ReMutt Control

Critical Design Review

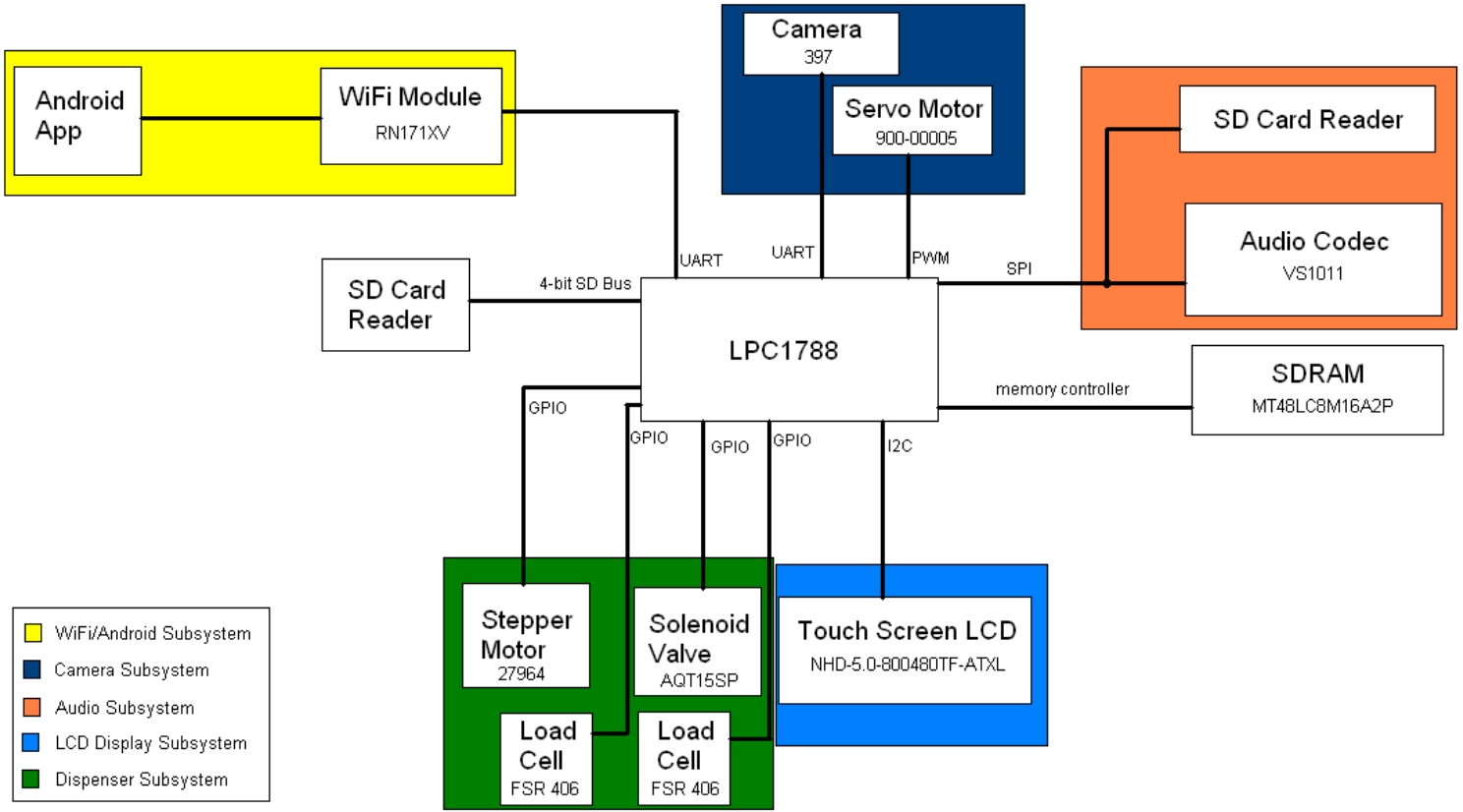
The Team

Team Leader: Steven Guan
Team Members: Eric Brunnett, Daniel Kwak, Joon Hee Lee, Alex Chepilev

