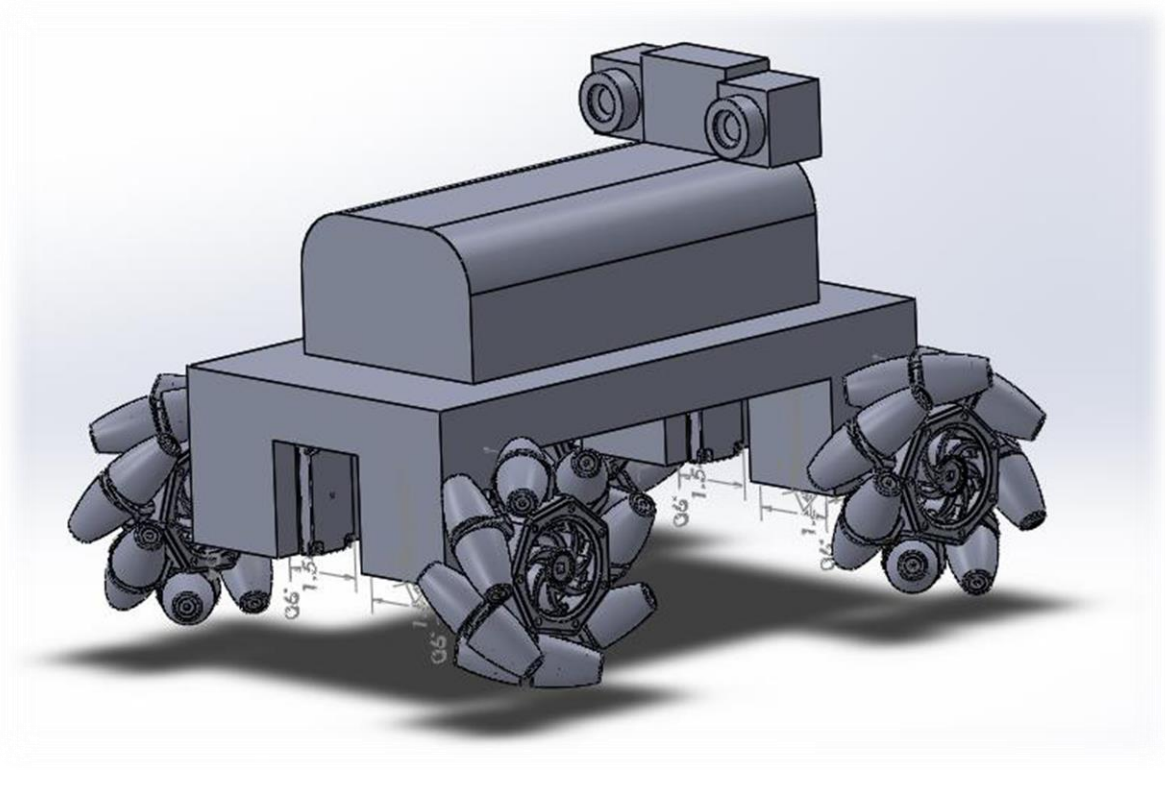


GROUP #4

Chris Carmichael
Ismael Rivera
Journey Sumlar
Warayut Techarut



T-100 WATCHDOG

Project Goals

Autonomous Vehicle

- System Integration
- Motor Control
- Computer Vision
- Wireless Communication
- Power Control

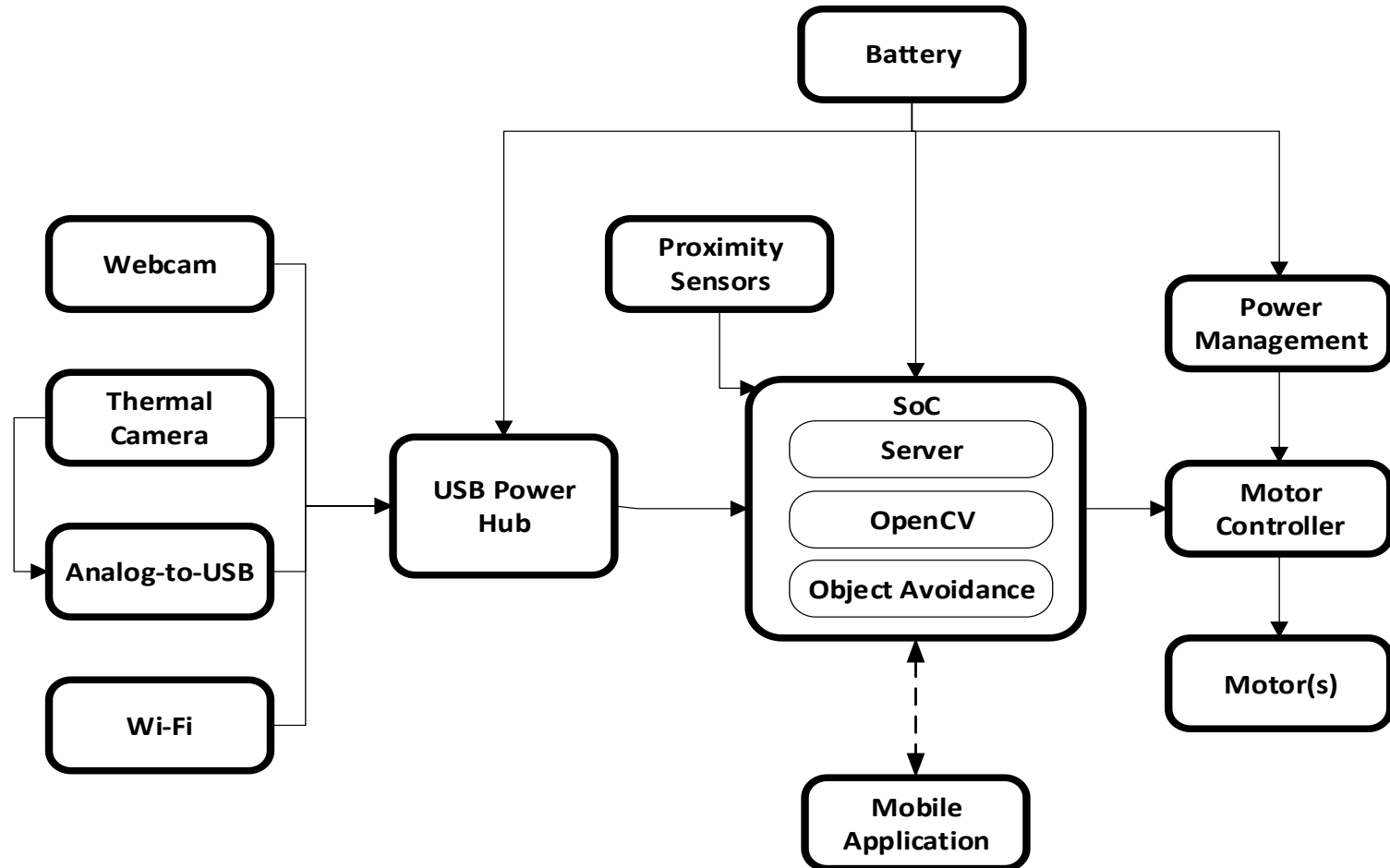
Requirements

- Fully Autonomous
- Object Detection within Range
- Wireless Communication Capable
- Utilize Thermal Camera

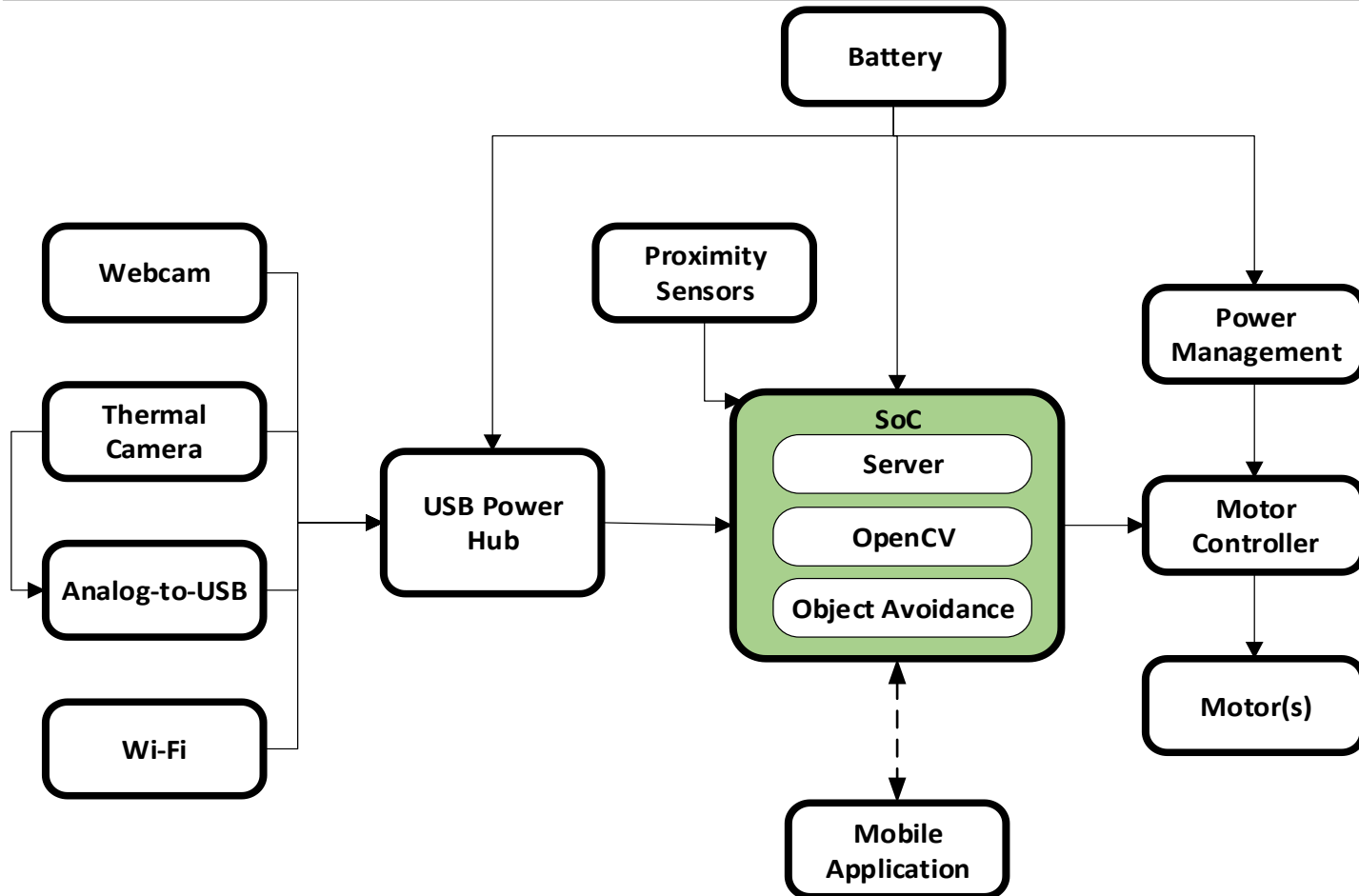
Specifications

Feature	Measurement
Dimension	11" x 6"
Operating Range	12 ft
Power Supply Voltage	15 v
Maximum Weight	20 lbs
Minimum Acceleration	1 ft/s ²
Maximum Speed	3 ft/s
Battery Life	3 hrs
Recharge Time	< 8 hrs

Block Diagram



System on Chip (SoC)

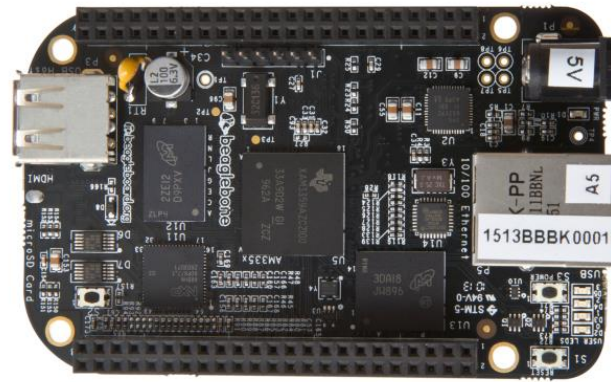


Microcontroller & Development Board

- ARM Cortex A8
- TI Sitara AM3359
- BeagleBone Black



ARM®



Microcontroller & Development Board

P9				P8			
DGND	1	2	DGND	DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3	MMC1_DAT6	3	4	MMC1_DAT7
VDD_5V	5	6	VDD_5V	MMC1_DAT2	5	6	MMC1_DAT3
SYS_5V	7	8	SYS_5V	GPIO_66	7	8	GPIO_67
PWR_BUT	9	10	SYS_RESETN	GPIO_69	9	10	GPIO_68
GPIO_30	11	12	GPIO_60	GPIO_45	11	12	GPIO_44
GPIO_31	13	14	GPIO_40	GPIO_23	13	14	GPIO_26
GPIO_48	15	16	GPIO_51	GPIO_47	15	16	GPIO_46
GPIO_4	17	18	GPIO_5	GPIO_27	17	18	GPIO_65
I2C2_SCL	19	20	I2C2_SDA	GPIO_22	19	20	MMC1_CMD
GPIO_3	21	22	GPIO_2	MMC1_CLK	21	22	MMC1_DAT5
GPIO_49	23	24	GPIO_15	MMC1_DAT4	23	24	MMC1_DAT1
GPIO_117	25	26	GPIO_14	MMC1_DAT0	25	26	GPIO_61
GPIO_125	27	28	SPI1_CS0	LCD_VSYNC	27	28	LCD_PCLK
SPI1_D0	29	30	GPIO_122	LCD_HSYNC	29	30	LCD_AC_BIAS_E
SPI1_SCLK	31	32	VDD_ADC	LCD_DATA14	31	32	LCD_DATA15
AIN4	33	34	GND_ADC	LCD_DATA13	33	34	LCD_DATA11
AIN6	35	36	AIN5	LCD_DATA12	35	36	LCD_DATA10
AIN2	37	38	AIN3	LCD_DATA8	37	38	LCD_DATA9
AIN0	39	40	AIN1	LCD_DATA6	39	40	LCD_DATA7
GPIO_20	41	42	GPIO_7	LCD_DATA4	41	42	LCD_DATA5
DGND	43	44	DGND	LCD_DATA2	43	44	LCD_DATA3
DGND	45	46	DGND	LCD_DATA0	45	46	LCD_DATA1

