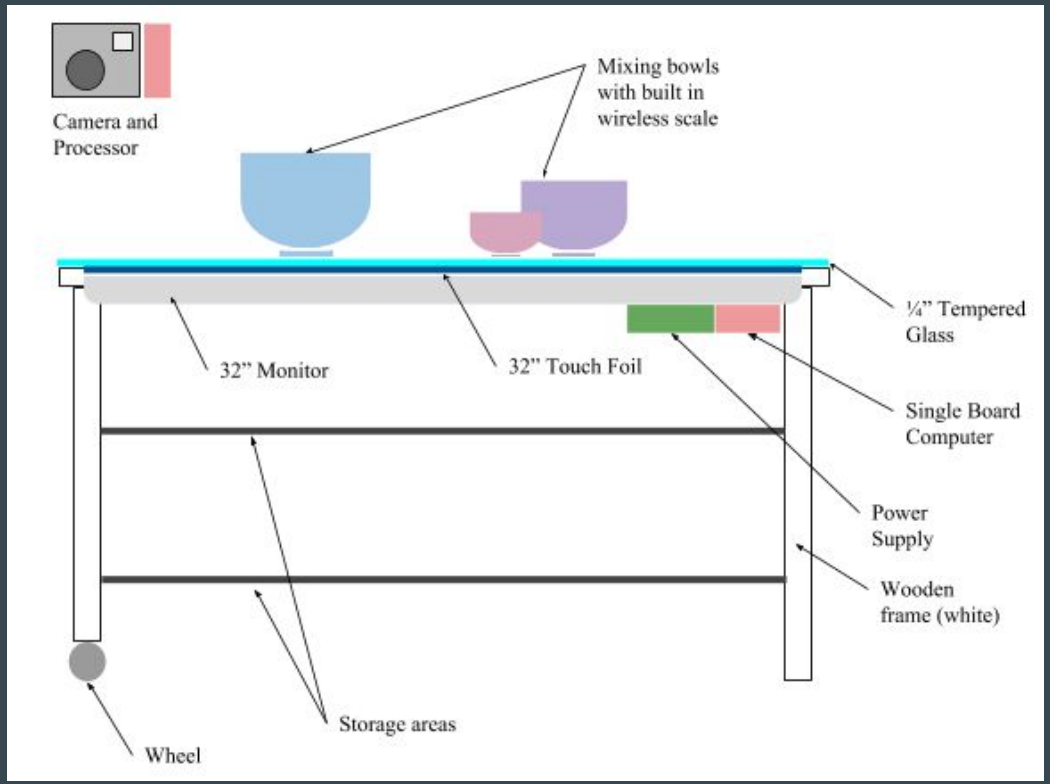
Software



Overall Approach and Proposed Implementation







Significant component and part selections

Single Board Computer

Microcontroller

Wifi Module

Touchfoil

Load Cells

Single Board Computer

Raspberry Pi 3 Model B+

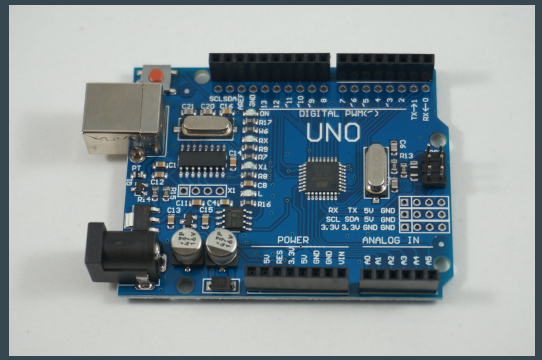
- Affordable
- Well documented
- Past projects have demonstrated what could be done with the Raspberry Pi

	Beagle Board	Raspberry Pi 3 b+	Jetson TX2
CPU	ARM37x 1 GHz	Quad core 1.4Ghz	L2+ Quad ARM
GPU	Power VR SGx530	Broadcom Videocore IV	Nvidia Pascal, 256 CUDA cores
USB ports	4 USB 2.0	4 USB 2.0	USB 3.0 + USB 2.0
Power	2.5A @5V	2.5A @ 5V	2.5 @ 5V
Memory	512 MB	1GB	8GB
Storage	Micro SD	Micro SD	32 GB eMMC
Software	Linux	Raspbian	Jetpack (linux)
Price	$150	$35	$468.00

Microcontroller

ATMEGA328P from Arduino Uno

- Easy to use
- Cheap
- Various Applications ranging in size

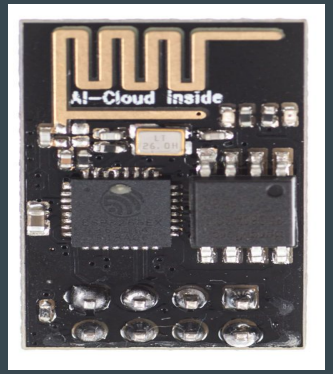


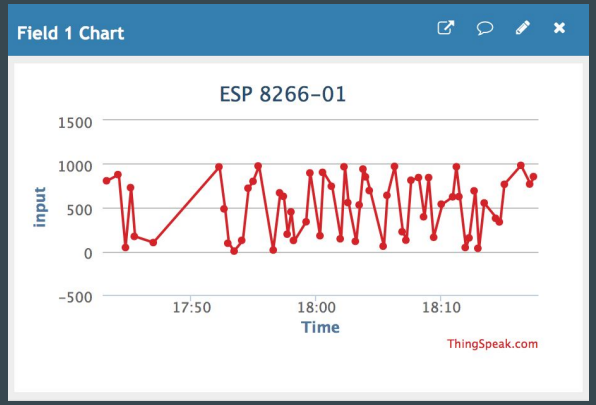
	CC3200	ATMega 328P
Cost	$0 (Provided by TI Lab)	$1.96
Clock speed	1MHz-80MHz	16Mhz
GPIO pins	27	54
Operating voltage	2.1V - 3.6V	5V
Communication	Wifi	With external module
Temperature sensor	yes	With external module

Wifi Module

ESP8266 ESP-01

- Used for breadboard testing
- Sent scale data to Thingspeak





ESP8266 ESP-12F

- The antenna RF performance optimization
- Similar footprint
- Communication distance is increased by 30% -50%

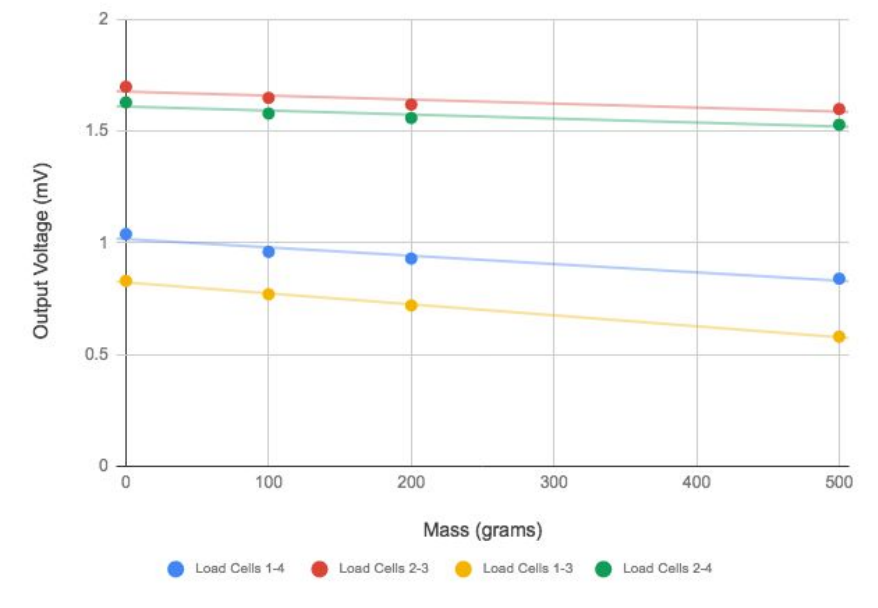
Touch Screen: Xiamen Touch Foil

- Important factors: estimated time for manufacturing, cost, response time, number of touch points, quality reviews, driver software
- Capacitive touch foils varied very widely in cost.
- Most US vendors cost upwards of $2000
- alibaba.com was used to purchase directly from the manufacturer at a much more affordable price

