SCREAM
Speech Controlled
Responsive Electronics and Mechanics

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Motivation

- Provide low cost home automation technology
- Simplify user input
- Simple modular units
- Conservative energy usage

Goals & Objectives

- After initial setup, user should be able to vocally control
- No software to install, minimum maintenance
- Use little power to operate
- Wirelessly control access to a door via servos
- Wirelessly control light actuation via relay

Specifications & Requirements

1	Base station must be easy to program by user
2	LCD display must be easy to read and provide clear user feedback
3	Microphone can communicate to the base station up to 10 meters away
4	Base station can communicate with remote stations up to 10 meters away
5	Wireless microphone operates for 5 hours before batteries need recharging
6	Speech recognition chip operates with 95% word accuracy
7	Low latency between voice command and actuation
8	Remote mechanical station must provide sufficient torque to turn a deadbolt

Microcontroller Options

- MSP 430
- Beaglebone Black
- Raspberry B+
- CC3200
- ODROID-C1

Wireless Protocol Options

- Wi-Fi or Wi-Fi Direct
- Zigbee
- Zwave
- Bluetooth

Overall Block Diagram

Bluetooth Headset

- MPOW Edge
- Transmission distance of 30 ft
- Talk time of 5 hours
- Charge time of 2.5 hours
- Bluetooth 4.0

SR Technology

- Recognition Style
  - Isolated
  - Connected
  - Continuous

- Speaker Dependent vs Independent

Speech Recognition Options

- Android
- PocketSphinx
- Images SI

Factors: OS, WiFi, Hardware, Latency

Speech Recognition

52 Pin PLCC Package
Images Scientific Instruments

- 20 to 40 words
- 0.96 or 1.92 seconds
- Speaker Dependent
- 64KB SRAM
- Non-volatile memory

| Item	Specification
Supply Voltage	5 VDC
Response Time	300 ms
Operating Current	6 mA
Output Drive Current	1.5 mA
Output Sink Current	1.5 mA
Input Leakage Current	0.1 μA
Input Current (Pull down)	200 μA
Output Data Enable Width	280 ns
Output Data Holding Time	480 ns
Memory Enable Width	560 ns
Address Setup Time (to Memory Enable)	280 ns
Memory Enable to Data (Reading Starting)	280 ns
Memory Write (Write signal)	560 ns

