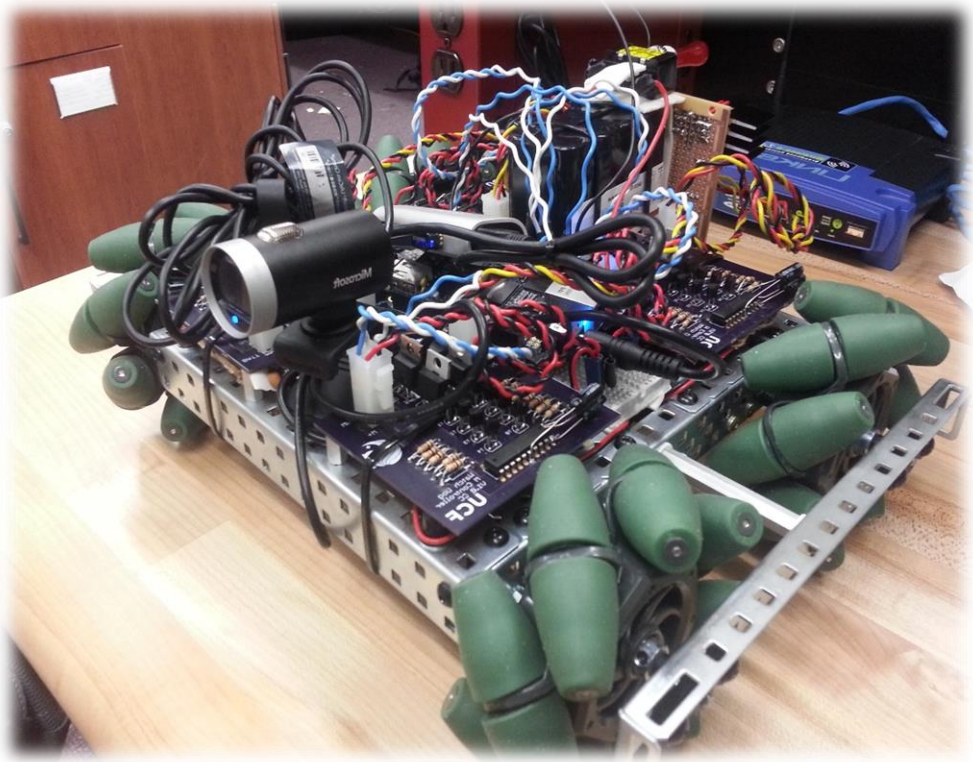
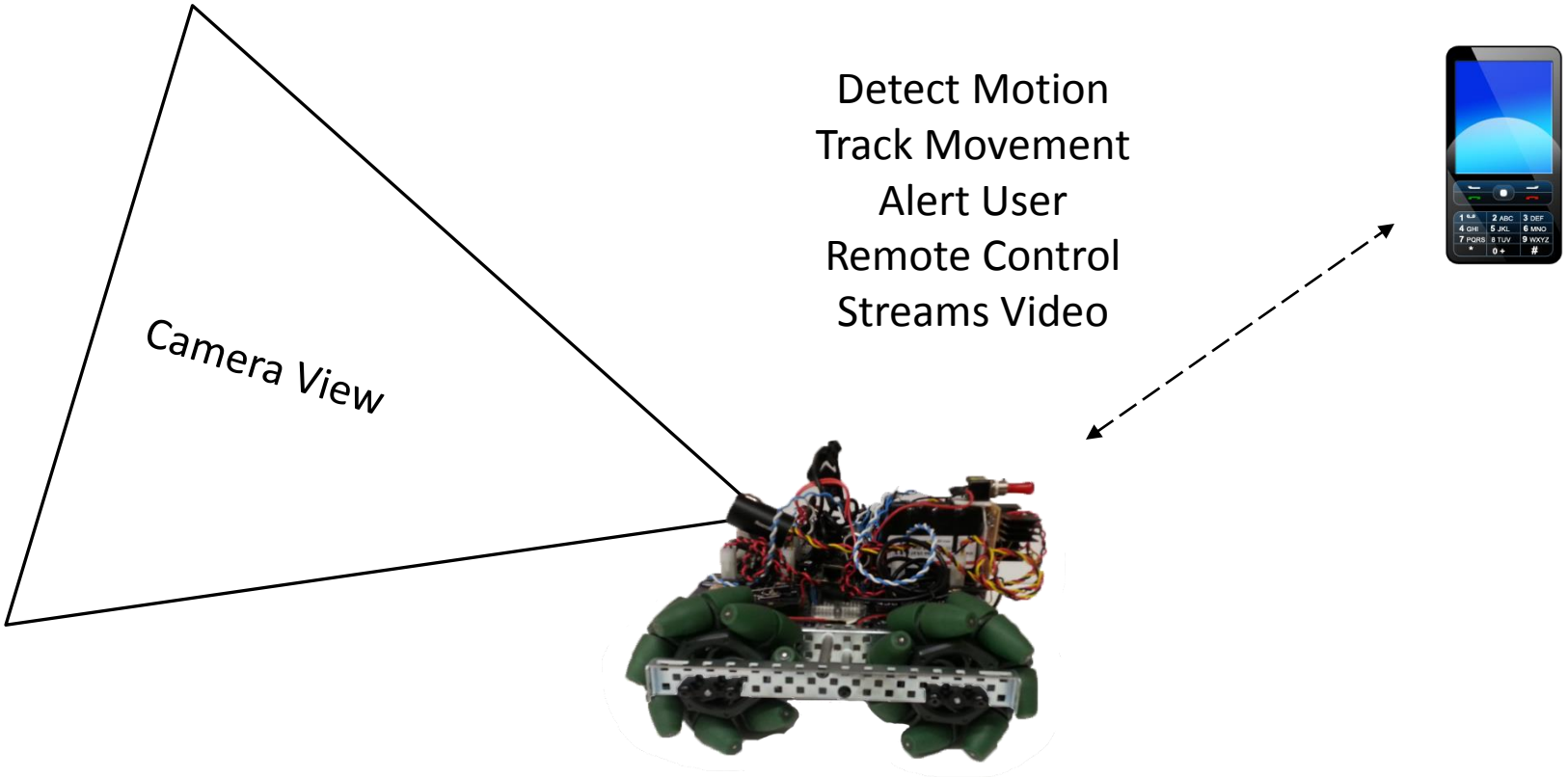
GROUP #4

Chris Carmichael, EE
Ismael Rivera , CpE
Journey Sumlar, EE
Warayut Techarut, CpE



T-100 WATCHDOG

Project Introduction



Project Goals

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

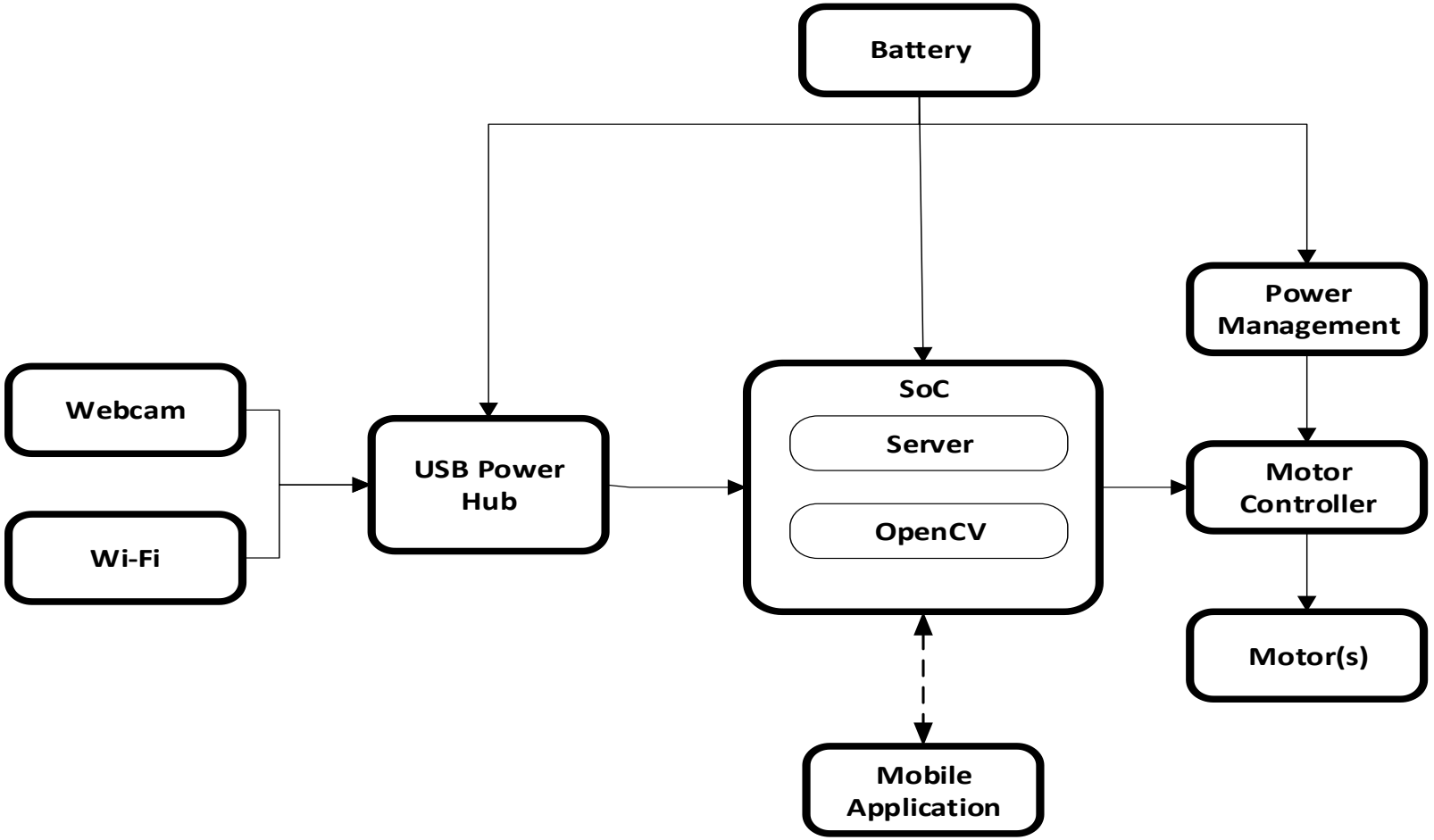
Requirements

- Autonomous
- Detect Motion
- Wireless Communication
- Video Streaming

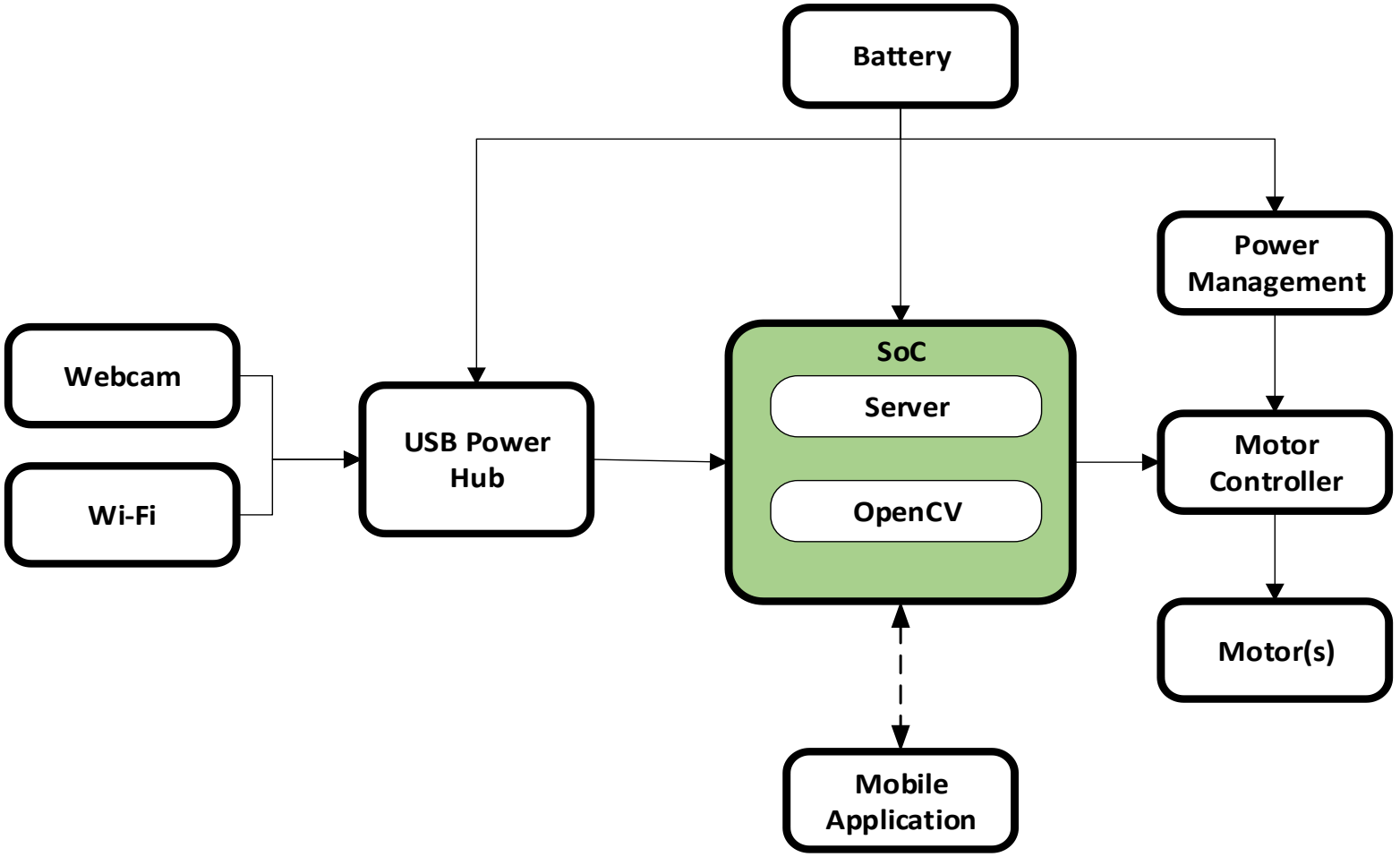
Specifications

Feature	Measurement
Dimension	12” x 8”
Operating Range	25 ft
Power Supply Voltage	14.4 v
Maximum Weight	20 lbs
Minimum Acceleration	1 ft/s^2
Maximum Speed	3 ft/s
Battery Life	3 hrs
Recharge Time	< 4 hrs