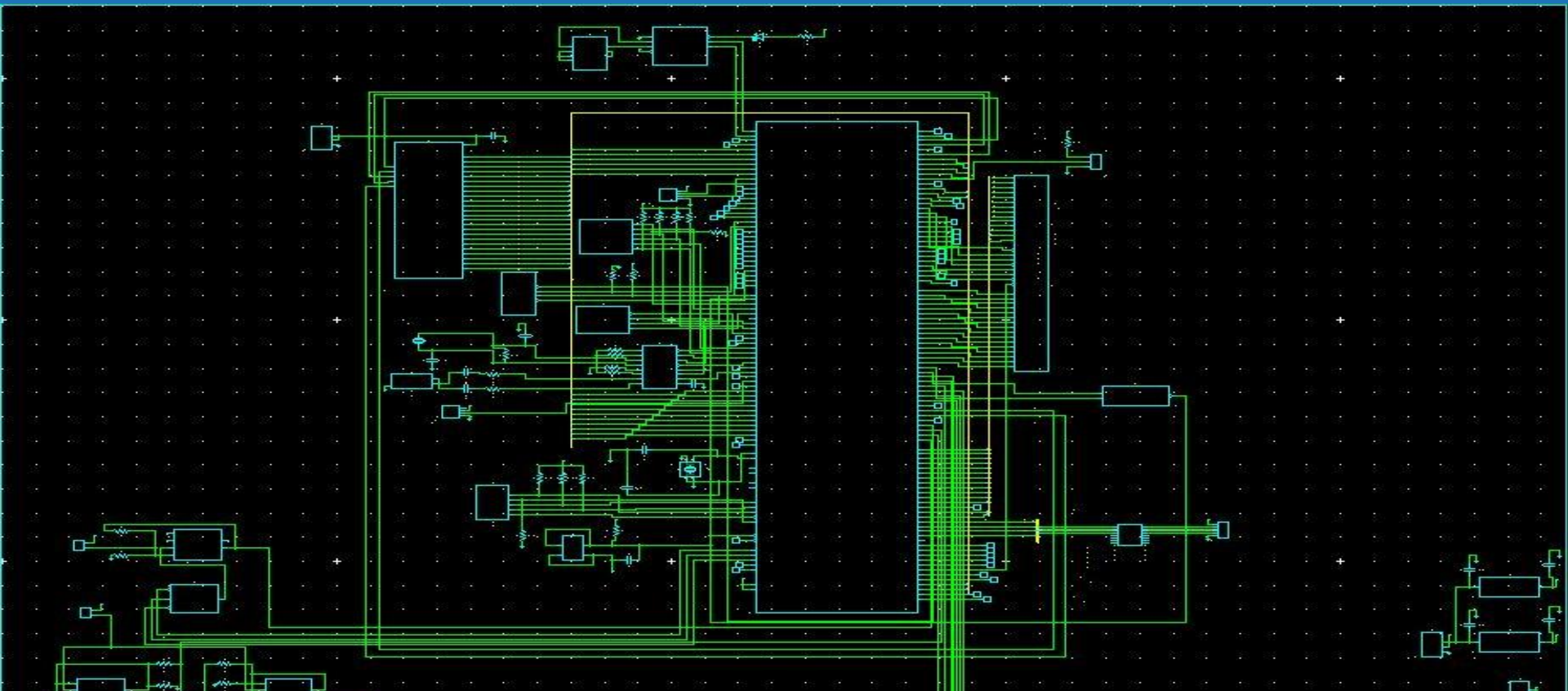
What is the ReMutt Control?

- Remote pet feeding system operated through a simple Android application
- Enables you to keep your pet fed by manually dispensing food or setting a feeding schedule that works on a real time clock
- Replenishes water automatically when it is low
- Pannable camera provides view of your pet through your phone
- Audio system allows you to call your pet over with a voice commands saved on SD card
- Set feeding and audio command schedules locally with touchscreen LCD

High Level Block Diagram



Schematic



Microcontroller

- NXP LPC1788 Cortex-M3
  - ARM Cortex-M3 processor, running at frequencies of up to 120 MHz
  - 3.3V operation
  - 96KB RAM, 512KB flash, 128MB external SDRAM
- Utilizing three uART busses, one I2C, and one SPI
  - UART used to program the LPC1788, camera, and WiFi
  - I2C bus for the touch screen LCD
  - Shared SPI bus for the audio codec and SD card reader
  - 4-bit SD card bus for redundant SD card reader
- On board LCD controller for the LCD panel
- GPIO for stepper motor, solenoid valve, and load cells
- PWM for servo motor

The Subsystems

- Camera - Kevin
- LCD Display - Kevin, Alex
- Audio/MP3 - Daniel, Alex
- Dispenser - Eric
- WiFi/Android - Steven, Alex

Camera Subsystem

- When user enters video viewing mode on Android device, camera begins taking pictures.
- Camera will be able to pan left and right via servo motor.
- Pictures will appear on phone at ~1 FPS.
- Will send picture data to the LPC1788, which will then send it to the WiFi module so that it can be viewed on an Android device remotely.