Analog to Digital Conversion

- On chip
- Pulse Code Modulation
- Sampling rate: 3.57 MHz
- Bit depth: 8
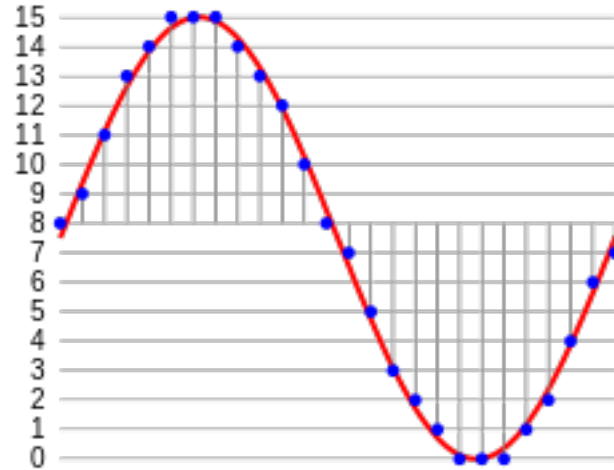
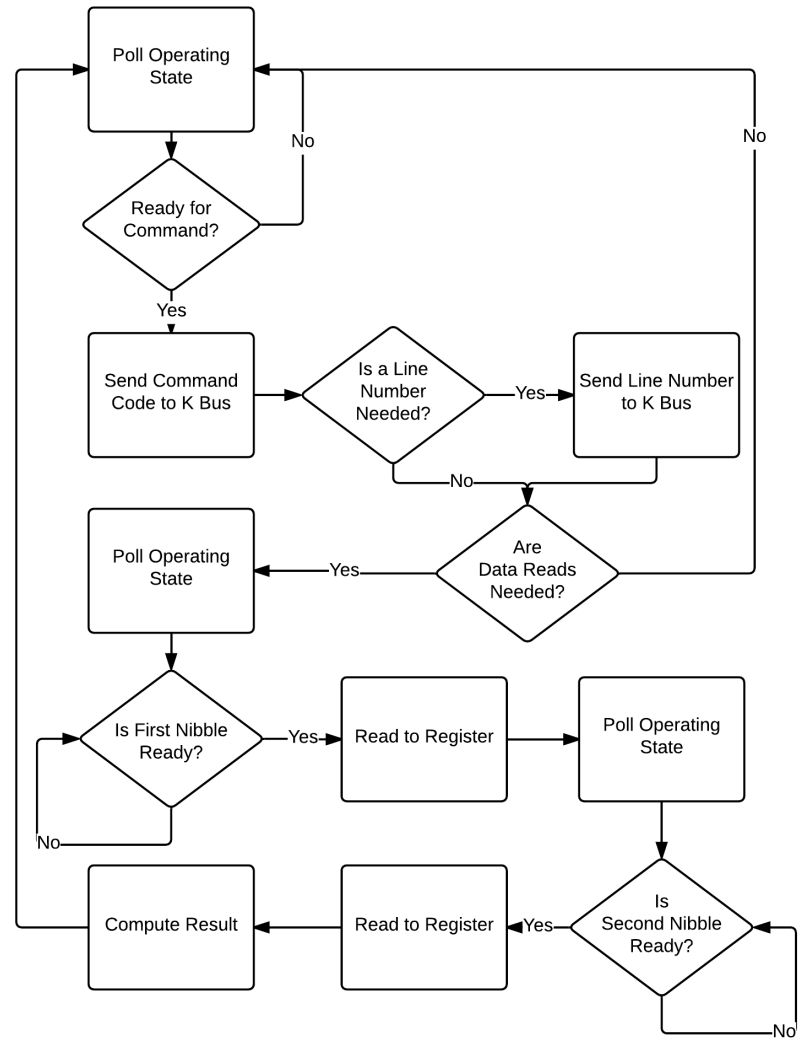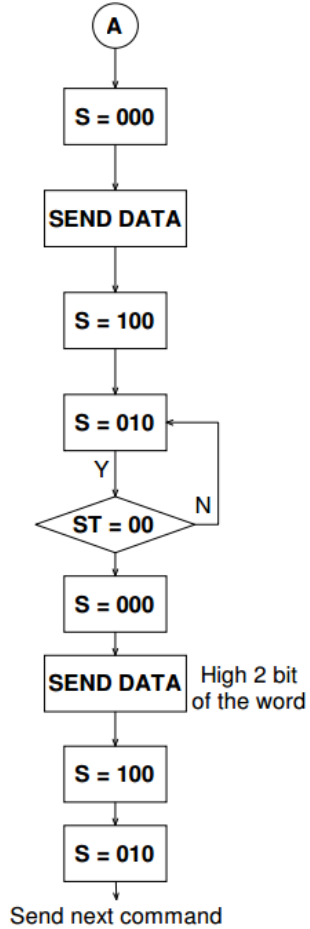# Proposed SR Schematic
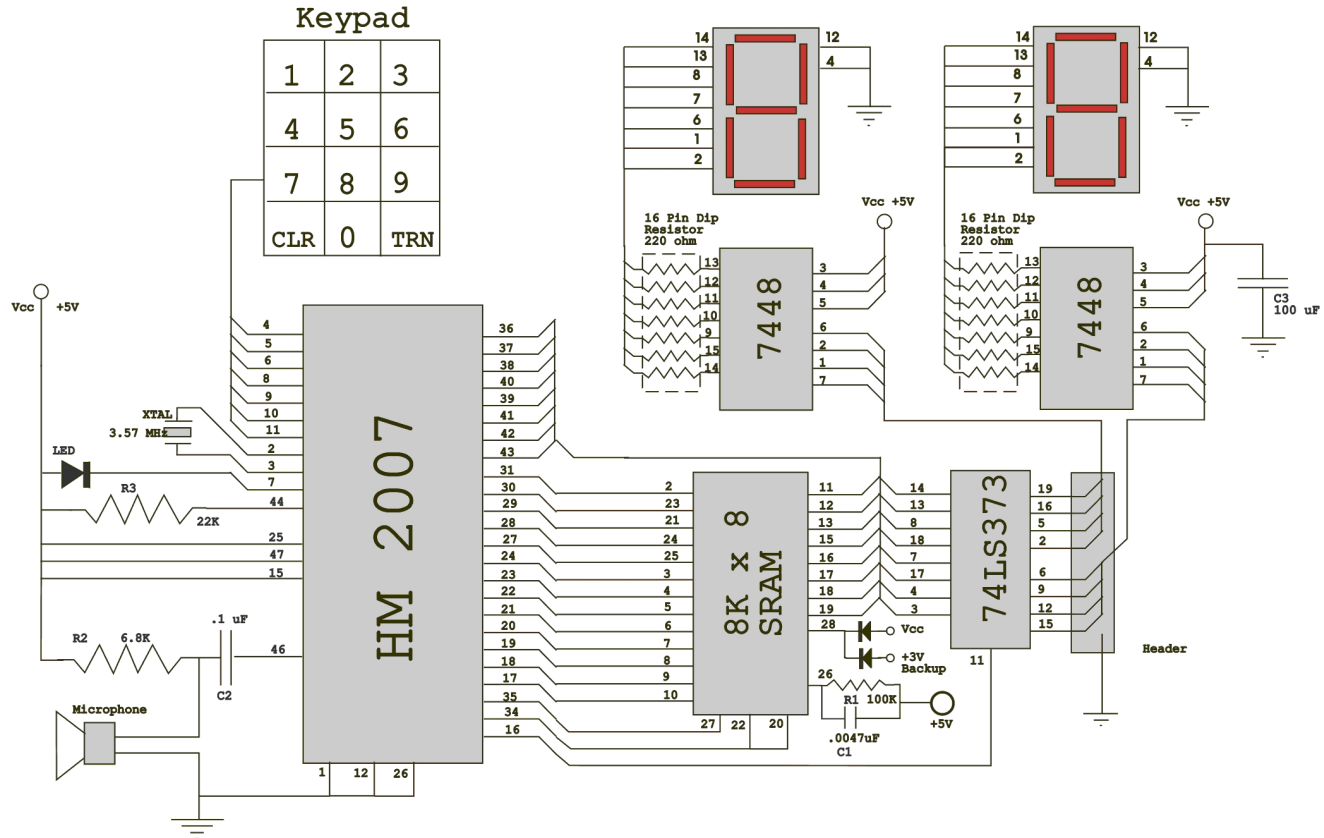
Modified SR Schematic
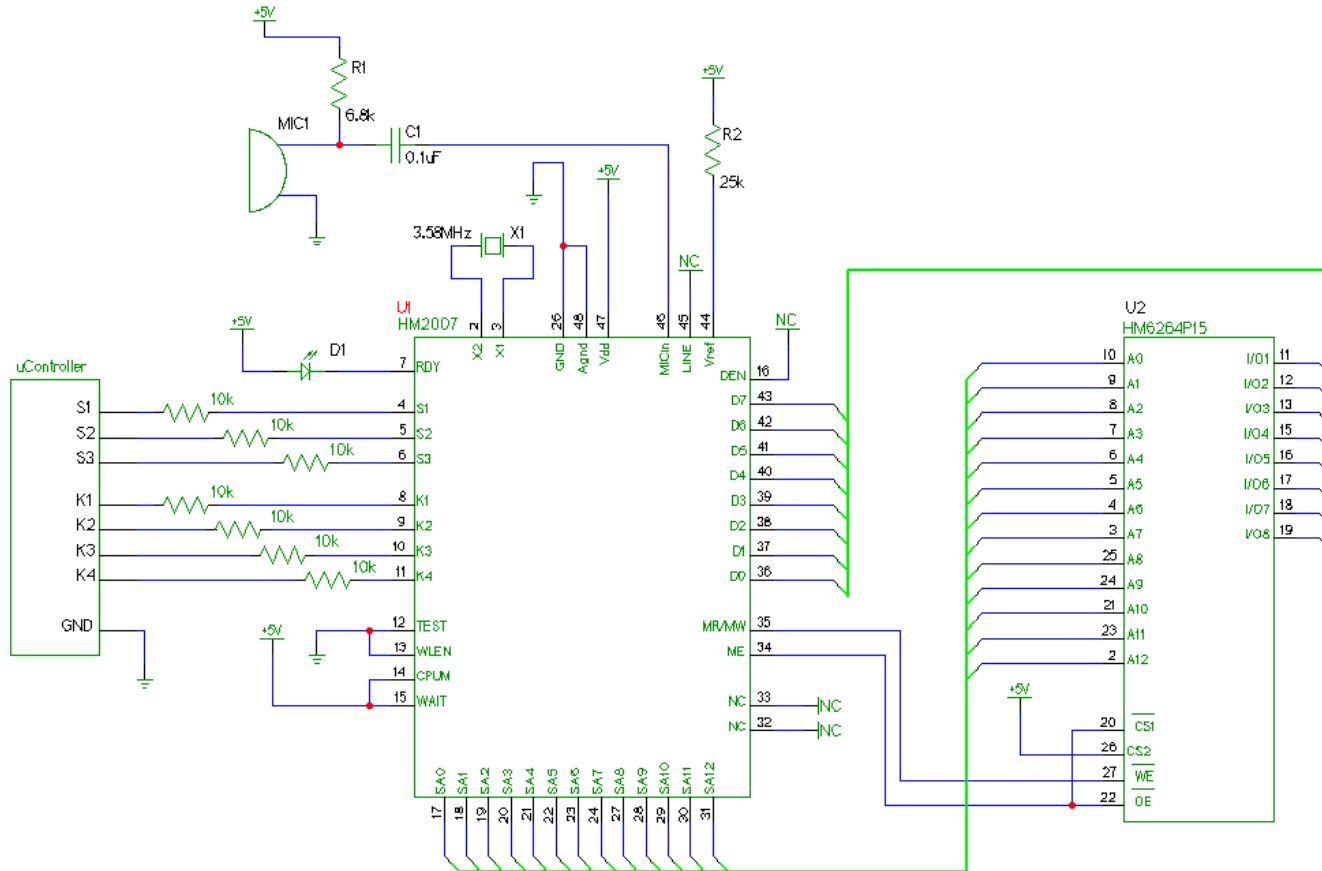
Relaying Commands