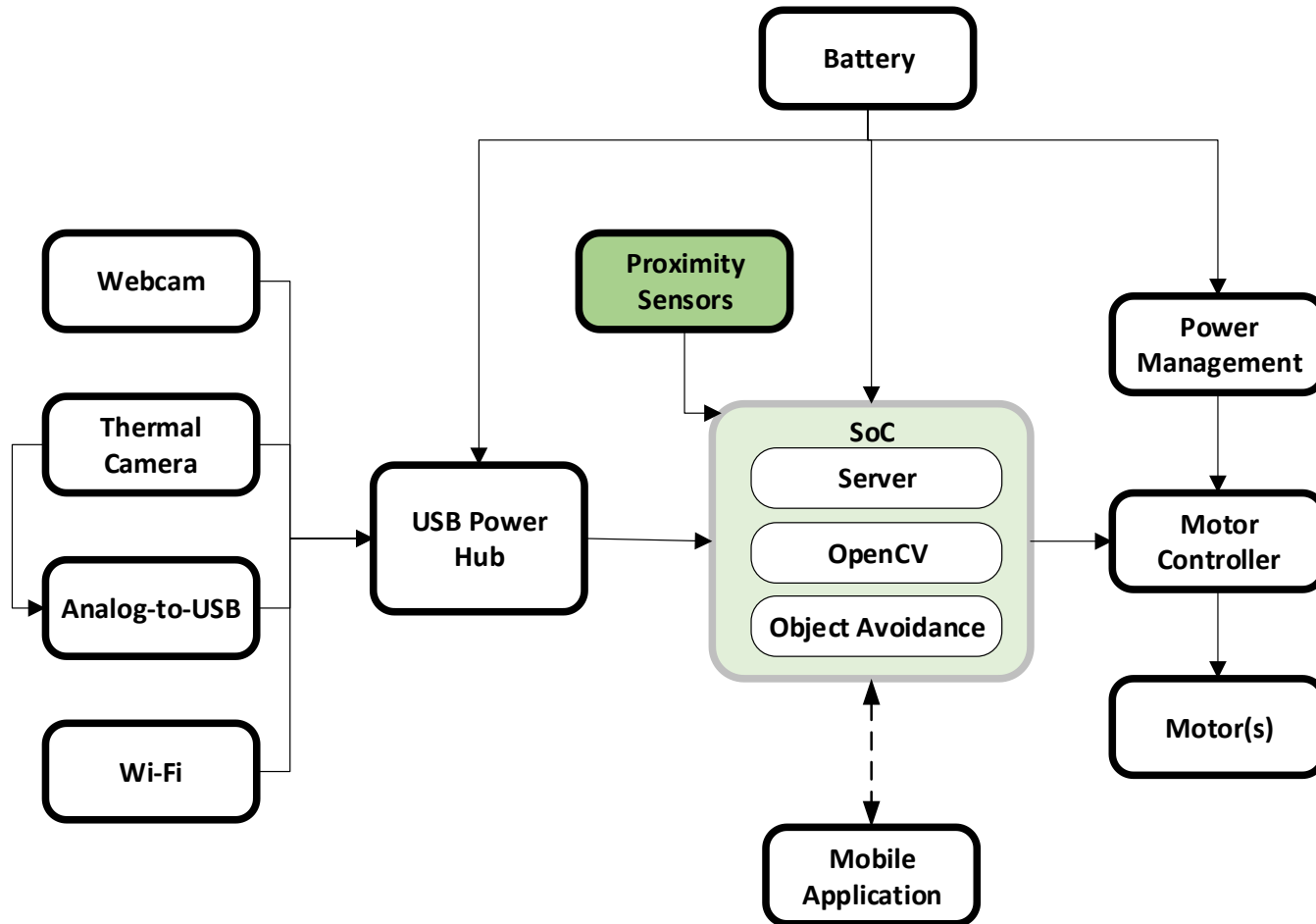
Operating Systems

- Angstrom
 - Included onboard
- ArchLinux | ARM
 - Most Lean
- Windows Embedded
 - Most Integrated

Ångström



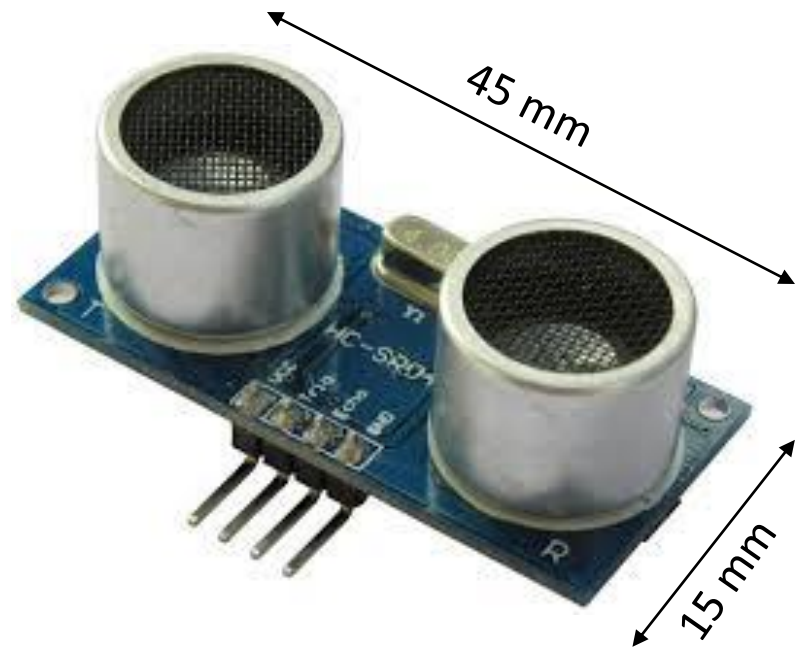
Proximity Sensors



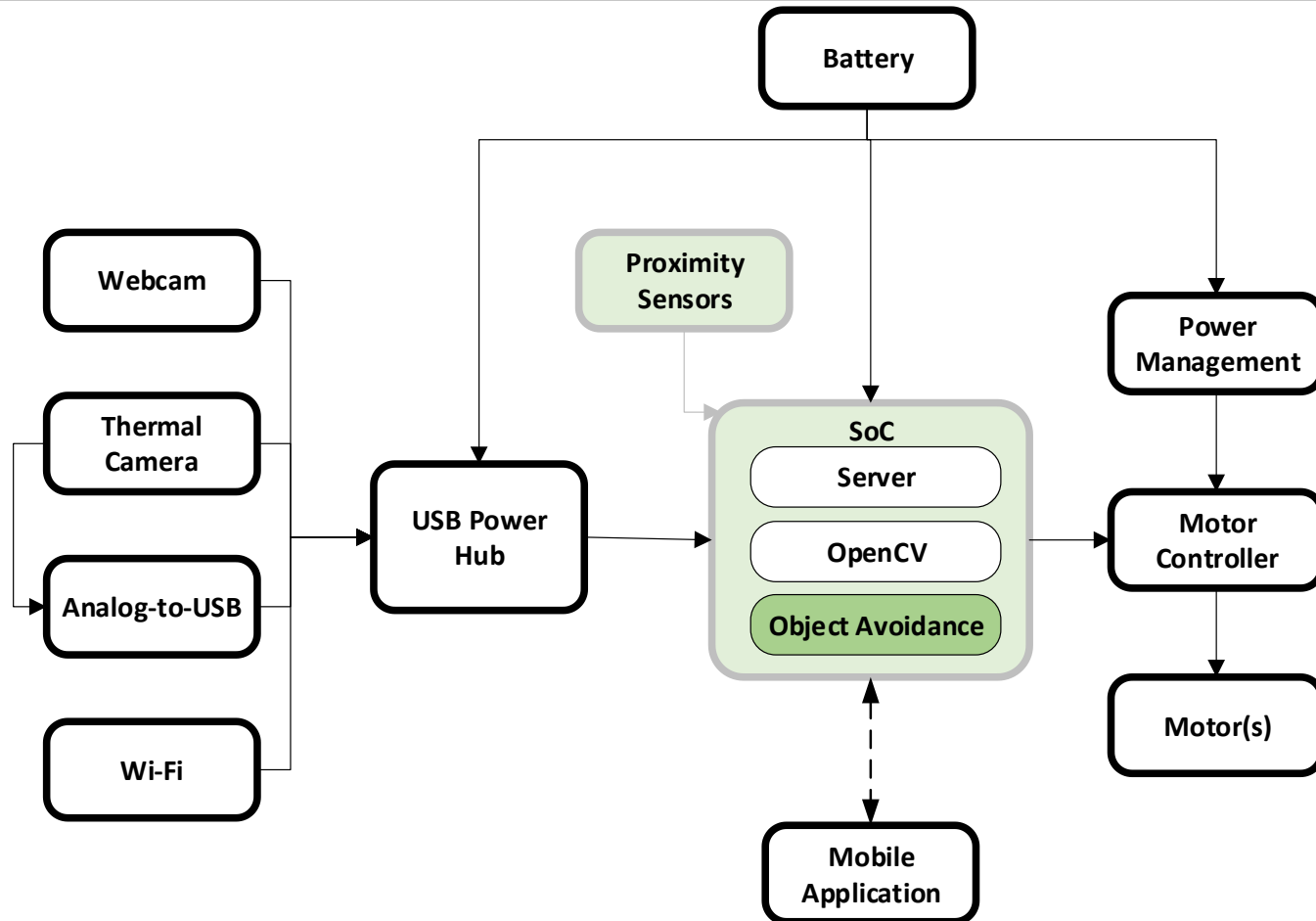
Proximity Sensors

HC - SR04

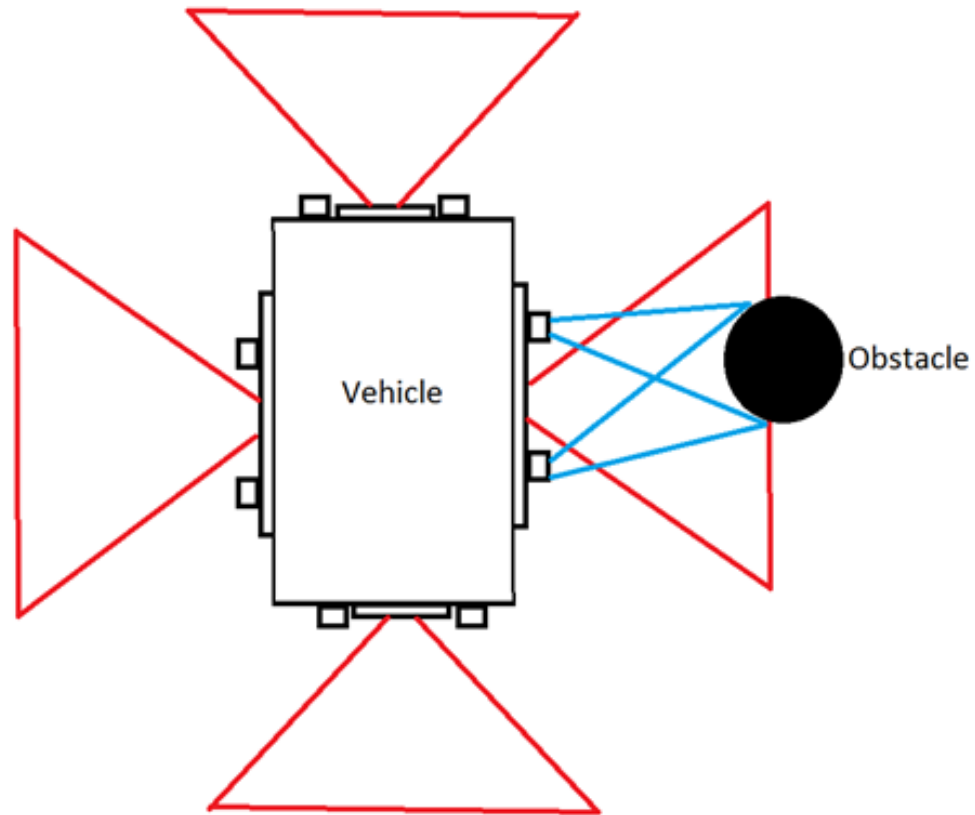
Features	Measurement
Working Voltage	DC 5 v
Working Current	15 mA
Working Frequency	40 Hz
Max Range	4 m
Min Range	2 cm