PTC08 Serial Camera Module

Interface	TTL uART
Resolution	640x480 , 320x240, 160x120
Max FPS	30 FPS
Power requirements	DC +5V @ >75 mA
Communication	3.3V TTL (TX, RX, GND)

Camera Subsystem

- Max Baud Rate : 115,200 bps (Bits Per Second)
- Potential Image Sizes:
    - 640 x 480
    - 320 x 240
    - 160 x 120

- Rough size of a 640 x 480 Image Compressed in JPEG: 40-50KB
    - 45KB * 8 Bits/Byte = 360,000 bits
    - 360,000 bits / 115,200 bps = 3.125 sec @ Maximum Baud Rate (115,200bps)

- Rough Size of a 320 x 240 Image Compressed in JPEG: 16KB
    - 16KB * 8 Bits/Byte = 128,000 bits
    - 128,000 bits / 115,200 bps = 1.11 sec @ Maximum Baud Rate (115,200bps)

- We will trade off Quality for Speed.
    - 1.11 sec is close enough to our goal of 1 fps.

LCD Display Subsystem

LCD Display Subsystem

- Using the 5 inch Capacitive TFT NHD-5.0-800480TF
- Receives input from user to set a schedule for automated feeding

LCD Display

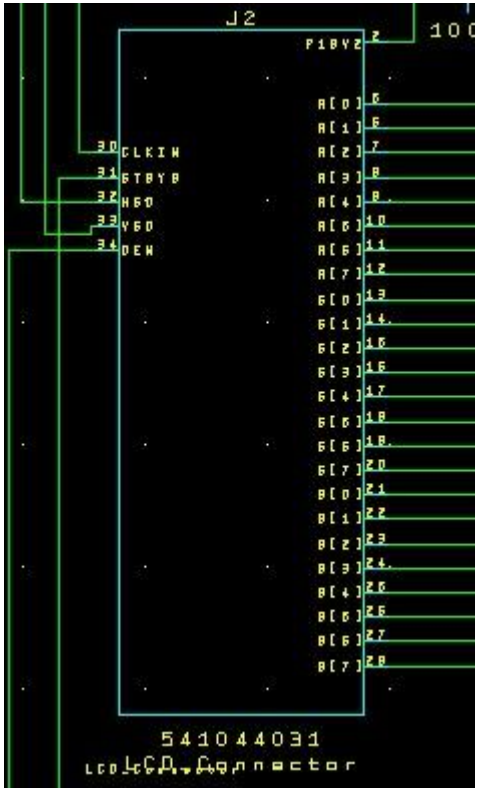
24 Data Wires (Input from Respective Display Pins on LPC1788)
Pin 5-12 [R0-R7]
Pin 13-20 [G0-G7]
Pin 21-28 [B0-B7]
11 Other Wires (Go to respective Pins on LPC1788 LCD Controller)

-LCD Panel Power Supply: 3.3V @ 164mA
-LED Backlight Power Supply: 19.2V @ 60mA

Touch Panel

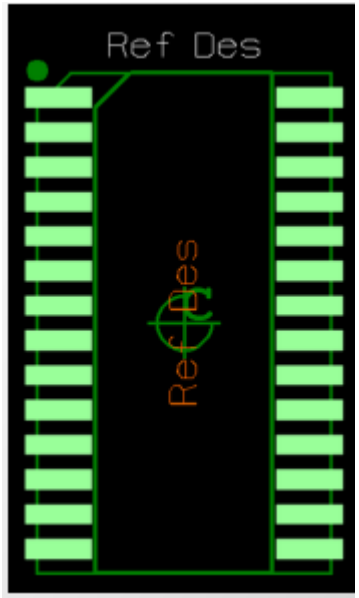
6 Wires (Go to respective Pins on LPC1788 ex. I2C and IO Pins)