Block Diagram



System on Chip (SoC)



Raspberry Pi vs BeagleBone Black

RASPBERRY PI

- $35.00
- 700 MHz ARM1176JZFS
- 512 MB SDRAM @ 400 MHz
- 8 GPIO Pins

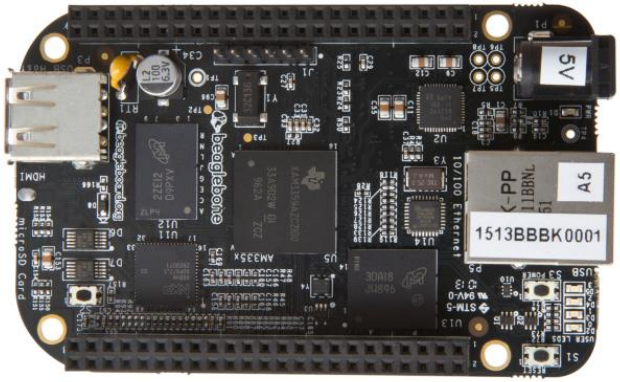
BEAGLEBONE BLACK

- $45
- 1GHz TI Sitara AM3359 ARM Cortex A8
- 512 MB DDR3L @ 400 MHz
- 65 GPIO Pins

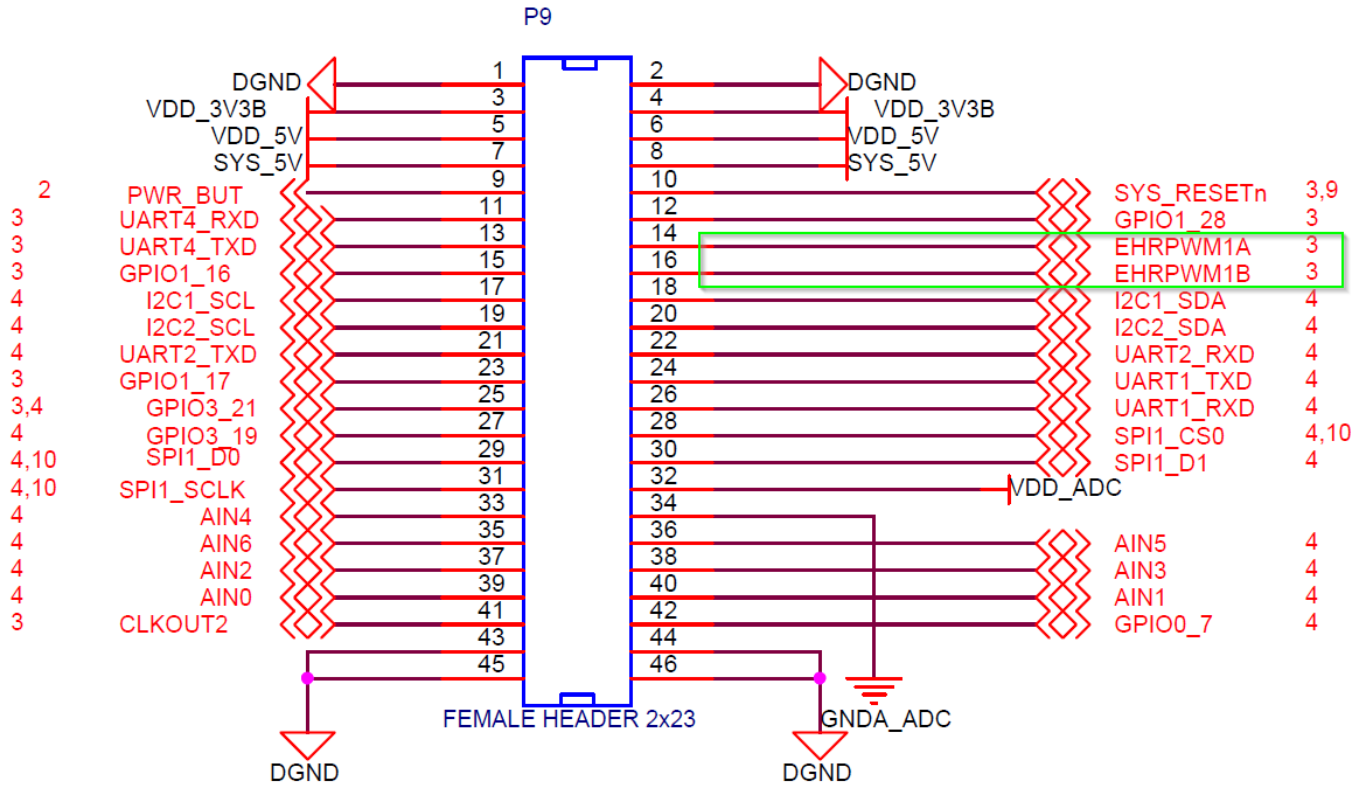
Microcontroller & Development Board

- ARM Cortex A8
- TI Sitara AM3359
- BeagleBone Black

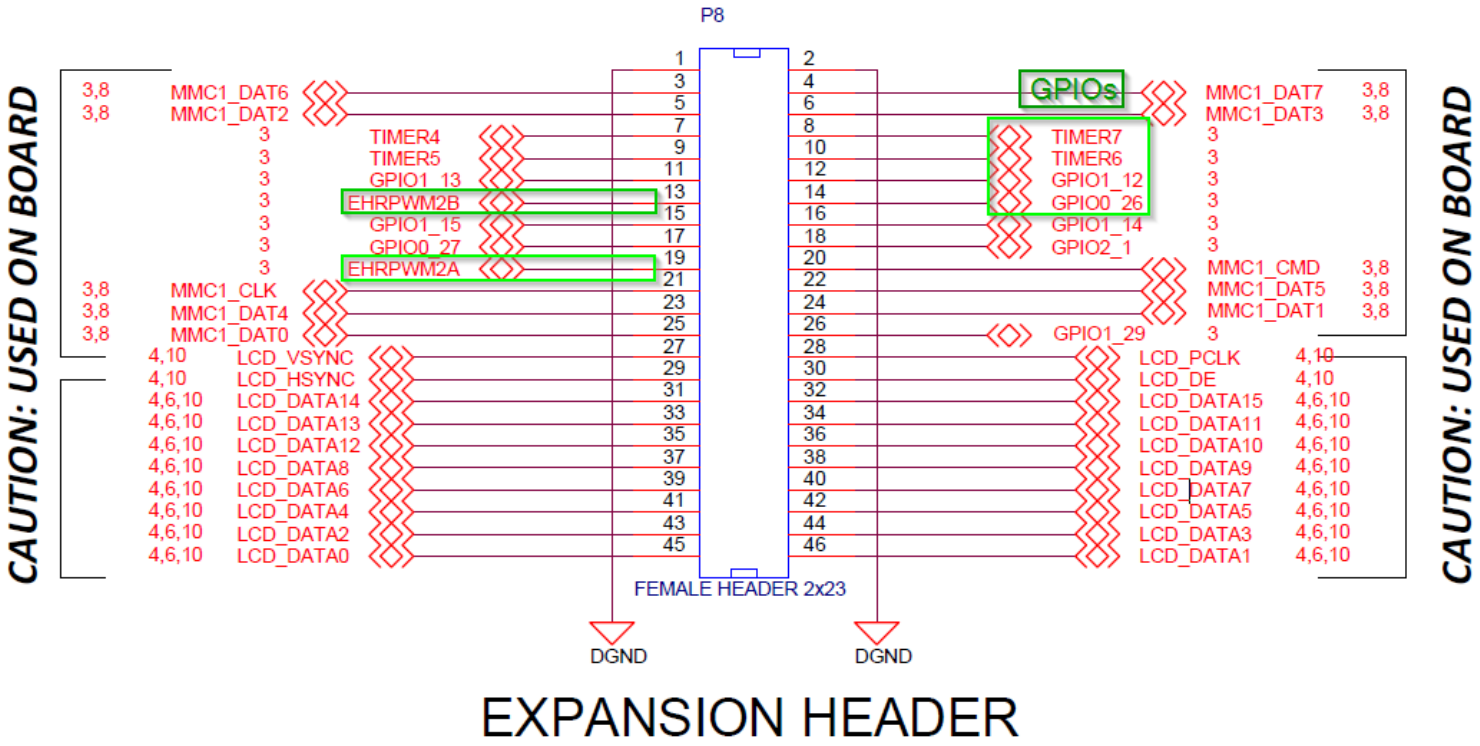
ARM®



Microcontroller & Development Board



Microcontroller & Development Board

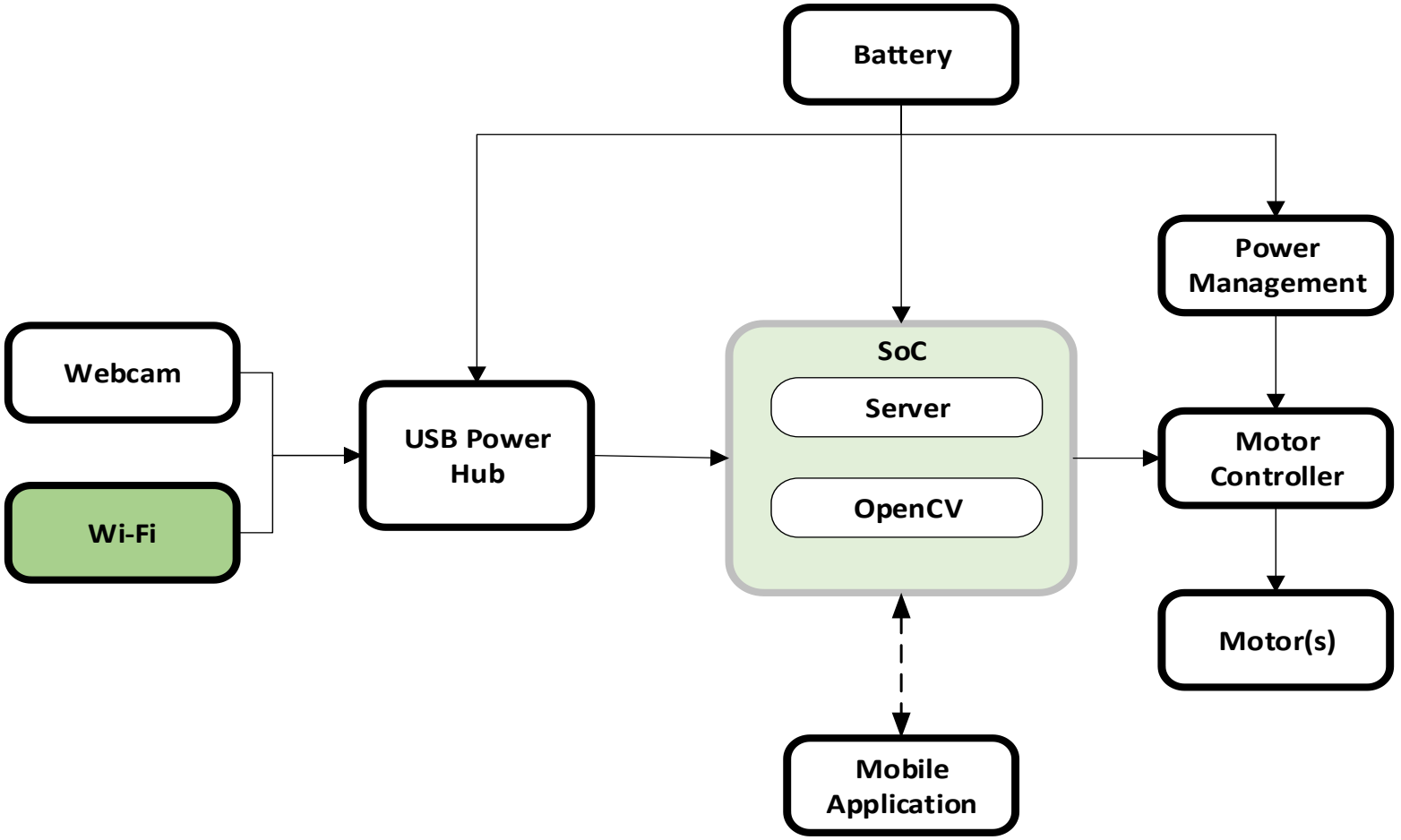


EXPANSION HEADER

Operating Systems

- **Debian**
  - Default OS
- ArchLinux|ARM
  - Most Lean
- Windows Embedded
  - Most Integrated