Vendor/Product name	Xiamen Touch [16]	Green Touch [15]	Gerteise [44]	Pro Display [45]
Touch Points	10	10	10	N/A
Response time	10ms	<10ms	<2.5ms	18-50ms
Driver Software	Linux, Mac	Linux, Mac	Windows, Linux	Windows, Linux
Light transmittance	>93%	>90%	N/A	>93%
Aspect Ratio	16:9	16:9	16:9	16:9
Diagonal Size	32-47”	5”-60”	27-55”	17”-100”
Time for shipping	7 days	N/A	1- 2 months	N/A
Cost	$115	$105	$174.50	$1,241

Load Cells

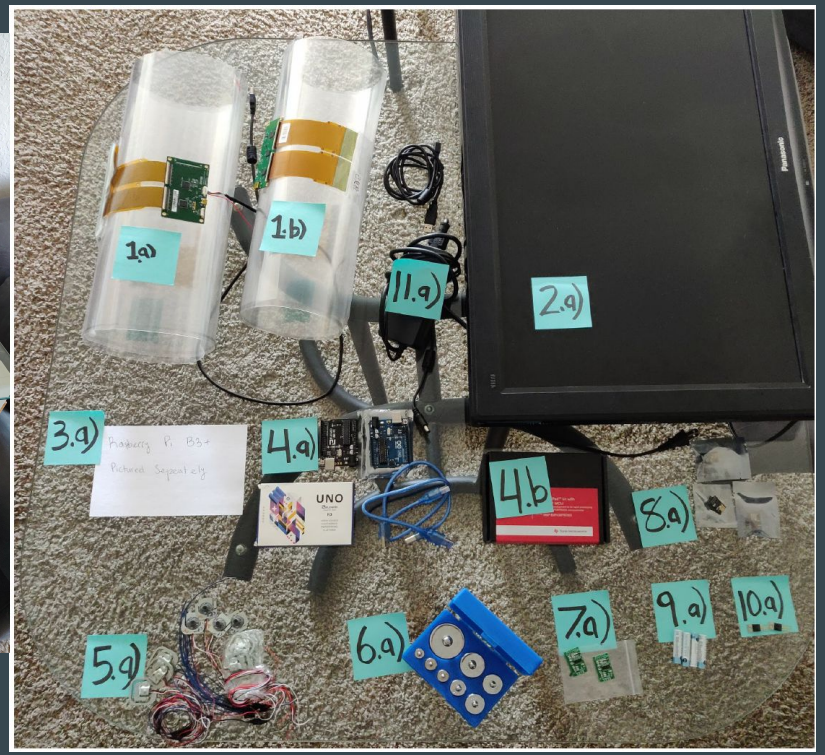
We choose to use load cells scavenged from previously owned kitchen scales due to budgetary constraints. All device specifications needed to be measured.



Load Cell Pair Output Voltage vs Applied Mass

Vendor/ Manufacturer	Omega [48]	Manyyear (alibaba) [49]	Bigaint Digital Kitchen Scale
Load Range	0-25lb	0-5kg	0-5kg
Output Voltage	1mV/V	unknown	unknown
Excitation Voltage	5 V (DC)	5 V (DC)	unknown
Bridge Resistance	≥350Ω	1000Ω	~500Ω
Thermal Sensitivity	Low	2% over operating temperature range	unknown
Type	Compression	Compression	Compression
Documentation	Available	Available	Not available
Bridge type	Full	Full	Half
Accuracy	0.5%	0.05%	unknown
Size	¾”	37x47 mm	¾”
Cost	$350.00	$150 (minimum order of 10 and shipping)	$0 (already owned)

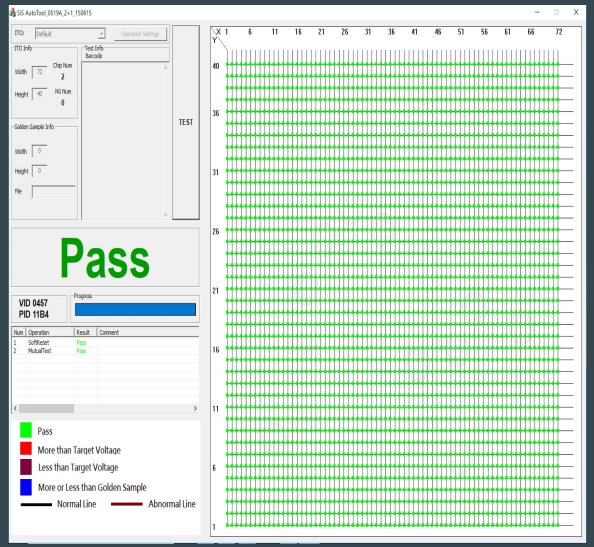
Part Selection for prototype



Subsystem 1: Single Board Computer and Touchscreen

Issues with other technologies

- Ghosting
- Bulky Projectors
- Expensive parts



Technology	Capacitive Touch foil [15],[16]	Rear Diffused Illumination (RDI)	Frustrated Total Internal Reflection (FTIR)
Response time	Fast	Medium	Medium
Multitouch	Touch points add to cost	Depends on software	Depends on software
Light transmittance	High	100%	100%
Sensitivity to objects	Low	High	High
Sensitivity to noise	Moderate (magnetic, electrical)	High (natural light)	Moderate (natural light)
Installation size	Small	Large	Large
Suitability for kitchen application	High	Moderate	Unsuitable (exposed LEDs and electronics on counter surface)
Software	Provided by manufacturer	Open source (OpenCV, CCV2)	Open source (OpenCV)
Cost	Large range ($100-$2000)	Moderate (~$100)	Moderate (~$100)

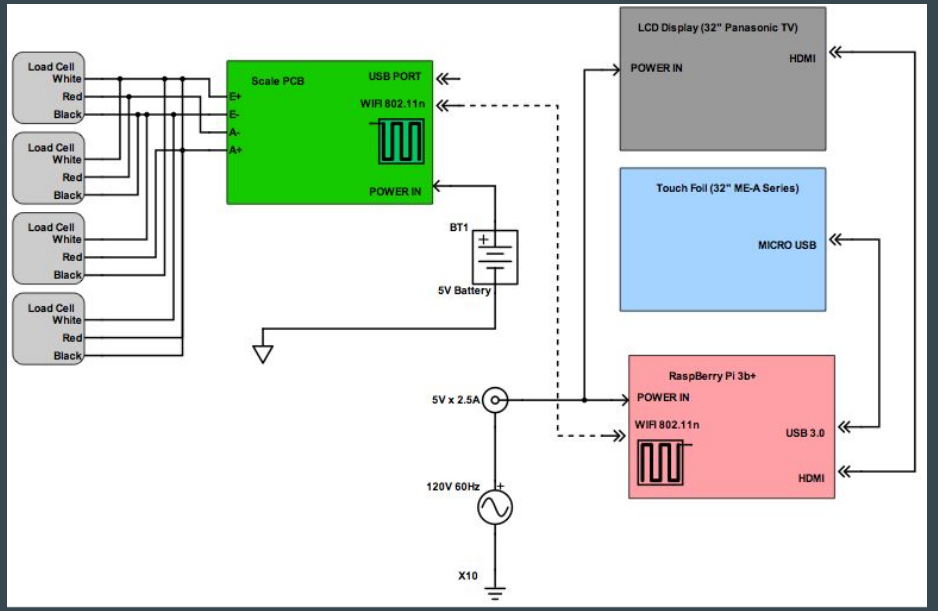
Subsystem 2: Wireless Scale

Successes:

- breadboard testing went well, load cells and A/D seem to be operating linearly and accurately
- breadboard testing of wifi module also successful

Challenges:

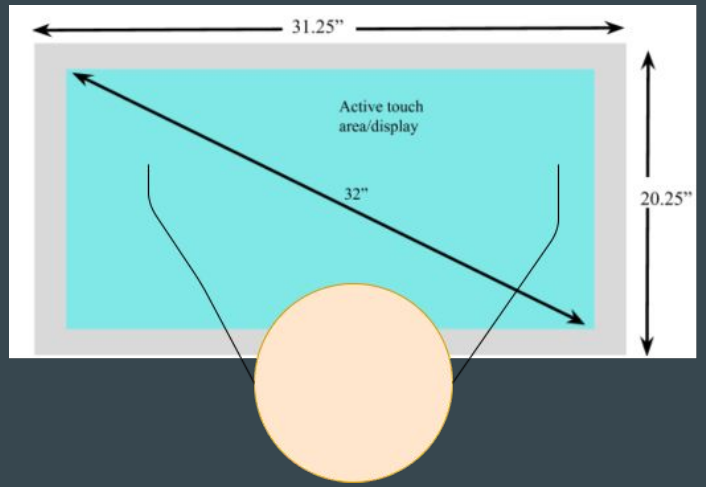
- PCB
- housing for scale



Part No.	Part Name	Quantity	Cost
1	AtMega 328p	1	$2.08
2	HX711 A/D	1	$2.40
3	Load Cells	4	$0
4	Wifi Module	1	$2.79
Total			$7.27

Software Design: Approach

- Front-end: HTML5, CSS3, Javascript, Materialize
- Back-end: Django
- Design UI for a counter-top
- Similar to tablets/phones but on a bigger scale



Software Design: Stack Choice

	WISA	MEAN	LAMP	LAMP+Django
OS	3	5	4	4
WebServer	2	1	2	3
Database	4	1	3	3
CGI Language	3	2	1	4
Learning Curve	4	1	3	3
Project Compatability	4	5	2	5
Total	20	15	15	22

Database Optimizations

- Optimize for memory
- Naive approach is multiplicative in memory O(#recipes*#ingredients*...)
- Optimized approach is linear in memory: O(#recipes+#ingredients+...)

RecipeID	RecipeTitle	IngredientID	IngredientName	Utensil	UtensilText
1	Mac & Cheese	1	Pasta	1	Pot
1	Mac & Cheese	2	Butter	1	Pot
1	Mac & Cheese	3	Cheese	1	Pot
1	Mac & Cheese	4	Cream	1	Pot
1	Mac & Cheese	1	Pasta	2	Colander
1	Mac & Cheese	2	Butter	2	Colander
1	Mac & Cheese	3	Cheese	2	Colander
1	Mac & Cheese	4	Cream	2	Colander