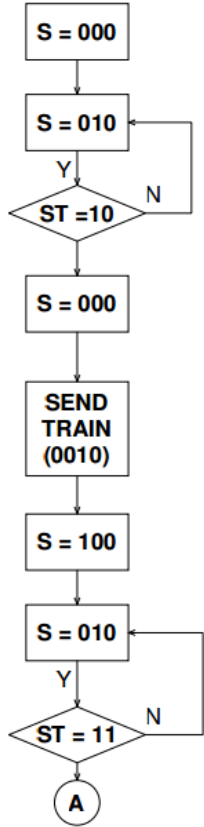- Recognition
- Resulting
- Training
- Upload
- Download
- Reset

ST3	ST2	ST1	ST0	Operating State
X	X	0	1	Ready for voice input
X	X	1	0	Ready for command
X	X	1	1	First nibble of data is ready
X	X	0	0	Second nibble of data is ready

Command	Code	Low Word	High Word
Recognition	001		
Training	010	B3 B2 B1 B0	0 0 B5 B4
Result	100		
Upload	101	B3 B2 B1 B0	0 0 B5 B4
Download	110	B3 B2 B1 B0	0 0 B5 B4
Reset	111		

```
S = 000
   │
   ▼
S = 010 ◄──────┐
   │Y          │N
   ▼           │
ST = 10 ───────┘
   │
   ▼
S = 000
   │
   ▼
SEND
TRAIN
(0010)
   │
   ▼
S = 100
   │
   ▼
S = 010 ◄──────┐
   │Y          │N
   ▼           │
ST = 11 ───────┘
   │
   ▼
  (A)
```

```
  (A)
   │
   ▼
S = 000
   │
   ▼
SEND DATA
   │
   ▼
S = 100
   │
   ▼
S = 010 ◄──────┐
   │Y          │N
   ▼           │
ST = 00 ───────┘
   │
   ▼
S = 000
   │
   ▼
SEND DATA   High 2 bit
            of the word
   │
   ▼
S = 100
   │
   ▼
S = 010
   │
   ▼
Send next command
```

ODROID-C1

Micro HDMI port   Micro USB OTG port   5V2A DC input

Boot media selector   Power switch port

Gigabit Ethernet PHY

Ethernet RJ-45 jack

USB VBUS controller

4 x USB 2.0 host ports

USB2.0 MTT hub controller

Status LED
Power LED

Power protector IC

Serial console port

RTC (Real Time Clock) backup battery connector

Infrared (IR) receiver

DC-DC Power supply circuit

40pin GPIO header
GPIO/I2C/SPI/UART/ADC

S805 quad core processor
(ARMv7)

1GByte DDR3 SDRAM
(2 x 512MB)

- 40 GPIO at 3.3V
- MicroSD or eMMC
- 5V power supply
- Onboard USB ports and ethernet

Wiring Pi

- GPIO Interface Library
    - Designed for Raspberry Pi
    - Ported to ODROID
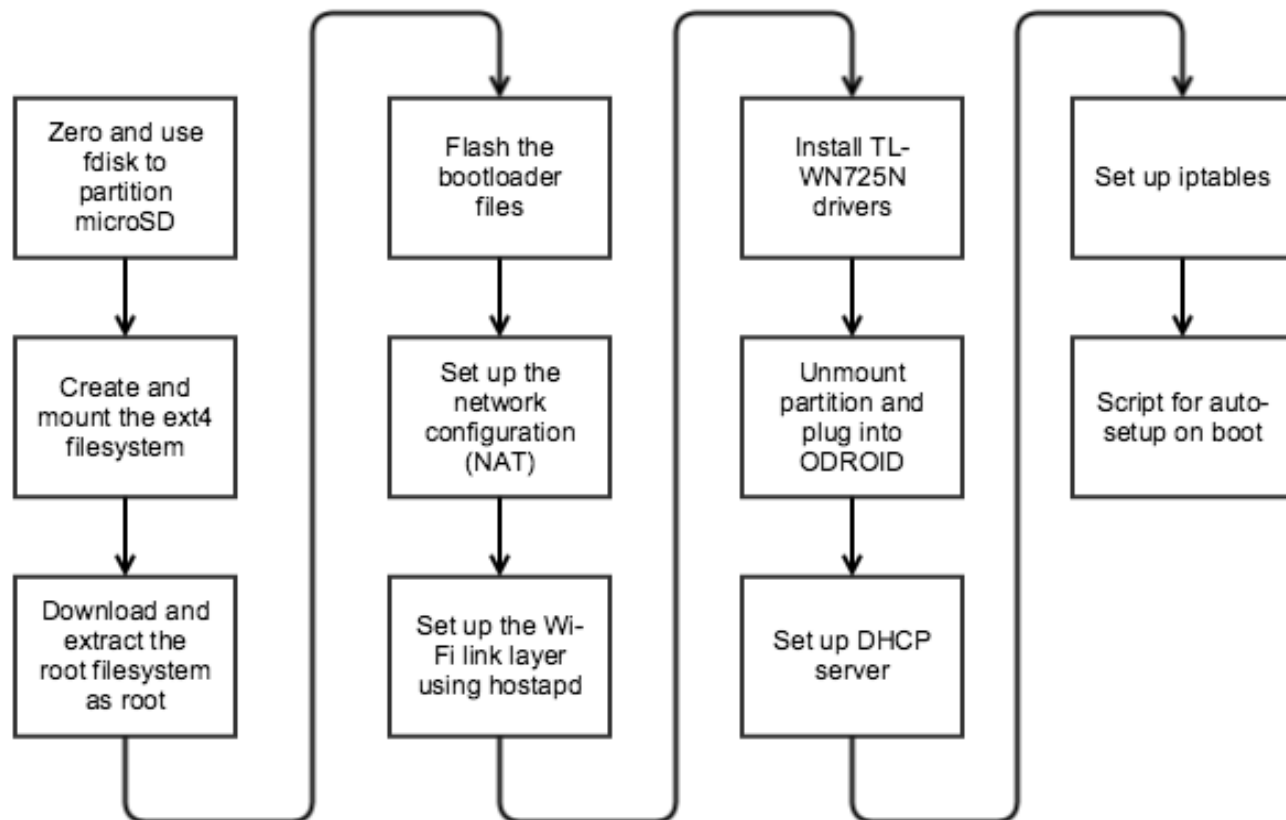   - Java, C/C++, and Python wrappers