Wi-Fi

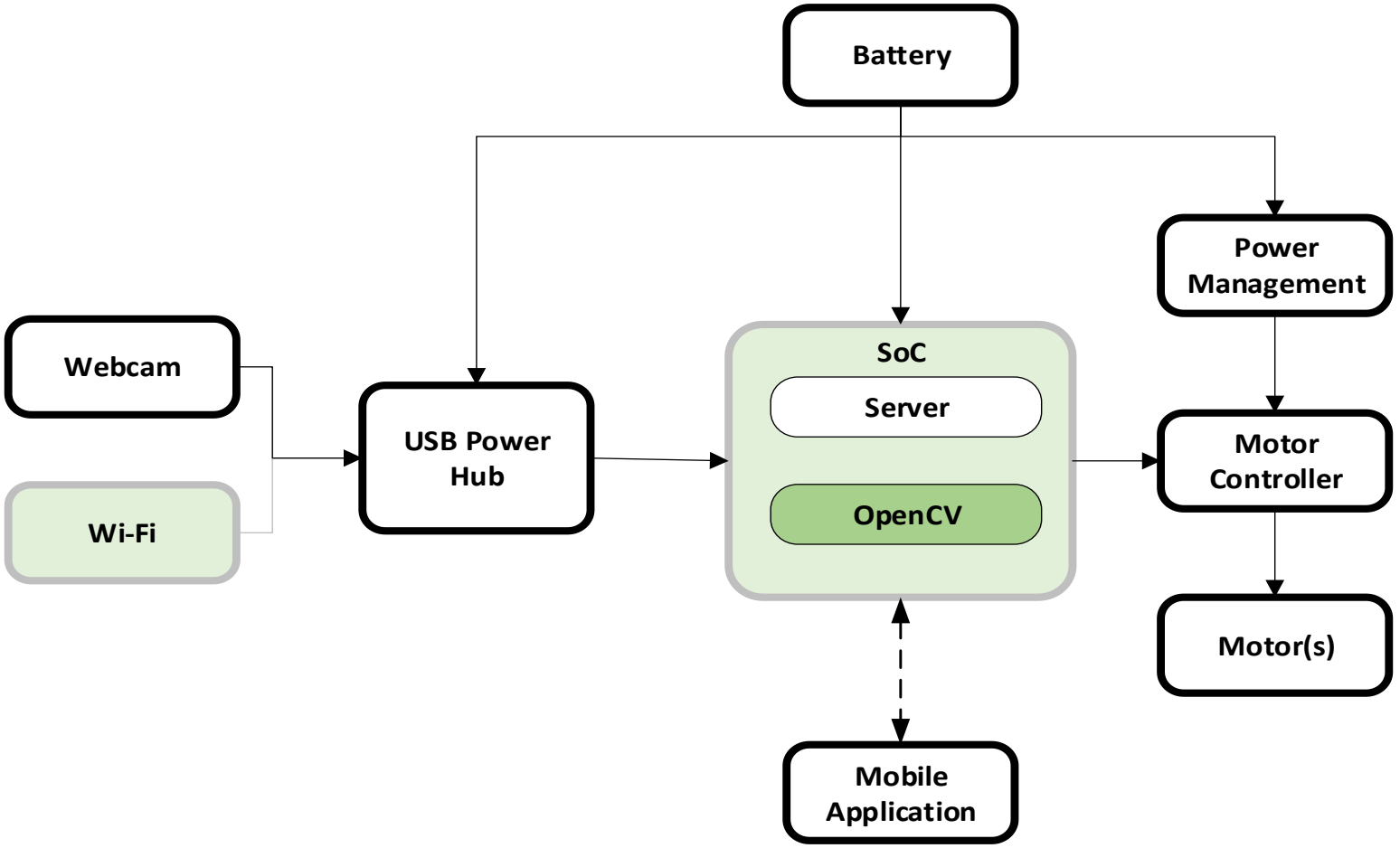

Battery
Power Management
Webcam
Wi-Fi
USB Power Hub
SoC
Server
OpenCV
Motor Controller
Motor(s)
Mobile Application

Wi-Fi

Edimax EW-7811Un

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

Computer Vision



Open Source Libraries

ROBOT OPERATING SYSTEM (ROS)

- Implementations for specific tasks.
- Not as big as OpenCV.
- Requires OpenCV for certain algorithms.

OPEN SOURCE COMPUTER VISION LIBRARY (OPENCV)

- C++ and JAVA implementations available.
- Compatible with multiple distributions of Linux.
- Large amount of tutorials and support community .

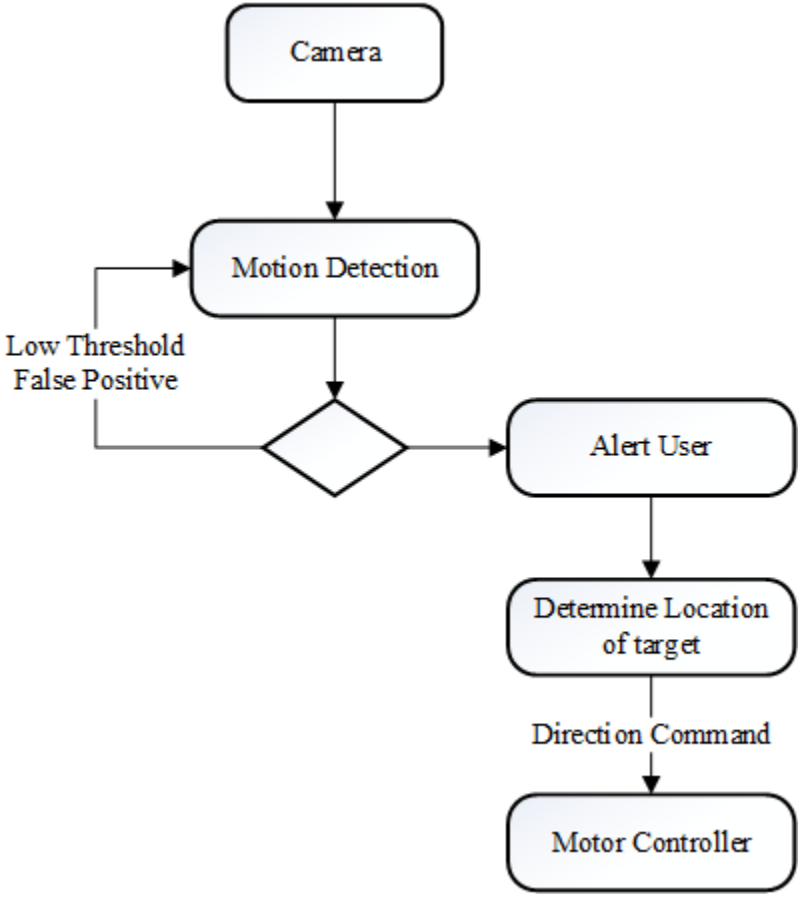
Computer Vision - OpenCV

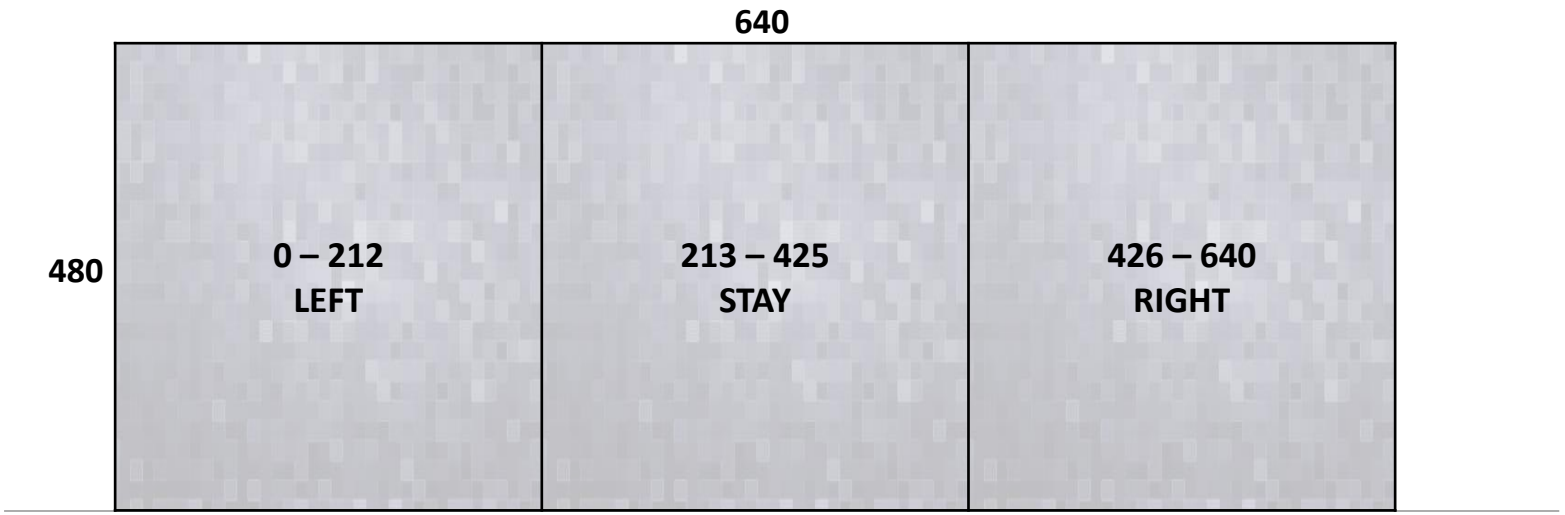
- Detect movement
- Recognize and track a moving person

OpenCV 2.4.2

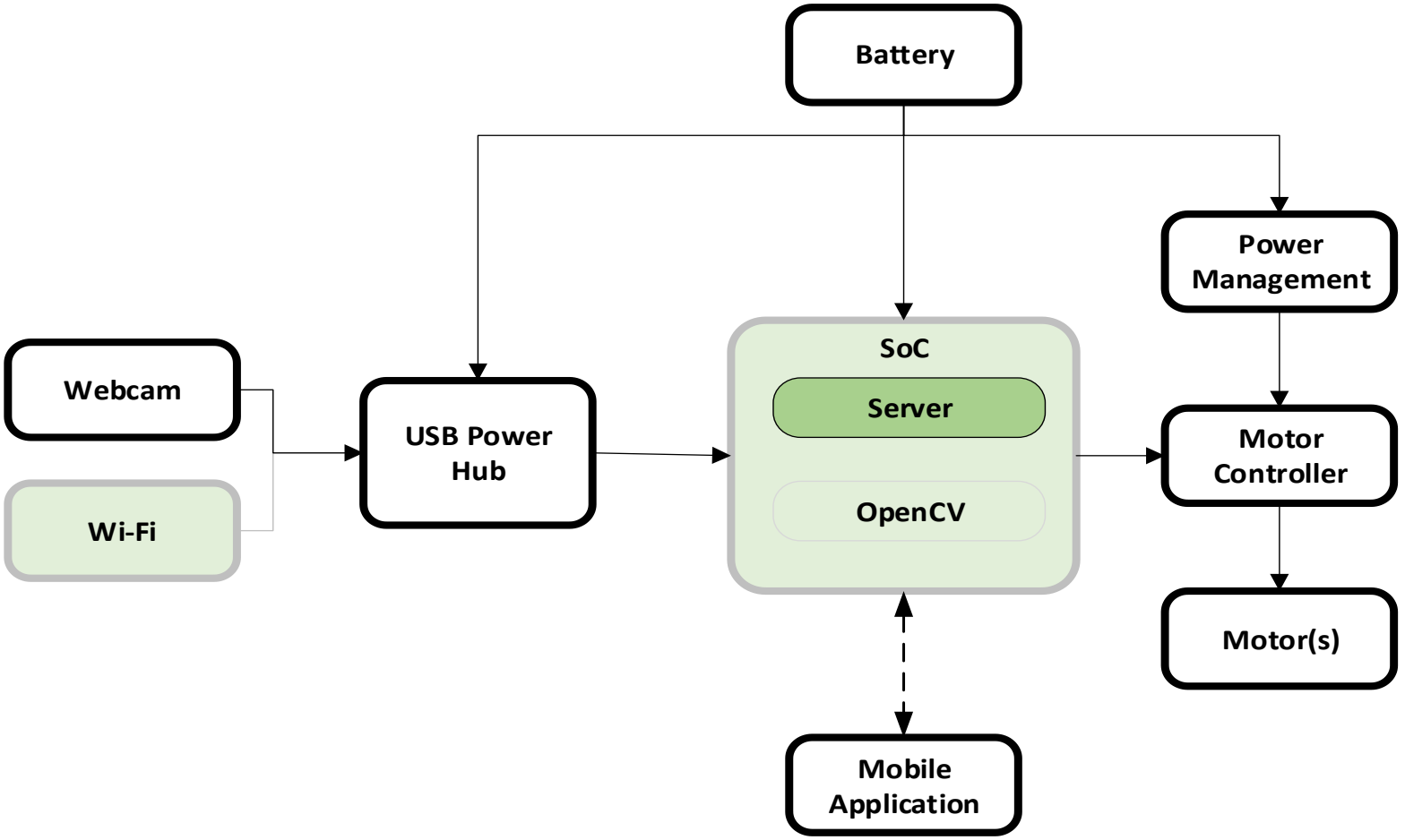
- Optimized computer vision functions and algorithms
- Built-in Object Detection and Tracking functions
- ARM Support
- Performance varies on functions being utilized.