Table: Recipes

RecipeID	RecipeTitle
1	Mac & Cheese

Table: RecipeToIngredient

RecipeID	IngredientID
1	1
1	2
1	3
1	4

Table: Ingredients

IngredientID	IngredientName
1	Pasta
2	Butter
3	Cheese
4	Cream

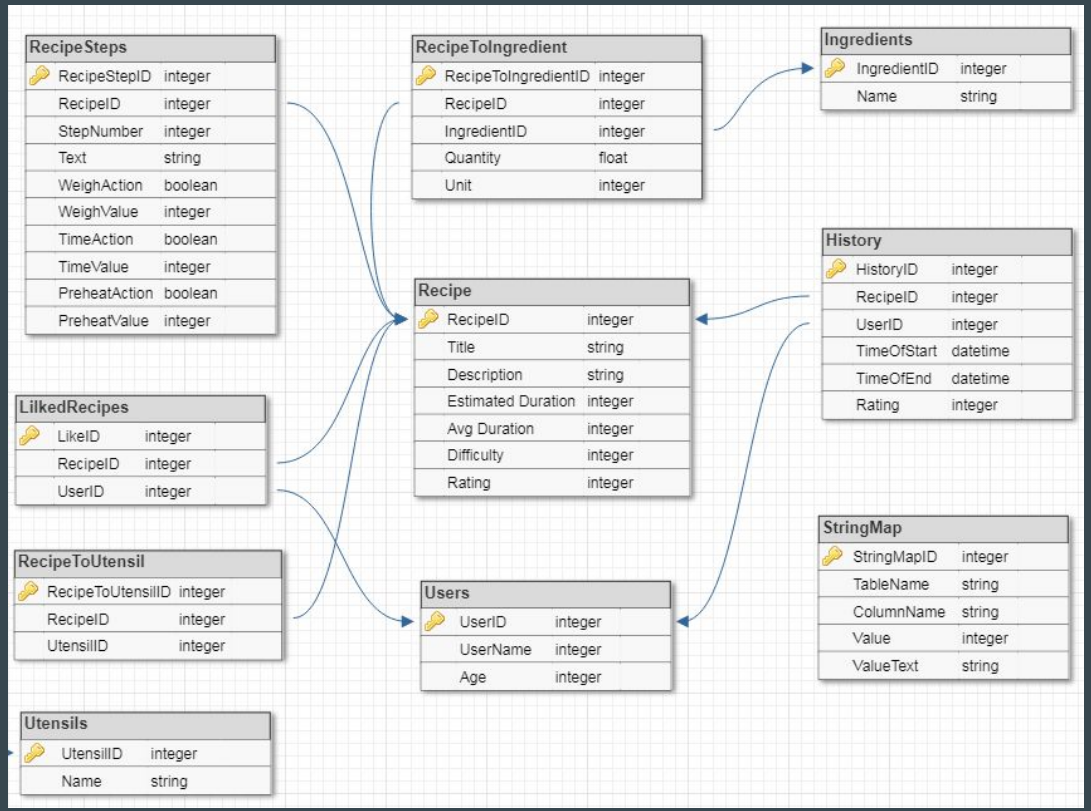
Table: RecipeToUtensil

RecipeID	UtensilID
1	1
1	2

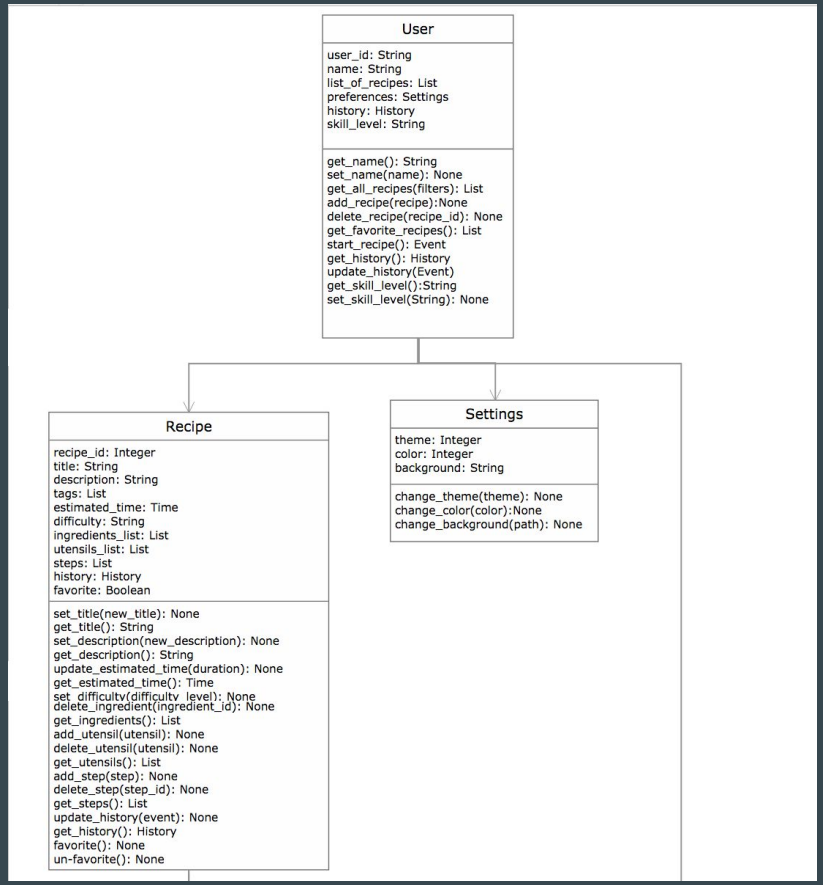
Table: Utensils

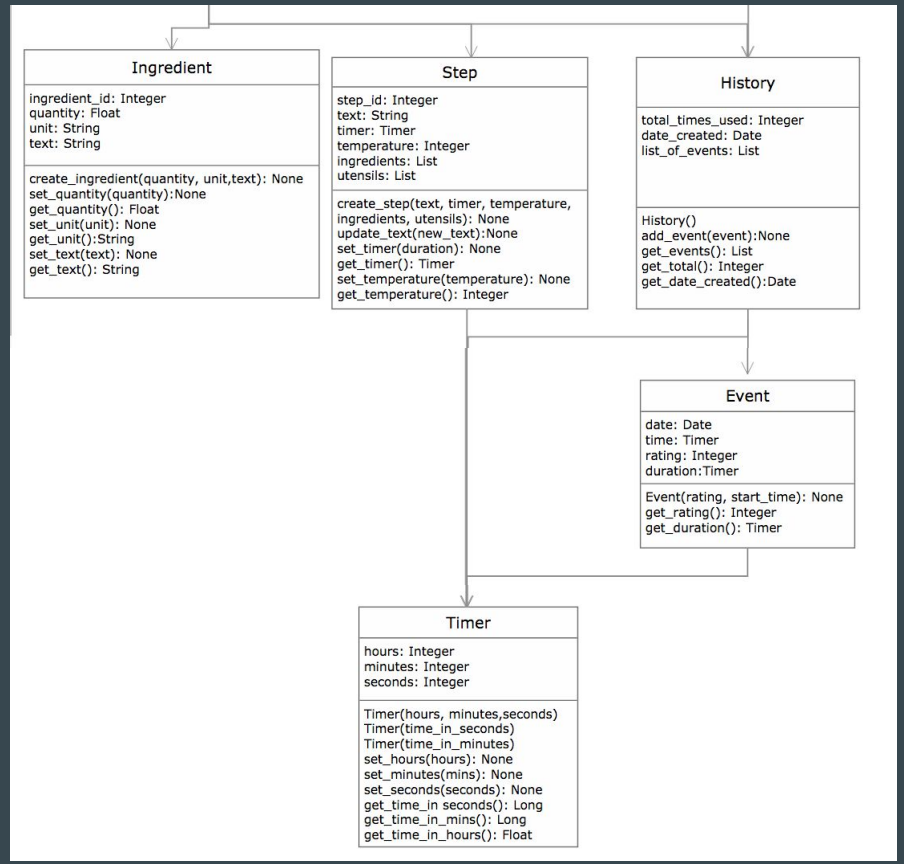
UtensilID	UtensilName
1	Pot
2	Colander

Database Design



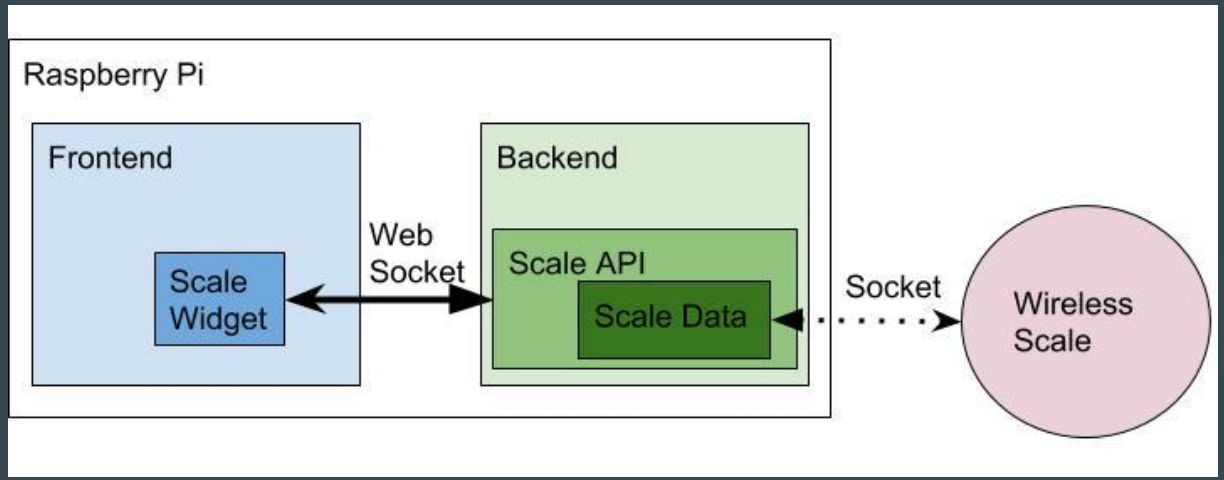
Software Design: Class Diagram



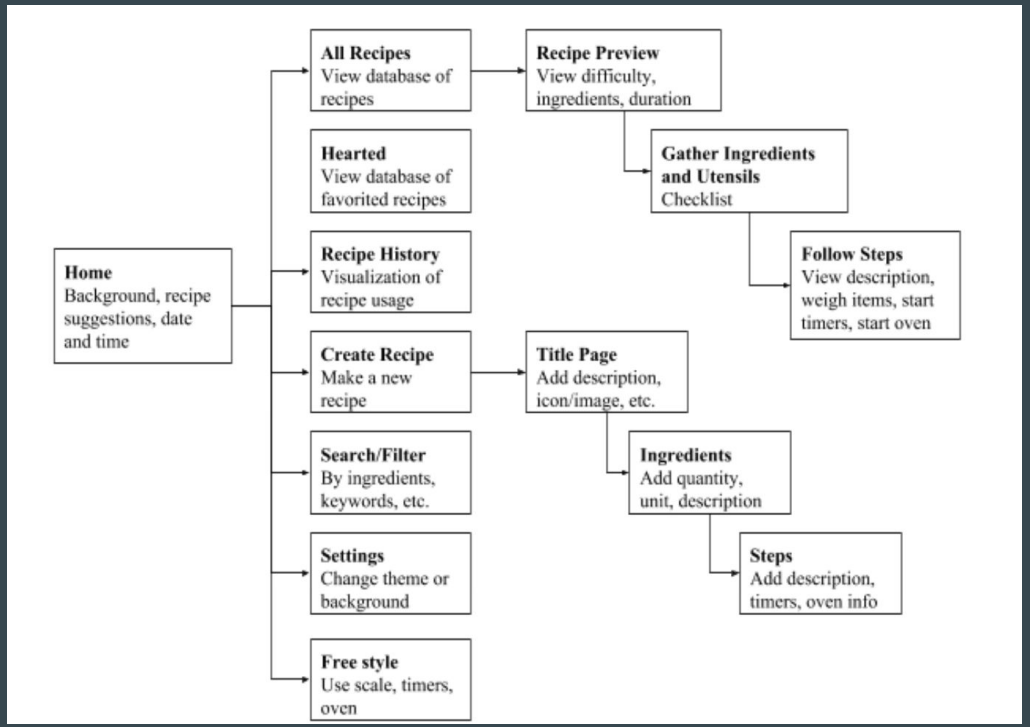


Software Design: Wireless Interface to Scale

- WiFi enabled scale
- Communicates with the Raspberry Pi via a socket
