THE WI-FI SEEKER

GROUP 30

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ADRIAN MORGAN

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SPONSORS:

LEIDOS

DUKE ENERGY

THE WI-FI SEEKER

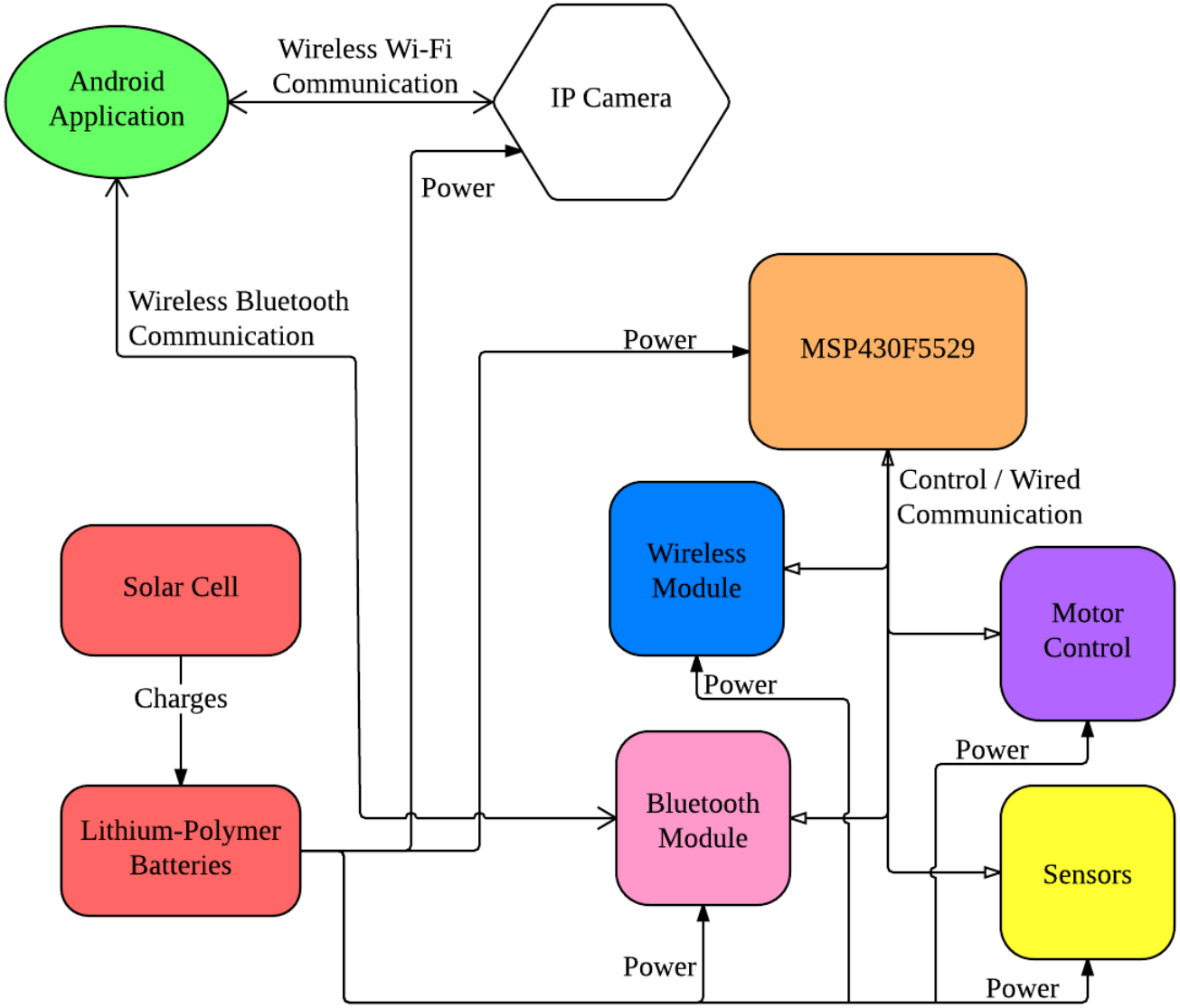
- **The Wi-Fi Seeker is a robot whose purpose is to determine the location where a Wi-Fi signal is strongest.**
- **This robot aims to solve the issue of locating where in an area the strongest connection to a network can be obtained.**
- **The robot features an autonomous algorithm to determine where this location is.**

GOALS AND OBJECTIVES

- **The robot will be controlled using a mobile application.**
- **The robot will have autonomous functionality, and be able to locate where in an area a wireless network is broadcasting the strongest.**
- **The robot will be powered by solar-charged batteries.**

SPECIFICATIONS

Component	Parameter	Design Specification
Battery	Charge time	8 hours
Battery	Average run time	45 minutes
Bluetooth	Minimum range	10 meters
Sensors	Sensing distance	1 ft
Motors	Maximum Speed	3.1 mph


Android Application
Wireless Wi-Fi Communication
IP Camera
Power
Wireless Bluetooth Communication
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MSP430F5529
Control / Wired Communication
Wireless Module
Motor Control
Solar Cell
Charges
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Lithium-Polymer Batteries
Bluetooth Module
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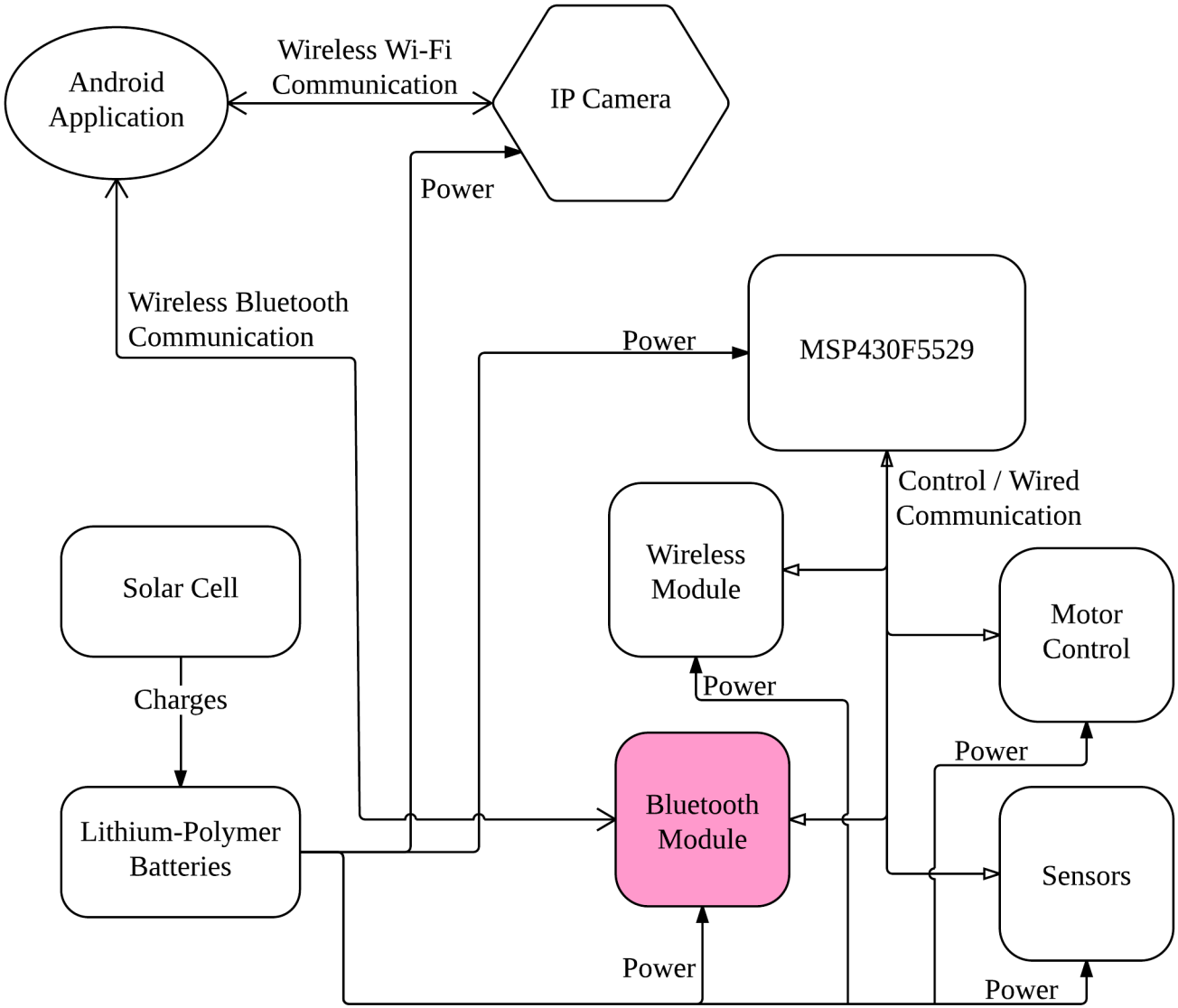
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MEANS OF WIRELESS TRANSMISSION

BLUETOOTH

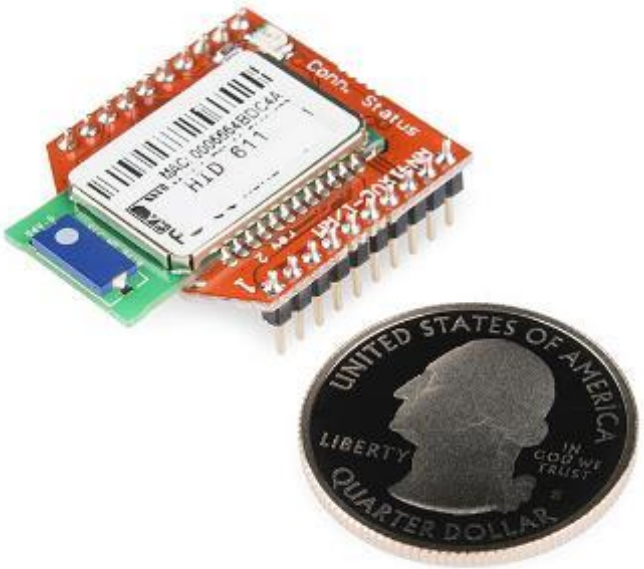
- Leading protocol for short range wireless transmission
- Vast documentation for Bluetooth usage in Android applications.
- Extremely power efficient