Computer Vision State Diagram




640
480
0 – 212
LEFT
213 – 425
STAY
426 – 640
RIGHT

Server & Streaming



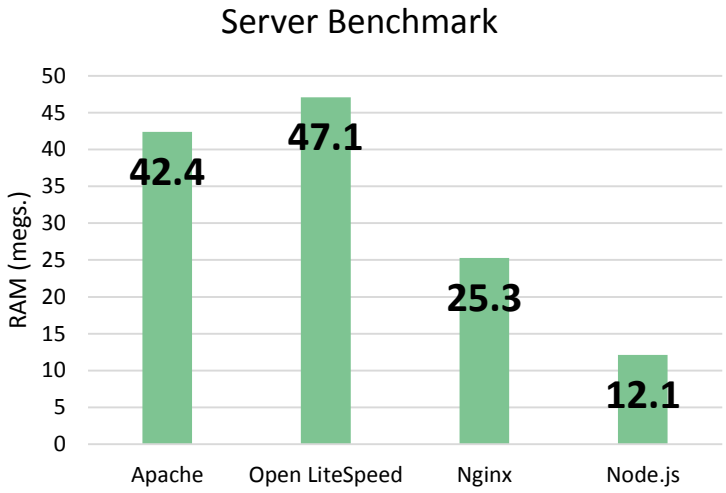
Server & Streaming

Node.js

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

UDP (User Datagram Protocol)

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

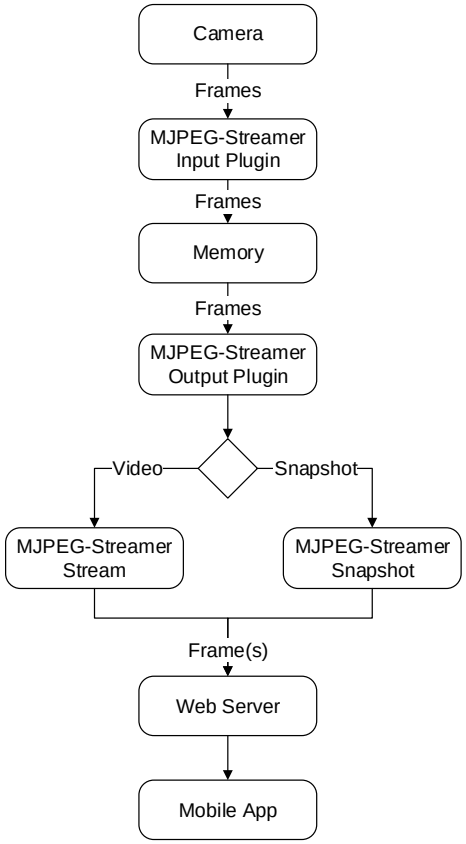


Server & Streaming

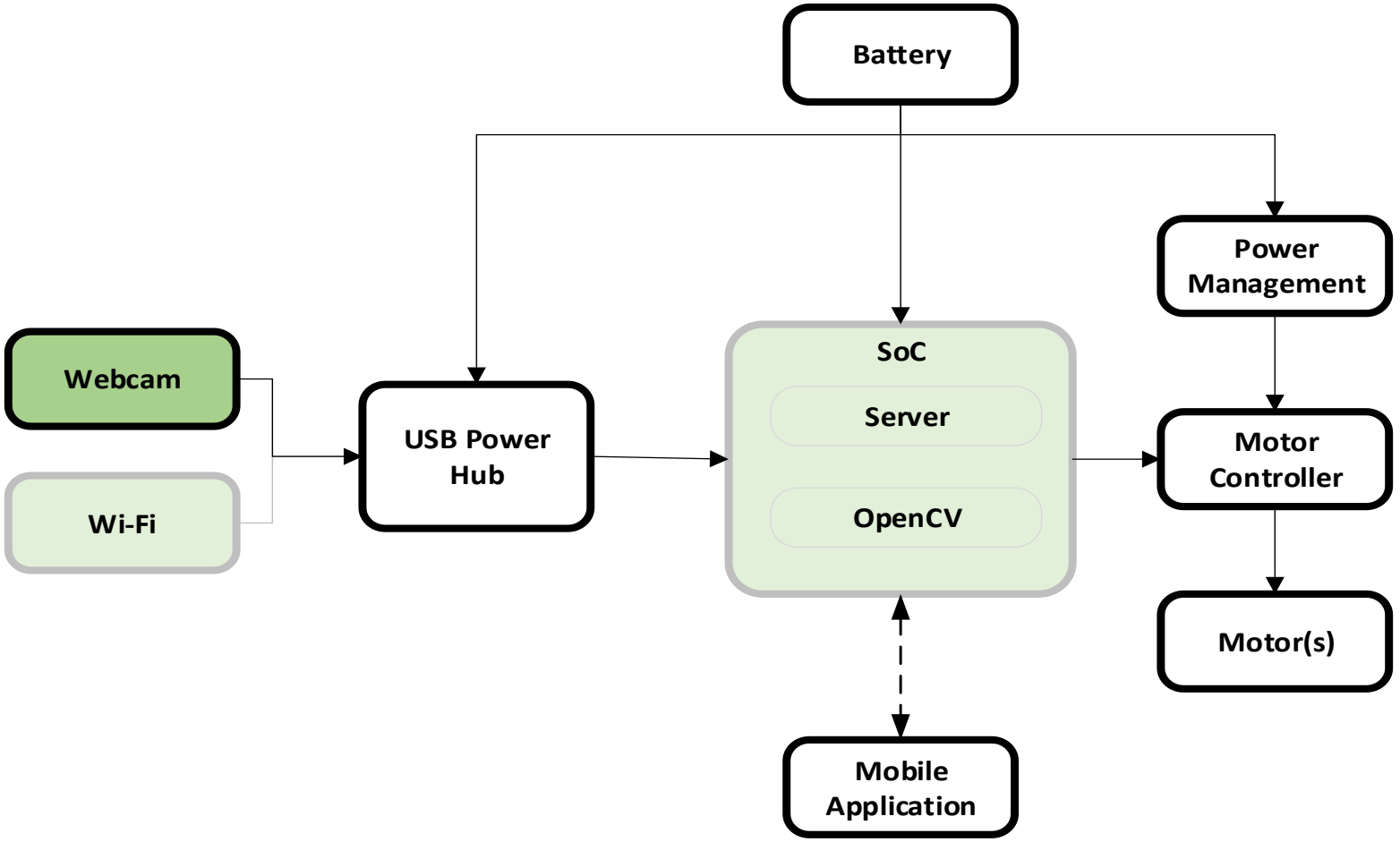
MJPG-Streamer

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

Streaming State Diagram



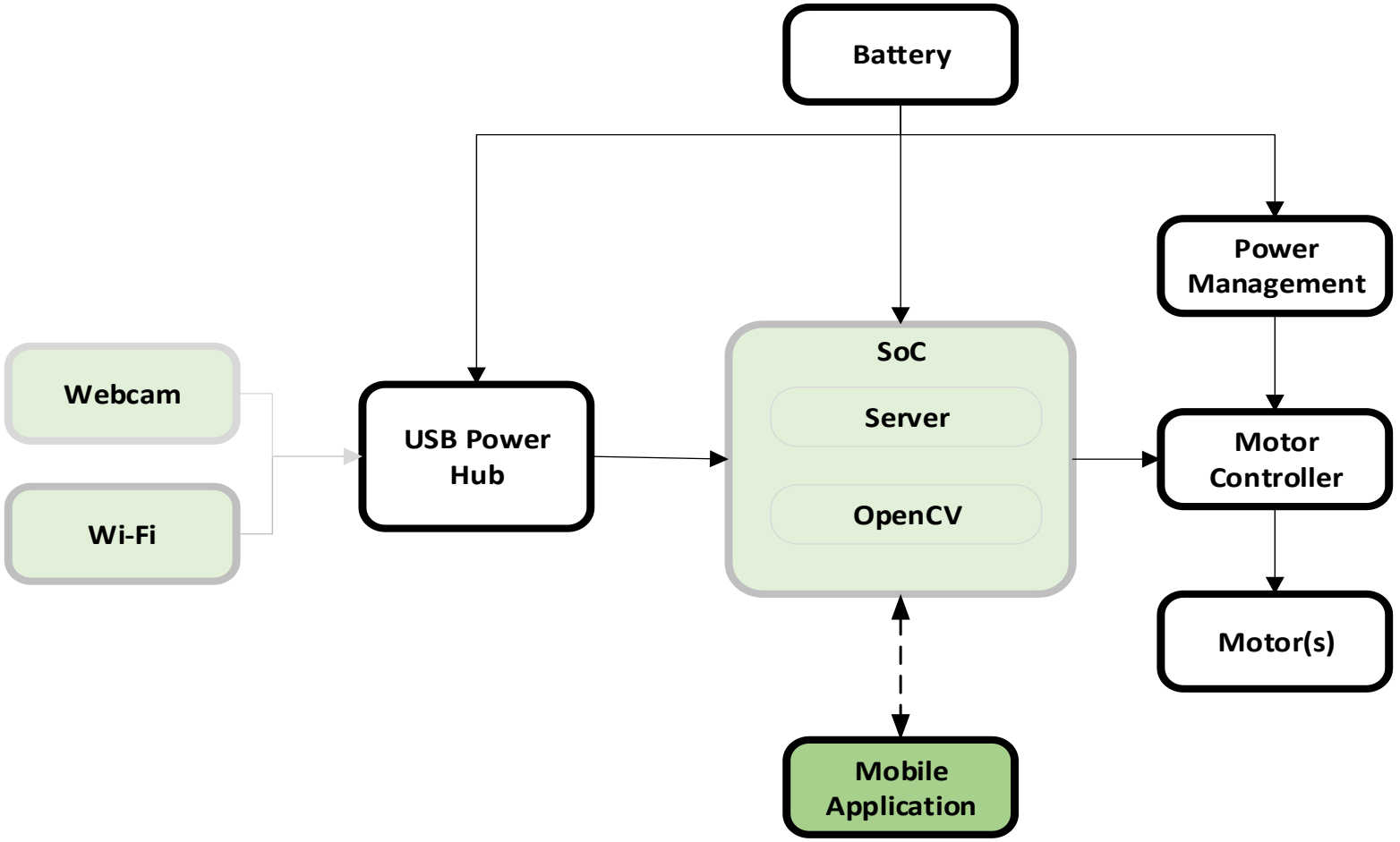
Webcam


Battery
Power Management
Webcam
Wi-Fi
USB Power Hub
SoC
Server
OpenCV
Motor Controller
Motor(s)
Mobile Application

Webcam

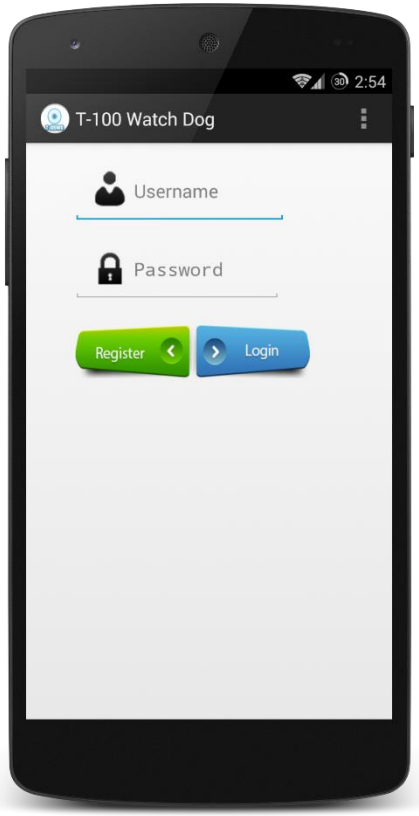
- Microsoft - LifeCam Cinema
  - USB 2.0 Connectivity
  - Linux Compatible
  - Multiple picture/video resolutions available