-Touch Screen is interrupt Driven
-Touch Panel Power Supply: 3.0V@ 6mA



Audio Subsystem

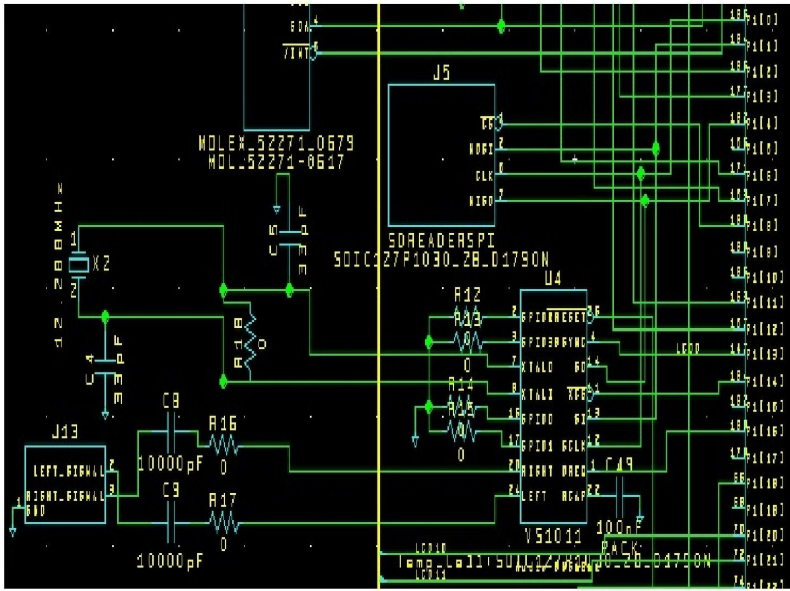
- Using the VS1011e(SOIC - 28Pins)
- 12.288Mhz Crystal
  - 320Kbits/s
- MP3 Decoder/DAC
- SPI Interface
- Input Power
  - Analog: 3.3V
  - Digital: 3.3V
- Memory
  - External SD card
  - Easy storage
- Outputs to audio jack
  - Cleaner connection than direct connect



Audio Subsystem(continued)

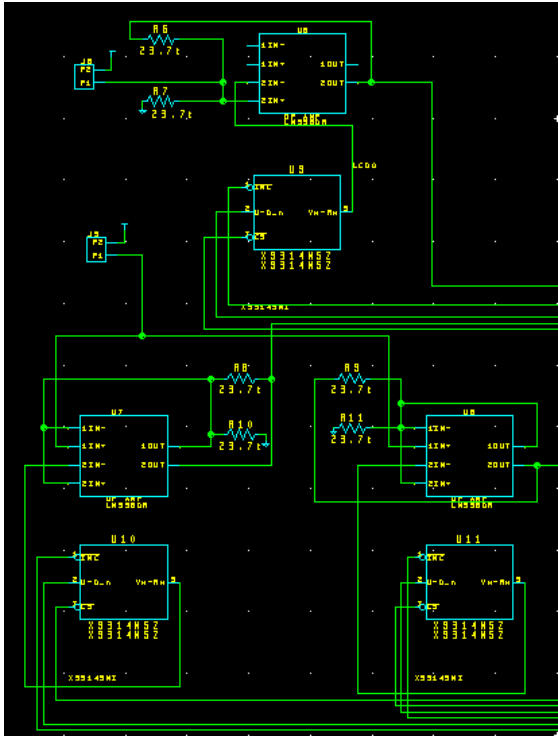
Recording, Storing, and Playing Audio

- User speaks into microphone of Android device and saves the data as.mp3 format
- Audio data is transmitted from WiFi module to 1788 via UART
- 1788 writes data to SPI-connected SD card
- SD card now has audio file stored
- When user chooses to play sound file, audio codec can read it directly from SD card and output left and right audio signals
- In case SPI-connected SD card reader doesn't work, there is a backup SD card reader connected to the processor with an SD data bus
- If backup is used, the 1788 will have to read the sound files from the SD card, then write them to the audio codec through SPI