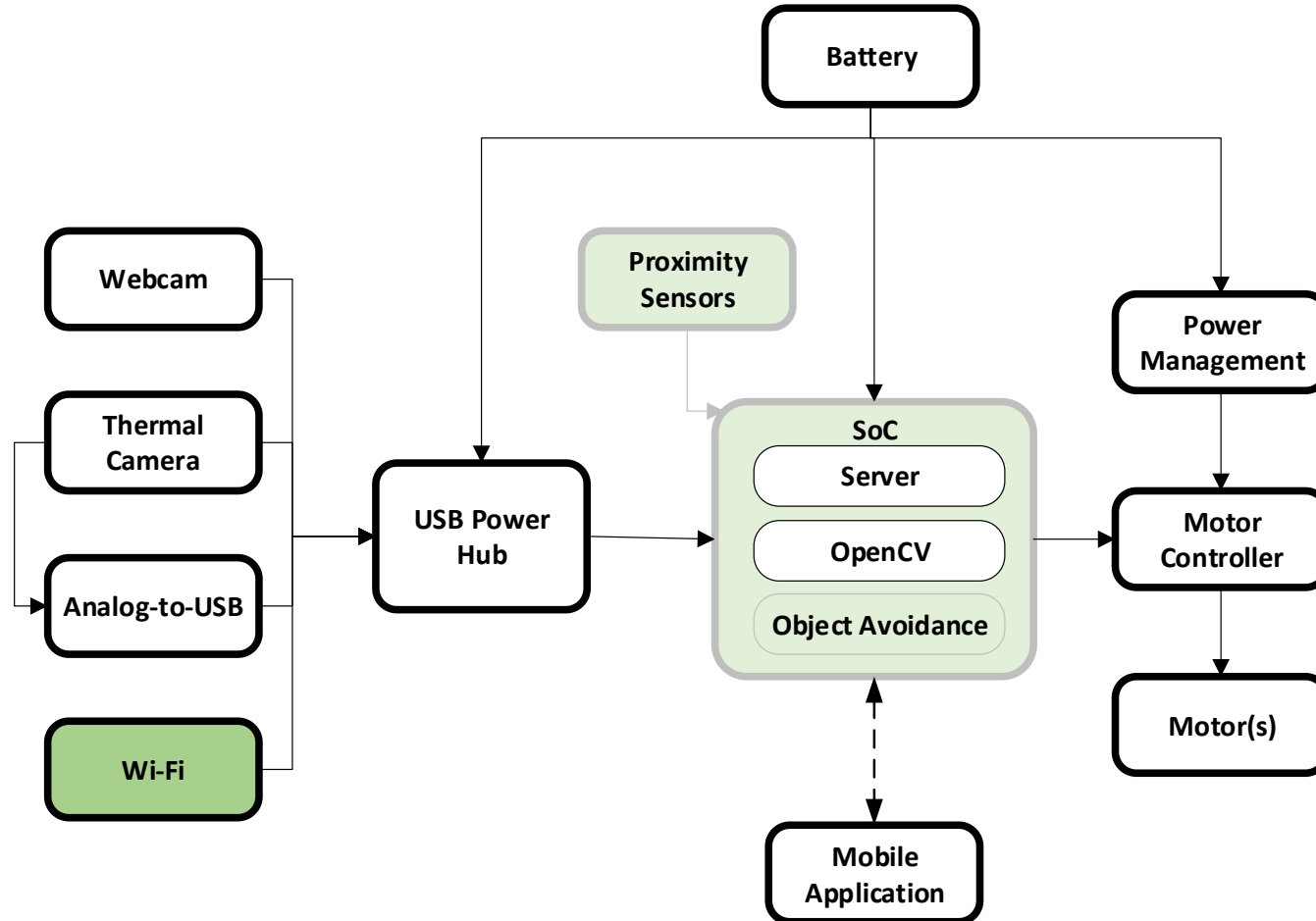
Object Avoidance



Object Avoidance



Wi-Fi



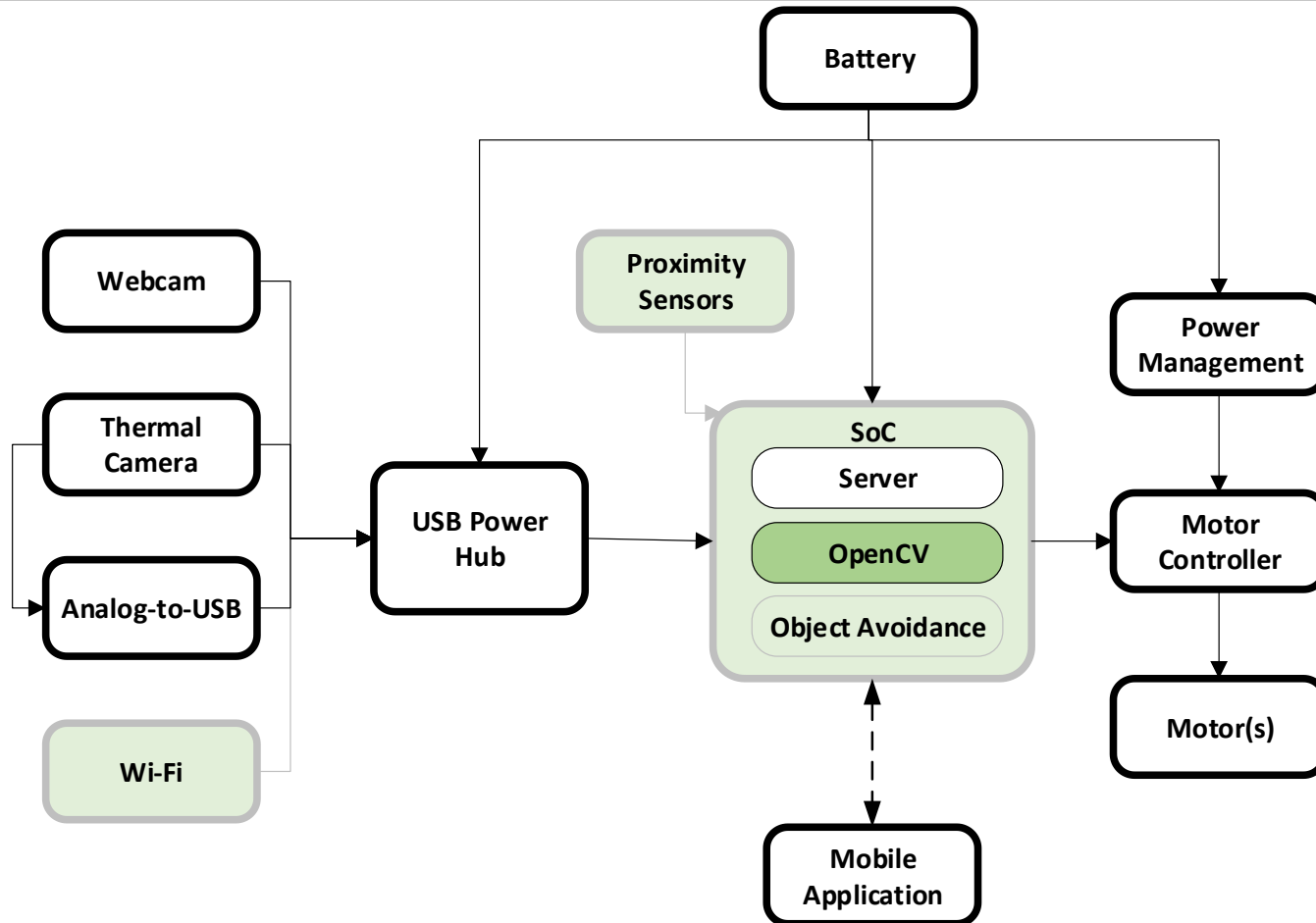
Wi-Fi

Edimax EW-7811Un

- IEEE 802.11b/g/n
- Compatible with Linux
- Small size
- Internal Antenna
- WEP/WPA/WPA2/WPS Compatible



Computer Vision - OpenCV



Computer Vision - OpenCV

- Detect movement
- Recognize and track a moving person

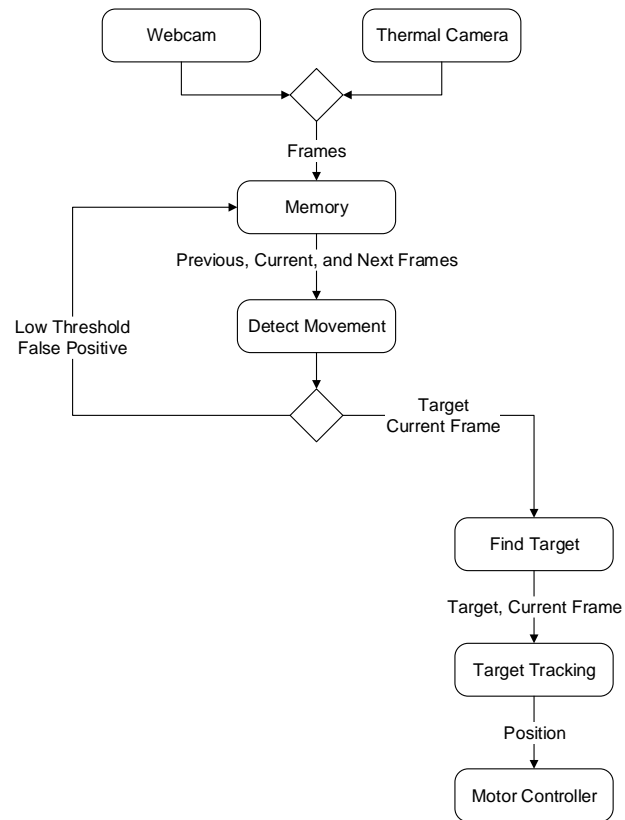
OpenCV 2.4.2

- Optimized computer vision functions and algorithms
- Built-in Object Detection and Tracking functions
- ARM Support
- Performance varies on functions being utilized.

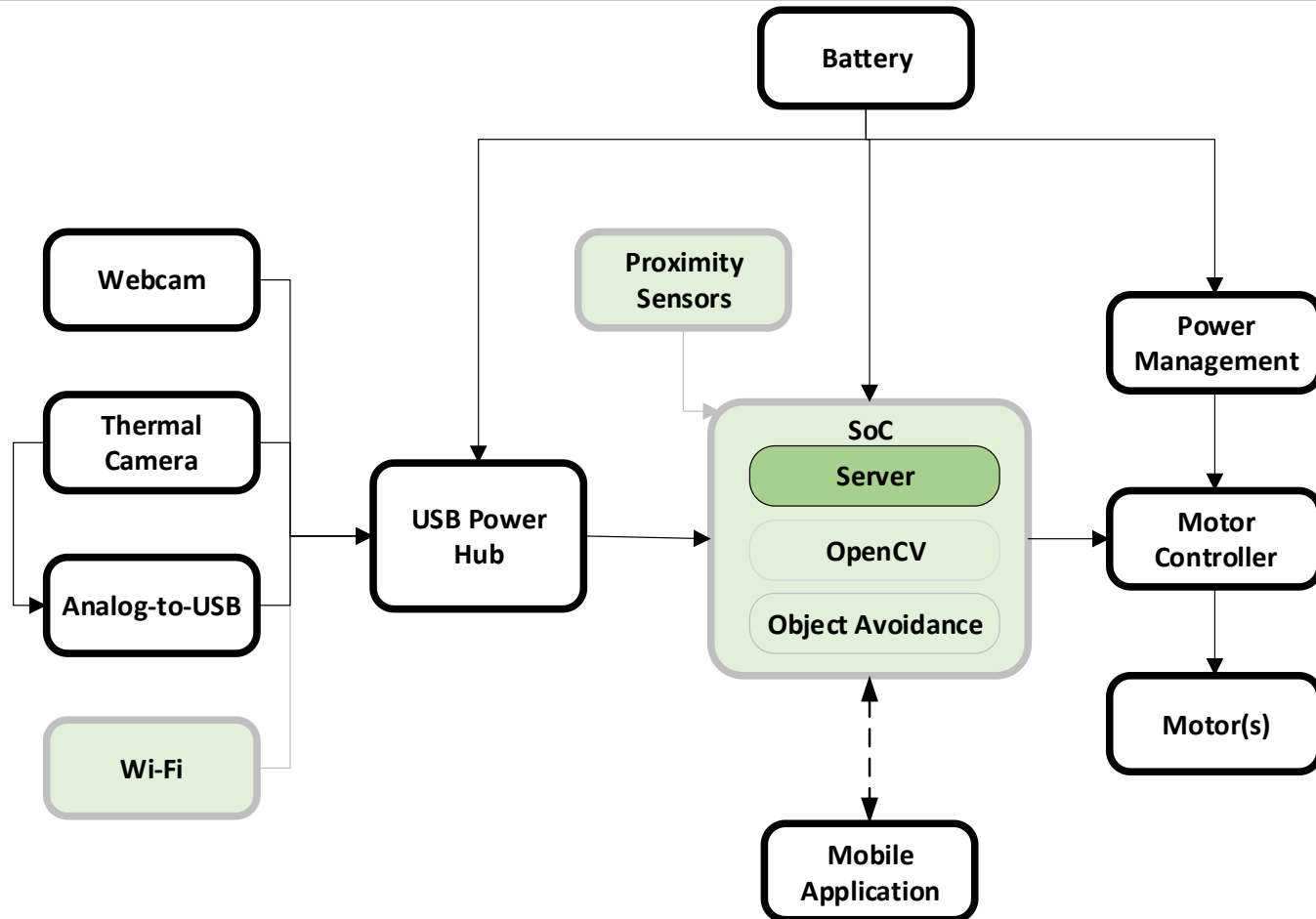
Motion

- Detect any movement
- Works together with OpenCV

Computer Vision State Diagram



Server & Streaming



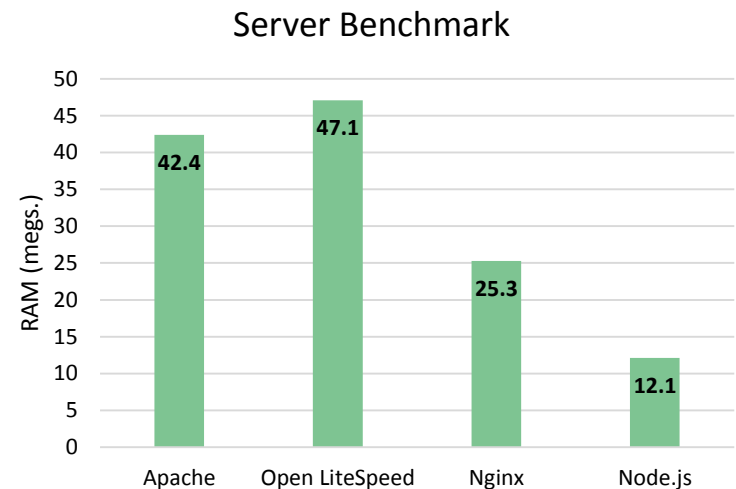
Server & Streaming

Node.js

- Enable internet HTTP communication
- Web GUI (Optional)
- Lightweight on resources under load

TCP (Transmission Control Protocol)

- JAVA Implementation (Android Compatible)
- Always listening for incoming commands from mobile phone
- Very lightweight on resources
- Port specific

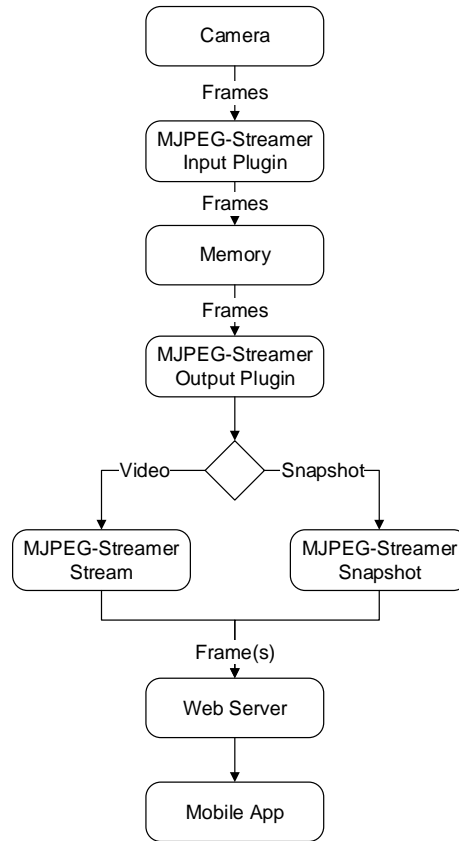


Server & Streaming

MJPEG Streamer

- Streams images from a folder over the internet
- Stream and Snapshot functions available
- Android compatible stream
- Low Resource