Mobile Application

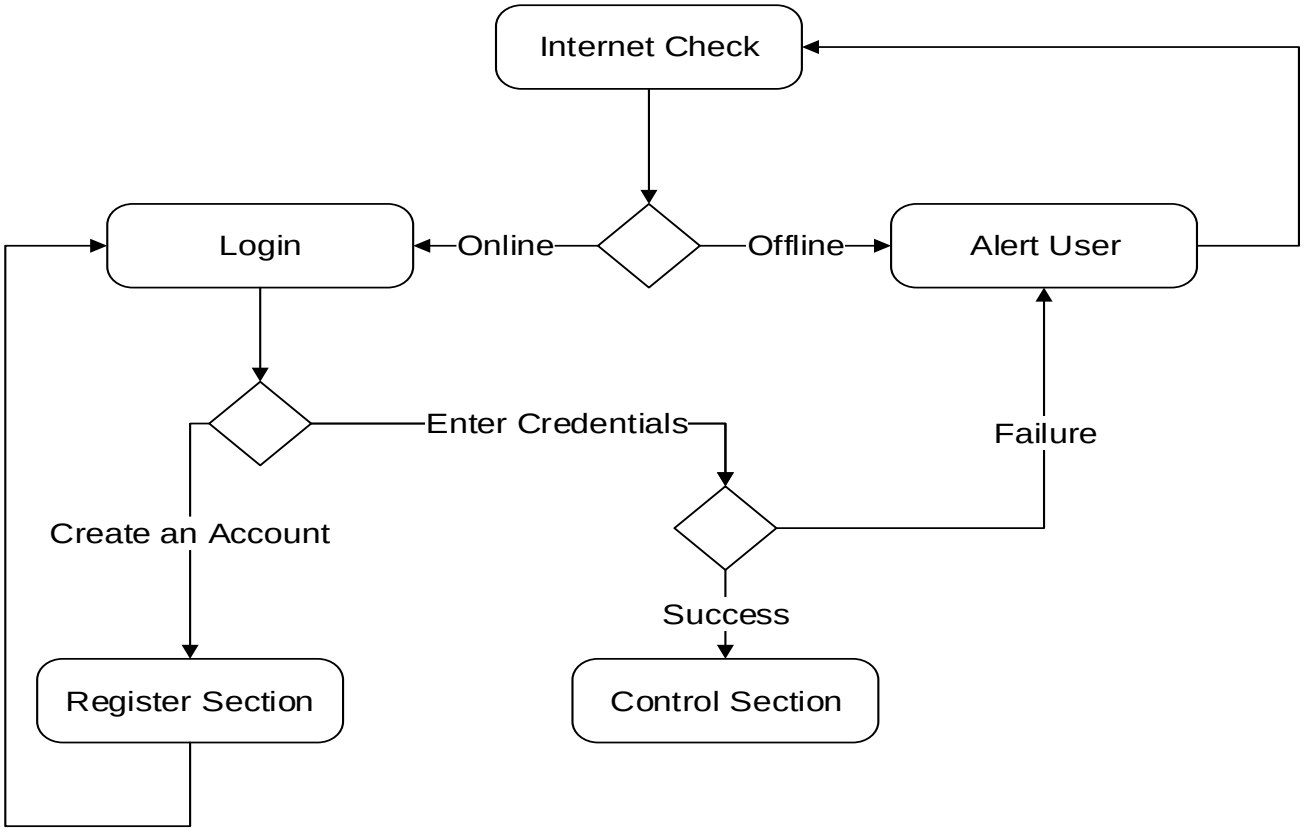


Mobile Application

- 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

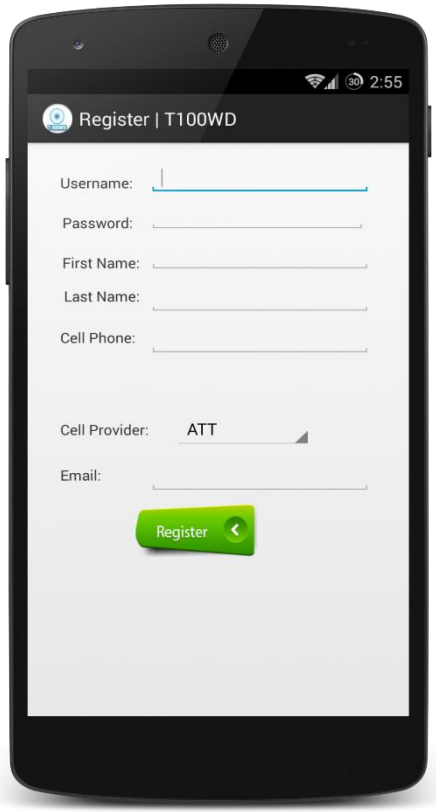


Mobile Application State Diagram



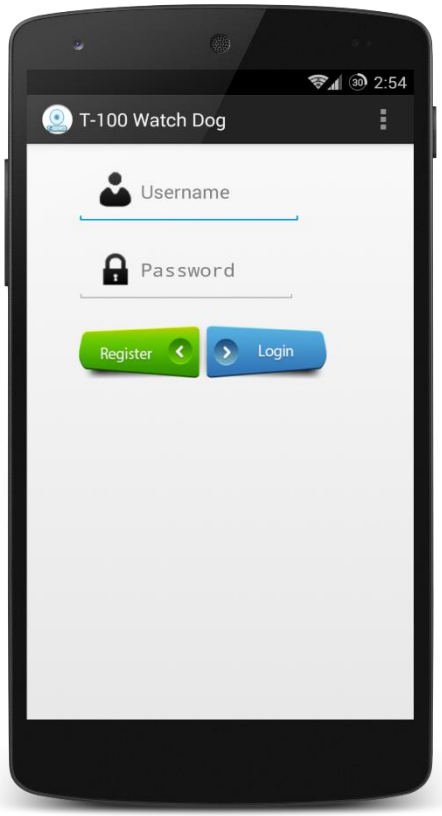
Mobile Application

- Registration Activity
  - 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/Get method.



Mobile Application

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

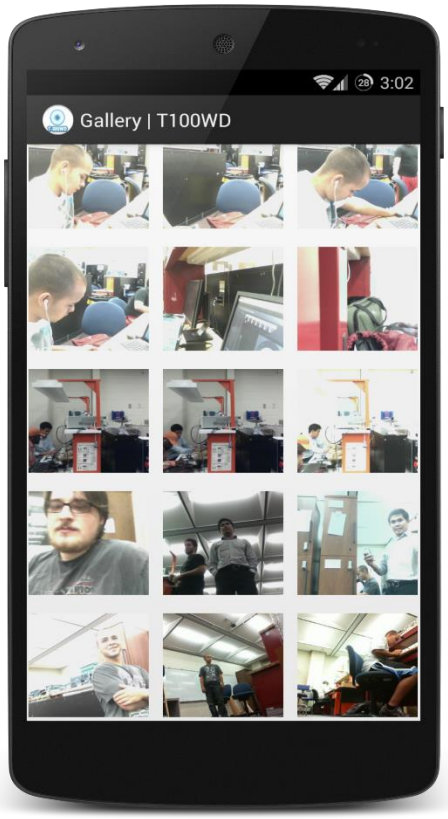


Mobile Application

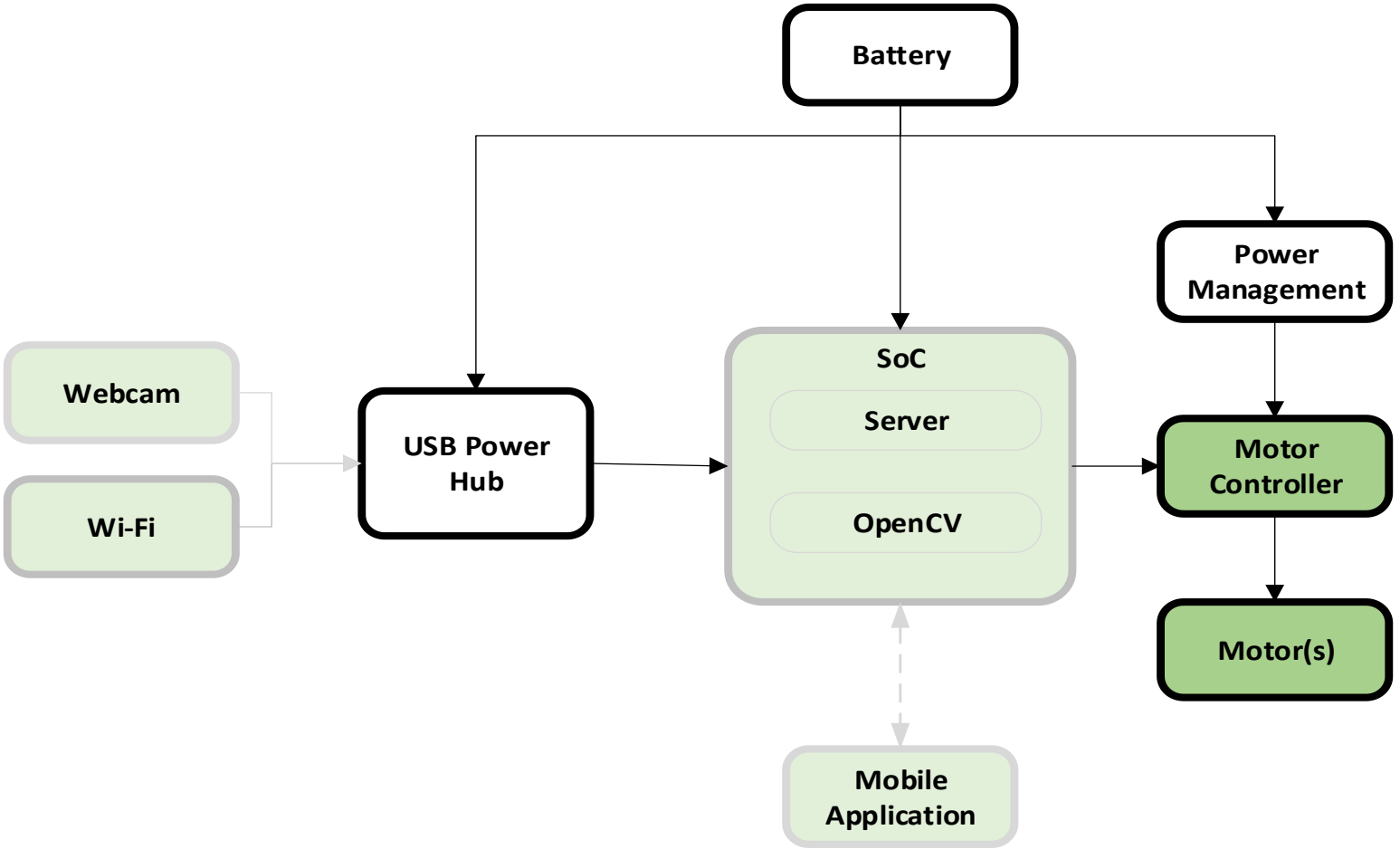
- Control Section
  - View live video feed
  - Control robot with virtual joystick
  - Store snapshot

Mobile Application

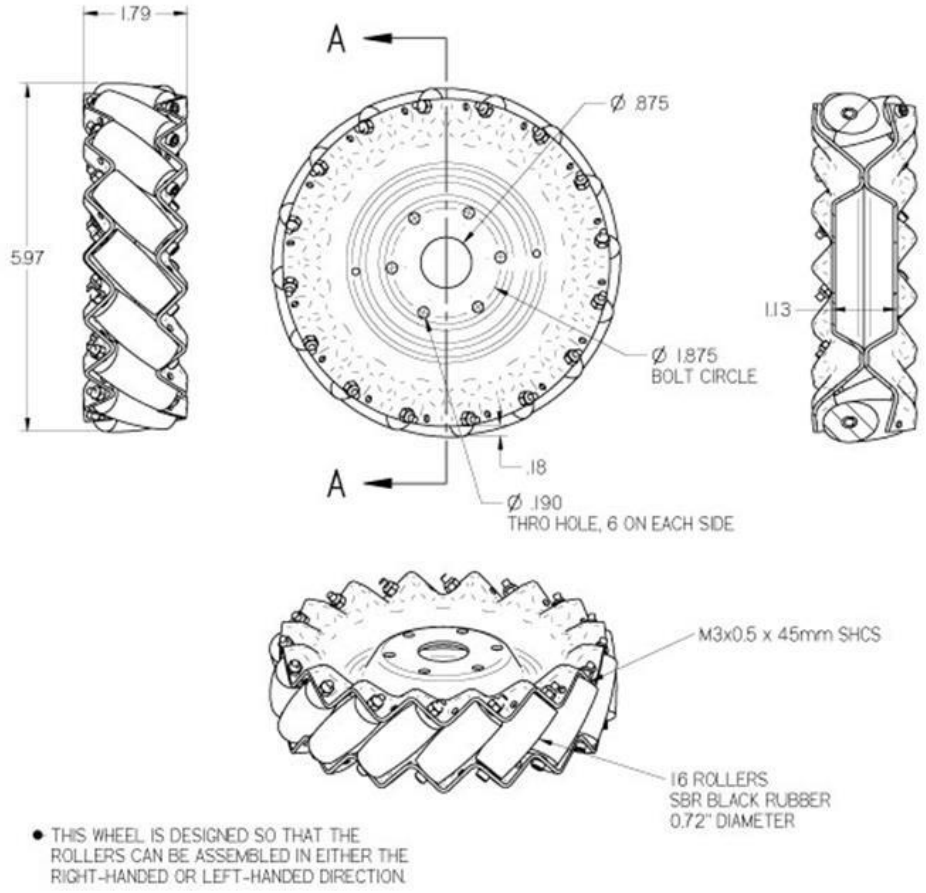
- Gallery Section
  - View snapshots stored on device
  - Share via Email/MMS