- Django Channels on top of Django
- WebSocket used to send data to the frontend

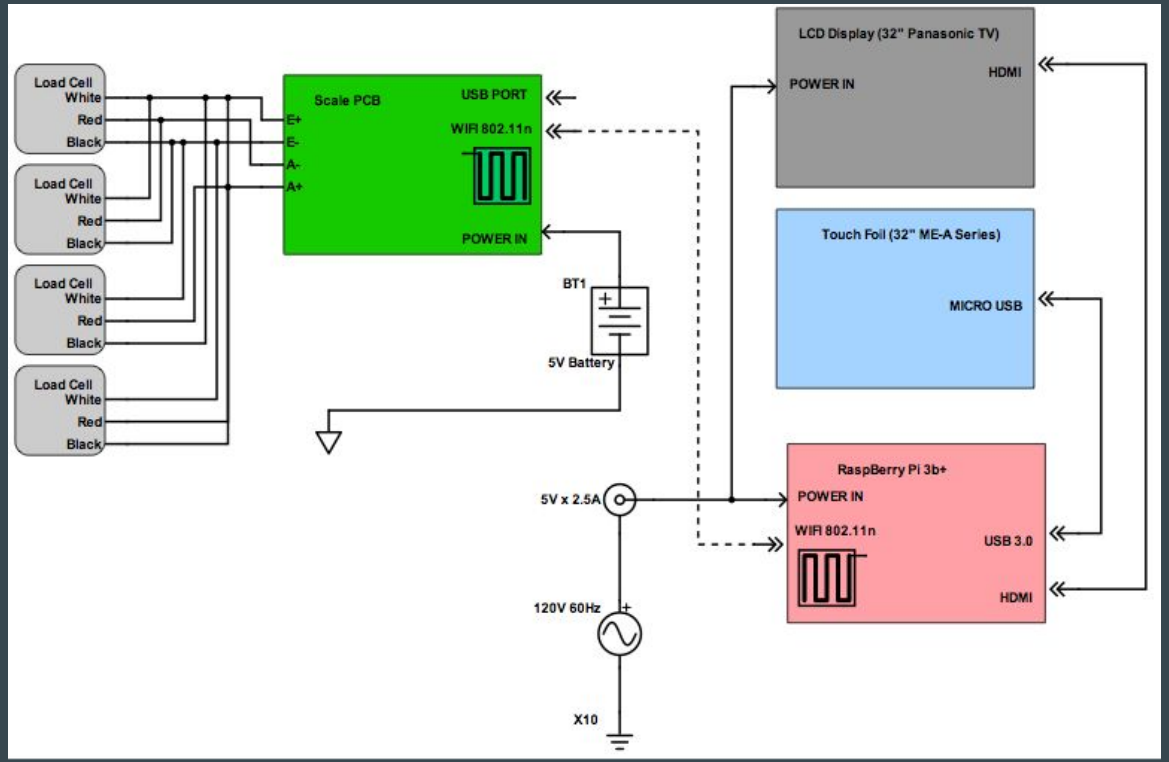


Software Design: UX

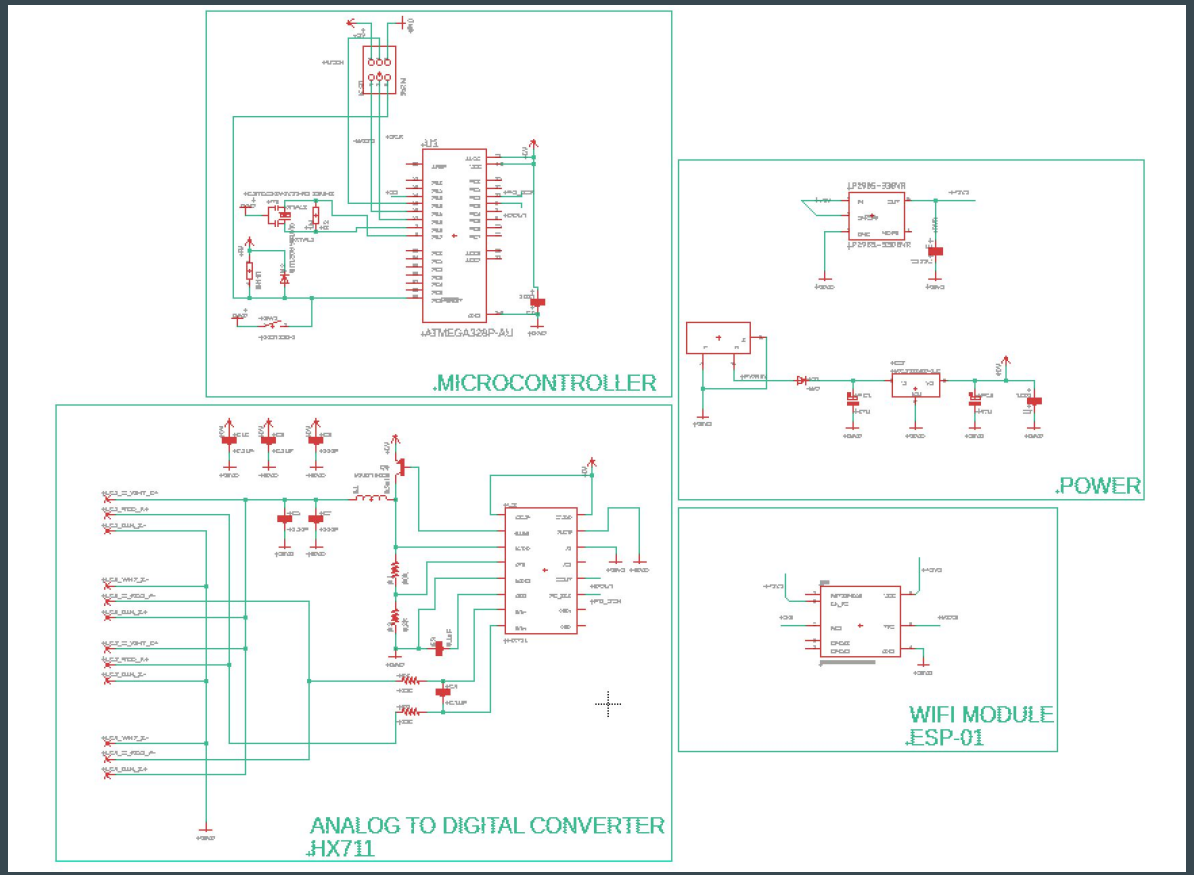


Hardware Design

- Two subsystems: the wireless scale and display/ touch-foil/ single board computer.
- Wireless Scale: custom designed and printed PCB connected to four load cells and powered by a 5V battery.
- Scale PCB: A/D converter, MCU, and wifi module as well as voltage regulation
- The second subsystem: LCD display, touch-foil, and single-board computer.
- This subsystem will be powered from AC mains via a wall wart.
- Touch foil will be powered by and transmit data via a USB connection to the raspberry pi.