Streaming State Diagram

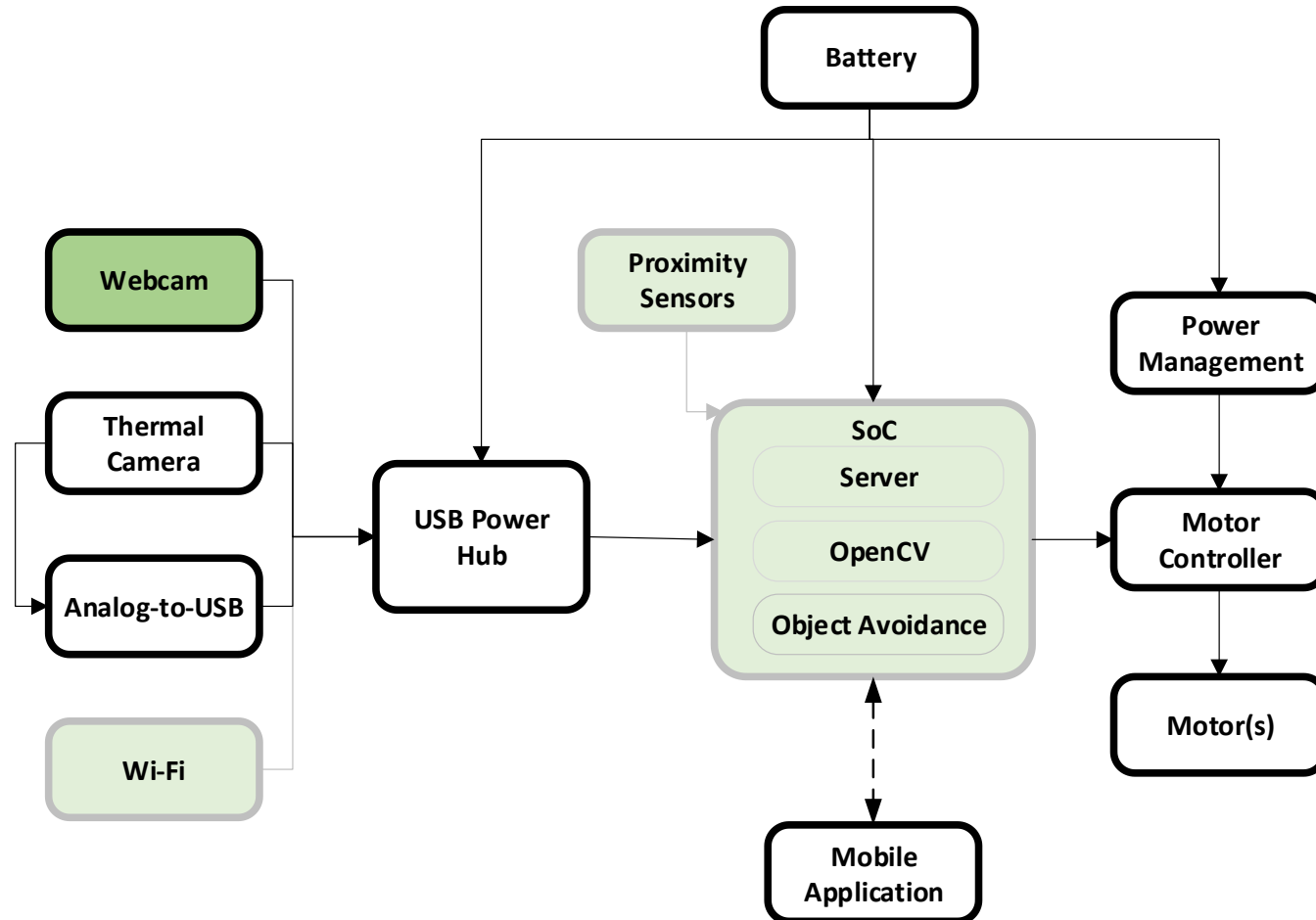


Difficulties

Port Forwarding not possible at UCF

- Solution – Use No-IP for Dynamic IP. Overwrite client rule to utilize Local IP instead of External IP

Webcam

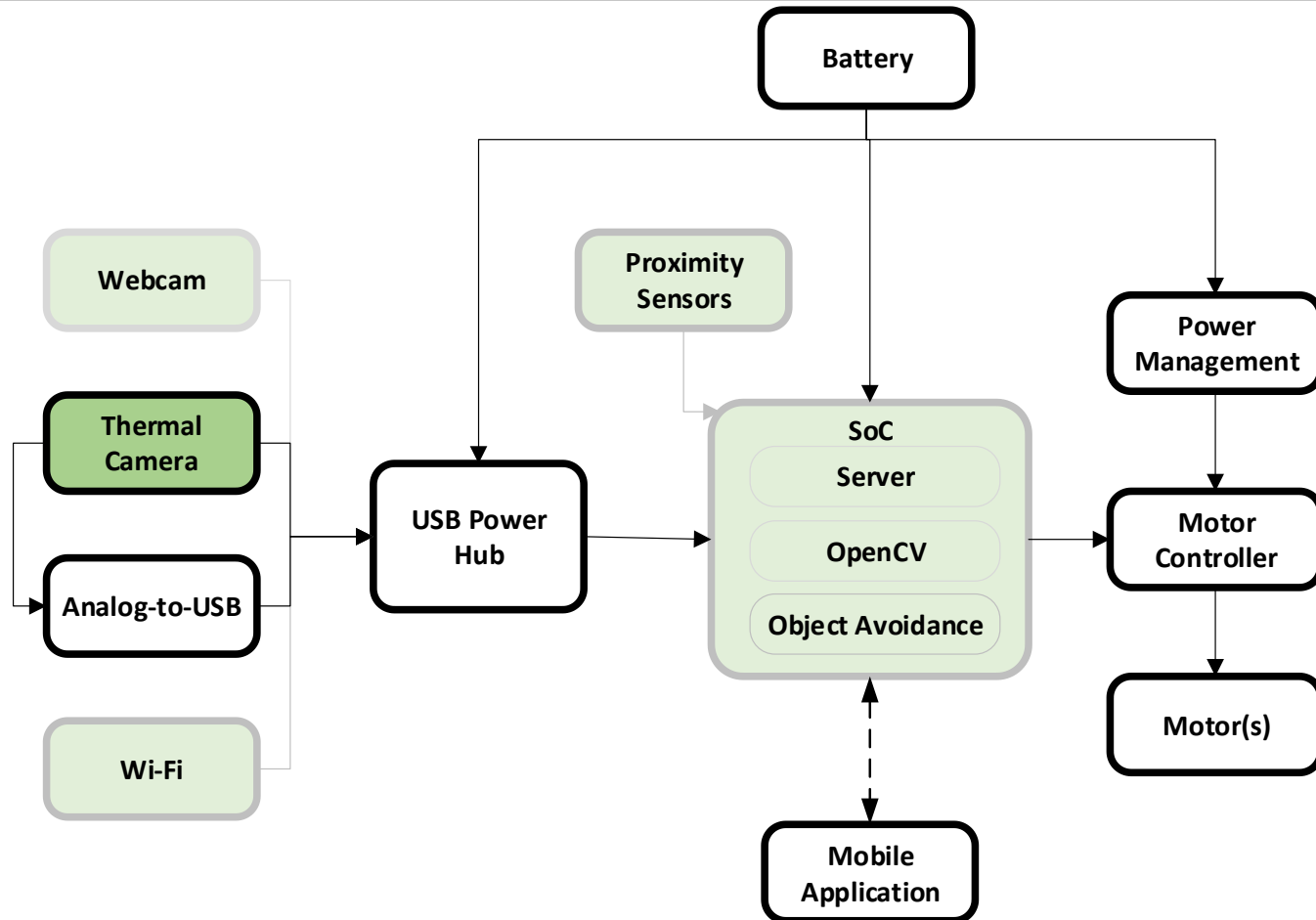


Webcam

- Logitech - HD Webcam C270
 - USB 2.0 Connectivity
 - Linux Compatible
 - Multiple picture/video resolutions available

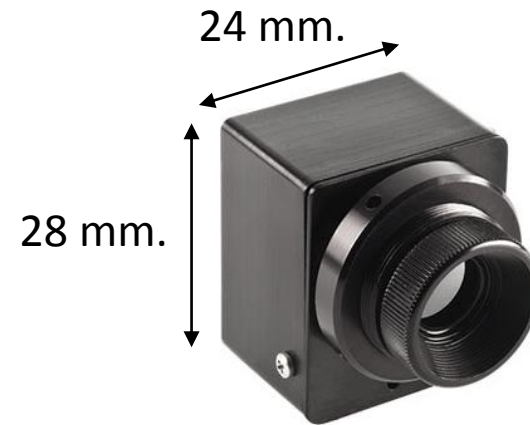


Thermal Camera



Thermal Camera

- DRS Tamarisk 320
 - Automatic Image Calibration
 - 320 x 240
 - 40° Field of View (FOV)
 - Low Power (< 1.0 W)
 - Shock/Vibration Resistant

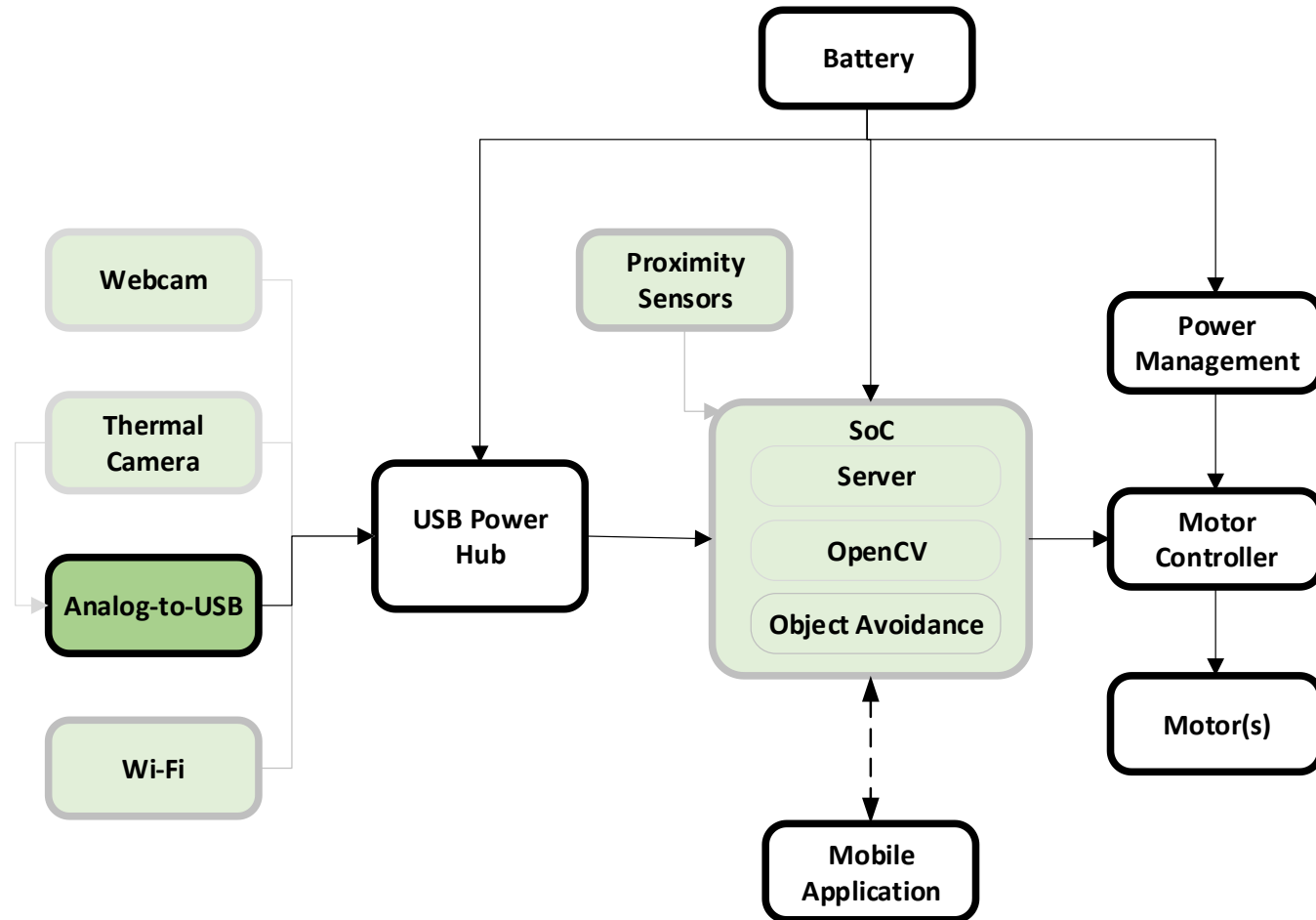


Difficulties

Analog Video Input

- Solutions:
 - DRS BlackBox – requires a computer/laptop with special serial card and cable. Not compatible with our current setup.
 - Analog-to-USB frame grabber – convert the analog input to USB.