Arch Linux

- Lightweight Linux distro with documentation
- DHCP server
- Increased security through WPA2, IP tables
- BASH scripting to automate
- Channel control
- Wireshark

Networking with Linux

- hostapd - Software service controller for wireless access control
- iptables - Firewall and routing control
- dhcpd4 - Assigns dynamic IP addresses to clients in the networks in the domain of 192.168/24

Software AP

Zero and use fdisk to partition microSD

Create and mount the ext4 filesystem

Download and extract the root filesystem as root

Flash the bootloader files

Set up the network configuration (NAT)

Set up the Wi-Fi link layer using hostapd

Install TL-WN725N drivers

Unmount partition and plug into ODROID

Set up DHCP server

Set up iptables

Script for auto-setup on boot

Wireless Dongle (TL-WN725N)

- 802.11b/g/n
- Up to 150 Mbps Data transfer rate (on 802.11n)
- Supports 64/128 WEP, WPA, PA2/WPA-PSK/WPA2-PSK(TKIP/AES)
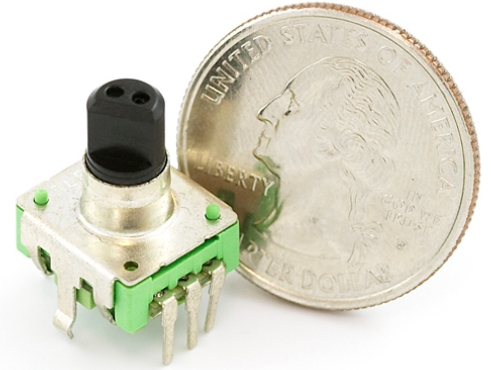- Support for Windows and Linux

LCD

- Amerlight 20x4 Display
- Based on HD44780
- 4 or 8 bit parallel interfacing
- 5V DC operation
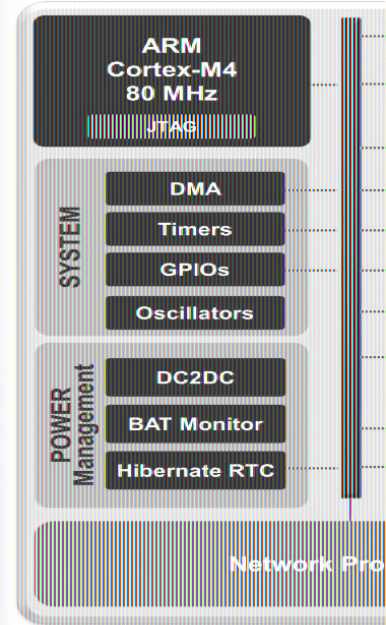- LED backlight
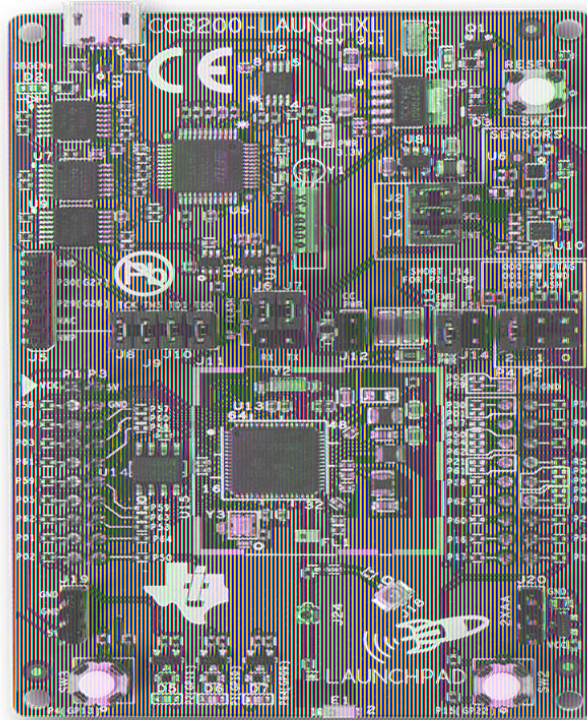- Adjustable contrast