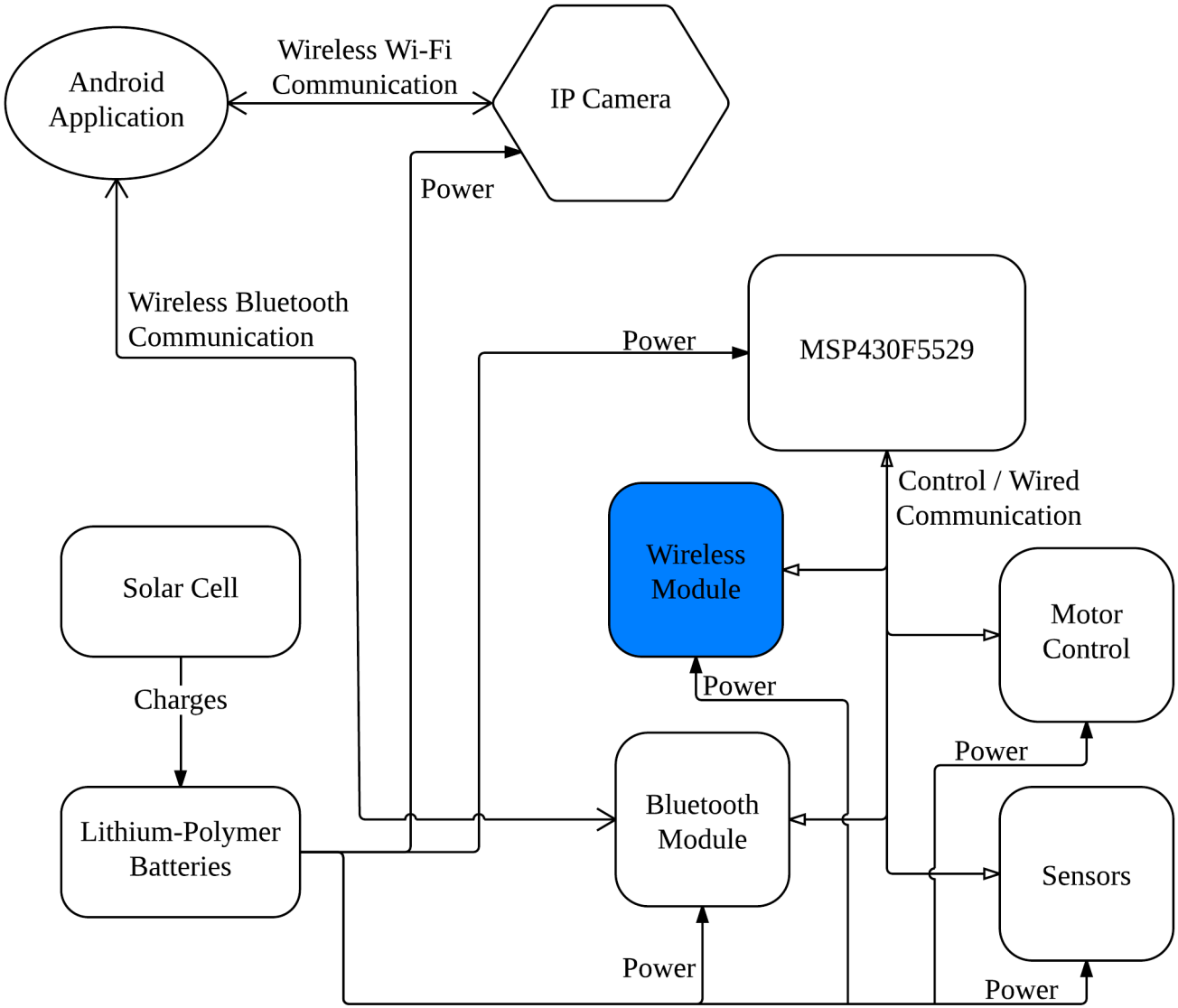
WI-FI DIRECT

- Newer, less frequently used protocol.
- Android developers documentation for Wi-Fi P2P
- Highly energy inefficient

BLUETOOTH MODULE

- **RN41-XV Bluetooth Module ($30, SparkFun)**
- **Operates at 3.3V, 30mA**
- **Bluetooth version 2.1**
- **Sustained data rate 240 Kbps**
- **115,200 baud**
- **Used to transmit data between the Android application and the MSP430F5529.**

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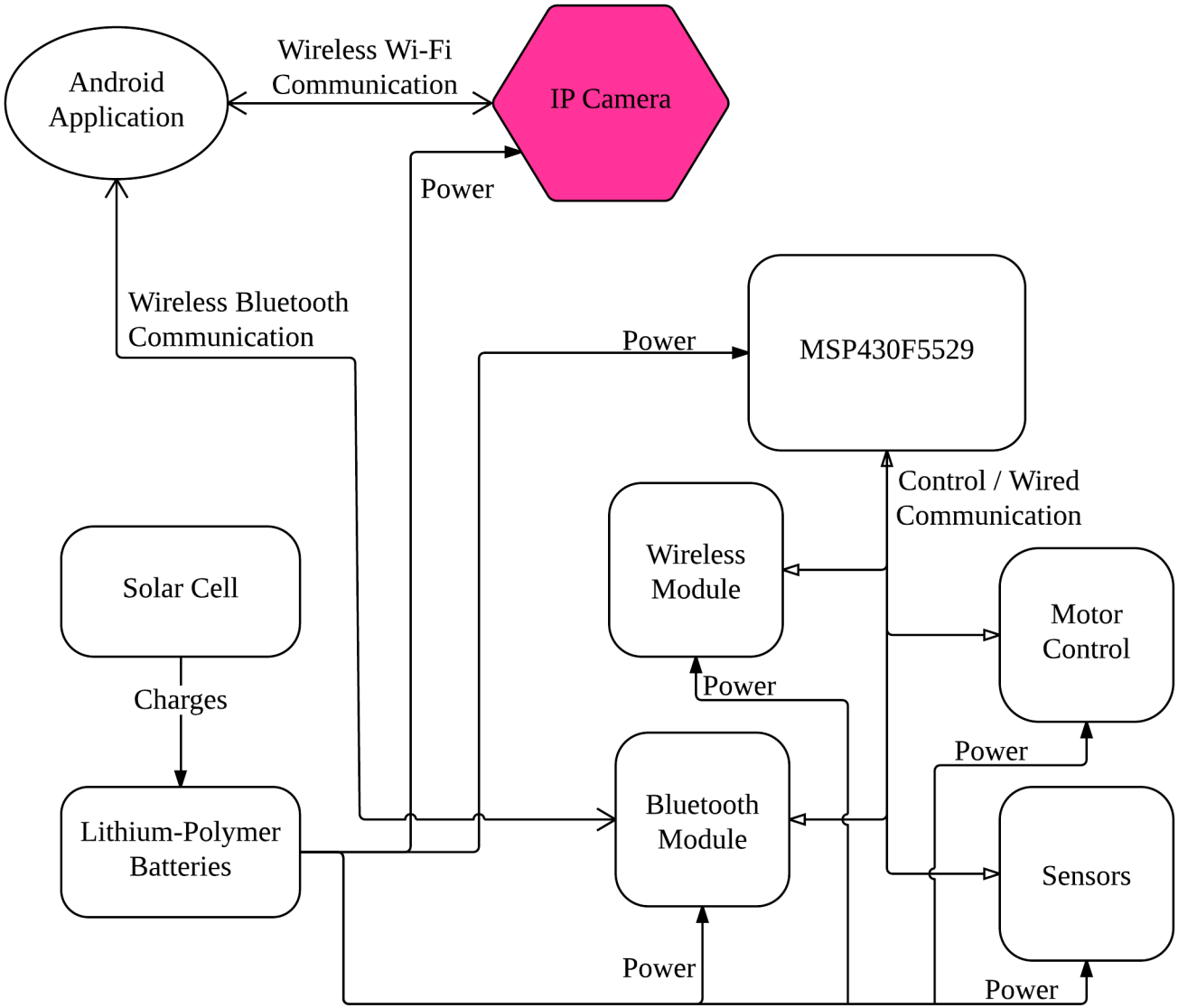
WIRELESS MODULE

- **RN-XV Wifly Module ($35, SparkFun)**
- **Operates at 3.3V, 38mA**
- **115,200 baud**
- **Once connected to a Wi-Fi network, module has a "show rssi" command that returns the current RSSI of the network.**
- **Ex)**
  RSSI =(-55) dBm

WHY BOTH MODULES?

- **The wireless module is preoccupied.**
  - Using the “show rssi” command means that the module must be in command mode
  - In command mode, normal operations are halted, and the user can only send specific commands to the module.
- **Thus, Bluetooth is used solely for communication, wireless is used solely for accessing wireless networks and retrieving data.**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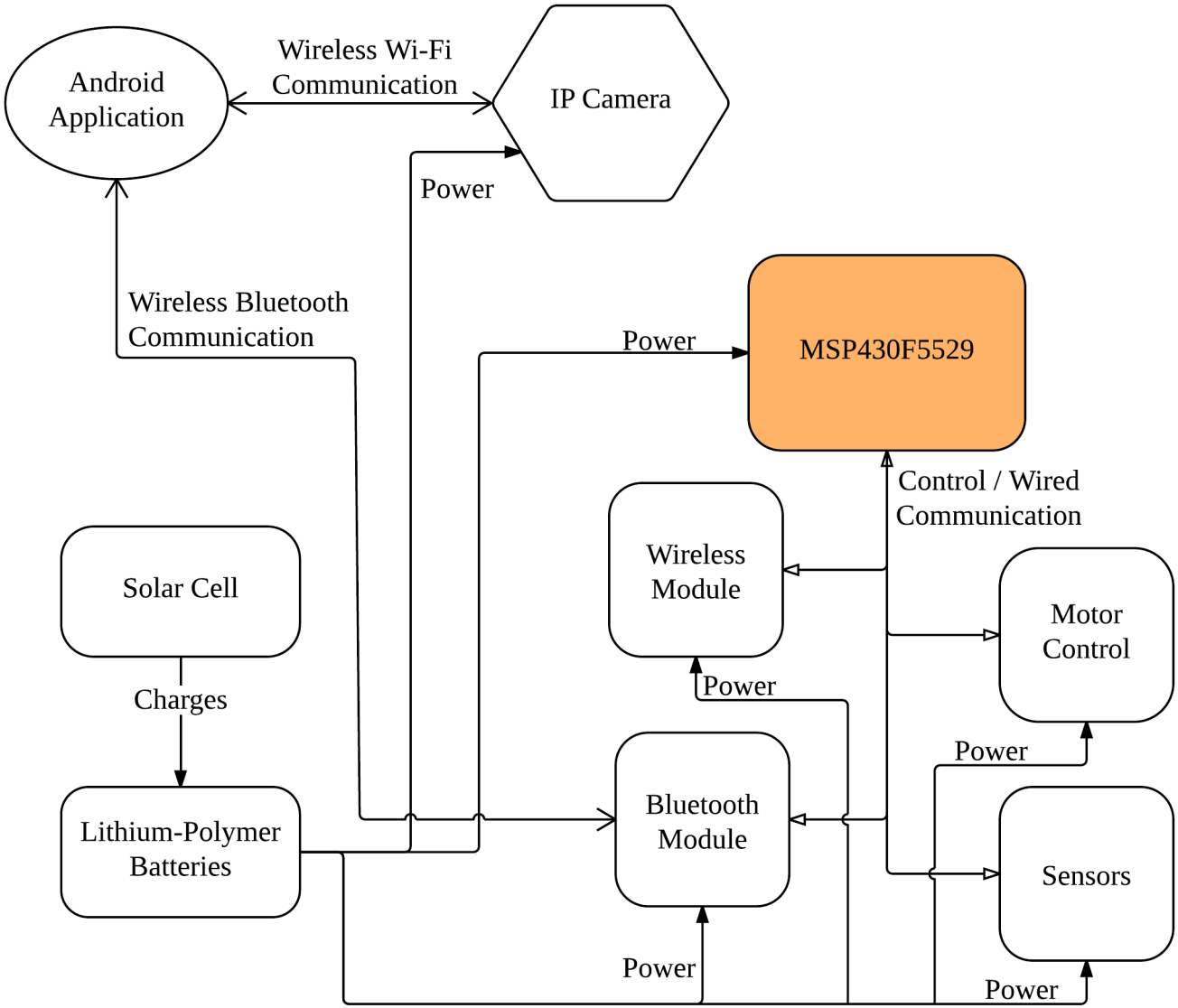
IP CAMERA

- **D-Link DCS-932L ($55, Amazon)**
- **Operates at 5V, 1.2A**
- **Directly connects to a wireless network**
- **Video stream can be accessed from its IP address**
- **Video stream can also be forwarded to a registered domain**

ACCESSING THE VIDEO FEED

- **The IP camera's video feed will be accessible through an IP address.**
- **The Android application will retrieve this video feed using the WebView class.**
- **The camera is equipped with security, requiring a username and password combination in order to access the video feed.**
  - This will prevent other users from accessing the camera.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CHOOSING A MICROCONTROLLER