Analog-to-USB Frame Grabber



Analog-to-USB Frame Grabber

Sabrent USB-AVCPT

- Converts Analog to USB
- Compatible with the Thermal Camera
- Low Cost
- Picture quality is not affected
- Size: 7 L x 1.2 W inches



VIDEO
CAPTURE

MPEG
ENCODER

PLUG & PLAY

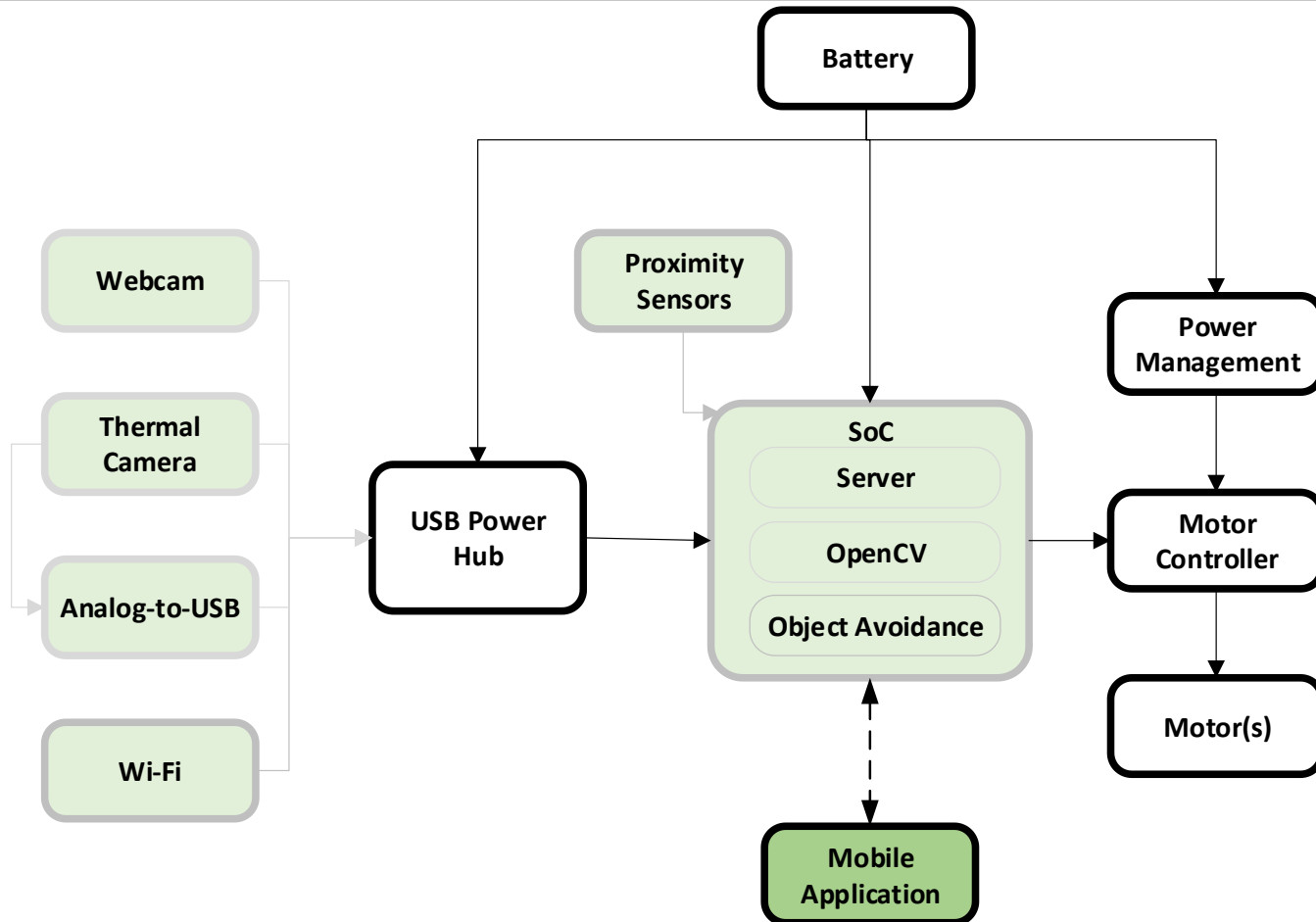
USB 2.0

Difficulties

Compatibility Issues - Linux recognizes device but picture is black with green lines at the bottom.

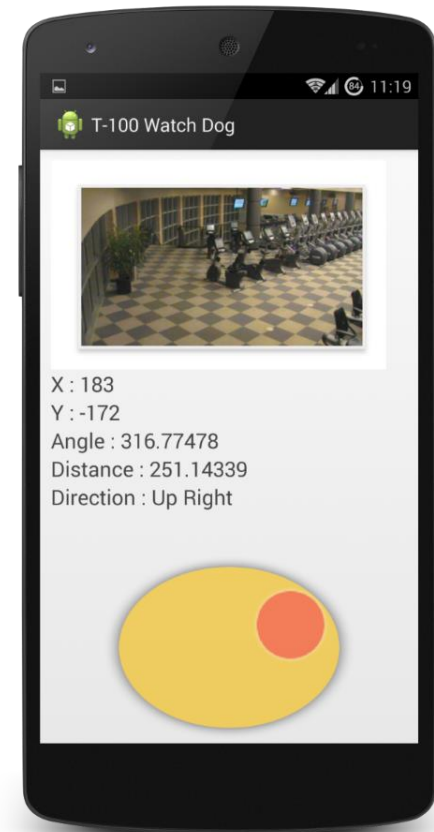
- Solution- multiple beta drivers on GitHub, currently testing them.

Mobile Application

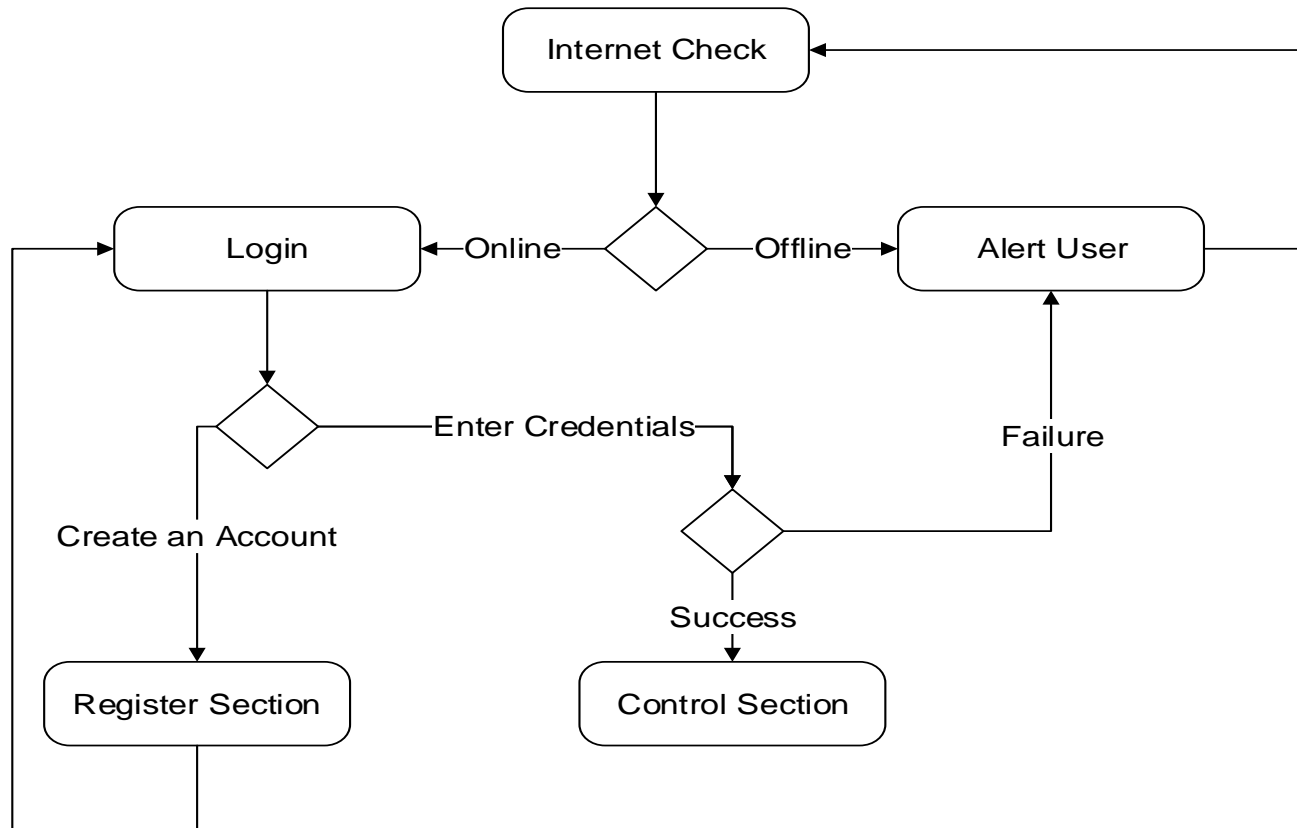


Mobile Application

- Support Android 4.0 and newer versions
- SQLite Database to store user credentials
- Control vehicle remotely
- View a live video feed
- Store snapshot on the device
- Ability to call 9-1-1



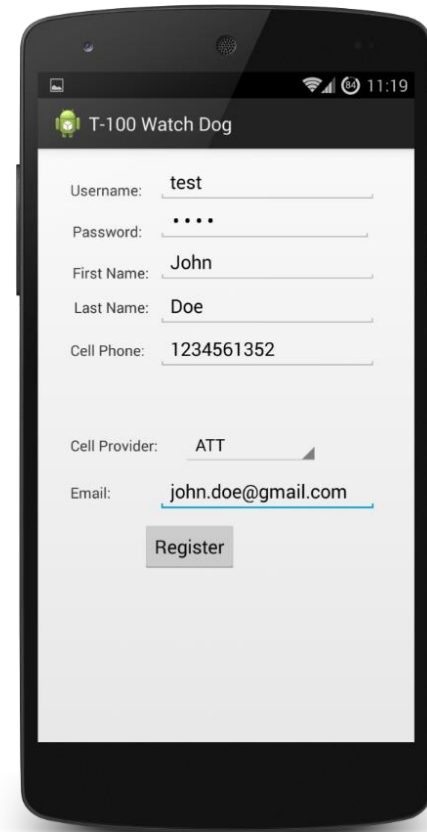
Mobile Application State Diagram



Mobile Application

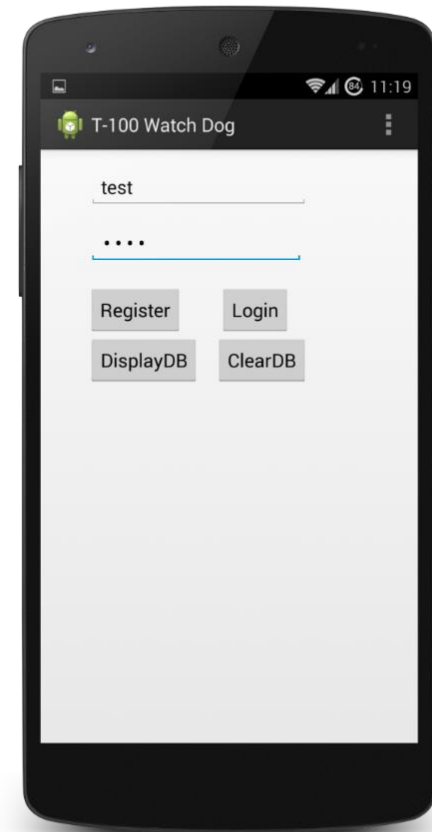
- Registration Section

- Allow user to register a username/password combination.
- Store cell phone for SMS and MMS alerts.
 - Supports: AT&T, Sprint, T-Mobile, Verizon, MetroPCS, Boost Mobile, Straight Talk.
- Store email for email alerts.
- Send SMS, MMS, and Email address to external server via PHP Post method.



Mobile Application

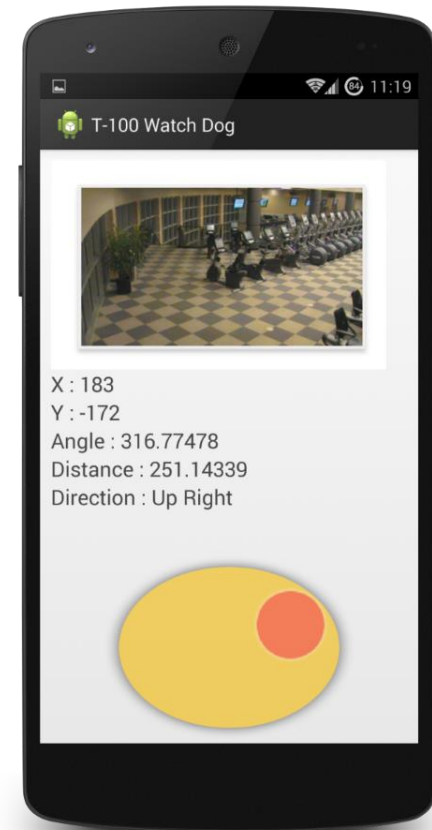
- Login Section
 - Allows user to register/login
 - Only authorized users will have access
 - Performs an Internet Check