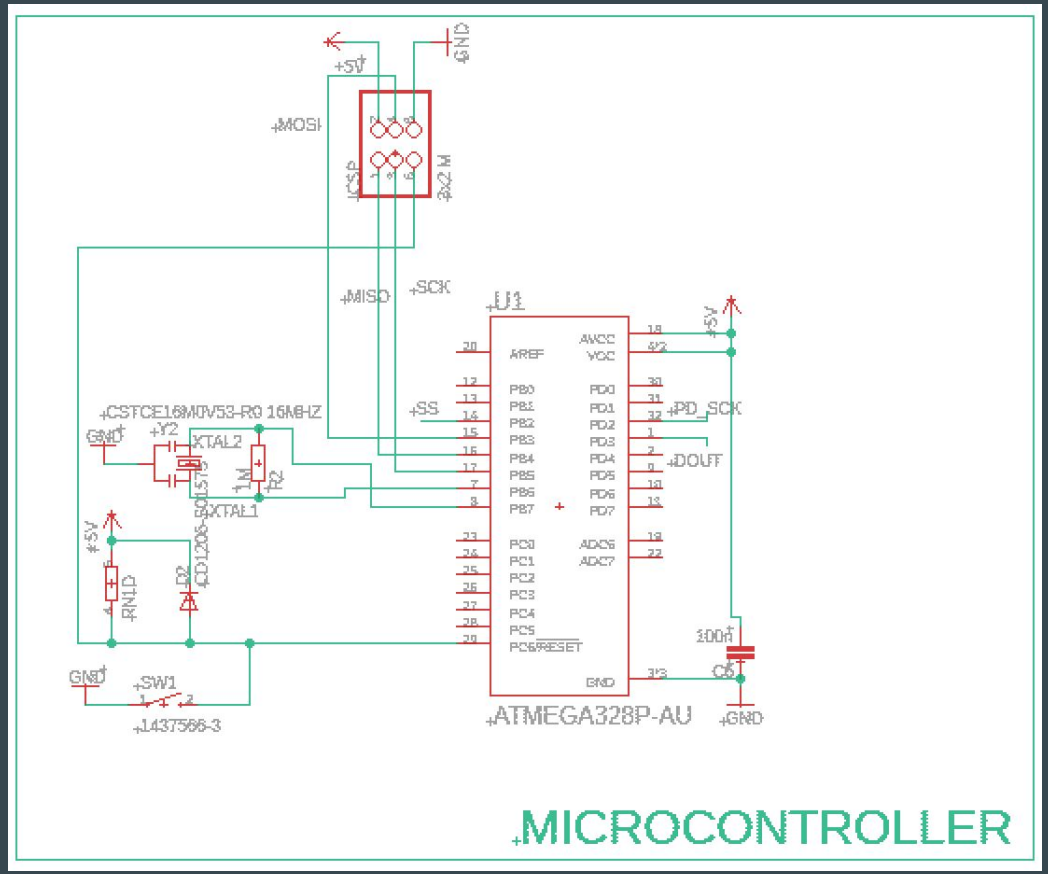


Schematic


.MICROCONTROLLER
.POWER
WIFI MODULE
.ESP-01
ANALOG TO DIGITAL CONVERTER
.HX711

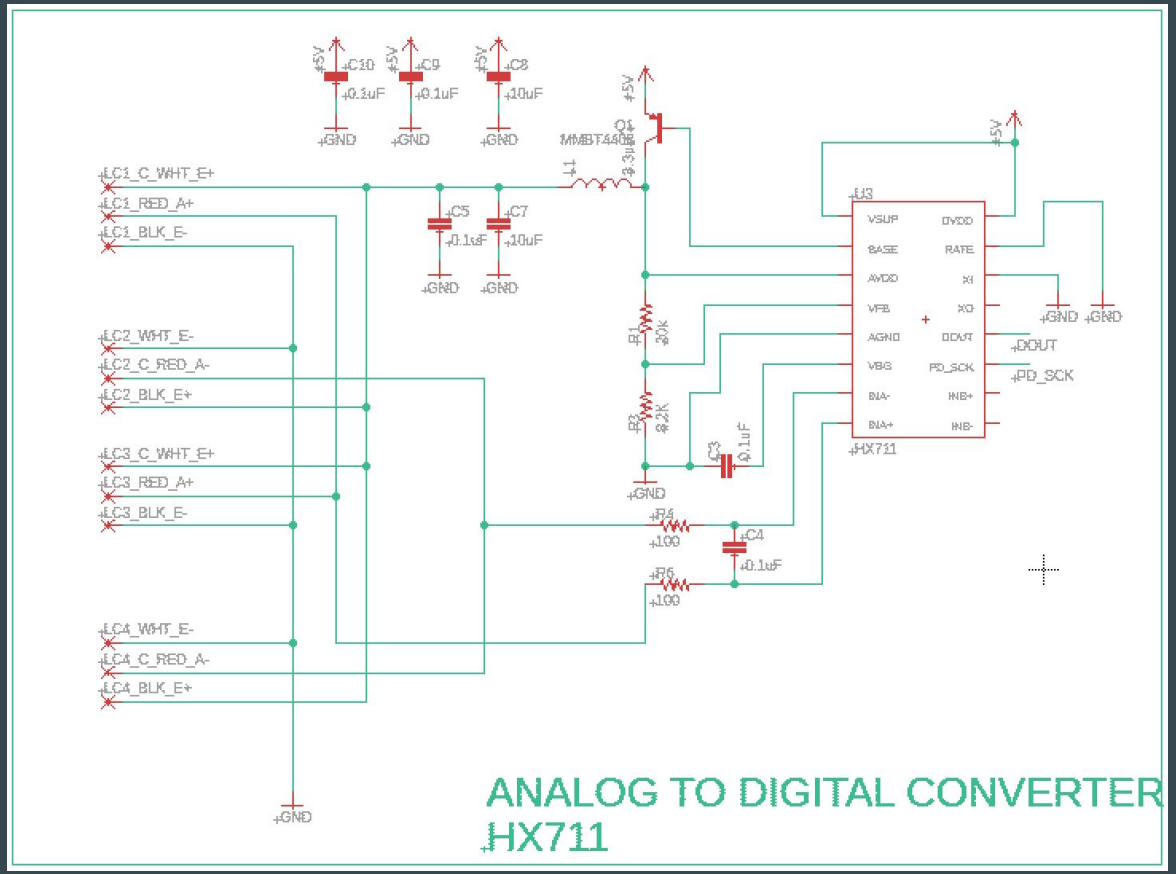
Microprocessor

- ICSP to program microprocessor
- 16 MHz clock
- Reset Button is active low



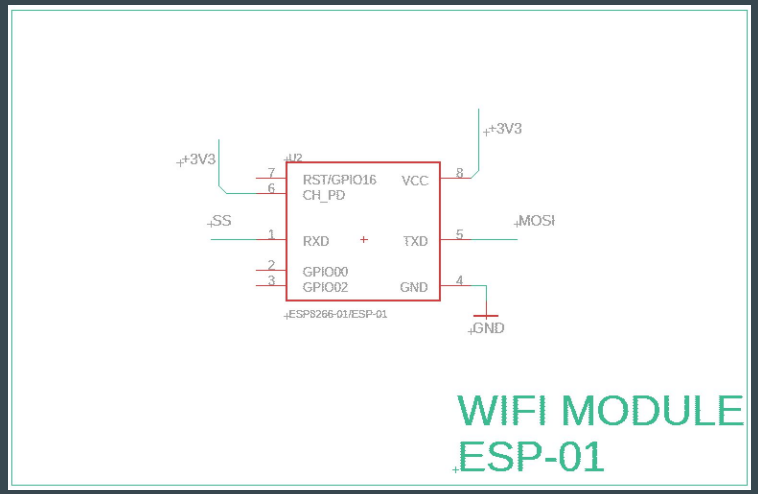
AD Converter

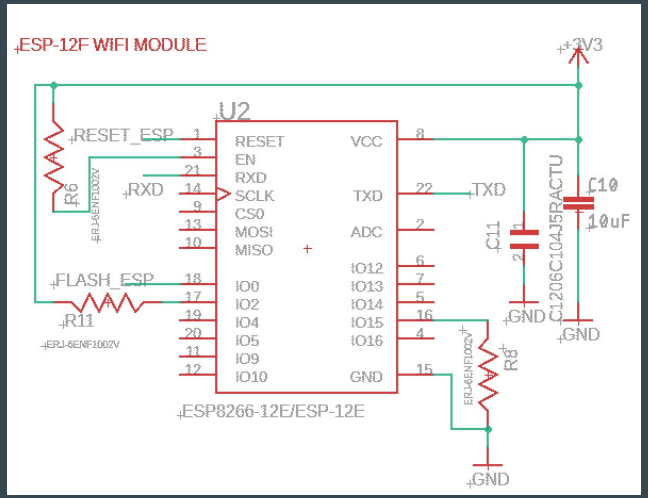