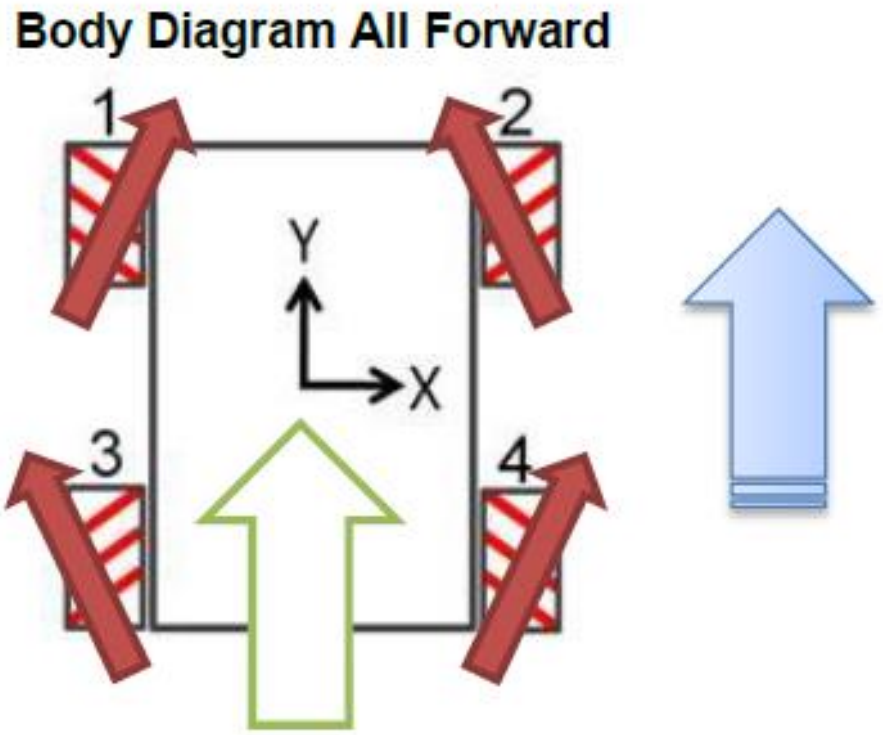
Motor Controller, Motors, & Wheels



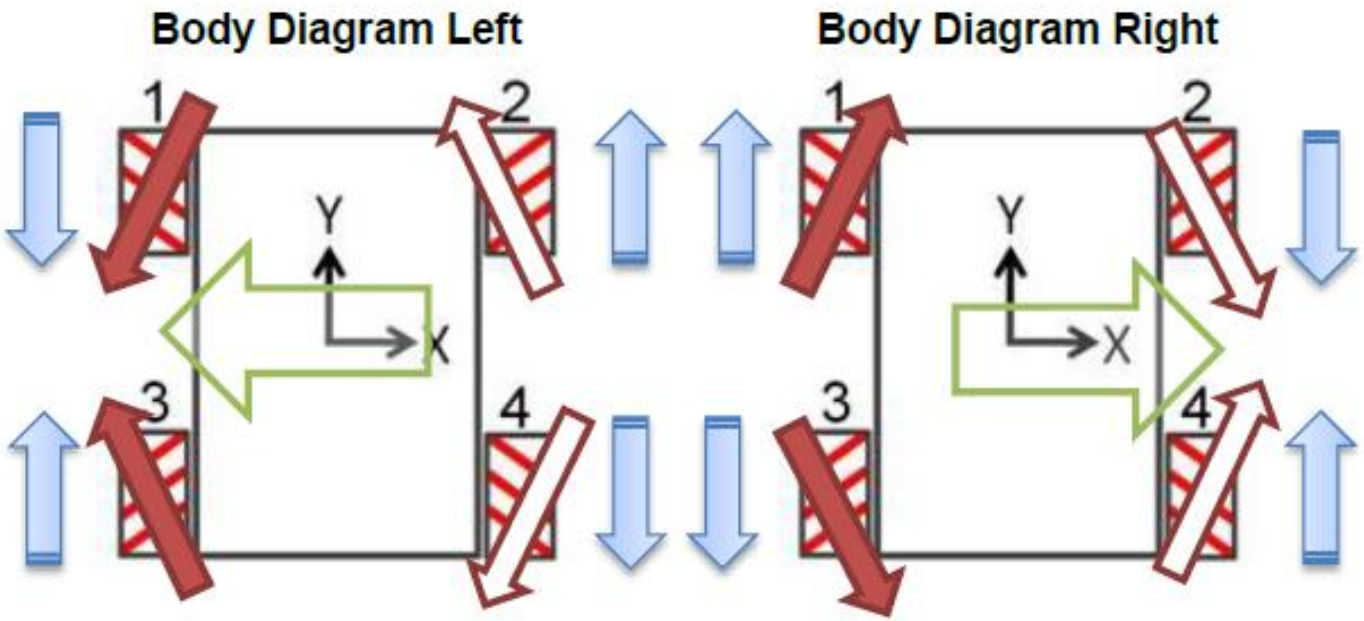
Mecanum Wheels



Mecanum Wheels



Mecanum Wheels

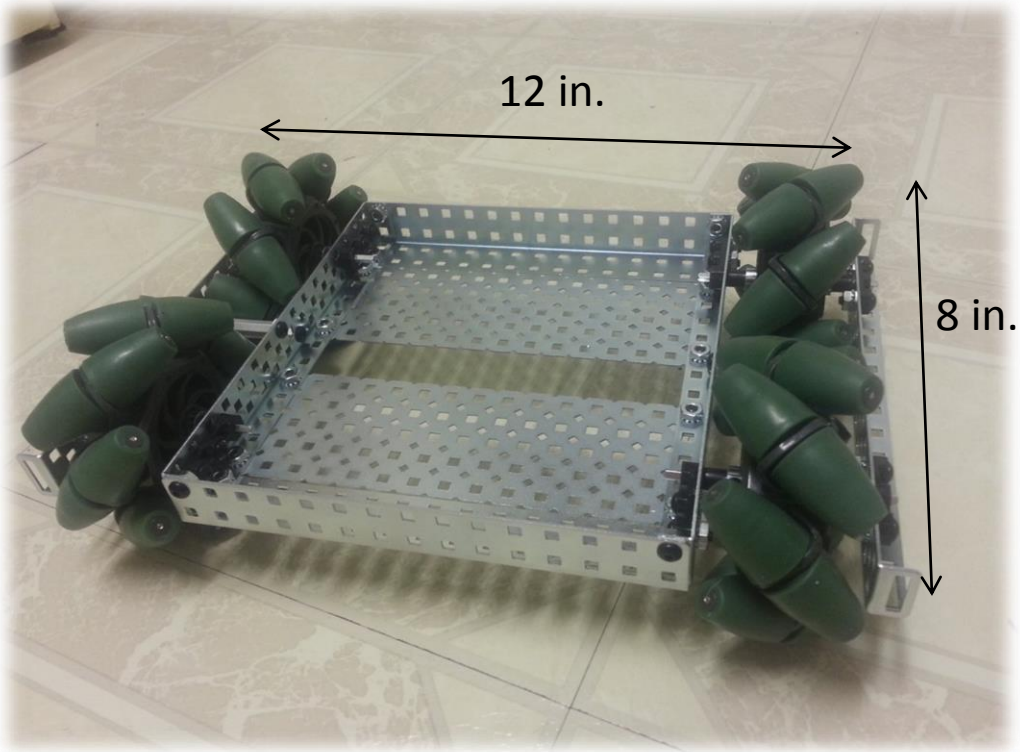


Mecanum Wheels

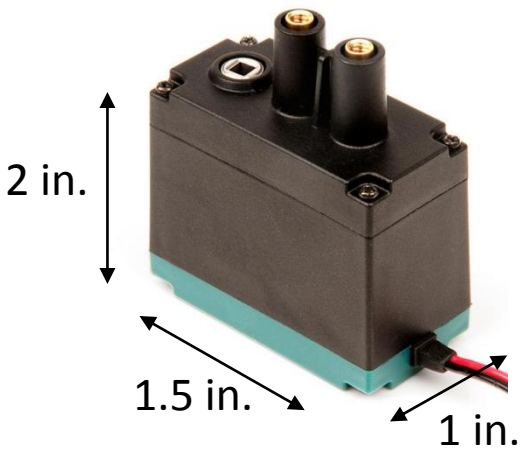
- Vex Robotics Mecanum Wheels
  - Affordability
    - $59.99 4 pack
  - Diameter: 4 in.
  - Thickness: 2 in.