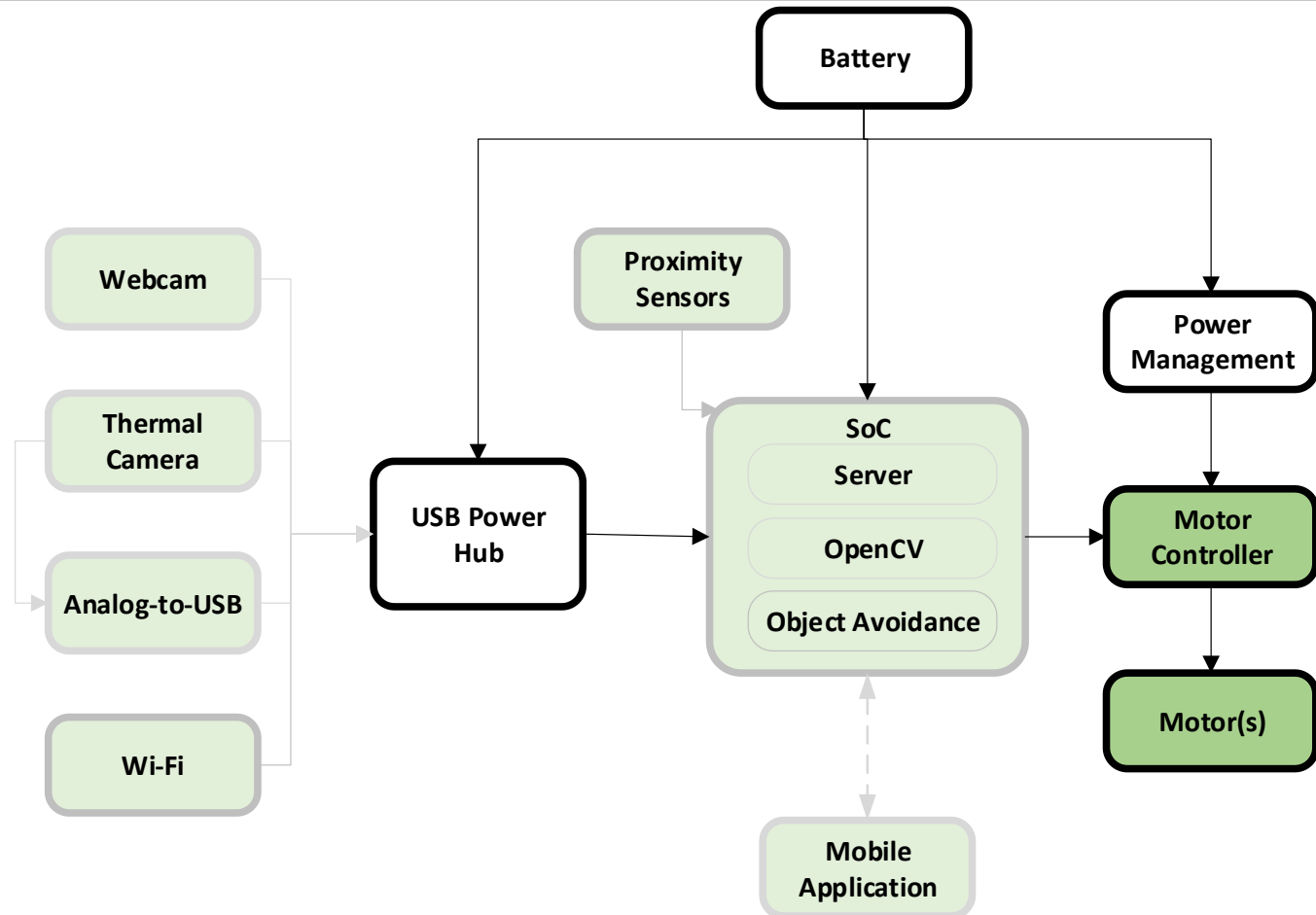
Mobile Application

- Control Section

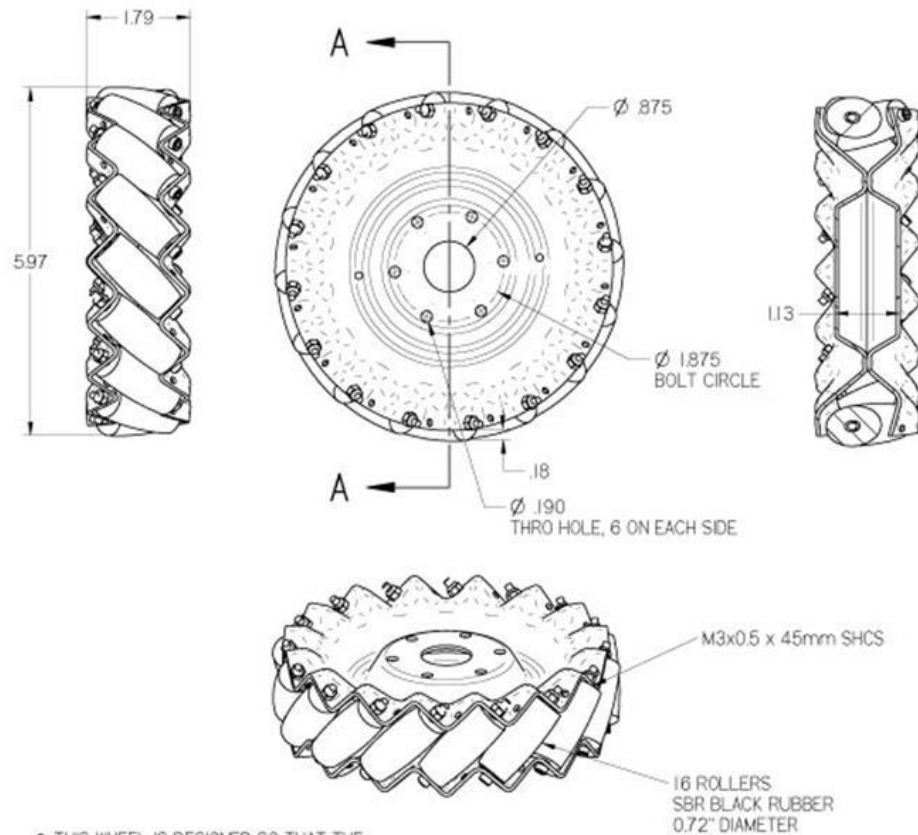
- View live video feed
- Control robot with virtual joystick
- Store snapshot
- Call 9-1-1



Motor Controller, Motors, & Wheels



Mecanum Wheels

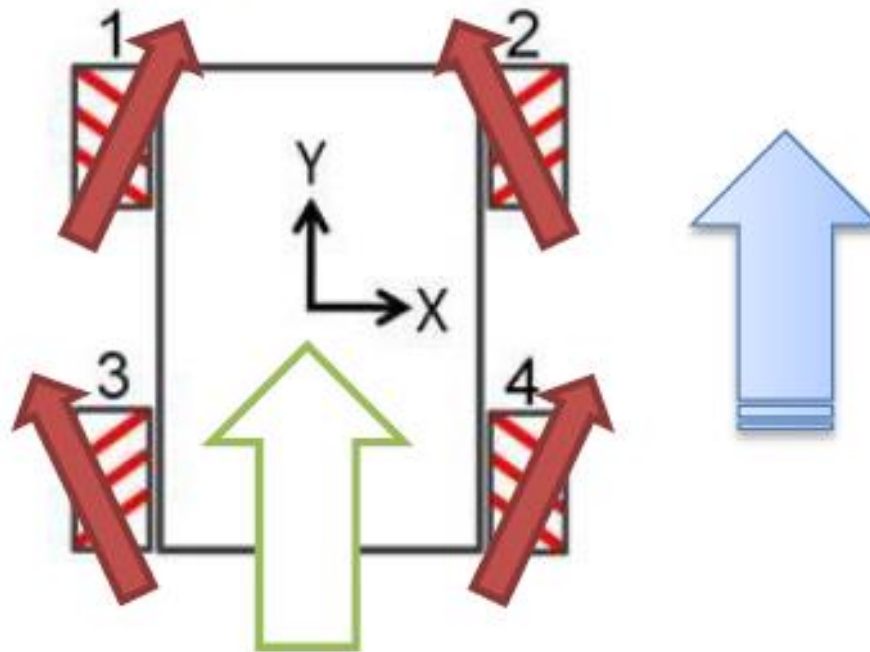


- THIS WHEEL IS DESIGNED SO THAT THE ROLLERS CAN BE ASSEMBLED IN EITHER THE RIGHT-HANDED OR LEFT-HANDED DIRECTION.

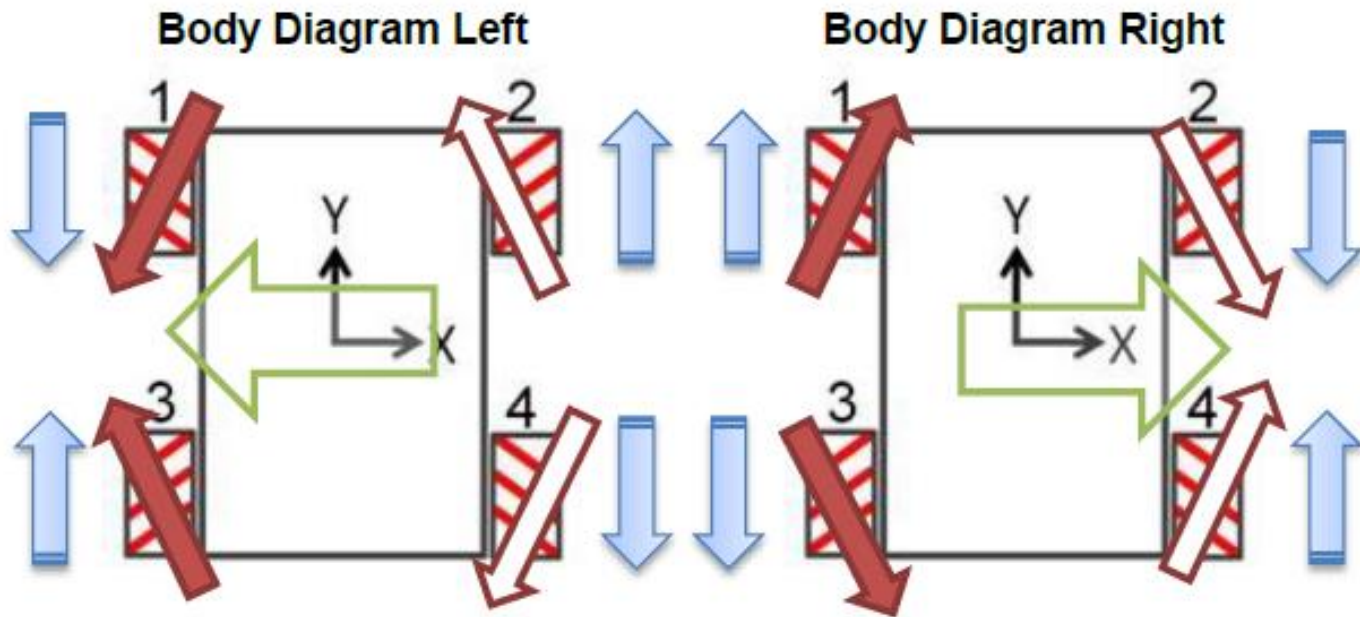


Mecanum Wheels

Body Diagram All Forward



Mecanum Wheels



Mecanum Wheels

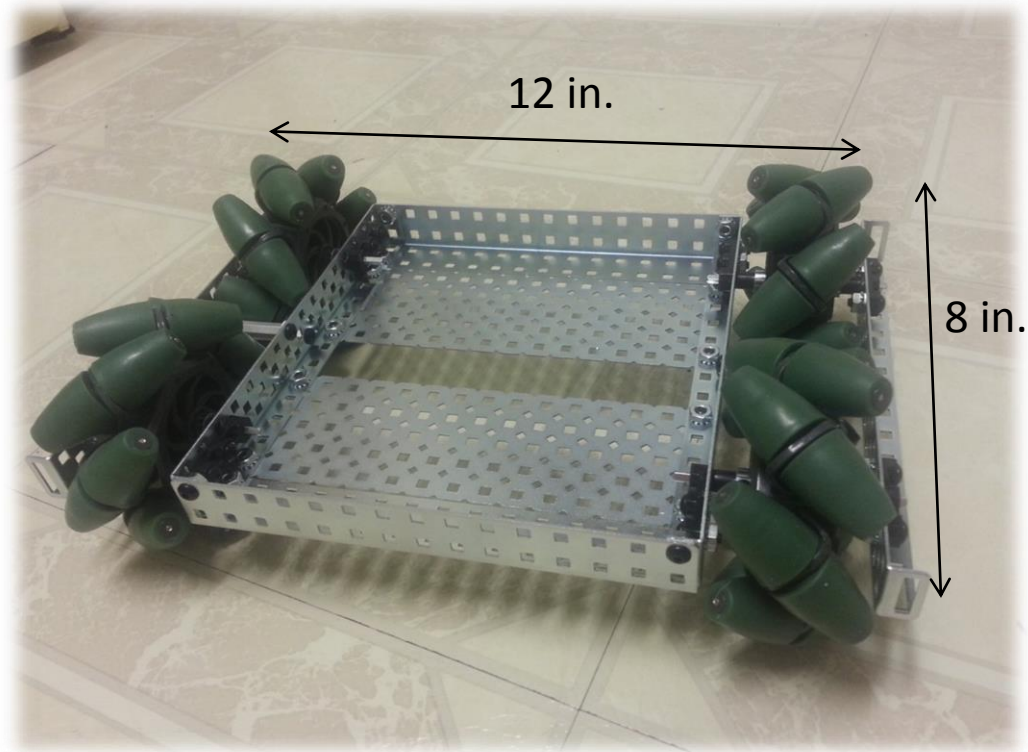
- Vex Robotics Mecanum Wheels

- Affordability
 - \$59.99 4 pack
- Diameter: 4 in.
- Thickness: 2 in.

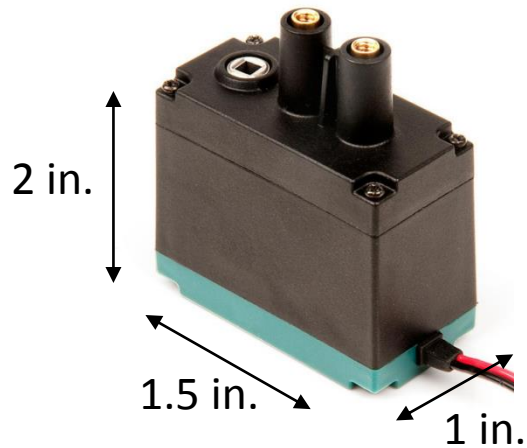


Platform

- Perforated Aluminum – Lightweight
- 2 pounds with wheels included
- Easily Adjustable