- 4 half bridge load cells will solder to wirepads on board for more reliable connection
- Measures voltage from load cells and sends it to microcontroller to measure weight
- HX711 provides serial interface for data retrieval via two control pins:
    - Clock line
    - Data line



Wireless Connection

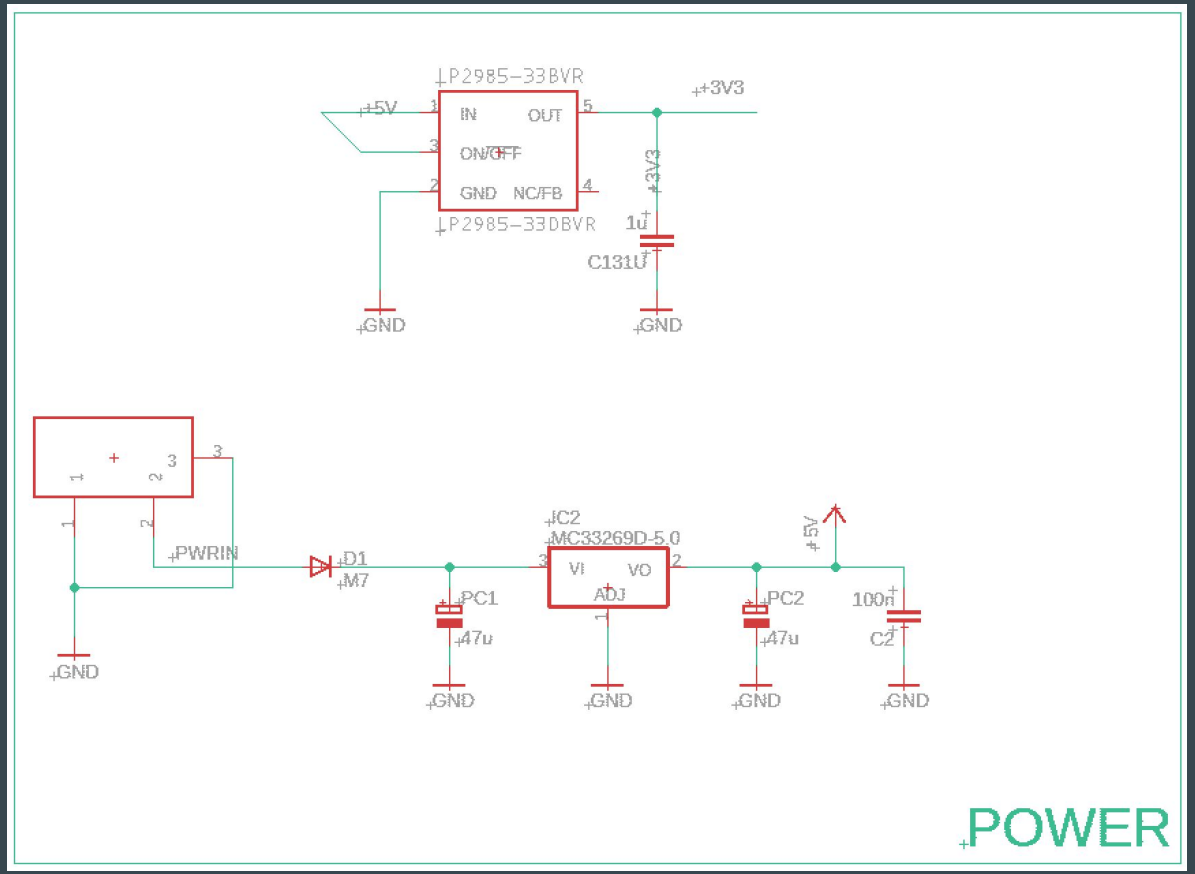
- ESP8266 ESP-01 Wifi Module for 1st pcb
- ESP8266 ESP-12f Wifi Module for future pcbs
- Powered by 3.3V