Rotary Encoder

- Incremental
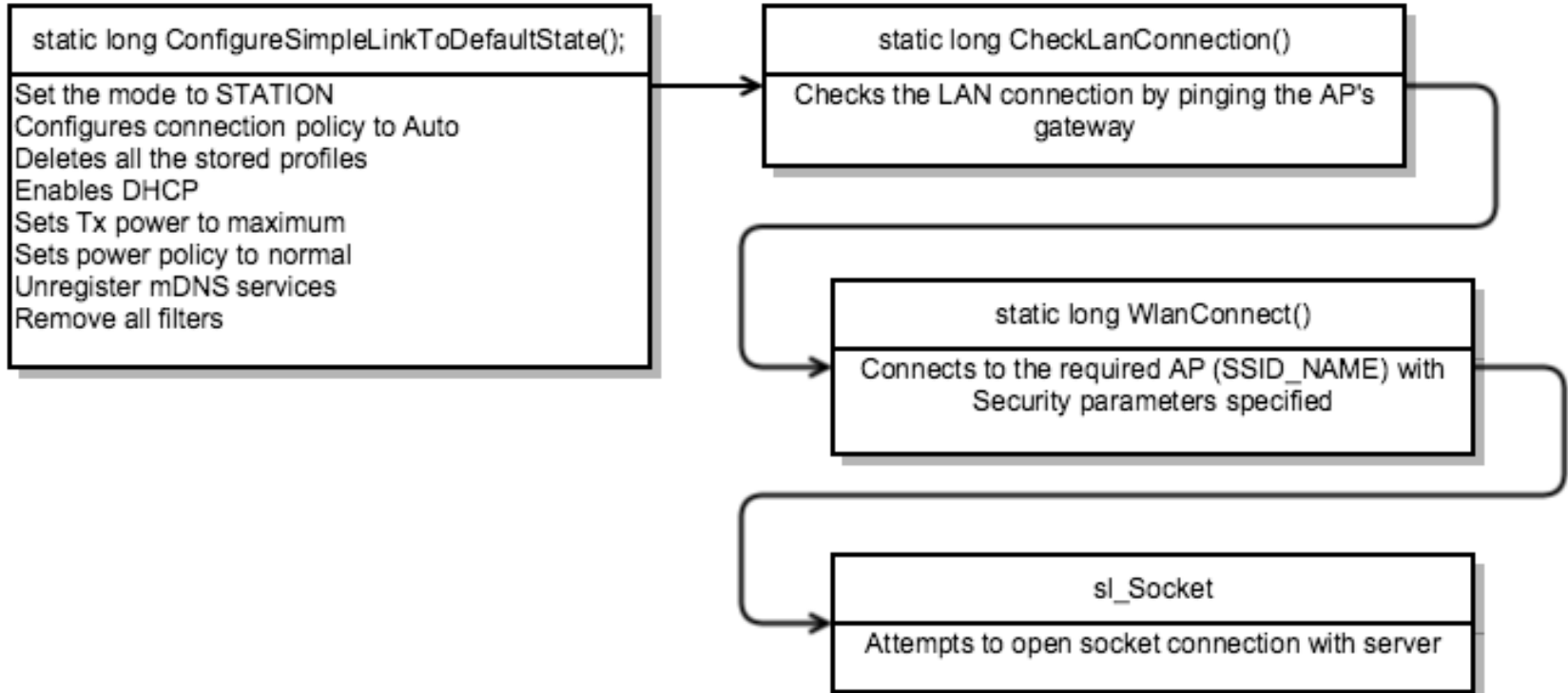- Relative Position
- Gray Code
- Push Button
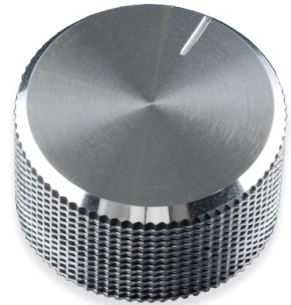
CC3200

- Built-in Wi-Fi driver
- TCP/IP Stack
- WPA2 compliant
- 802.11 b/g/n
- 2.4 Ghz
- STA, AP, P2P modes
- 5 V power supply

Networking with the CC3200

static long ConfigureSimpleLinkToDefaultState();

Set the mode to STATION
Configures connection policy to Auto
Deletes all the stored profiles
Enables DHCP
Sets Tx power to maximum
Sets power policy to normal
Unregister mDNS services
Remove all filters

static long CheckLanConnection()

Checks the LAN connection by pinging the AP's gateway

static long WlanConnect()

Connects to the required AP (SSID_NAME) with Security parameters specified

sl_Socket

Attempts to open socket connection with server

Wireshark

16 5.000837	Tp-LinkT_9d:dc:34	TexasIns_06:2d:d9	ARP	42	Who has 192.168.1.103? Tell 192.168.1.1
17 5.074100	TexasIns_06:2d:d9	Tp-LinkT_9d:dc:34	ARP	42	192.168.1.103 is at 5c:31:3e:06:2d:d9
18 5.117377	192.168.1.103	192.168.1.1	ICMP	62	Echo (ping) request id=0x0167, seq=1/256
19 5.117512	192.168.1.1	192.168.1.103	ICMP	62	Echo (ping) reply id=0x0167, seq=1/256
20 9.116947	192.168.1.103	192.168.1.1	ICMP	62	Echo (ping) request id=0x0167, seq=2/512
21 9.117082	192.168.1.1	192.168.1.103	ICMP	62	Echo (ping) reply id=0x0167, seq=2/512

Servo Control System

Pulse wave Peak to Peak Square Wave
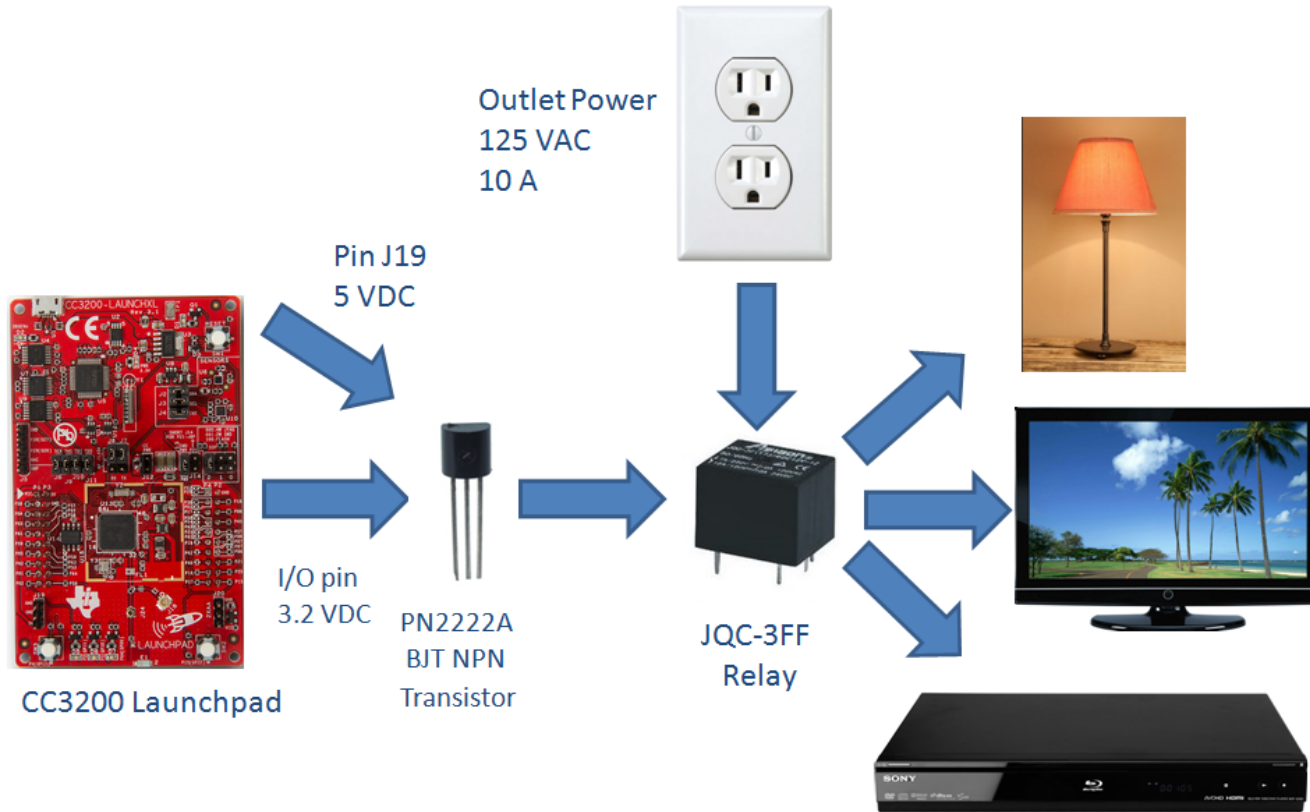
Pin J19 5 VDC