ATMEGA328

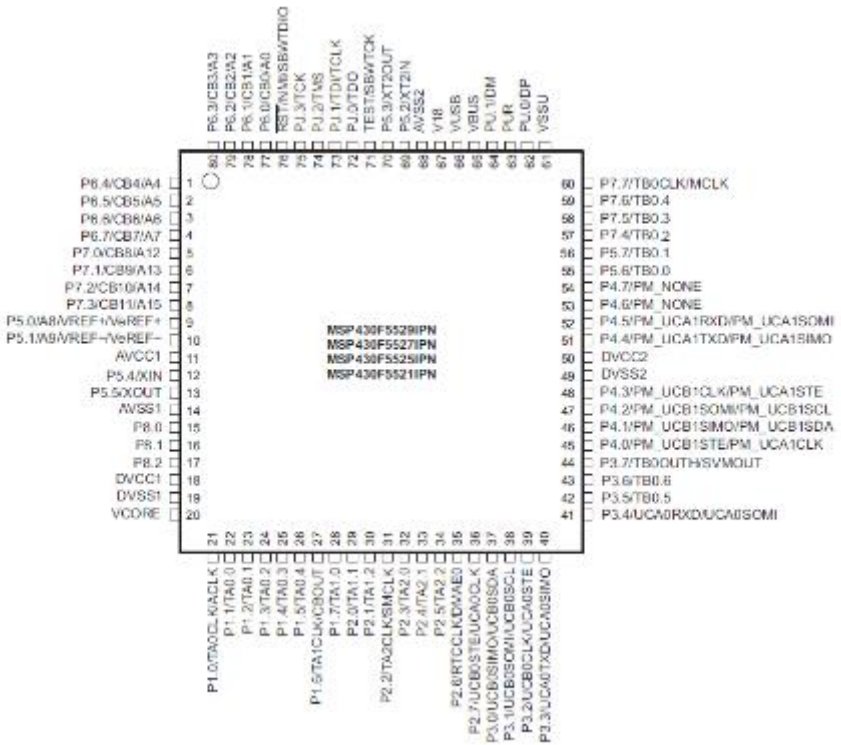
- 1 UART, 1 I2C, 0 SPI
- 14 Digital I/O pins
- 1.8-5.5V
- 2KB RAM
- 32KB Memory
- 20 MHz CPU speed

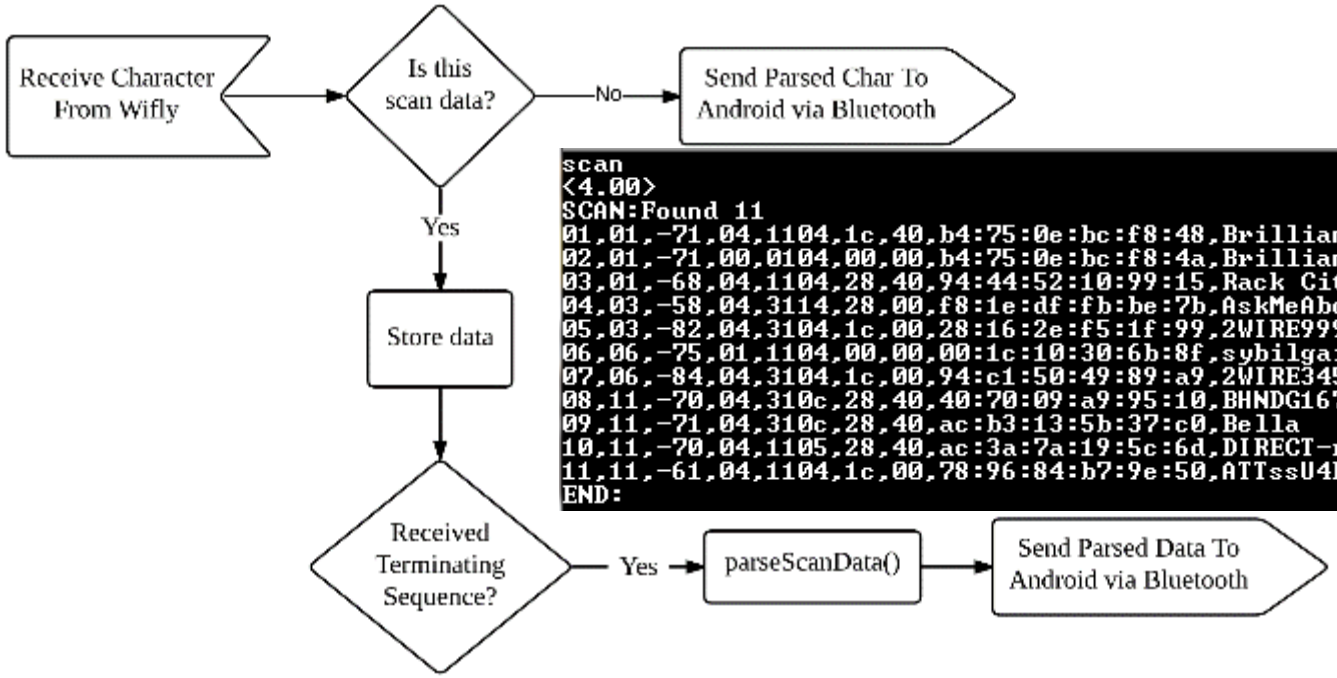
MSP430F5529

- 2 UART, 2 I2C, 4 SPI
- 63 Digital I/O pins
- 1.8-3.6V
- 8KB RAM
- 128KB Memory
- 25 MHz CPU speed

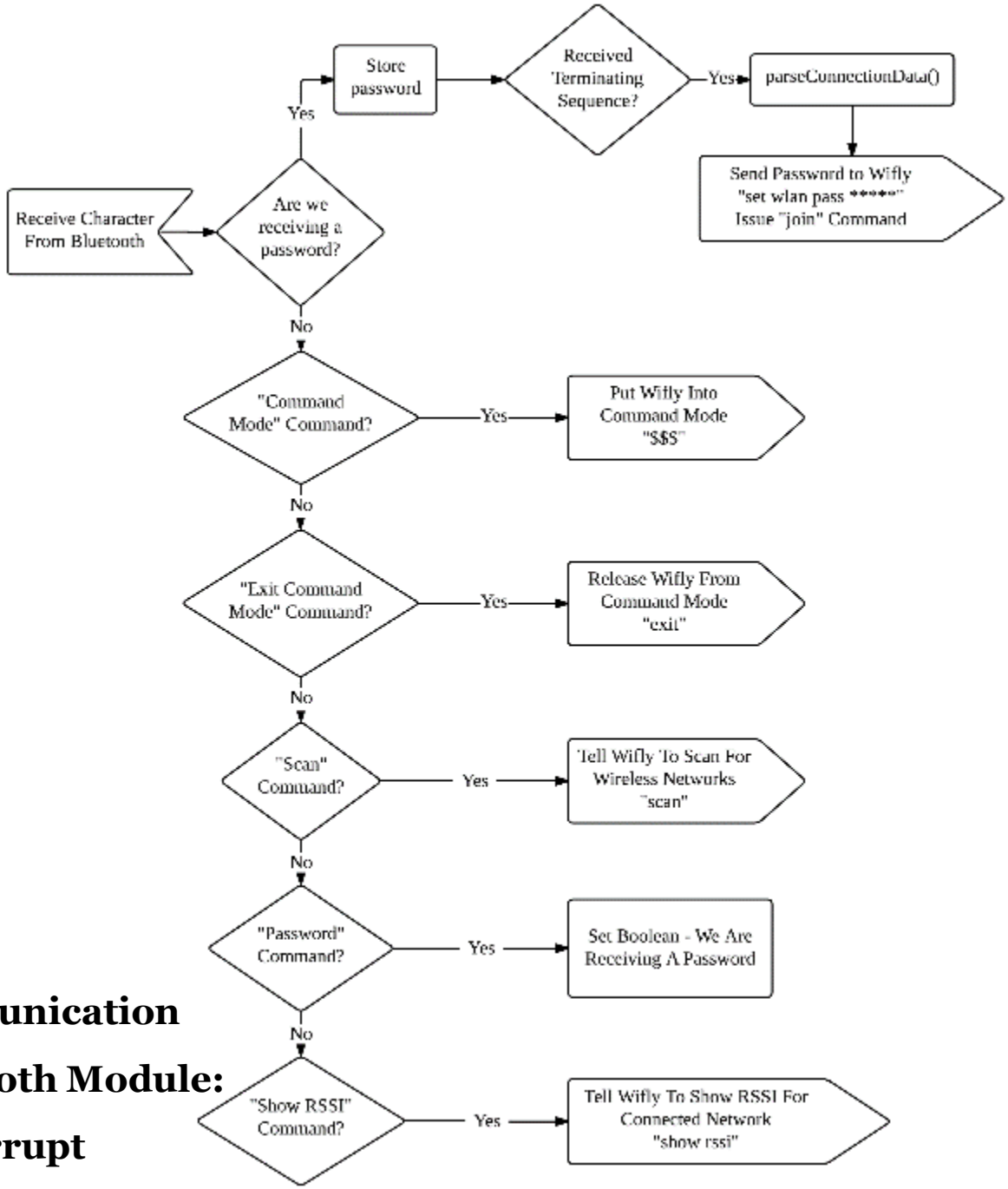
MSP430F5529

- **TI's MSP430F5529 will be the brain of the Wi-Fi Seeker robot**
- **Communicates with**
  - **Bluetooth module**
  - **Wireless module**
  - **Sensors**
  - **Motor controllers**
- **Will be responsible for the autonomous seeking algorithm**





MSP Communication with Wi-Fi Module: UCAo_Interrupt



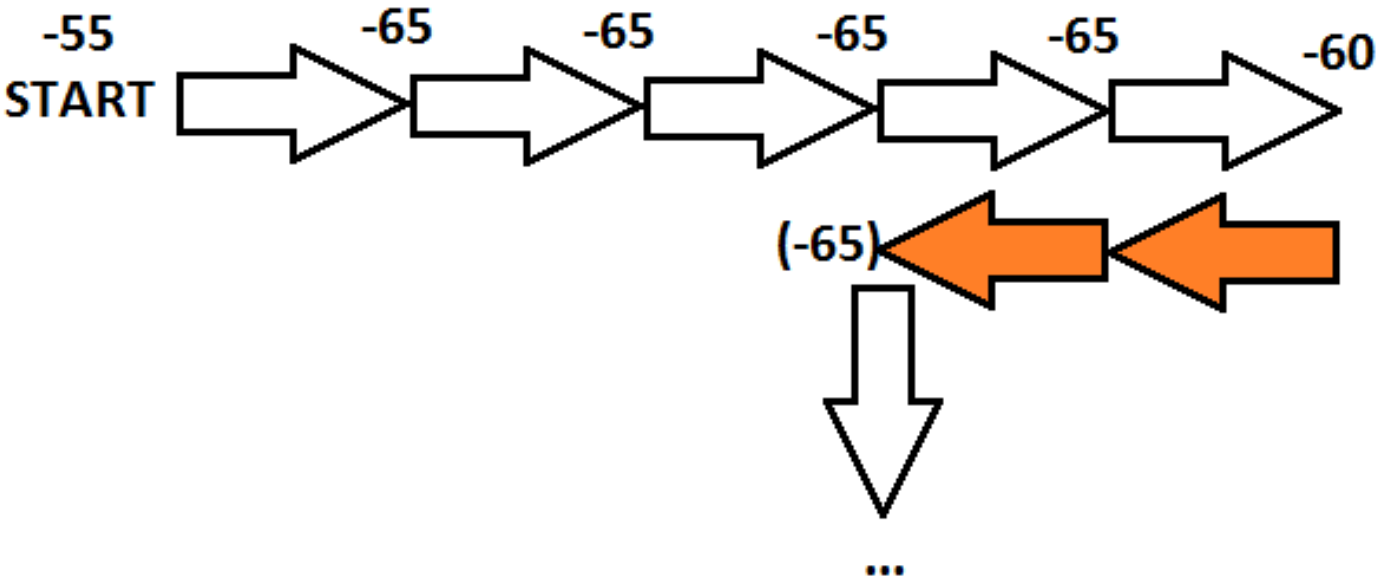
MSP Communication with Bluetooth Module: UCA1_Interrupt