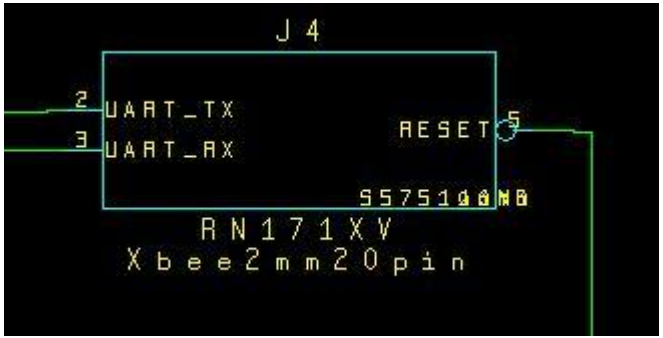
Dispenser Subsystem

- 4 interfaces with LPC1788:
  - motor driver (Texas Instruments ULN2803) - 4GPIO
  - solenoid valve (Aqua Tech Trading Corp. Ltd AQT15SP) - 1 GPIO
  - water sensor (Interlink Electronics FSR406)
    - full/empty signal - 1 GPIO
    - digitally controlled potentiometer for setting limit - (3 GPIO)x2
  - food sensor (Interlink Electronics FSR406)
    - full signal - 1 GPIO
    - digitally controlled potentiometer for setting limit - (3 GPIO)
- Stepper motor for food dispenser, electro valve for water dispenser
- The food dispenser will be enabled by either the user or a preset timer
- Water can automatically refill based on current water level, user input or a timer
- Ability to predefine a high level for the food and high and low signals for the water
  - the potentiometer/op amp circuit is used to create a limit signal



WiFi/Android Subsystem

- Using the RN-171VX WiFi module with UART bus
- Capable of 54Mbps 802.11 on the 2.4GHz frequency channel
- Built in UDP/IP stack and supports IEEE security encryptions (WEP, WPA/WPA2, etc)
- 3.3V @ 180mA
- Android API level 14 (Ice Cream Sandwich)



Software Overview

- Two states: “initial state” acts as a server
  - Connects to user’s local area network and awaits a UDP connection
  - Only the micro controller and WiFi is powered on
- Upon receiving a UDP request, simple authorization passcode is required to enter the “data transfer state”
  - If authorization is successful, an ephemeral port will be issued for data transfer, while initial connection will be a control connection
    - Controls include dispensing commands, session key transfers, notices of when audio/camera data are going to be sent, etc.
  - Camera is powered on and will start taking snapshots periodically
  - Will use a client/server rolling session key model

    as a means to achieve “state”

Power Distribution

- 3 External Power Supplies
  - 19.2V : LCD Backlight Power Supply
    - Laptop Power Connector
  - 12V : Dispensing Subsystem
    - Stepper Motor
    - Motor Driver IC (Darlington Pair)
    - Solenoid Valve Relay
  - 5V : Servo Motor, Camera module
    - 5V to 3.3V Regulator
      - Microcontroller, WiFi, SDRAM, Audio Codec, SD Card Reader
    - 5V to two 3V Regulators : Touch Panel and analog power for Audio Codec