Platform

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



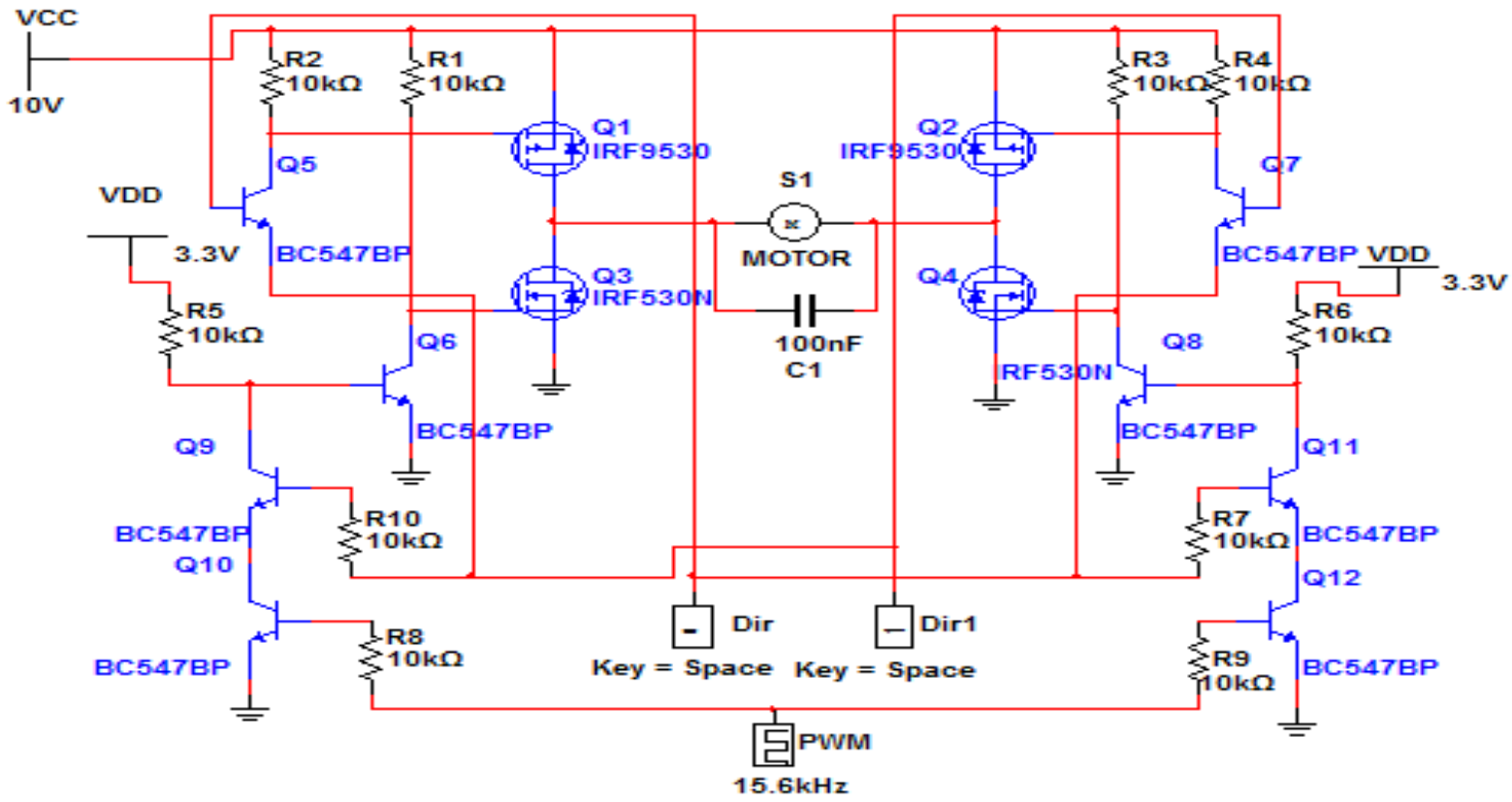
Motor



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

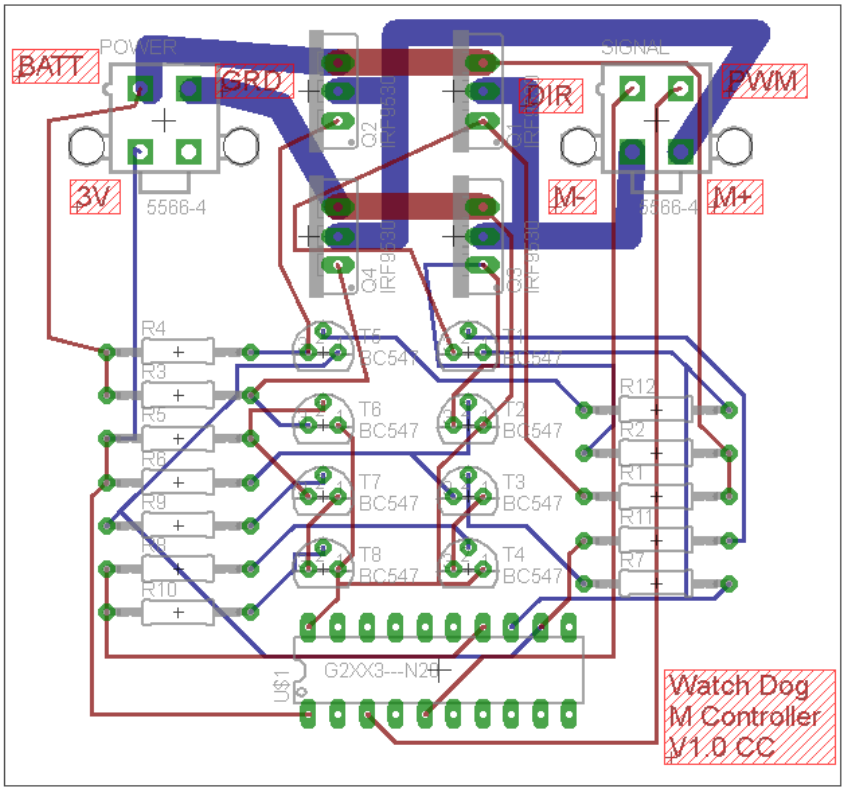
10 K OHM Current Limiting Resistors

Controller Budget

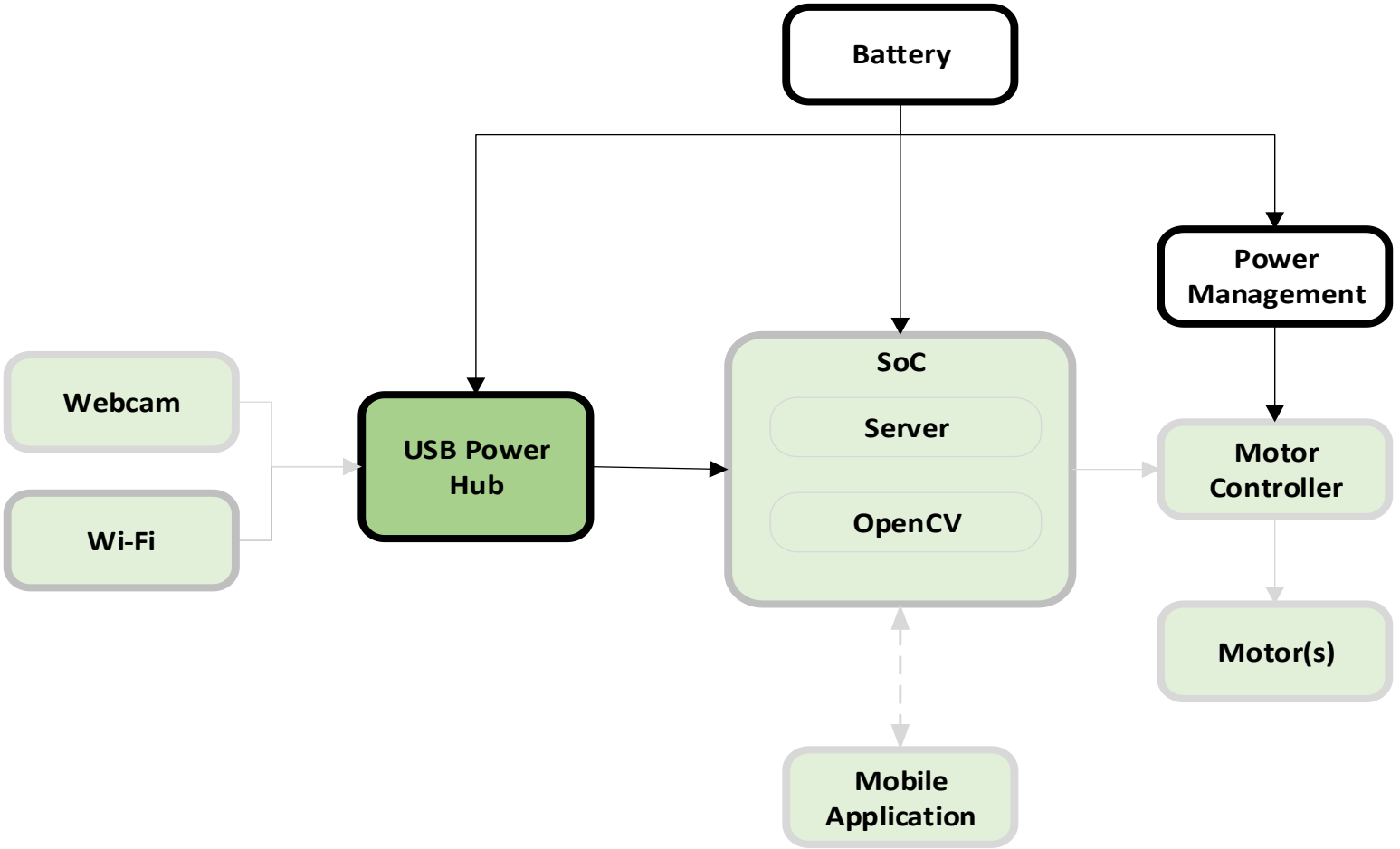
Component	How many	Price per unit	Total
MSP430G2552	4	$2.79	$11.16
IRF9530	8	$1.29	$10.32
IRF530	8	$1.03	$8.24
BC547	32	$0.20	$6.40
Capacitor(100nF)	4	$.05	$0.20
Resistor (10k)	40	$.04	$1.60
Total: (without pcb)			$37.92

Motor Controller- PCB

Specifications
3”x3”
Thick Traces for high current lines
2 layer
Oshpark, $5/sq in. 3 PCB’s per order.

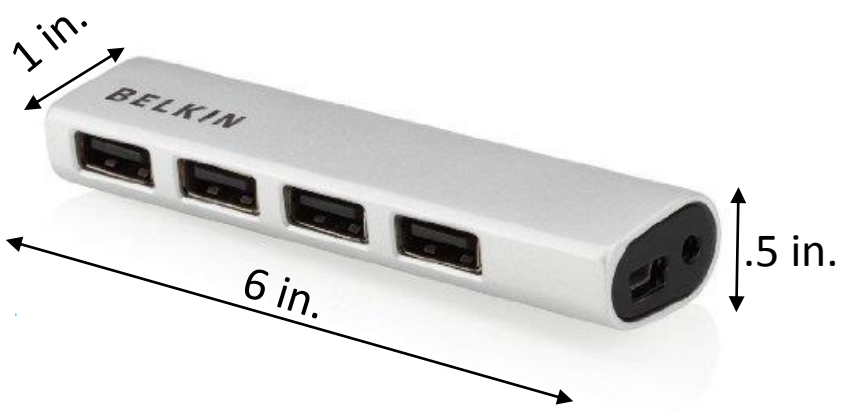


USB Power Hub

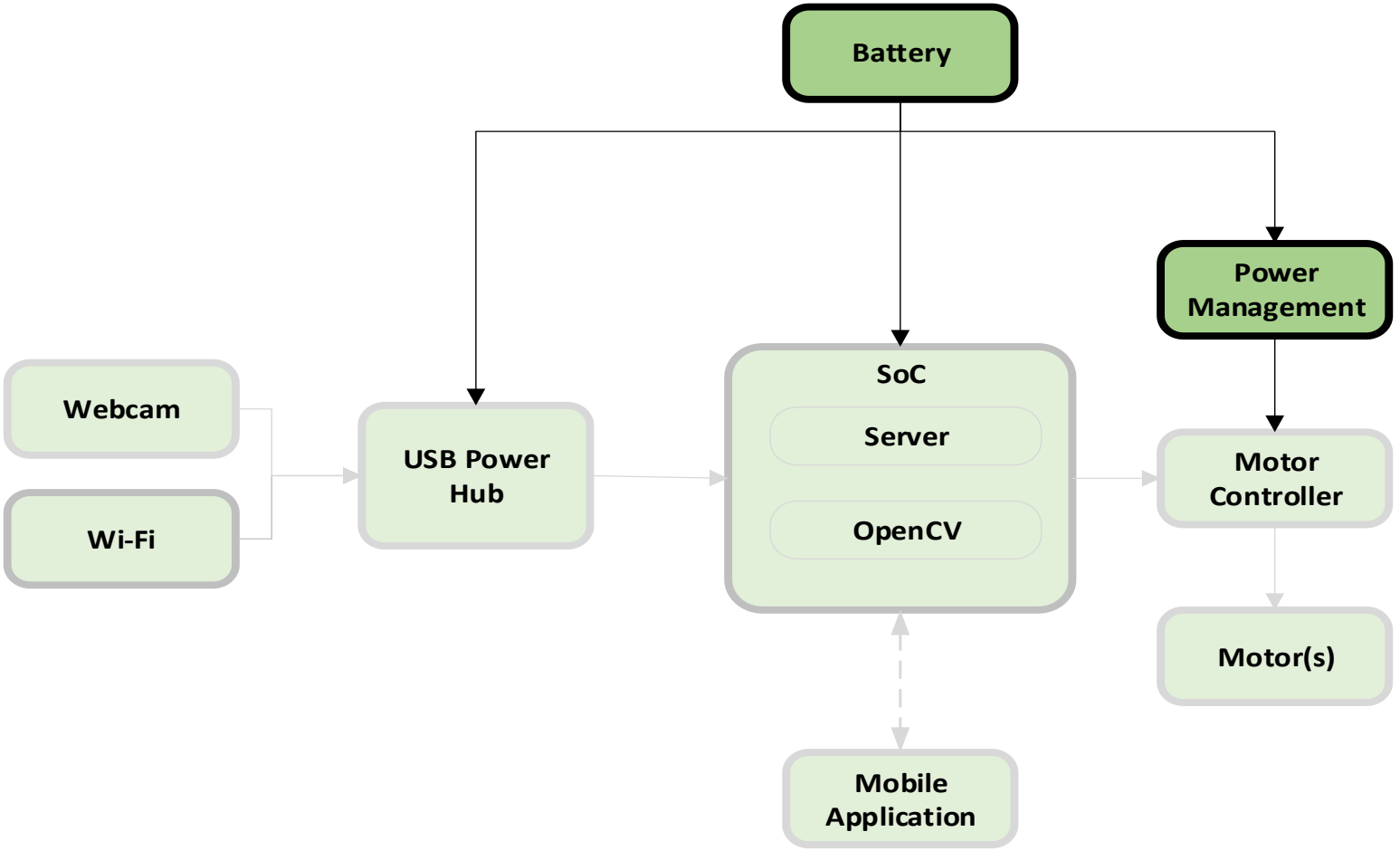


USB Power Hub

- BeagleBone 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?

- **Multi 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	31038	18650
Brand	Tenergy	Tenergy	Supower
Capacity (mAh)	1600	4400	2200
Voltage (V)	7.4	14.8V	7.4
Weight (lb)	0.2	1.2	0.2
Discharge Rate (C)	20 (32 A)	25 (60A)	2.5 (5.5A)
Price ($)	24.5	59.99	17.99
Chemistry	Lipo	Li-on	Li-on

Battery Selection Motor Controller

- Tenergy 14.8V 4400mAh Battery
- Weighs the most but supply the most current out of the batteries.
- Expected Battery Life needs to be at least 3 Hours

Model	31604	31038	18650
Brand	Tenergy	Tenergy	Supower
Capacity (mAh)	1600	4400	2200
Voltage (V)	7.4	14.8V	7.4
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Price ($)	24.5	59.99	17.99
Chemistry	Lipo	Li-on	Li-on

Battery Selection Microcontroller

USB Powered Battery

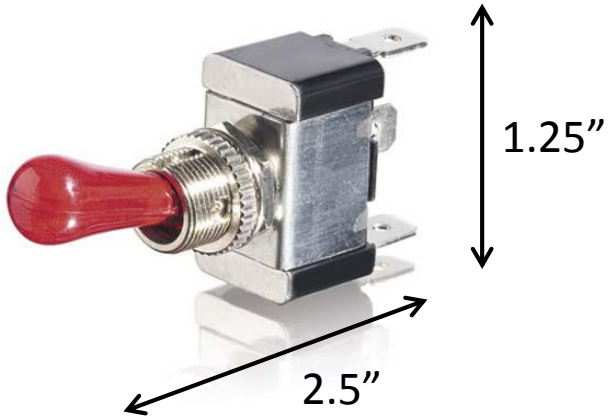
- 7.4V Lithium Ion 6600mah
- Two output ports
  1. 5V at 1A
  2. 5V at 2A
- Powers off automatically once the devices are disconnected.

Battery Charger

- Tenergy TLP-2000 Smart Charger
  - Built in Balancer
  - Price $25.99
  - Powers both Lion and LIPO batteries.
  - Led Indication Status on when battery is charging and when the battery is fully charged
  - Cuts off once battery is fully charged.