THE AUTONOMOUS ALGORITHM

- **The algorithm is based off of the dynamic reception of the wireless signal strength.**
  - The RSSI value can be retrieved by sending a “show rssi” command to the wireless module.
- **When the user begins the autonomous algorithm, the robot will begin taking RSSI measurements and moving accordingly.**

THE AUTONOMOUS ALGORITHM

- **The robot will move two tire rotations, then take an RSSI measurement.**
  - This RSSI value will then be compared to the previously measured RSSI value.
  - A count will be kept for when the same RSSI value is measured consecutively.
- **If the new RSSI measurement is greater than or equal to the previous RSSI measurement, continue to move in the current direction.**
- **Else if the new RSSI measurement is less than the previous RSSI measurement, reverse for half of the measurements taken at the previous RSSI measurement, and then turn 90 degrees.**

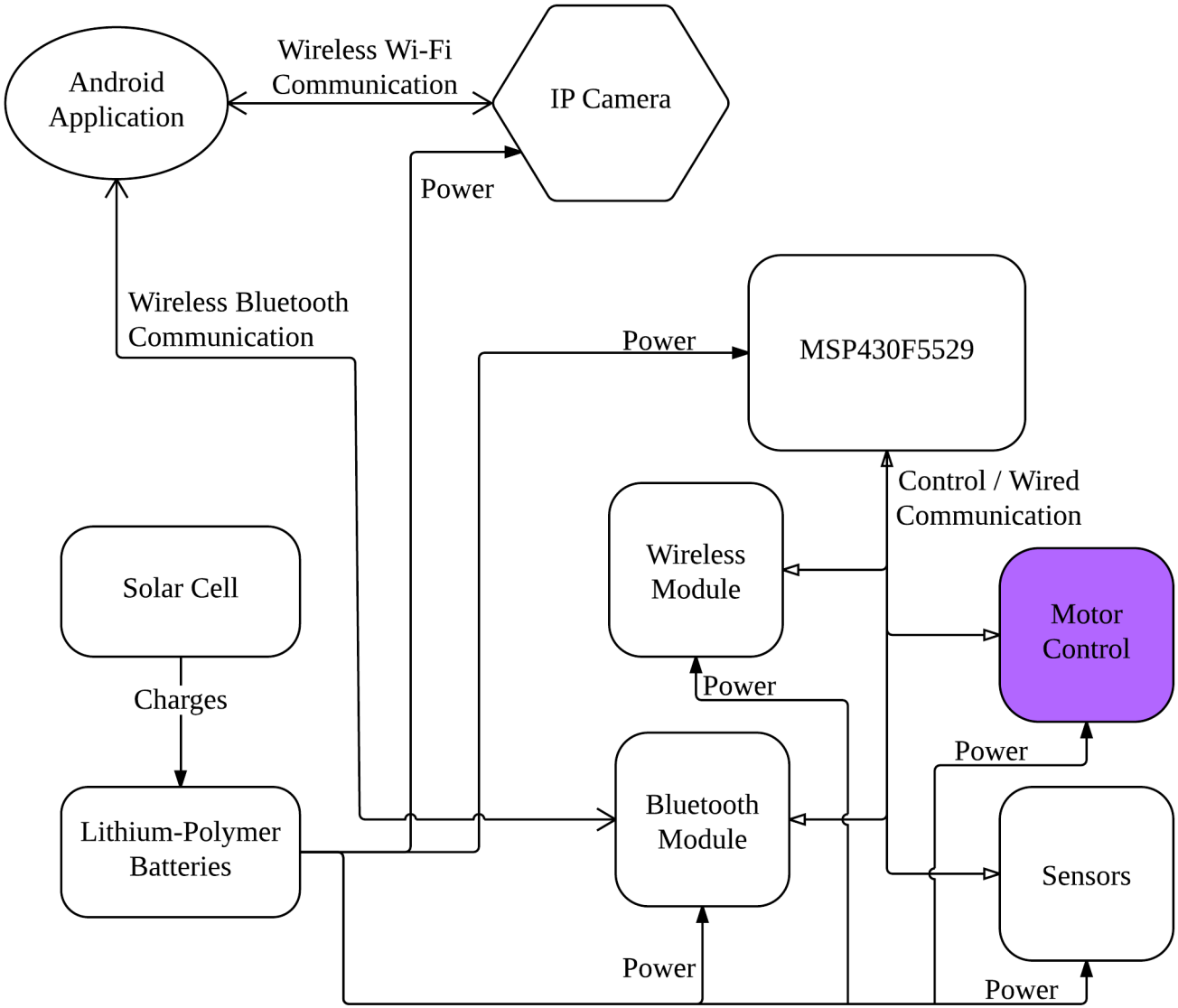


Autonomous Algorithm – Visual Example

PROGRAMING THE MSP

- **Programming the MSP430F5529 chip is its own problem.**
- **Possible options include designing a JTAG, or buying an expensive programming tool.**
- **Using a G2553 is a third, and is the cheapest and easiest to implement.**

G2553	F5529
3.3V	3.3V
GND	GND
TEST under J3	SBW TEST
RST under J3	SBW RST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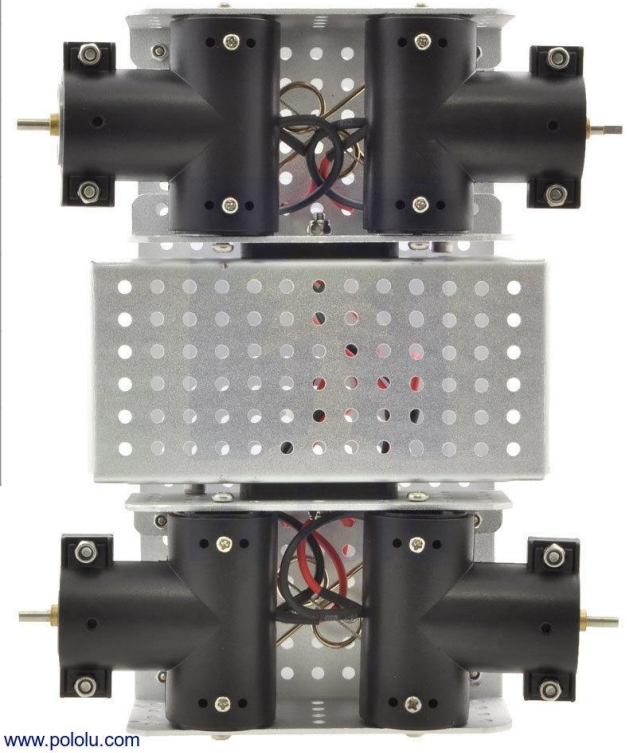
ROBOT PLATFORM

- **4-wheel drive chassis**
- **“Super-twist” suspension**
- **Spiked tires**

Dagu Wild Thumper 4WD	
Dimension	280x300x130mm
Weight	1.9kg
Ground Clearance	60mm
Wheels	120x60mm

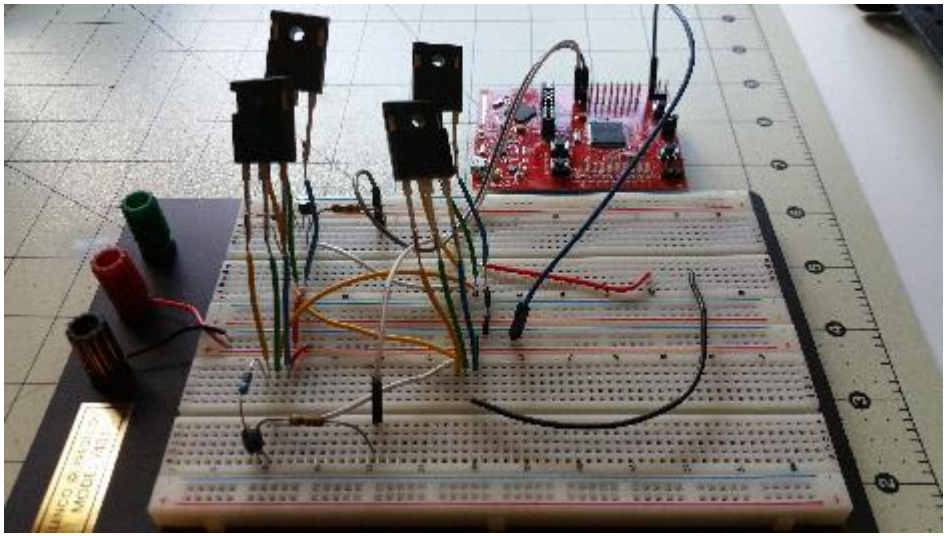
MOTORS

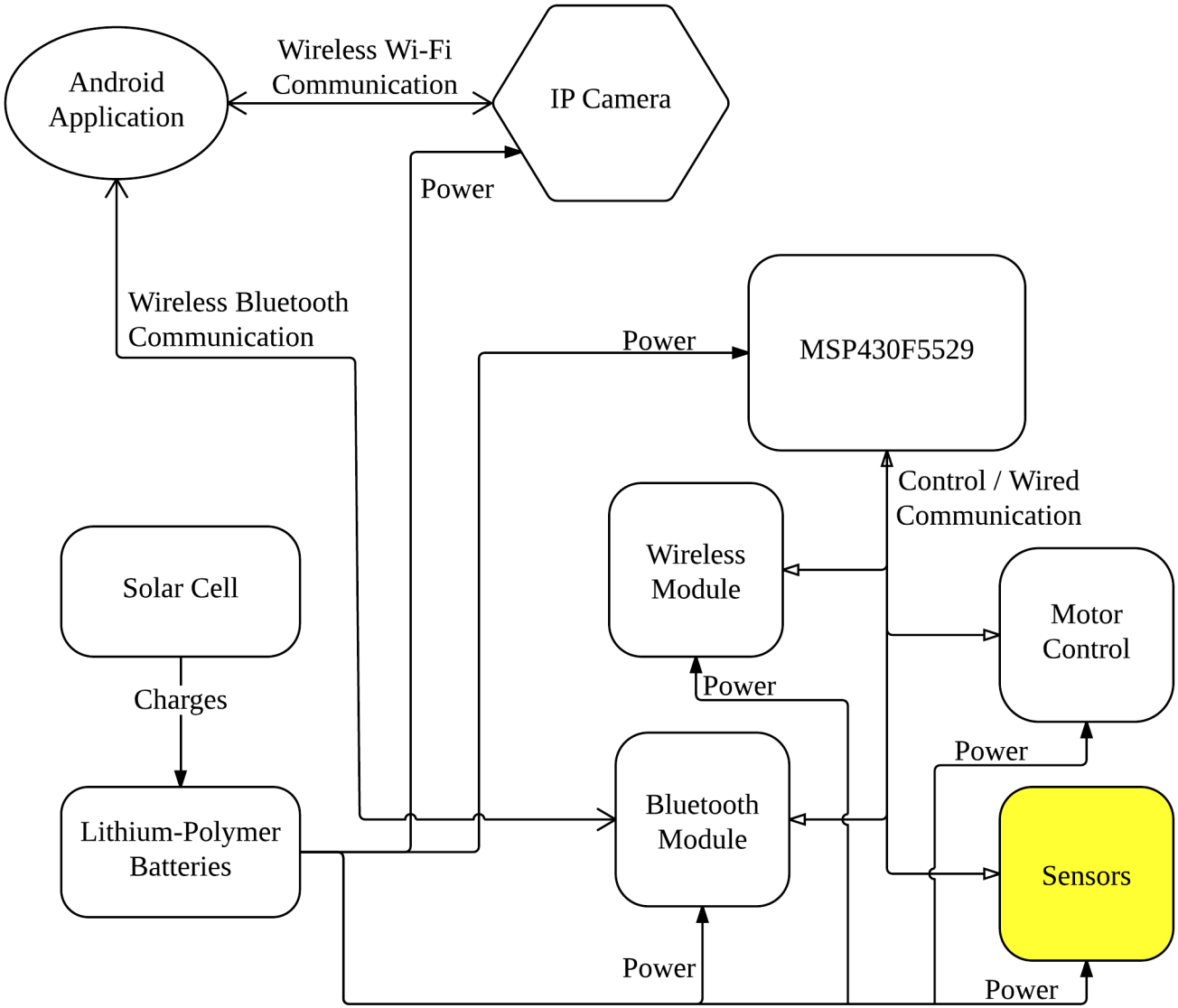
DC Motor	
Description	**Value**
Gear ratio	34:1
Working voltage	2-7.2V
Stall current	6.6A
No-load current	420mA
Top Speed @ 7.2V	4.5 mph
Stall torque	5kg-cm
No-load shaft speed @ 7.2V	350 RPM