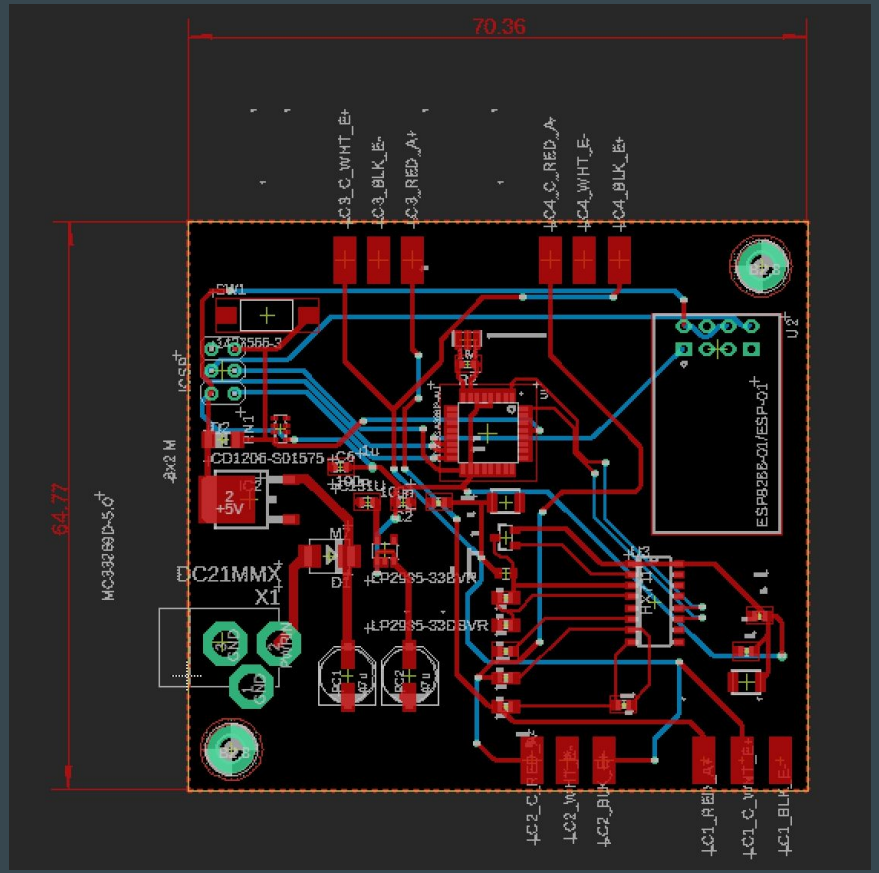
Power

- Power to be received from 4 AA or 1 9V batteries through barrel jack
- 5V regulator to power microcontroller and HX711 (ADC)
- 3.3V regulator to power Wifi Module
- Coupling Capacitors are placed in the design to prevent interference



PCB

- Created in Eagle
- 64.77mmx70.36mm
- Microcontroller is centered in board design
- Surface mount wire pads for four 3 wire load cells
- Two (2) mounting holes to secure design in place



PCB Concerns

- First PCB ordered, awaiting arrival
- Haven’t tested first board
- There are two large power consuming devices on the board:
  - The Wifi Module, which draws 215mA max
  - The Microcontroller, which draws 360mA max
- Total max current draw is 575mA at any one time through the 5V regulator

Budget

- Budget of $2000

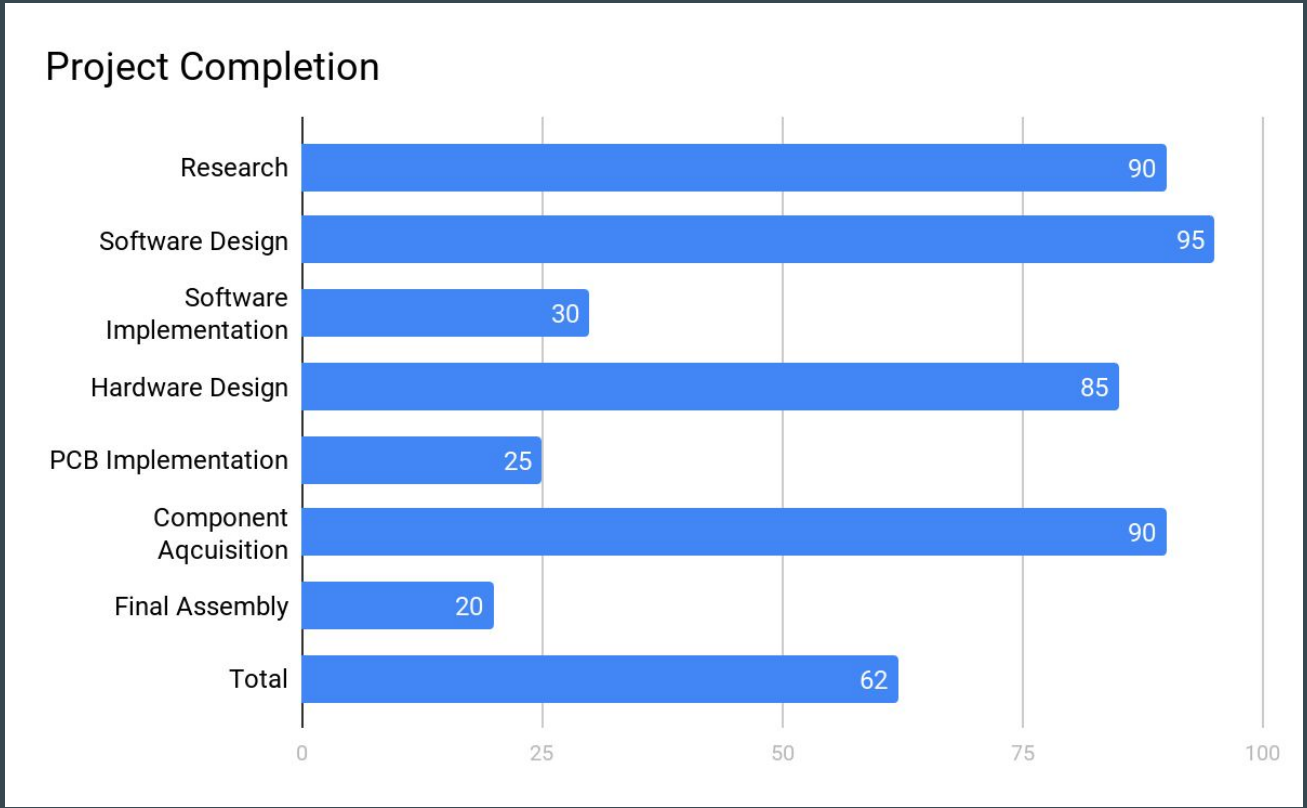
Part	Cost
Raspberry pi 3 b+	$80.00
Scale	$20.00
Toaster oven	$20.00
Sd card	$11.00
Tempered Glass	$68.00
Touch foil	$115.00 + Shipping
Kitchen Cart	$0 (already had)
32” Monitor	$0
Breadboard Testing Kit	$33.50
Arduino Mega 2560	$20
TI ADS2132REF	$0 (TI provided)
HX711 A/D Converter	$24
A/D Converter and Load Units for Scale	$30
Total	$421.5

Part	Unit Cost	Our Unit cost
Monitor	$109	$0 (donated)
Kitchen Cart	$159	$0 (donated)
Raspberry Pi 3 b+(kit)	$80.00	$80.00
Load Cells	$7.99	$7.99
Tempered Glass	$68.00	$68.00
Touch foil	$120.00	$120.00
Arduino ATMega 328p	$1.96	$1.96
Hx711 A/D Converter	$5.00	$5.00
PCB	$1.00	$1.00
Wifi module	$4	$4
Total	$551.95	$283.95

Group Member Responsibilities

	Jason	Gera	Miguel	Edwin
Hardware Design		Primary	Secondary	Secondary
Software Design	Primary	Secondary	Primary	
Wireless Scale	Secondary	Primary	Primary	Secondary
PCB		Secondary	Secondary	Primary

Project Progress



Current Challenges

- PCB: hard to do breadboard testing with individual components because many are only available as SMD
- Wifi Communications
- Noise in touch foil
- TV doesn’t fit

Plan for Project Completion

- PCB final design and testing
- Code for app and scale
- Frame for TV
- Enclosure for scale

Questions?

References

- https://www.electroluxgroup.com/en/3-trends-from-smart-kitchen-summit-that-will-reinvent-the-cooking-journey-25743/
- https://infographicjournal.com/the-smart-kitchen-of-the-future-is-here/