Door
Deadbolt

3.1 Kg cm
Torque
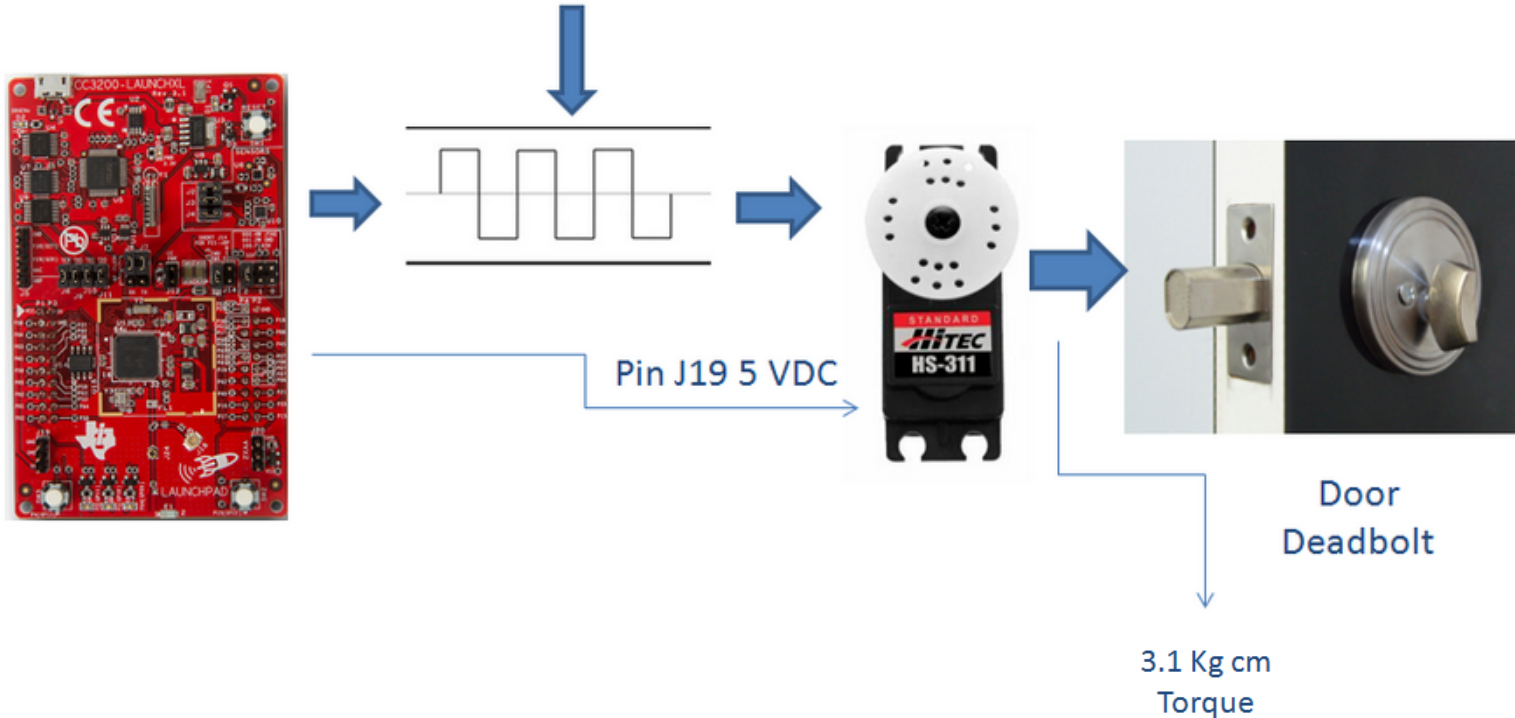
Servo

- Three-Pole Ferrite Motor
- Compact size
- Operating Voltage Range:4.8 to 6.0 VDC.
- Variable Operating Speed: 0.19sec/60°to 0.15sec/60°
- Pulse Wave 3 to 5 V Peak to Peak Square Wave
- Pulse Wave Control 1500μsec Neutral
- Operating Torque Range: 3.0kg/cm to 3.7kg/cm
- Low Cost Standard Size Servo

Relay Control Unit

Outlet Power
125 VAC
10 A

Pin J19
5 VDC

I/O pin
3.2 VDC

CC3200 Launchpad

PN2222A
BJT NPN
Transistor

JQC-3FF
Relay

Relays

Features

- High Current Contacts
- Switching Capacity to 10 A
- Standard PCB Layout (Subminiature)
- Economically Priced

Relays(cont)

Specifications

Item	HF-JQC-3FF
Type	Power Relay
Nominal Voltage	5 VDC
Coli Power	360 mW
Coil Resistance	400 ohm
Configuration	1 Form A (SPST)
Contact Rating	10A 250 VAC/12A 125 VAC
Pin Count	4
Weight	10 g
Operating time	10 ms
Dimensions	19.0 x 15.2 x 15.5 mm
Price	$0.40

Outline Dimensions

19
15.5
15.5
4.5
0.3
1
0.4
1

PCB layout

4- Ø1.3
6
6
12.2
2
3.4
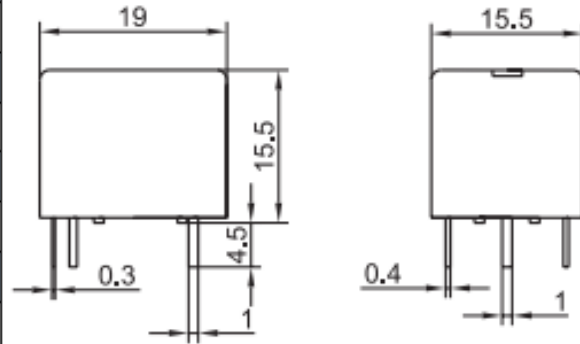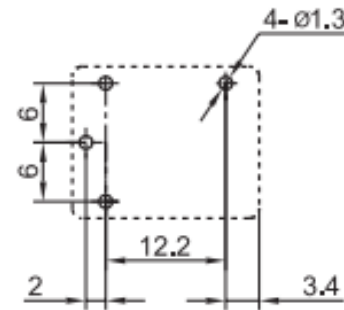
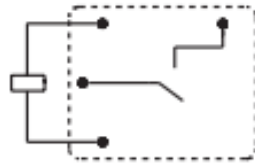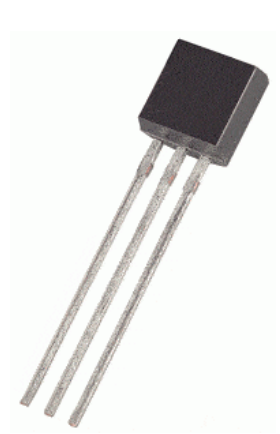**Wiring Diagram**