MOTOR CONTROLLER

MJH6284 (NPN) MJH6284 (PNP)	
Description	**Value**
Collector-Emitter Voltage	100V
Collector-Base Voltage	100V
Collector Current	20A Continuous 40A Peak

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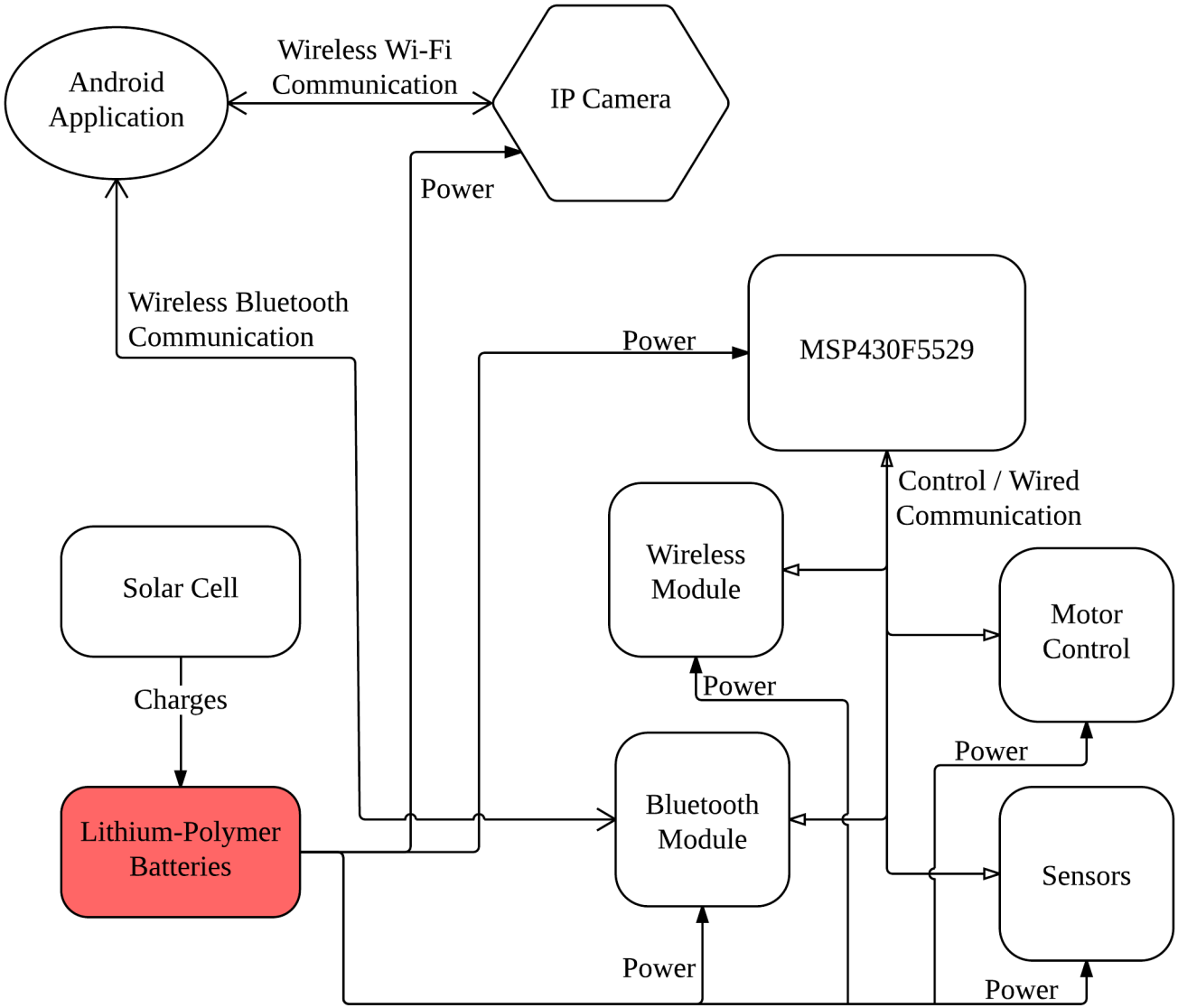
PROXIMITY SENSORS

HC-SR04	
Description	**Value**
Working Voltage	5V
Working Current	15mA
Max Range	400 cm
Min Range	2 cm
Measure Angle	15 degrees
Trigger Input Signal	10uS TTL pulse
Echo Pulse	Input TTL lever signal and the range in proportion
Dimension	45x20x15mm

PROXIMITY SENSORS

Sharp GP2Y0A21YK	
Description	**Value**
Operating Voltage	5V
Working Current	30mA
Max Range	80cm
Min Range	10cm
Measure Angle	40 degrees
Dimension	40x13x13.5mm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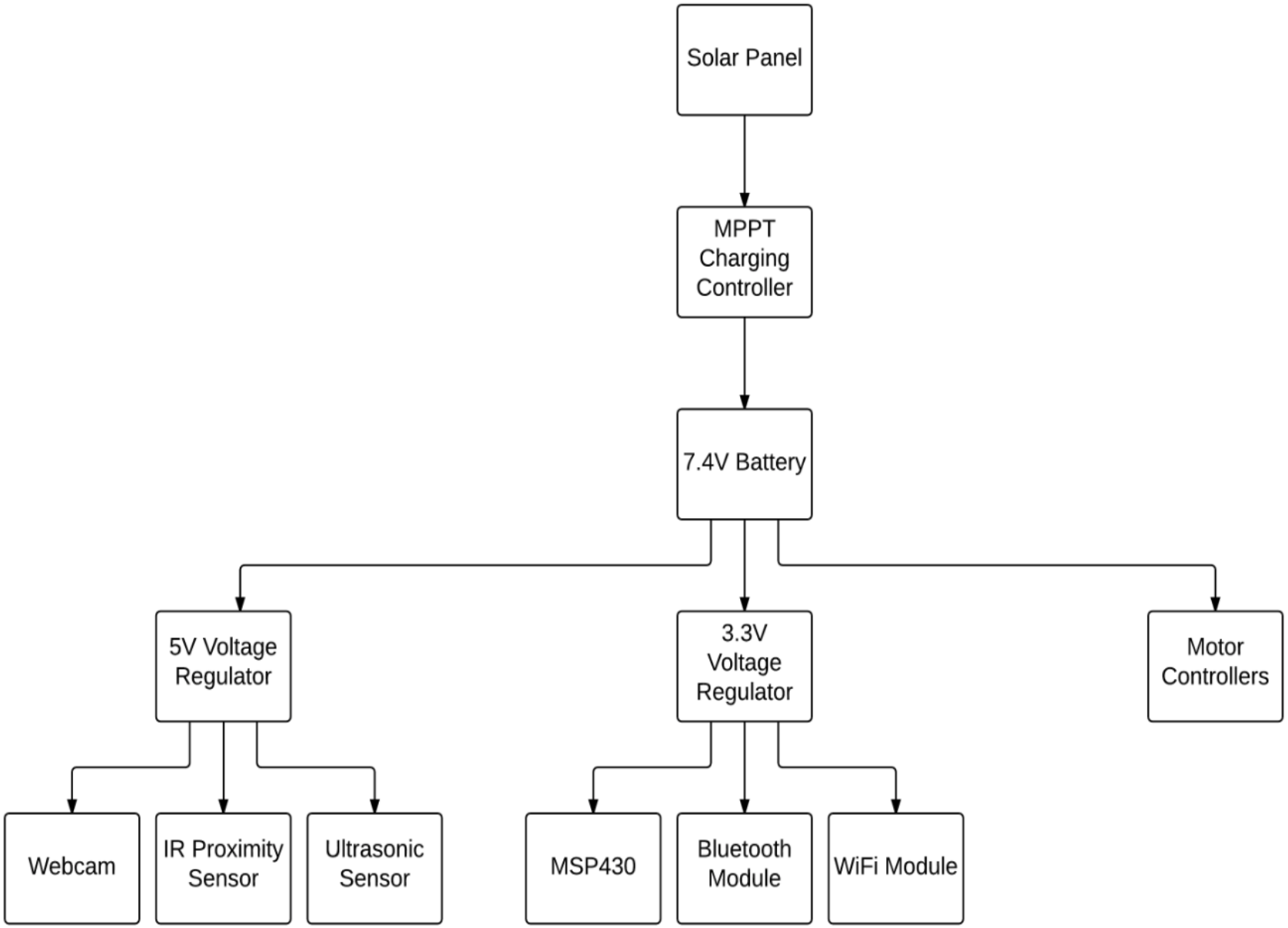
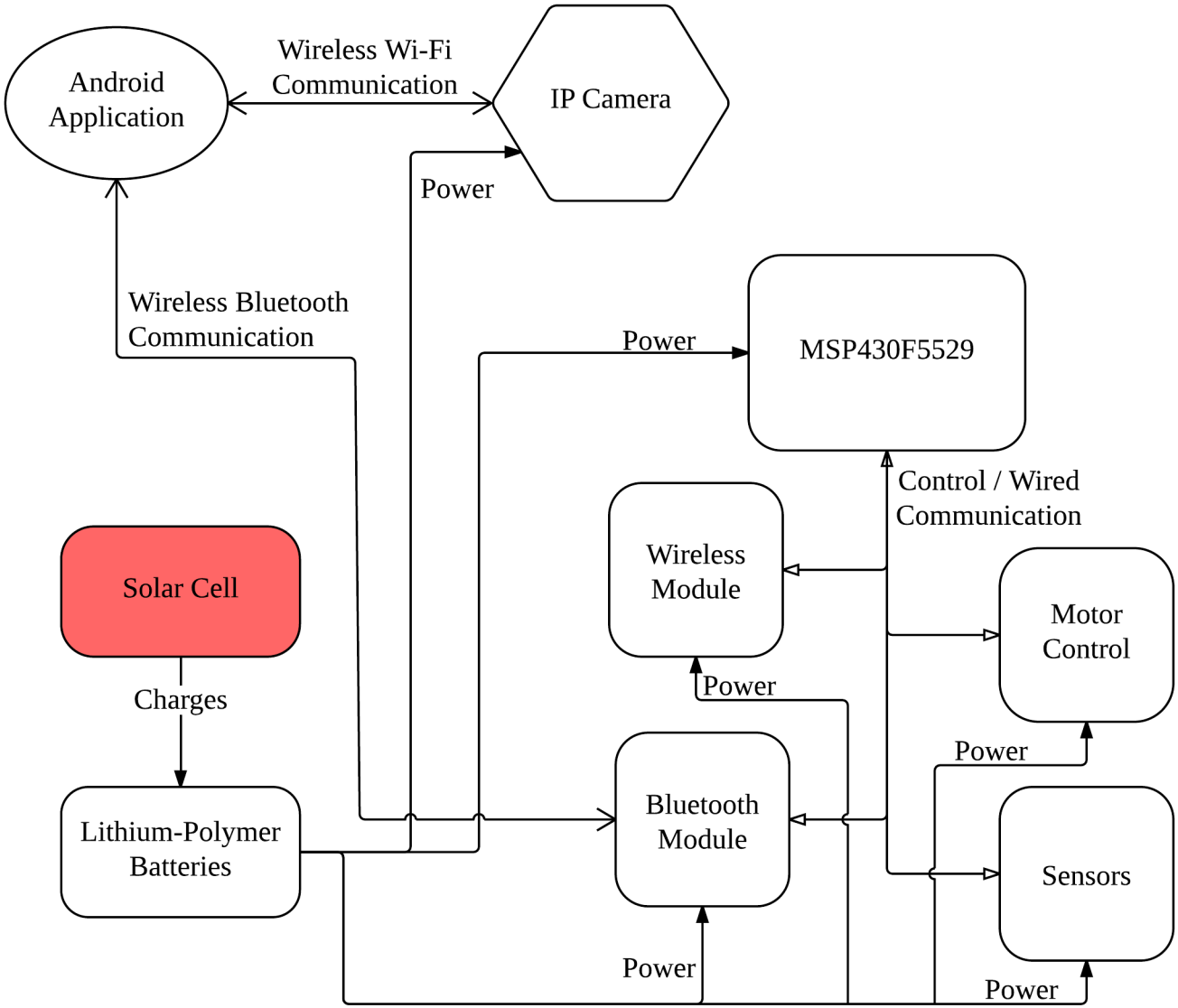
BATTERY