Bill of Materials

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Ref Des	D-CAPS	Part Label	Manufacturer	Manufacturer Part Number	Vendor	Vendor Part Number	Package / Cell	Unit Price	Units Per Board	x5 (1 = 1per board, 0 = 1 overall)	total quantity	Total Price	Description
2	C1,C2		Capacitor	AVX Corporation	08055A180JAT2A	Digi-Key	478-1307-1-ND	805	$0.05	2	1	10	$0.50	CAP CER 18PF 50V 5% NP0 0805
3	C3		100nF Capacitor (reset switch)	Samsung Electro-Mechanics America	CL21F104ZBCNNNC	DigiKey	1276-1007-1-ND	805	$0.10	1	1	5	$0.50	CAP CER 0.1UF 50V Y5V 0805
4	C4-C5		33pF Capacitor (audio)	Samsung Electro-Mechanics America	CL21C330JBANNNC	DigiKey	1276-1105-1-ND	805	$0.10	2	1	10	$1.00	CAP CER 33PF 50V 5% NP0 0805
5	C6-C7		1uF Capacitor (VRM)	Yageo	CC0805ZRY5V8BB105	DigiKey	311-1358-1-ND	805	$0.10	2	1	10	$1.00	CAP CER 1UF 25V Y5V 0805
6	C8-C9		10000pF Capacitor(audio)	Samsung Electro-Mechanics America	CL21B103KBANNNC	DIgiKey	PRT-11362	805	$0.10	2	1	10	$1.00	CAP CER 10000PF 50V 10% X7R 0805
7	C10-C53		Decoupling Capacitors	Samsung Electro-Mechanics America	CL21F104ZBCNNNC	DigiKey	1276-1007-1-ND	805	$0.10	44		44	$4.40	CAP CER 0.1UF 50V Y5V 0805
8	CR1		LED	Lite-On Inc	160-1414-2-ND	DigiKey	LTST-C170KGKT	805	$0.37	1	1	5	$1.85	LED GREEN CLEAR 0805 SMD
9	J1		DB9 connector	FCI	10090097-P094VLF	Digi-Key	609-4003-ND		$0.83	1	1	5	$4.15	DSUB R/A US 9POS PIN
10	J2	C44	LCD connector	Molex, Inc.	541044031	Digi-Key	WM3431CT-ND		$2.69	1	1	5	$13.45	CONN FFC 40POS 0.50MM SMD R/A
11	J3	C52	Touch connector	Molex, Inc.	522710679	Digi-Key	WM7955DKR-ND		$1.22	1	1	5	$6.10	CONN FFC 6POS 1MM R/A ZIF SMD
12	J4	C48	Wifi Socket	4UCON	N/A	SparkFun	PRT-08272		$1.00	2	1	10	$10.00	2mm 10pin XBee Socket
13	J5,J14		SD Card Socket	4UCON Technology		Sparkfun	PRT-11362	n/a	$1.95	1	1	5	$9.75	SD Card Reader
14	J6,J15	C46(cam), C47(motor)	4 Pin Header (male)	TE Connectivity	1735446-4	DigiKey	A100098-ND	2mm through hole	$0.17	2	1	10	$1.70	Camera Header (male), Servo Motor
15	J7	C45	6 Pin Header (male)	TE Connectivity	440055-6	DigiKey	A100047-ND	2mm through hole	$0.42	1	1	5	$2.10	Stepper Motor Headers (male)
16	J8-J9		2 Pin Header (male)	TE Connectivity	440055-2	DigiKey	A100043-ND	2mm through hole	$0.15	2	1	10	$1.52	Load Sensor Headers (male)
17	J10-12		2.1x5.5mm Barrel Jack	CUI Inc	PJ-102AH	DigiKey	CP-102AH-ND	3 pin right-through hole	$1.01	3	1	15	$15.15	barrel jack for 19/V12V/5V
18	J13		Audio Jack	CUI Inc	SJ1-3523NG	DigiKey	CP1-3523NG-ND	500	$1.18	1	1	5	$5.90	3.5mm Audio Jack(Female)
19	J16		JTAG Header	Harwin	M50-3500542	Mouser	855-M50-3500542	n/a	$1.44	1	1	5	$7.20	
20	R1		10k Ohm Pull Down Resistor (SD Card)	TE Connectivity	1623097-1	DigiKey	A106054CT-ND	805	$0.10	1	1	5	$0.50	RES 10.0K OHM 1/8W 1% 0805
21	R2-R5		33k Ohm Pull Up Resistors (SD Card)	Panasonic Electronic Components	ERJ-6GEYJ333V	DigiKey	P33KACT-ND	805	$0.10	4	1	20	$2.00	RES 33K OHM 1/8W 5% 0805 SMD