Transistor PN2222A

- NPN Switching Transistor
- Low Power Consumption
- Low Cost
- Current Control Switch
- Maximum Current Gain up to 300
- Maximum Collector Current of 1A

Power Supply

Device	Required Voltage	Required Current	Power Supply
Speech Recognition Circuit (HM2007 IC)	5 V	1A	9 V battery with voltage regulator
Wireless MCU (CC3200)	5 V	0.9 A	9 V battery with voltage regulator
ODROID-C1	5 V	2A	AC/DC Converter(Phone Charger with connector)
Servo Motor	5 V	167 mA	CC3200 (Pin J19)
Relay	5 V (Coil voltage)	72 mA	CC3200 (Pin J19)
NPN Switching Transistor	0.6 V(VBE)	--------	CC3200 (I/O pin)

Voltage Regulator LM7805C

- Three Terminal Regulator
- Output Current up to 1.5 A
- High Power Dissipation Capability
- Internal Short Circuit Current Limiting
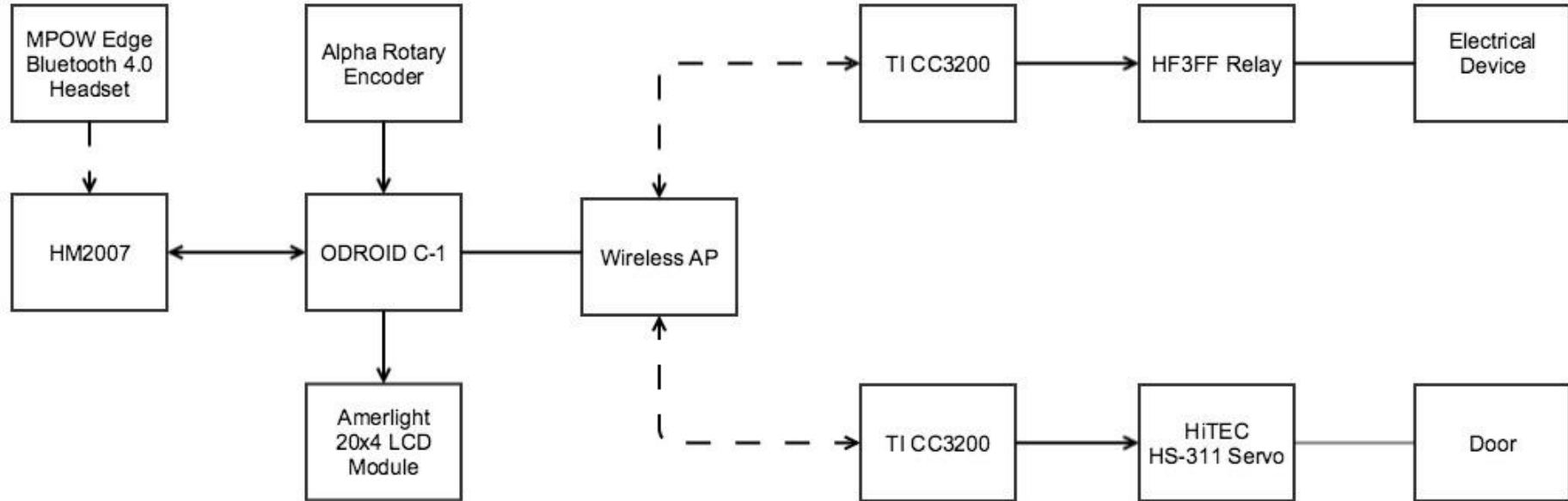- Able to input 9 VDC and output 5 VDC