SPST 12VDC/30A Switch

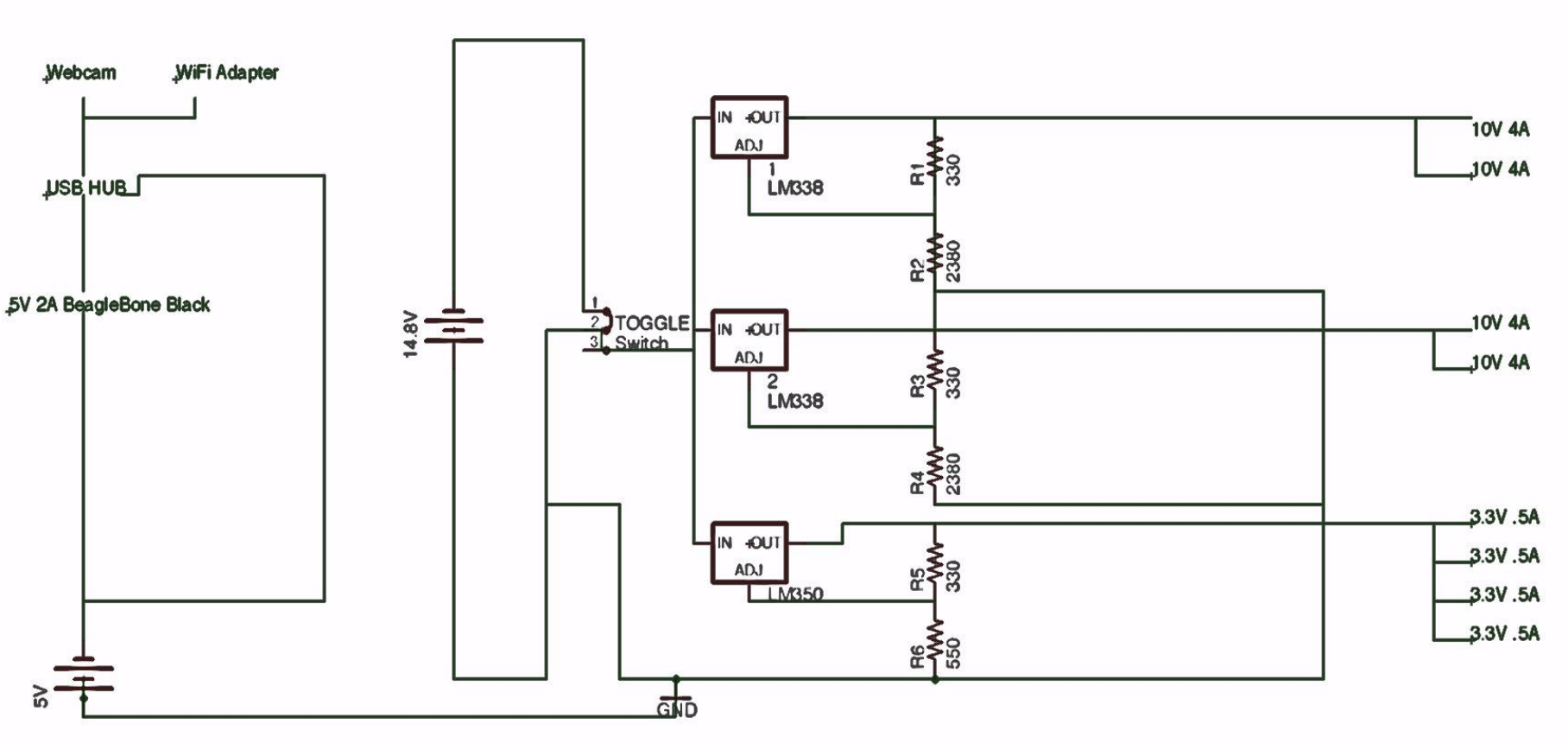
- Rated at 12V 30A
- Red LED illuminates while on
- Great to Conserve Battery life
- Nickel plated brass



Power Requirements

Items	Voltage input needed	Current input needed
BeagleBone Black	5 V	2 A
Motor Controllers	10 V	16 A
Conventional Webcam	3 V	<500 mA
MSP 430	3.3 V	.5 mA
Wi-Fi Adapter	3 V	<500 mA
USB Power Hub	3-5 V	1.5 A

Power System



Voltage Regulators

LM 338

- Output Voltage range is 1.2V to 32V
- Output current Max 5A
- Output voltage is 10V
- Heatsinks Needed
- 2 regulators

LM 350

- Output Voltage range is 1.2V to 32V
- Output current Max 2A
- Output voltage is 3.3V
- Heatsinks Needed
- 1 regulator

Work Breakdown

Task	Ismael Rivera	Warayut Techarut (Wye)	Journey Sumlar	Chris Carmichael
Motor Controller				X
Power Management			X	
Server	X			
Computer Vision	X	X		
Mobile Application	X			
Microcontroller Communication		X		

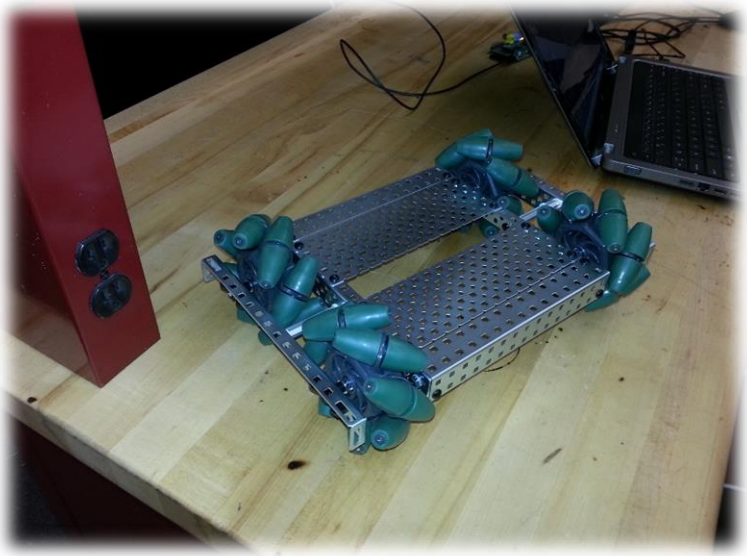
Budget & Finance

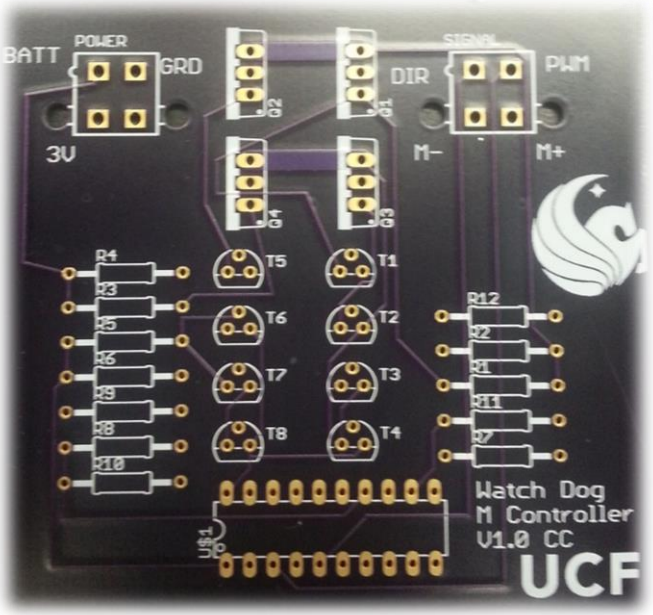
Part Name	Quantity	Price (each)	Total
Wifi USB Adapter	1	$5.99	$5.99
MicroSD Card	1	$7.99	$7.99
USB AC Powered Hub	1	$7.99	$7.99
Motor	5	$14.99	$74.95
Mecanum Wheels	1	$59.99	$59.99
Robot Frame kit	1	$79.99	$79.99
Motor controller PCBs	2	$43.95	$87.90
Motor Controller Parts	1	$46.00	$46.00
22 guage wire set	1	$20.00	$20.00
Wire connectors	1	$40.00	$40.00
Barrel jack connectors	2	$2.95	$5.90
USB Battery	1	$29.95	$29.95
Battery + Charger	1	$88.55	$88.55
BeagleBone Black	1	$62.71	$62.71
Miscellaneous			$50
		Total	$667.91
		Over budget	$42.54

Issues

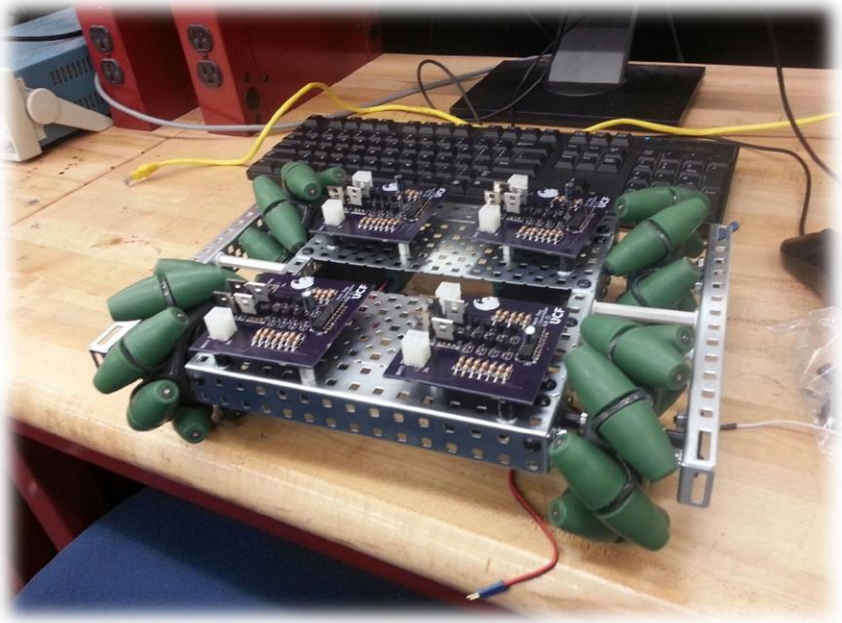
- Low performance for OpenCV (1-2 frames per second)
  - Driver not fully compatible
  - Faster Processor
- UCF Network Restrictions
- Time constraints
- Budget

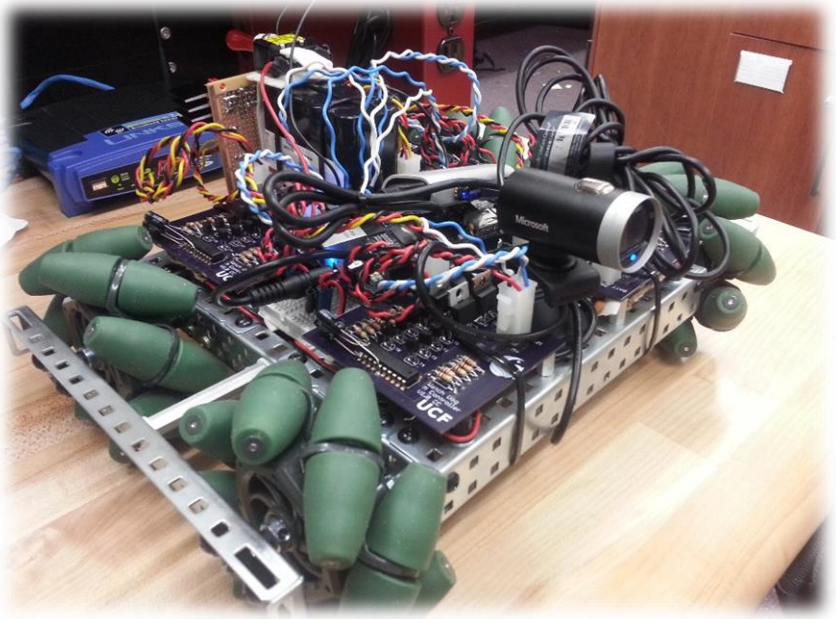
Project Process





Project Process





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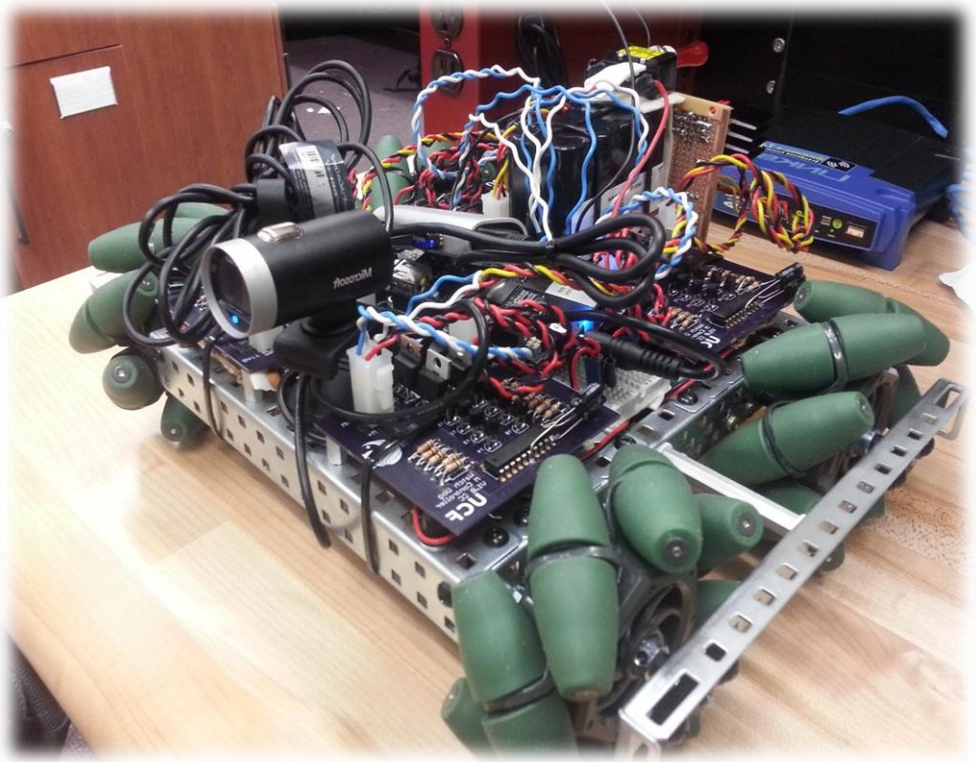
Journey Sumlar
Warayut Techarut



QUESTIONS?