- **Chemistry: Lithium Polymer**
- **Voltage: 7.4V**
- **Capacity: 3200 mAh**
- **Discharge Rate: 20C**
- **Max Output Current: 3200*20 = 64,000 mA or 64 A**
- **Total Current of System (worst case): 28A**

POWER REQUIREMENTS

Component	Voltage Requirement	Current Requirement
Ultrasonic Sensor	4.5-5.5 V	10-20 mA
Infrared Proximity Sensor	4.5-5.5 V	30-40 mA
Webcam	5V	1.2 A
Motor Controller	7.2 V	26.4 A
Microcontroller	1.8-3.6 V	15.4-17.2 mA
WiFi Module	3-3.7 V	15-180 mA
Bluetooth Module	3-3.6 V	35-160 mA


Solar Panel
MPPT Charging Controller
7.4V Battery
5V Voltage Regulator
3.3V Voltage Regulator
Motor Controllers
Webcam
IR Proximity Sensor
Ultrasonic Sensor
MSP430
Bluetooth Module
WiFi Module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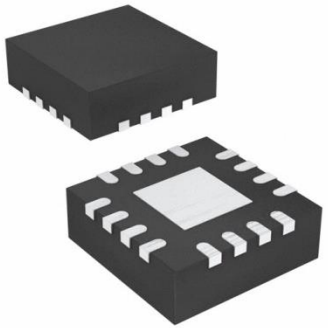
SOLAR PANEL

Specification	Value
Manufacturer	Solartech Power Inc.
Model #	SPM010P
Price ($)	69.95
Maximum Power (Watts)	10
Nominal Voltage (V)	12
Operating Current (A)	0.59
Efficiency (%)	9.5
Weight (lb)	3.3
Area (in^2)	176.9
Crystal Structure	Polycrystalline

Battery Charge Time: 3200 mAh/ 590 mA = 5.4 hrs

CHARGING CONTROLLER

- **Part #: bq24650**
- **Package: QFN 16**
- **Charging Cycle: Preconditioning, CC, CV**
- **Maximum Power Point Tracking**
- **V_{mppset} = 17.3V**
- **V_{batt} = 7.4V**
- **I_{charge} = 3A**



$$V_{MPPSET} = 1.2\ V \times \left[1 + \frac{R3}{R4}\right]$$

$$V_{BAT} = 2.1\ V \times \left[1 + \frac{R2}{R1}\right]$$

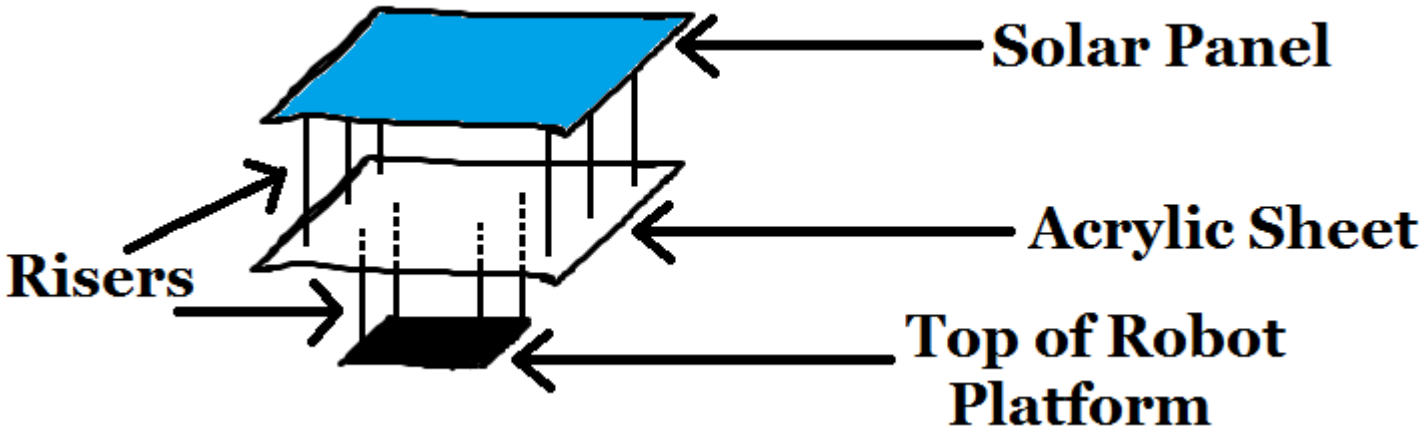
$$I_{CHARGE} = \frac{40\ mV}{R_{SR}}$$

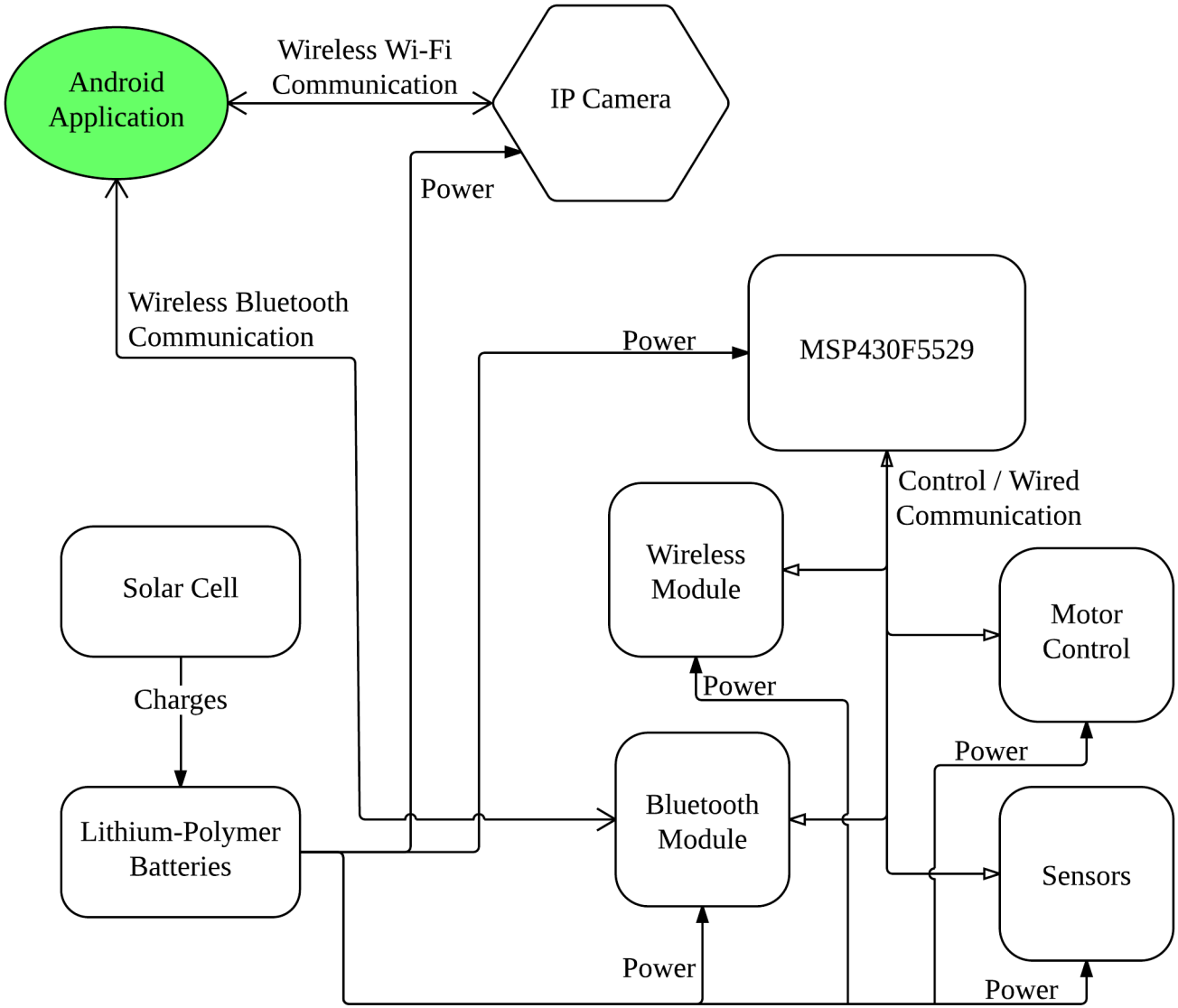
SWITCHING VOLTAGE REGULATOR

- **Part # TPS54336**
- **Package: SOIC 8**
- **Adjustable Output**
- **3.3V & 5V**
- **Efficiency: 86-93%**
- **Max Current: 3A**
- **Small Footprint**
- **Switching Frequency: 340 kHz**

SOLAR PANEL MOUNT

- **Solar panel will be mounted via a custom mount made of acrylic**

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CHOOSING ANDROID

GOOGLE'S ANDROID

- No developer's fee
- Extensive documentation and example code
- Widely compatible with Bluetooth