Voltage Regulator

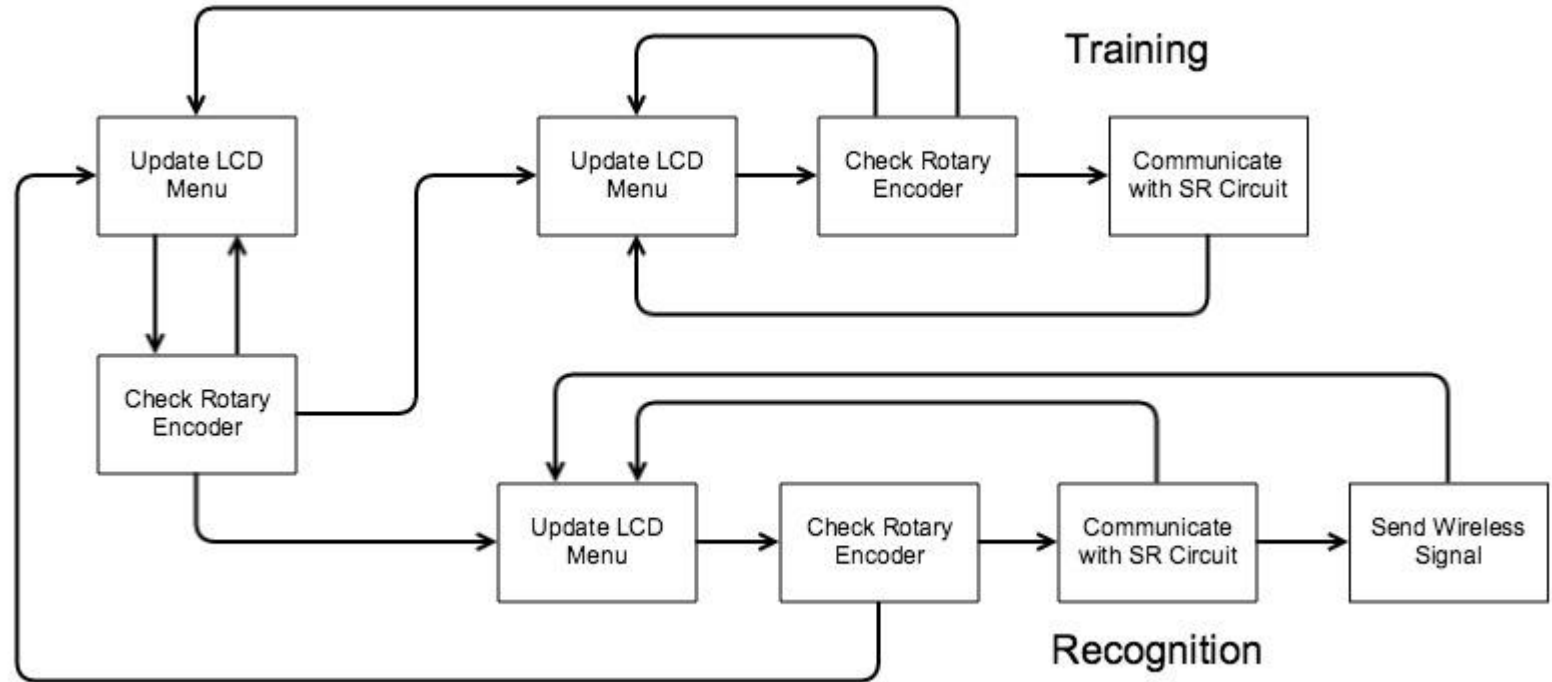Prototype of the Voltage Regulator
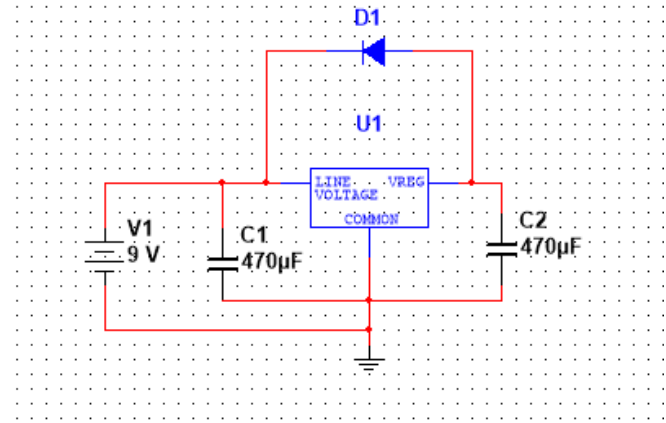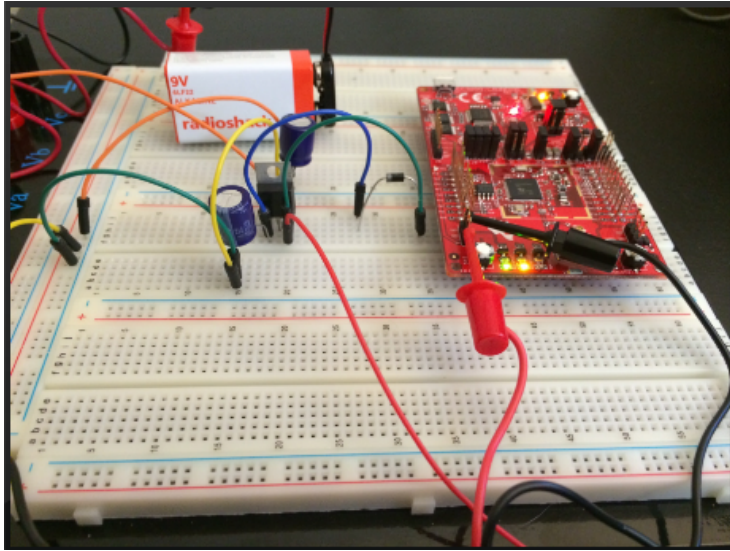
Schematic for Voltage Regulator

Hardware Overview

Software Overview

PCB Design

- Hardware Changes
- Developing Prototype
- Not started PCB

Enclosure Design

- Dimensions
  - 9"w x 4"h x 6d"

- Cutouts
  - LCD, Rotary Encoder
  - Power Supply, USB, Antenna

Work Distribution

	Speech Recognition	Software	Wireless AP	Relays	Servos	PCB	Enclosure
Heather		Primary	Primary				Secondary
Brett	Primary	Secondary				Primary	Primary
Angelo				Primary	Primary	Secondary	

Budget

Item	Price	QTY	Total
Bluetooth Headset	$70.00	1	$70
Bluetooth Dongle	$10.00	1	$10
Speech Recognition Chip	$114.95	1	$115
Microcontroller	$40.00	4	$160
Power Supply	$5.00	4	$20
Wireless Transceiver	$5.00	5	$25
Servo	$20.00	1	$20
Relay Control Unit	$5.00	4	$20
Contingency	$87.99	1	$88
Subtotal			$440
Total			**$528**

Qty	Description	Supplier	Part #	Unit Price	Total Price
1	MPOW Edge Headset	MPOW	B00M1EJNY2	$19.99	$19.99
1	USB Micro Bluetooth Adapter	Azio	BTD-V201	$12.99	$12.99
1	Speech Recognition Circuit	Imagesco	HM2007	$127.45	$127.45
1	USB Female Single Connector PCB mount	Velleman	CC088	$0.96	$0.96
2	AC/DC Wall Power Charger Adapter	HP	728002801	$5.98	$11.96
1	Experiment Breadboard w/ Jumper Wires	Amazon	IB751750	$14.49	$14.49
3	Wireless MCU	TI	CC3200	$29.99	$89.97
1	Generic High Torque Servo Motor	HiTec	HS-311	$12.95	$12.95

Qty	Description	Supplier	Part #	Unit Price	Total Price
3	Extension Cords	Home Depot	N/A	$11.97	$35.91
6	BJT Transistor	JAMECO	NP2222A	$0.12	$0.72
4	Power Relay SPST	OrzParts	JQC-3FF	$0.75	$3.00
2	2 pack 9 V battery	RadioShack	N/A	$14.99	$29.98
4	Voltage Regulator	RadioShack	7805C	$1.99	$7.96
4	Battery Holder	RadioShack	N/A	$1.99	$7.96
1	150 W Light Bulb Lamp	Walmart	N/A	$6.17	$6.17
1	Door	Home Depot	N/A	Free	Free
1	ODROID-C1	Hardkernel	S-805	$35.00	$35.00

Qty	Description	Supplier	Part #	Unit Price	Total Price
1	802.11n Wireless USB Adapter	TP-Link	TL-WN725N	$9.23	$9.23
1	Enclosure Fabrication				
1	PCB Fabrication	Advanced Circuits			
				Total	**$426.69**

Progress

Issues

- Lack of documentation for HM2007
- Excessive documentation for CC3200s

  new product line

- CC3200 single connectivity
- TL-WN725N drivers
- Hardware cursor nonexistent

  (except in SSH, known issue)

- Final design of the power supply for SCREAM.

Successes

- Successful breadboarding and programming of speech recognition circuit
- Successful setup of ODROID as software AP
- Successful communication between

  ODROID and CC3200

- Working relays for light module
- Development of the Voltage Regulator for Power Supply

Questions?

Suggestions: Method to start recognition?
- Multifunction button
- Key word
- Always listening