Bill of Materials continued

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
22	R6-R11		23.7k Ohm Resistors (dispenser)	Yageo	RC0805FR-0723K7L	DigiKey	311-23.7KCRCT-ND	805	$0.10	6	1	30	$3.00	RES 23.7K OHM 1/8W 1% 0805 SMD
23	R12-R15		100k Ohm Resistors(audio)	Panasonic Electronic Components	ERJ-6GEYJ104V	DigiKey	P100KACT-ND	805	$0.10	4	1	20	$2.00	RES 100K OHM 1/8W 5% 0805 SMD
24	R16-R17		20 Ohm Resistor (audio)	Bourns Inc.	CR0805-JW-200ELF	DigiKey	CR0805-JW-200ELFCT-ND	805	$0.10	2	1	10	$1.00	RES 20 OHM 1/8W 5% 0805 SMD
25	R18		1M Ohm Resistors (audio)	Panasonic Electronic Components	ERJ-6GEYJ105V	DigiKey	P1.0MACT-ND	805	$0.10	1	1	5	$0.50	RES 1M OHM 1/8W 5% 0805 SMD
26	R19		10k Ohm Resistor (reset switch)	TE Connectivity	1623097-1	DigiKey	A106054CT-ND	805	$0.10	1	1	5	$0.50	RES 10.0K OHM 1/8W 1% 0805
27	R20-R21		1K Ohm Pull Up Resistors	Panasonic Electronic Components	ERJ-6GEYJ102V	DigiKey	P1.0KACT-ND	805	$0.10	2	1	10	$1.00	RES 1K OHM 1/8W 5% 0805 SMD
28	R22		100 Ohm Resistor (level shifter)	Panasonic Electronic Components	ERJ-6GEYJ101V	DigiKey	P100ACT-ND	805	$0.10	1	1	5	$0.50	RES 100 OHM 1/8W 5% 0805 SMD
29	R23-26		10K Ohm Resistor (JTAG)	TE Connectivity	1623097-1	DigiKey	A106054CT-ND	805	$0.10	4	1	20	$2.00	RES 10.0K OHM 1/8W 1% 0805
30	R27-R29		1K Ohm Pull Up Resistors	Panasonic Electronic Components	ERJ-6GEYJ102V	DigiKey	P1.0KACT-ND	805	$0.10	2	1	10	$1.00	RES 1K OHM 1/8W 5% 0805 SMD
31	SW1		Reset Switch	NKK Switches	UB15SKG03N-C	DigiKey	360-2651-ND		$6.77	1	1	5	$33.85	SWITCH PUSH SPDT 0.4VA 28V
32	SW2		Master Reset Switch	C&K Components	PTS645SK95-2 LFS	DigiKey	CKN10051-ND	THROUGHHOLE	$0.16	1	1	5	$0.80	SWITCH TACTILE SPST-NO 0.05A 12V
33	U1	C10-C23, C53	uController	NXP Semiconductors	LPC1788FBD208,551	Digi-Key	568-6689-ND	208 LQFP	$11.90	1	1	5	$59.50	MCU ARM 512K FLASH 208-LQFP
34	U2	C24	Level Shifter	Maxim Integrated Products	MAX3233ECWP+G36	Digi-Key	MAX3233ECW ND	20 SOIC	$6.84	1	1	5	$34.20	IC TXRX RS232 DUAL250KBPS 20SOIC
35	U3	C25-C31	SDRAM	Micron Technology	MT48LC8M16A2P-7E:G TR	Digi-Key	557-1100-6-ND	54 TSOP	$5.07	1	1	5	$25.35	IC SDRAM 128MBIT 133MHZ 54TSOP
36	U4	C32-C36, C49	Audio Codec	VLSI	VS1011E-L	Sparkfun	COM-08126	28 SOIC	$19.95	1	0	1	$19.95	IC VLSI MP3 DECODER
37	U5	C37	Motor Driver	Texas Instruments	ULN2803	Sparkfun	COM-00312		$1.95	1	1	5	$9.75	8 Darlington Arrays in 18-Pin DIP Package
38	U6-U8	C38-C40	Dual Op AMP (comparator)	Texas Instruments	LM358DR	DigiKey	296-1014-1-ND	8 SOIC	$0.55	3	1	15	$8.25	IC OPAMP GP 700KHZ 8SOIC
39	U9-11	C41-C43	Digitally Controlled Potentiometer	Intersil	X9314WSZ	Mouser	968-X9314WSZ	8 SOIC	$3.30	3	1	15	$49.50	IC XDCP SGL 32-TAP 10K 8-SOIC
40	U12		Voltage Regulator (5V to 3.3V	Microchip Technology	MCP1700-3302E/TO	DigiKey	MCP1700-3302E/TO-ND	3 pin through hole	$0.44	1	1	5	$2.20	5V to 3.3V VRM