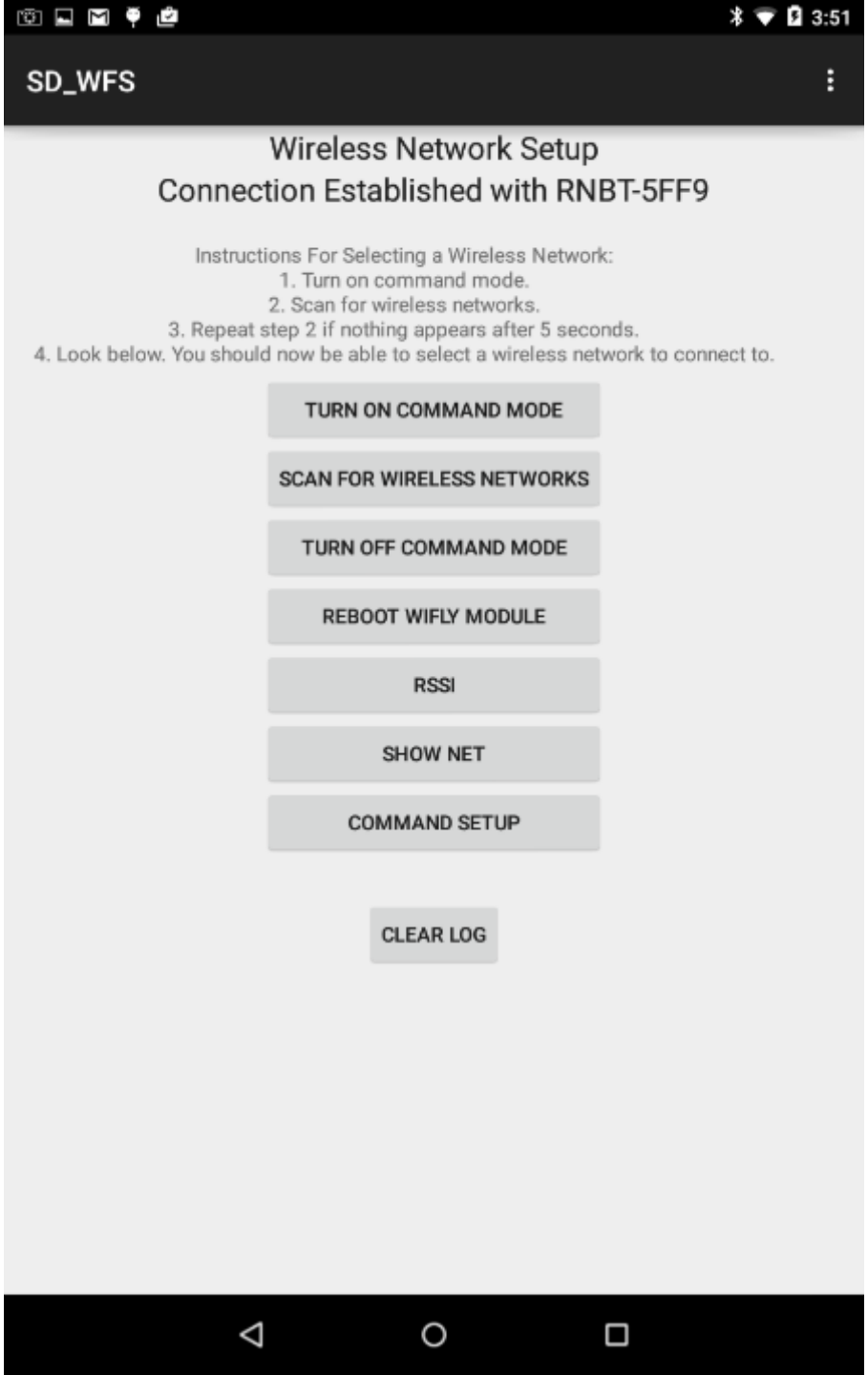
APPLE'S IOS

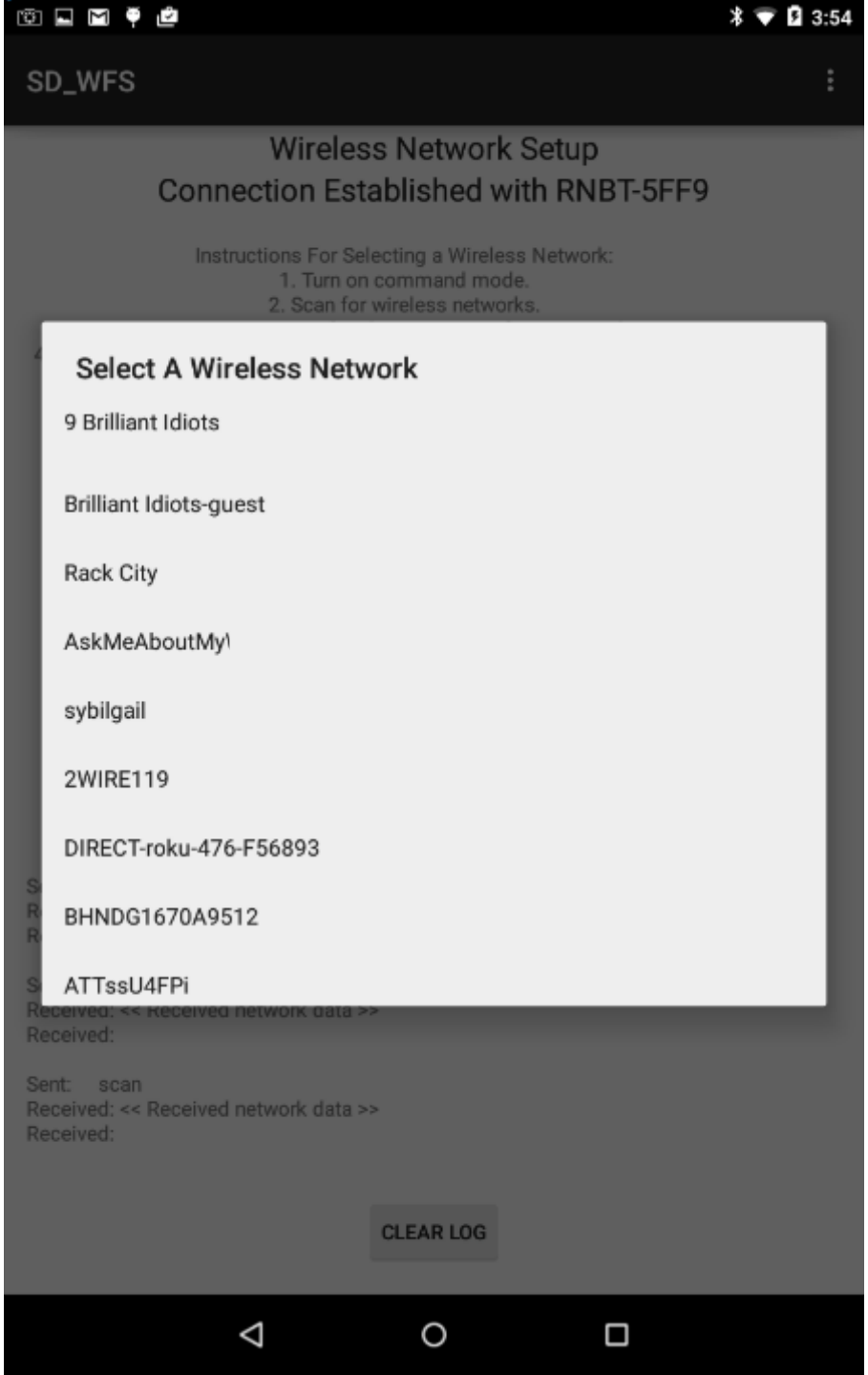
- $100 annual developers fee
- Well-documented, Apple developer forums
- Encrypted, would need special Bluetooth module

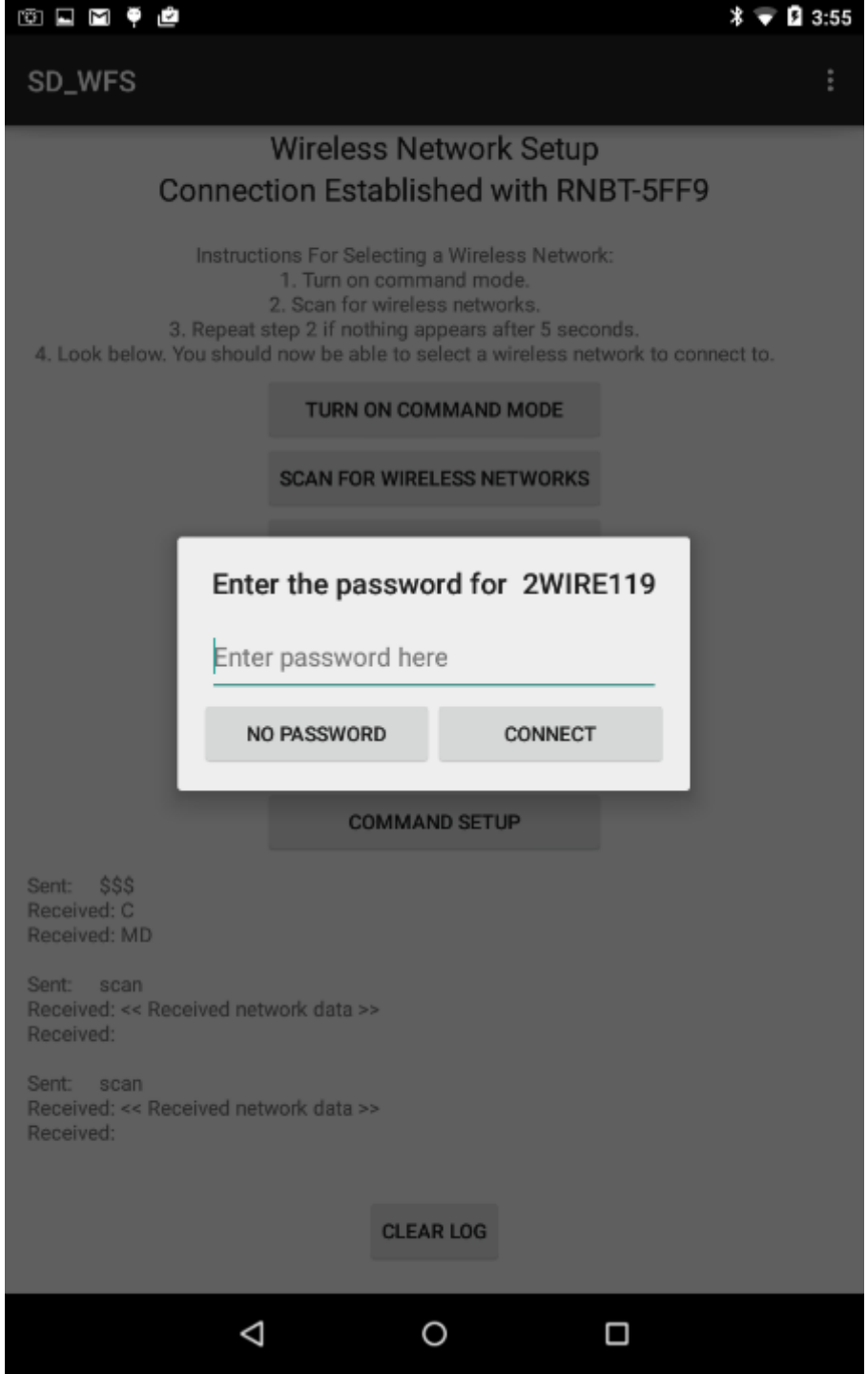
ANDROID APPLICATION

- **Developing for Android version 4.4 (KitKat)**
- **IDE: Android Studio**
- **User interface for the user to control the Wi-Fi Seeker robot**
  - Bluetooth connection setup
  - IP camera setup
  - Selecting a wireless network
  - Manual control
  - Autonomous functionality


3:51
SD_WFS
Bluetooth Setup
Attempting to Connect to Selected Bluetooth Device
Bluetooth Devices:
CHRISTY-PC
AC:72:89:DE:73:8E
RNBT-5FF9
00:06:66:61:5F:F9
SEARCH FOR BT DEVICES
STOP SCANNING


3:51
SD_WFS
Wireless Network Setup
Connection Established with RNBT-5FF9
Instructions For Selecting a Wireless Network:
1. Turn on command mode.
2. Scan for wireless networks.
3. Repeat step 2 if nothing appears after 5 seconds.
4. Look below. You should now be able to select a wireless network to connect to.
TURN ON COMMAND MODE
SCAN FOR WIRELESS NETWORKS
TURN OFF COMMAND MODE
REBOOT WIFLY MODULE
RSSI
SHOW NET
COMMAND SETUP
CLEAR LOG


3:54
SD_WFS
Wireless Network Setup
Connection Established with RNBT-5FF9
Instructions For Selecting a Wireless Network:
1. Turn on command mode.
2. Scan for wireless networks.
Select A Wireless Network
9 Brilliant Idiots
Brilliant Idiots-guest
Rack City
AskMeAboutMy\
sybilgail
2WIRE119
DIRECT-roku-476-F56893
BHNDG1670A9512
ATTssU4FPi
Received: << Received network data >>
Received:
Sent: scan
Received: << Received network data >>
Received:
CLEAR LOG