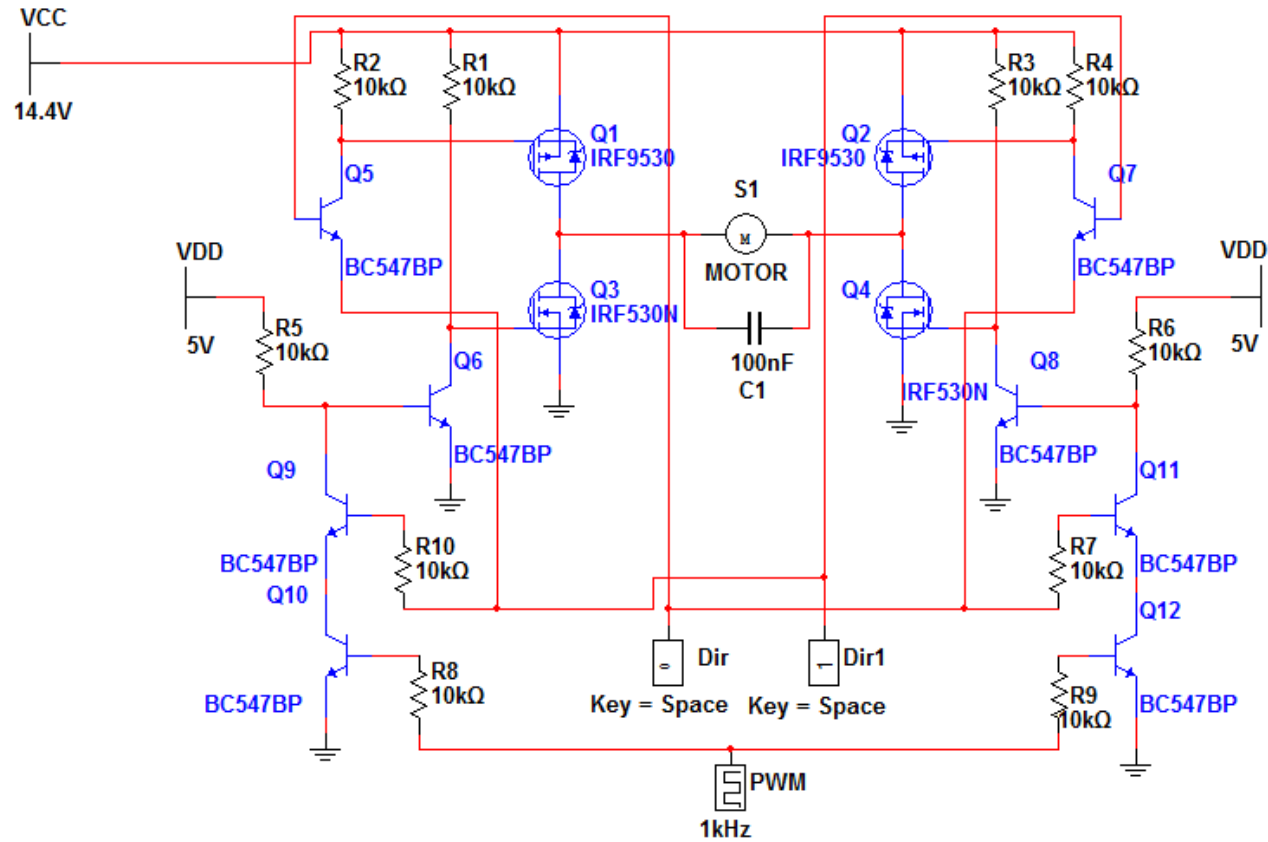
Motor



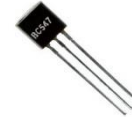
VEX 2-Wire motor 393

VEX 2-Wire motor 393	Requirements	Specs-Low Speed	Specs- High speed
Price	< \$20	\$14.99	\$14.99
RPM's	130	100	160
Torque	1.3 Nm	1.67 Nm	1.04 Nm
Weight	< .5 lbs	.2 lbs	.2 lbs
Stall current		4.8 A	4.8A
Max Power	All measured at 7.2 V	34.56 W	34.56 W

H-Bridge Circuit



H Bridge Components



IRF 9530 P-Channel	IRF 530 N-Channel	BC547
100 Vds	100 Vds	47 V Breakdown
12 A	14 A	100 mA
\$1.29	\$1.03	\$ 0.20

10 K OHM Current Limiting Resistors

Controller Budget

Component	How many	Price per unit	Total
MSP430G2552	4	2.79	11.16
IRF9530	8	1.29	10.32
IRF530	8	1.03	8.24
BC547	64	0.20	12.80
Capacitor(100nF)	4	.05	0.20
Resistor (10k)	40	.04	1.60
Total: (without pcb)			44.32

Motor Controller- PCB

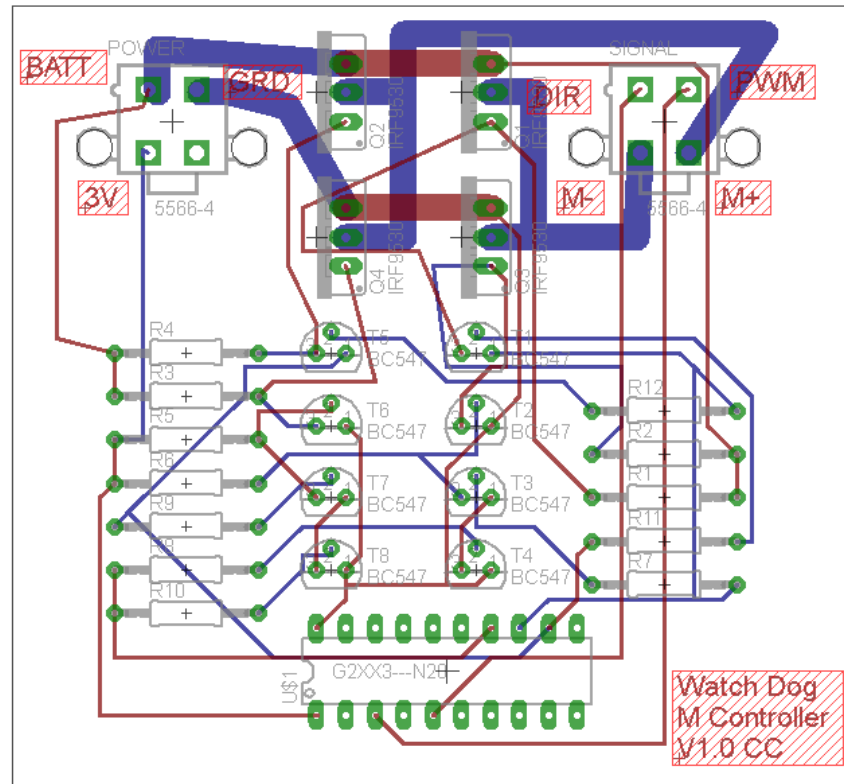
Specifications

3"x3"

Thick Traces for high current lines

2 layer

\$33- 60 square inches
4pcb.com



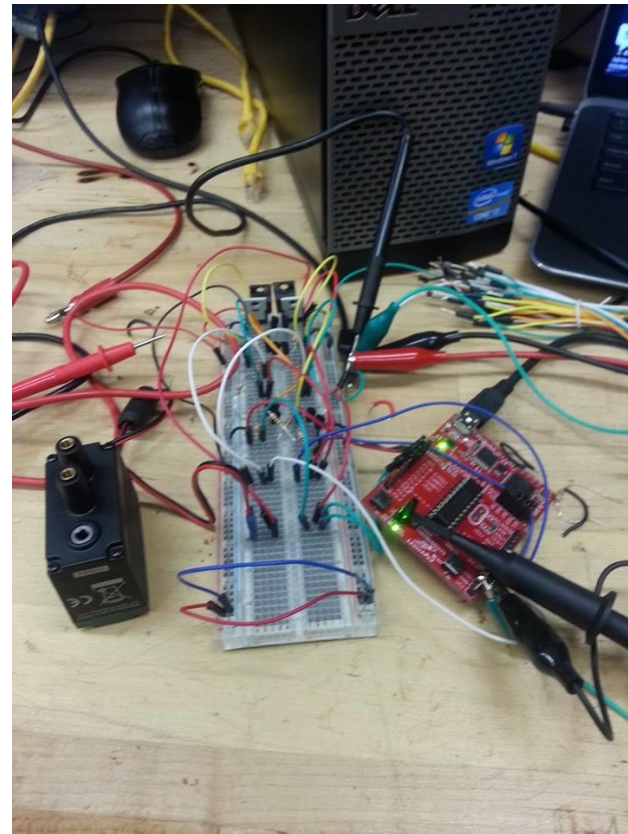
Testing

Tests

Digital Signal controls Motor Direction.

Analog signal from 0-3 V controls duty cycle of PWM from 0-100% in steps of 1.61%

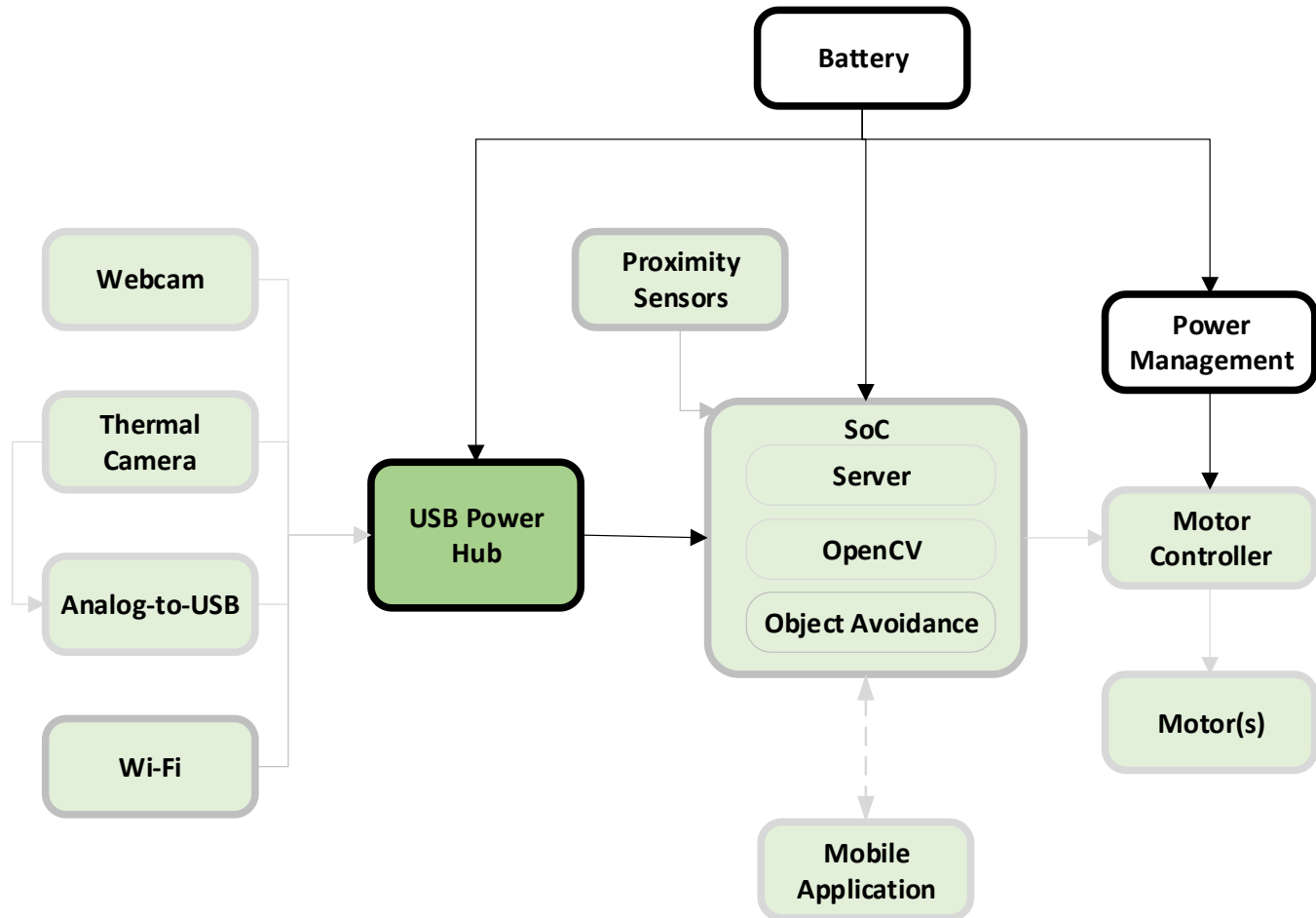
3.6 A continuous through MOS-FET's without noticeable heat production



Difficulties

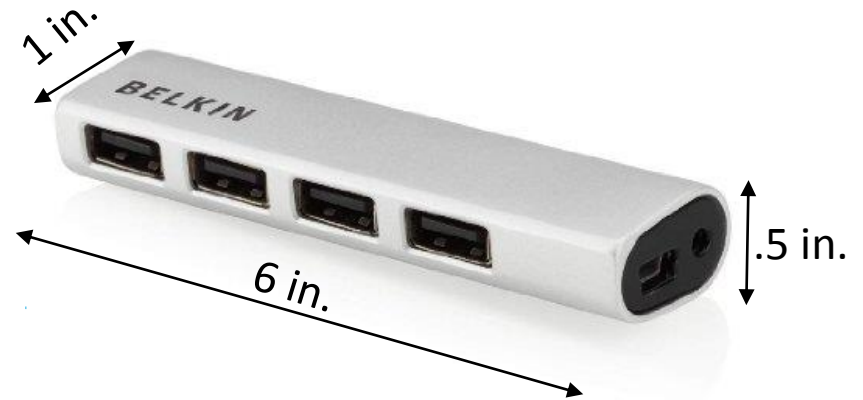
- Heat Dissipation with PCB
 - Solution-Add a heat sink if we have heat dissipation issues
- Current Capabilities of PCB
 - Solution – remake PCB utilizing thicker traces

USB Power Hub

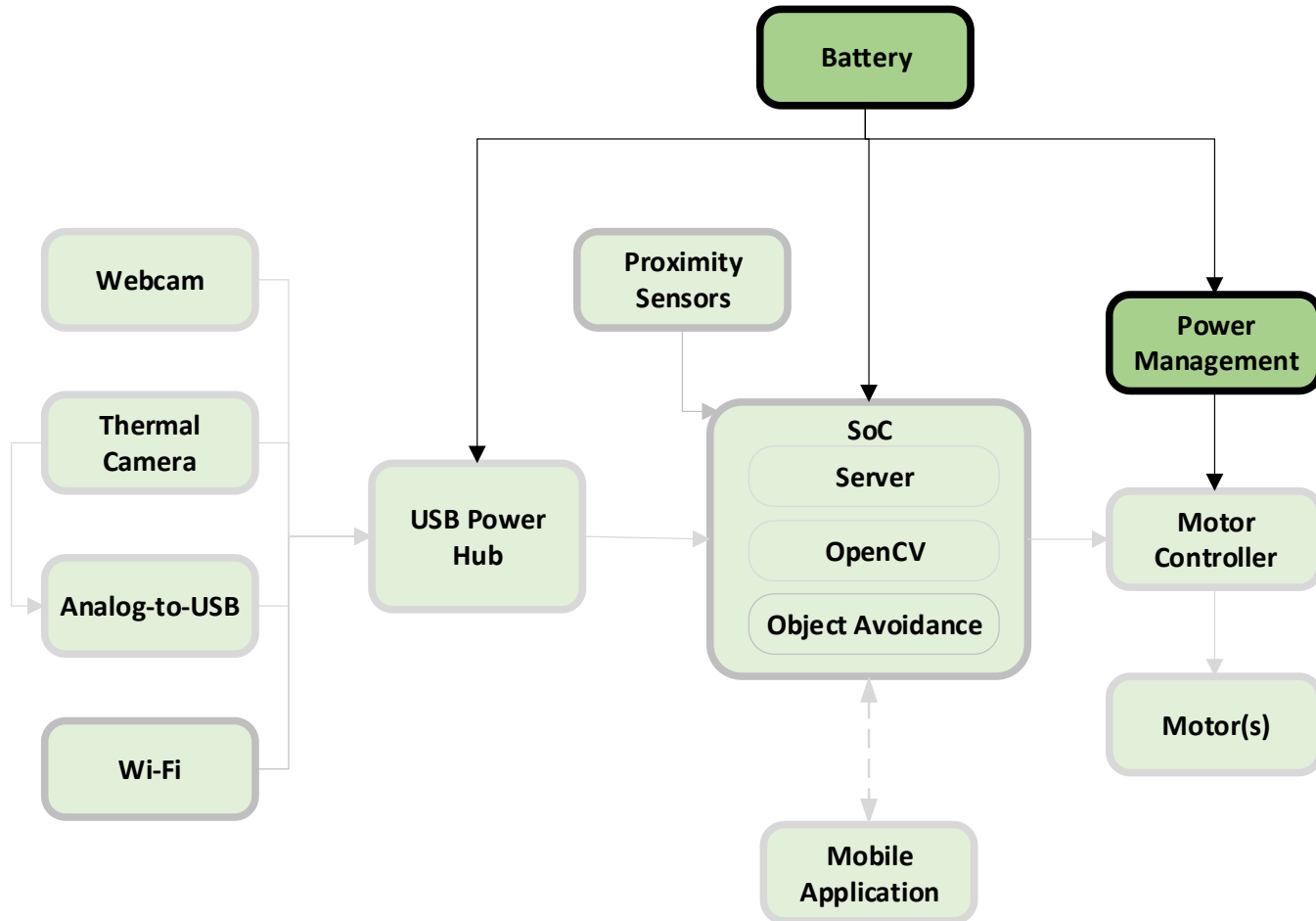


USB Power Hub

- Beagle Bone Black only has 1 USB port
- 2.0 USB Ports
- Input voltage is 3-5V
- Constant power to each USB port
- Weight 8 oz.