Bill of Materials continued

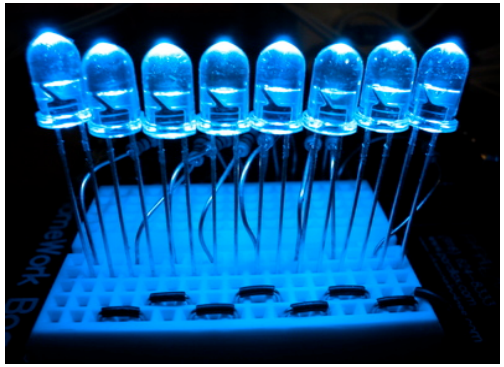
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
40	U12		Voltage Regulator (5V to 3.3V	Microchip Technology	MCP1700-3302E/TO	DigiKey	MCP1700-3302E/TO-ND	3 pin through hole	$0.44	1	1	5	$2.20	5V to 3.3V VRM
41	U13	C50-C51	Voltage Regulator (5V to 3V	Microchip Technology	MCP1700-3002E/TO	DigiKey	MCP1700-3002E/TO-ND	3 pin through hole	$0.44	1	1	5	$2.20	IC REG LDO 3V 0.25A TO92-3
42	X1		Main crystal	TXC Corporation	7B-20.000MEEQ-T	Digi-Key	887-1303-1-ND		$0.97	1	1	5	$4.85	CRYSTAL 20MHZ 10PF SMD
43	X2		MP3 crystal	Abracon Corporation	ABM3B-12.288MHZ-10-1-U-T	DIgiKey	300-8198-1-ND	805	$1.50	1	1	5	$7.50	ABM3B-12.288MHZ-10-1-U-T
44	X3		Real Time Clock	EPSON	C-2 32.0000K-P:PBFREE	DigiKey	SER3310-ND	through hole	$1.07	1	1	5	$5.35	CRYSTAL 32KHZ 11PF THRU
45			WiFi Module	Microchip Technology	RN171XV	Digi-Key	740-1044-ND	49-SMD	$38.45	1	0	1	$38.45	MODULE 802.11B/G 2.4GHz
46			LCD Display	Newhaven Display Intl	NHD-5.0-800480TF-ATXL#-CTP	Digi-Key	NHD-5.0-800480TF-ATXL#-CTP-ND		$70.00	1	0	1	$70.00	DISPLAY TFT MODULE W/ TOUCH
47			Servo Motor	Parallax	900-00005	Digi-Key	900-00005-ND	n/a	$12.99	1	0	1	$12.99	MOTOR SERVO DC GEARED 6V
48			Load Cell	Interlink Electronics	FSR 406	Digi-Key	1027-1002-ND	n/a	$9.98	2	0	2	$19.96	OP amp unity gain buffer (LM741)
49			Camera	ADAFRUIT INDUSTRIES	397	Jameco	2144340	n/a	$49.95	1	0	1	$49.95	5V
50			Stepper Motor	Parallax	27964	Mouser	619-27964	n/a	$17.29	1	0	1	$17.29	MOTOR STEPPER
51			Solenoid Valve	Aqua Tech Trading Corp. Ltd	AQT15SP	Sparkfun	ROB-10456	n/a	$7.95	1	0	1	$7.95	12V Solenoid Valve - 3/4"
52			Dispenser	zevro	GAT101	The WEBstaurant store	993GAT1WH	n/a	$19.49	1	0	1	$19.49	Black Single Canister Dry Food Dispenser
53			4 Pin Header (male)	TE Connectivity	1735446-4	DigiKey	A100098-ND	2mm through hole	$0.17	1	0	1	$0.17	Camera Header (male, on camera)
54			4 Pin (female)	TE Connectivity	1735447-4	DigiKey	A100021-ND		$0.10	3	0	3	$0.30	Camera Connector (female)
55			6 Pin Header (female)	TE Connectivity	440129-6	DigiKey	A100015-ND	2mm through hole	$0.24	1	0	1	$0.24	Stepper Motor Headers (female)
56			2 Pin Header (female)	TE Connectivity	440129-2	DigiKey	A100011-ND	2mm through hole	$0.10	2	0	2	$0.20	Load Sensor Header (female)
57			Switch Slide	C&K Components	JS202011SCQN	DigiKey	401-2002-1-ND		$0.44	1	1	5	$2.20	Switch
58			12V AC-DC Adapter	Jameco Reliapro	ADPV16	Jameco	2167445	N/A	$22.95	1	0	1	$22.95	12V 2.1x5.5mm power adapter
59			5V AC-DC Adapter	CUI Inc.	EPS050100-P5N	DigiKey	CP-006A-ND	N/A	$8.06	1	0	1	$8.06	5V 2.1x5.5mm power adapter
60			19.2V AC-DC Adapter	CUI Inc.	ETSA190342U-P5P-SZ	DigiKey	T1203-P5P-ND	N/A	$24.65	1	0	1	$24.65	19.2V 2.1x5.5mm power adapter
61	TP1-TP53		Berg Pins-1	FCI	68000-401HLF	DigiKey	609-3466-ND	N/A	$0.10	54	0	54	$5.40	BERGSTIK II .100" SR STRAIGHT
62														
63														
64												TOTAL:	$664.77	

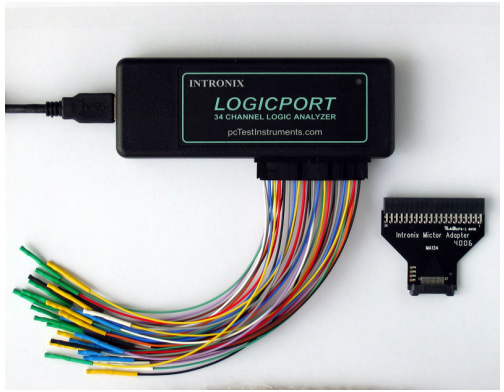
Debugging Methodology

1) Redundant SD card reader incase we have issues with the SPI bus.

2) After finalizing pin outs, we connected the remaining GPIO pins to test headers. Power pins to every IC has a header as well.

3) Making the relay for the solenoid valve external in case we have issues providing enough current or voltage to “open” the valve.





Questions or Comments?