Power Management & Battery



Single Power Supply or Multi Power Supply?

- **Single power supply to power all components**
- Battery Characteristics
 - High discharge Rate
 - No/low Memory Effect
 - Light Weight
 - High Capacity
 - Price Effective
 - High Nominal Voltage

Battery Specifications

Top three candidates for batteries

Most important aspects are
Capacity, Discharge Rate, and
Voltage

Model	31604	11427	18650
Brand	Tenergy	Tenergy	Supower
Capacity (mAh)	1600	2000	2200
Voltage (V)	7.4	9.6	7.4
Weight (lb)	0.2	0.52	0.2
Discharge Rate (C)	20 (32 A)	10 (20 A)	2.5 (5.5 A)
Price (\$)	24.5	19.99	17.99
Chemistry	Lipo	NiMH	Li-on

Battery Selection

- Tenenergy 7.4V 1600mah
- Two Lithium Polymer Ion Batteries in Series
- Expected Battery Life needs to be at least 3 Hours



Model	31604	11427	18650
Brand	Tenergy	Tenergy	Supower
Capacity (mAh)	1600	2000	2200
Voltage (V)	7.4	9.6	7.4
Weight (lb)	0.2	0.52	0.2
Discharge Rate (C)	20 (32 A)	10 (20 A)	2.5 (5.5A)
Price (\$)	24.5	19.99	17.99
Chemistry	Lipo	NiMH	Li-on

Battery Charger

- Tenergy Airsoft Battery Charger
 - LIPO tends to overheat easily
 - Built in Balancer
 - Price \$19.99
 - Powers both Lion and LIPO batteries.



Power Requirements

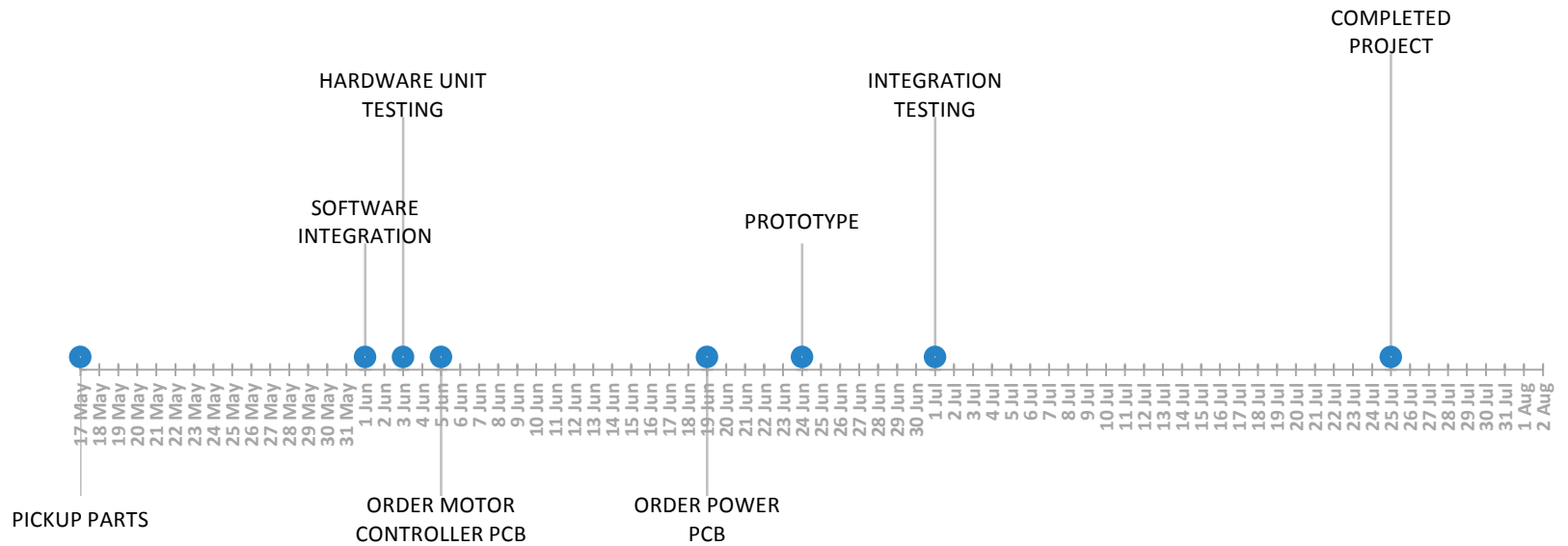
Items	Voltage input needed	Current input needed
BeagleBone Black	5 V	2 A
Motor Controllers	12 V	16 A
Thermal Camera	3-5.5 V	<600 mA
Conventional Webcam	3 V	<500 mA
Proximity Sensors	4 V	15 mA
MSP 430	3 V	.5 mA
Wi-Fi Adapter	3 V	<500 mA
USB Power Hub	3-5 V	1.5 A

Voltage Regulator Motor Controllers

- Needs to be able to provide 12V and 16A to power all four of the motor controllers
- Provide 3.3 V to power the MSP 430

Name	Type of Regulator	Footprint	Efficiency	BOM Count	BOM Cost
LM27402	Buck Controller	419	97	28	\$3.81
TPS40304	Buck Controller	318	94	24	\$3.85
TPS40305	Buck Controller	305	98	24	\$4.35

Project Milestones

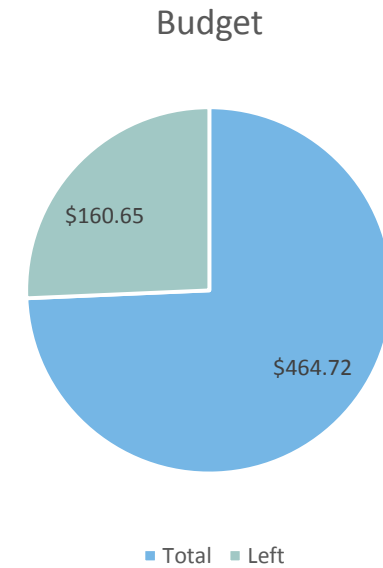


Work Breakdown

Task	Ismael Rivera	Warayut Techarut (Wye)	Journey Sumlar	Chris Carmichael
Motor Controller				X
Power Management			X	
Server	X			
OpenCV	X	X		
Object Avoidance		X		
Mobile Application	X			

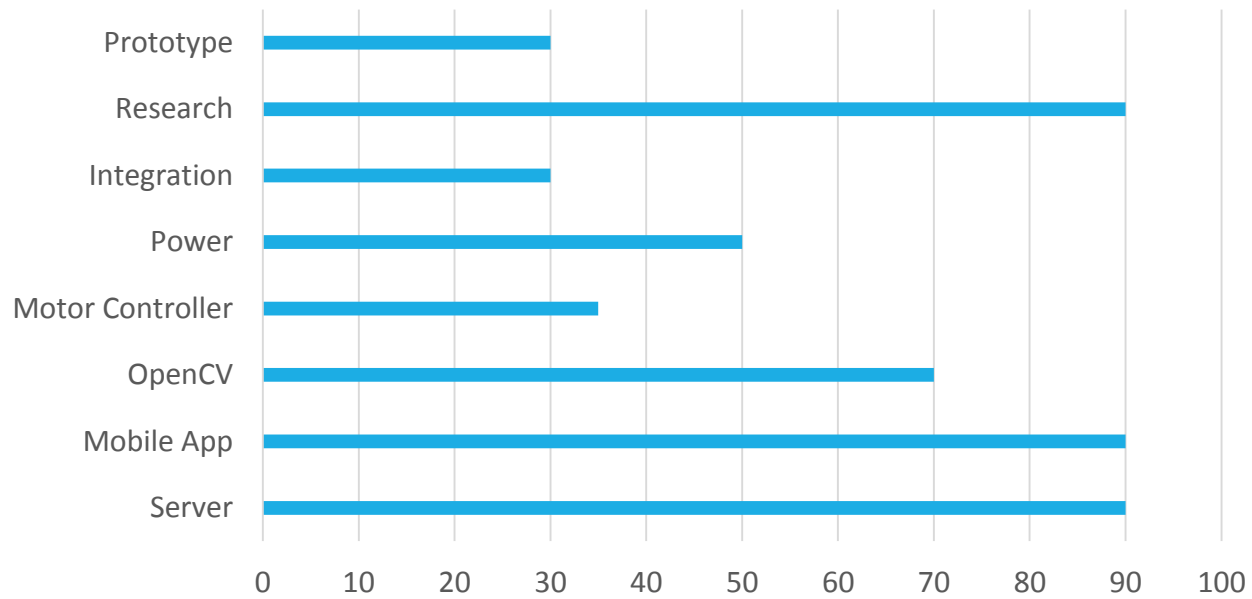
Budget & Finance

Part Name	Quantity	Price (each)	Total
HC-SR04 Proximity Sensor	4	\$1.33	\$5.32
Tamarisc 320	1	\$0.00	\$0.00
Wi-Fi USB Adapter	1	\$5.99	\$5.99
MicroSD Card	1	\$7.99	\$7.99
USB Power Hub	1	\$7.99	\$7.99
Motor	4	\$14.99	\$59.96
Mecanum Wheels	1	\$59.99	\$59.99
Drive shaft pack	1	\$5.49	\$5.49
Shaft Collar 16 pack	1	\$7.99	\$7.99
Motor Controller Parts	4	\$20.00	\$80.00
PCB Motor Controller	1	\$33.00	\$33.00
PCB Power	2	\$33.00	\$66.00
Batteries and Charger	1	\$80.00	\$80.00
Microcontroller	1	\$45.00	\$45.00
		Total	\$464.72



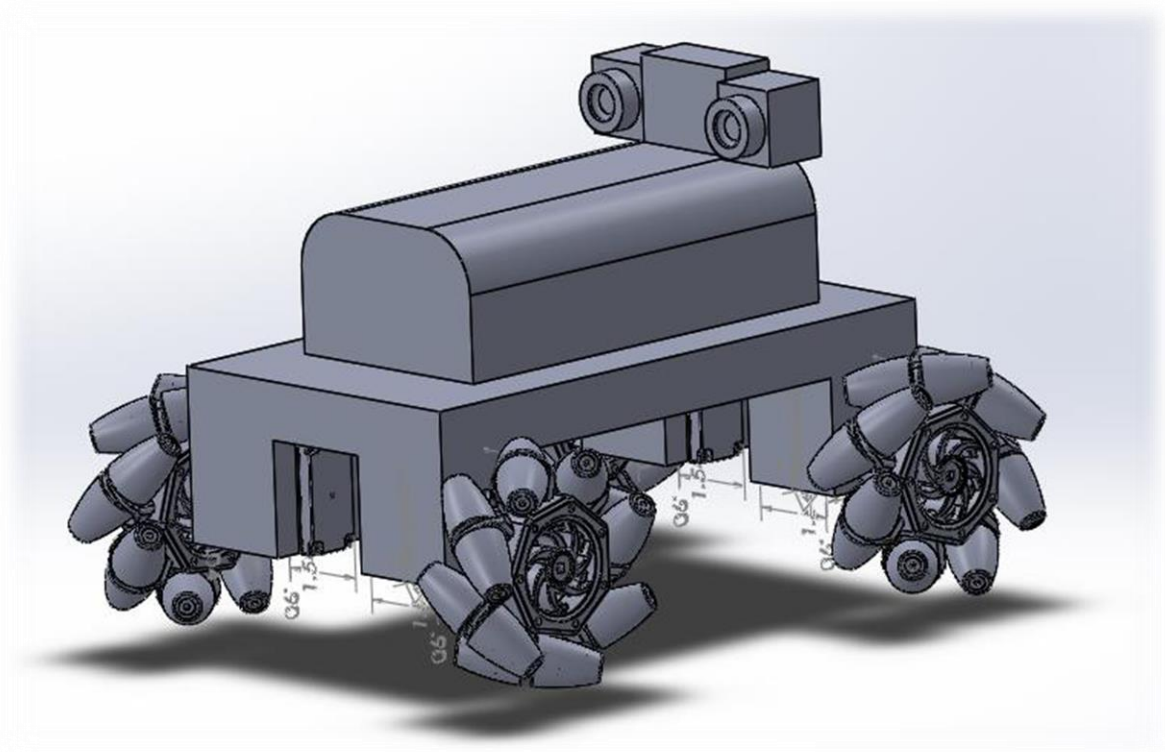
Current Progress

Subsystem Completion Status



GROUP #4

Chris Carmichael
Ismael Rivera
Journey Sumlar
Warayut Techarut



QUESTIONS?