3:55
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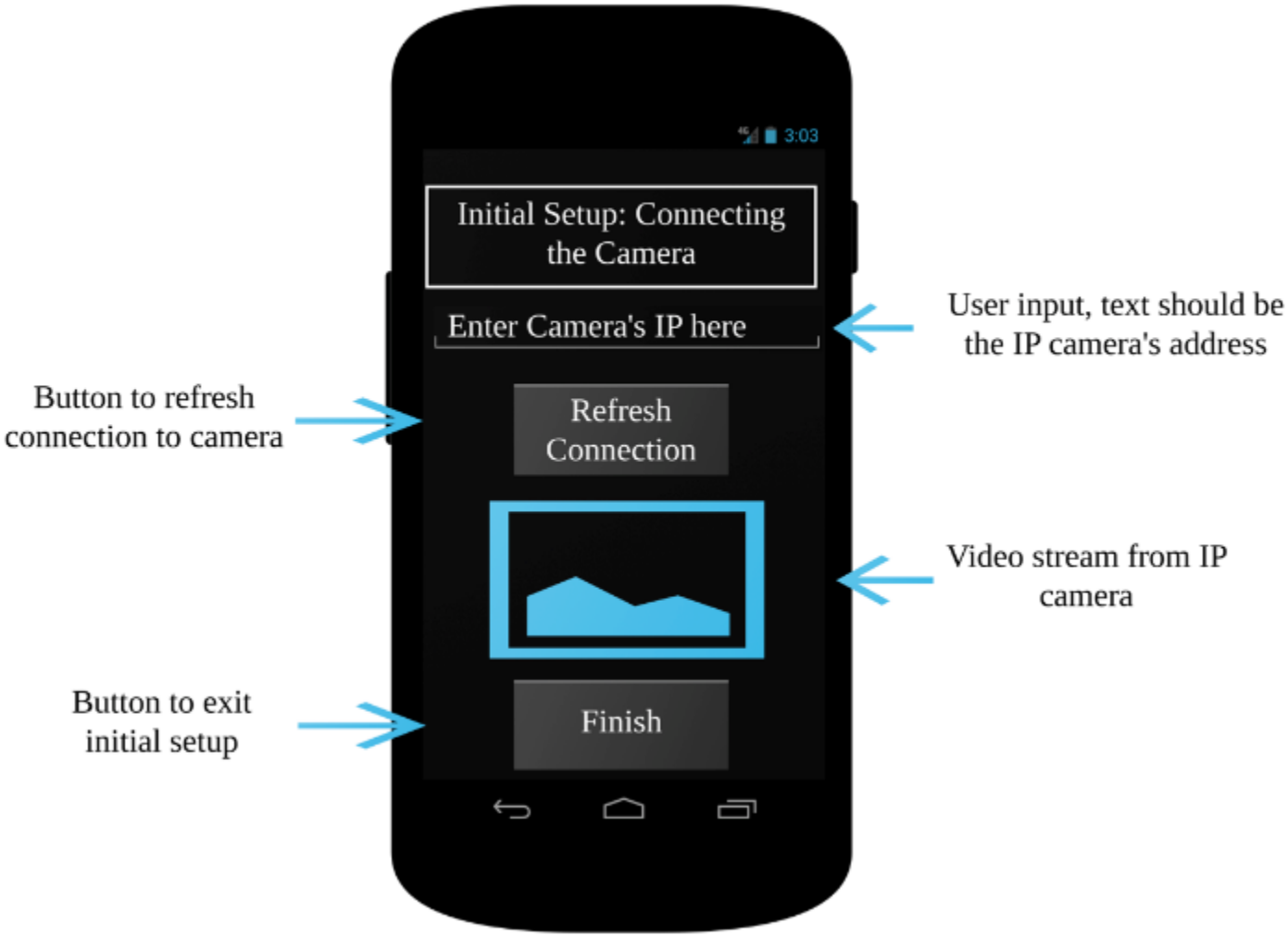
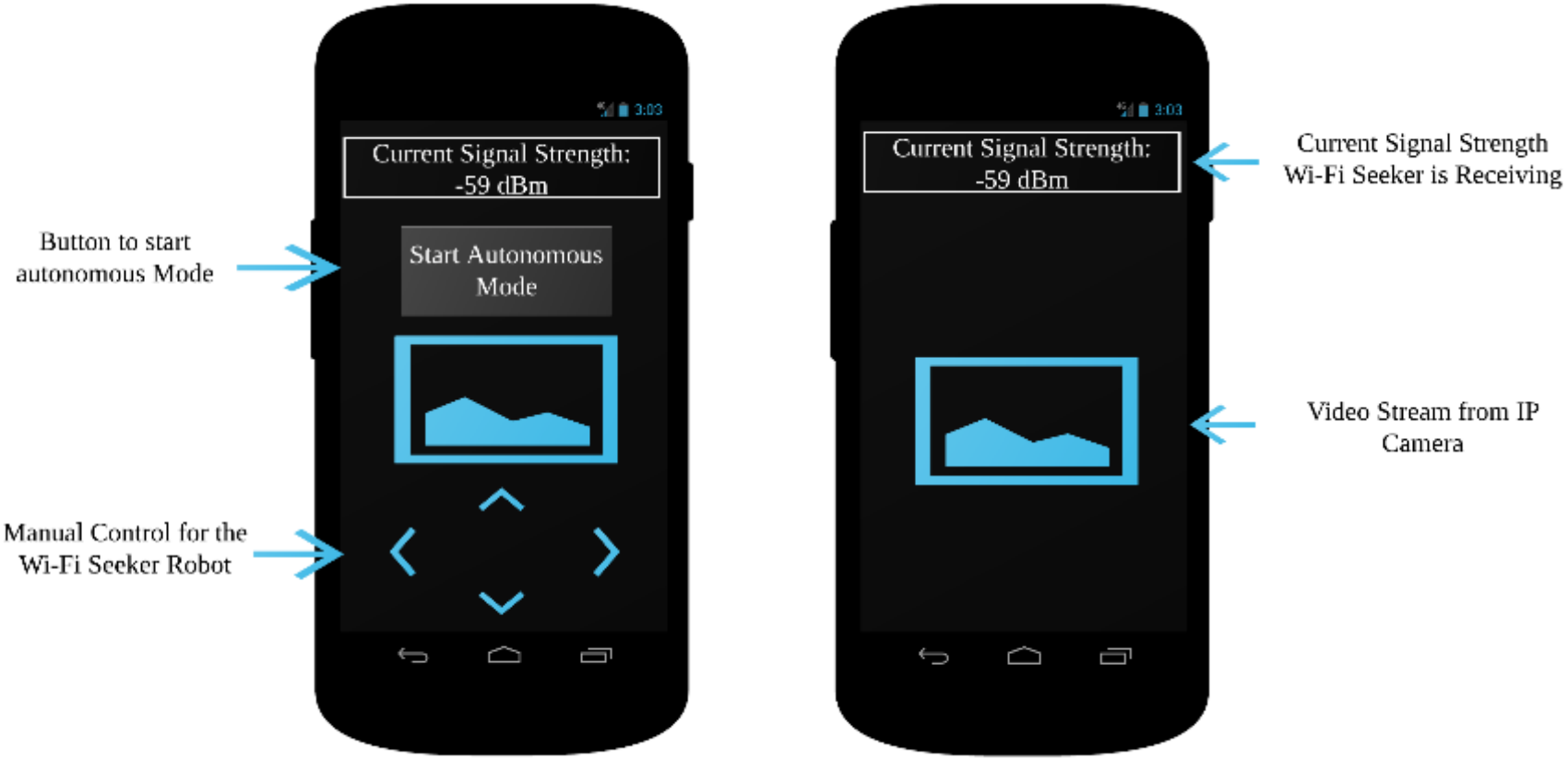
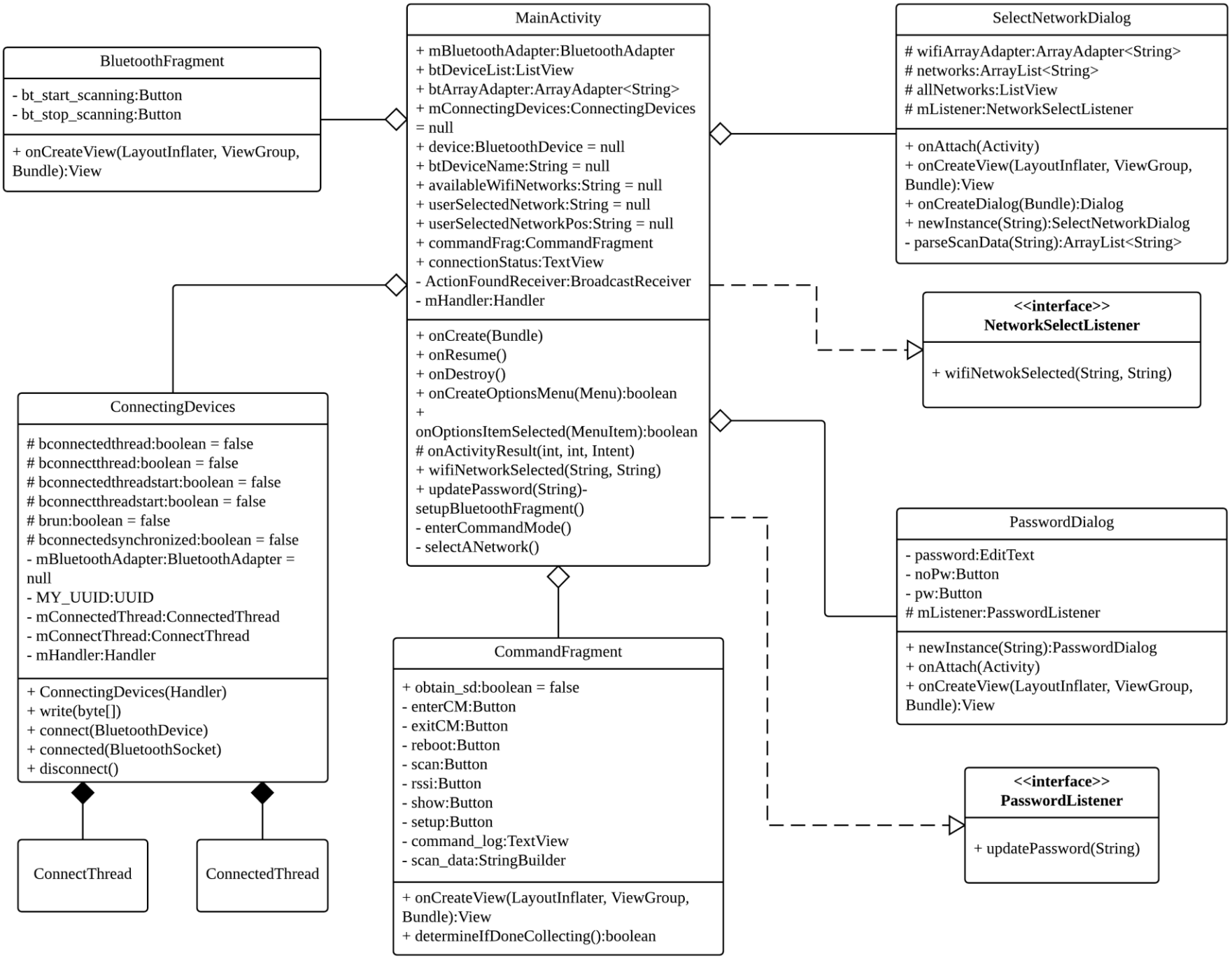
TURN ON COMMAND MODE
SCAN FOR WIRELESS NETWORKS
Enter the password for 2WIRE119
Enter password here
NO PASSWORD
CONNECT
COMMAND SETUP
Sent: $$$
Received: C
Received: MD
Sent: scan
Received: << Received network data >>
Received:
Sent: scan
Received: << Received network data >>
Received:
CLEAR LOG



IP Camera Setup - Design

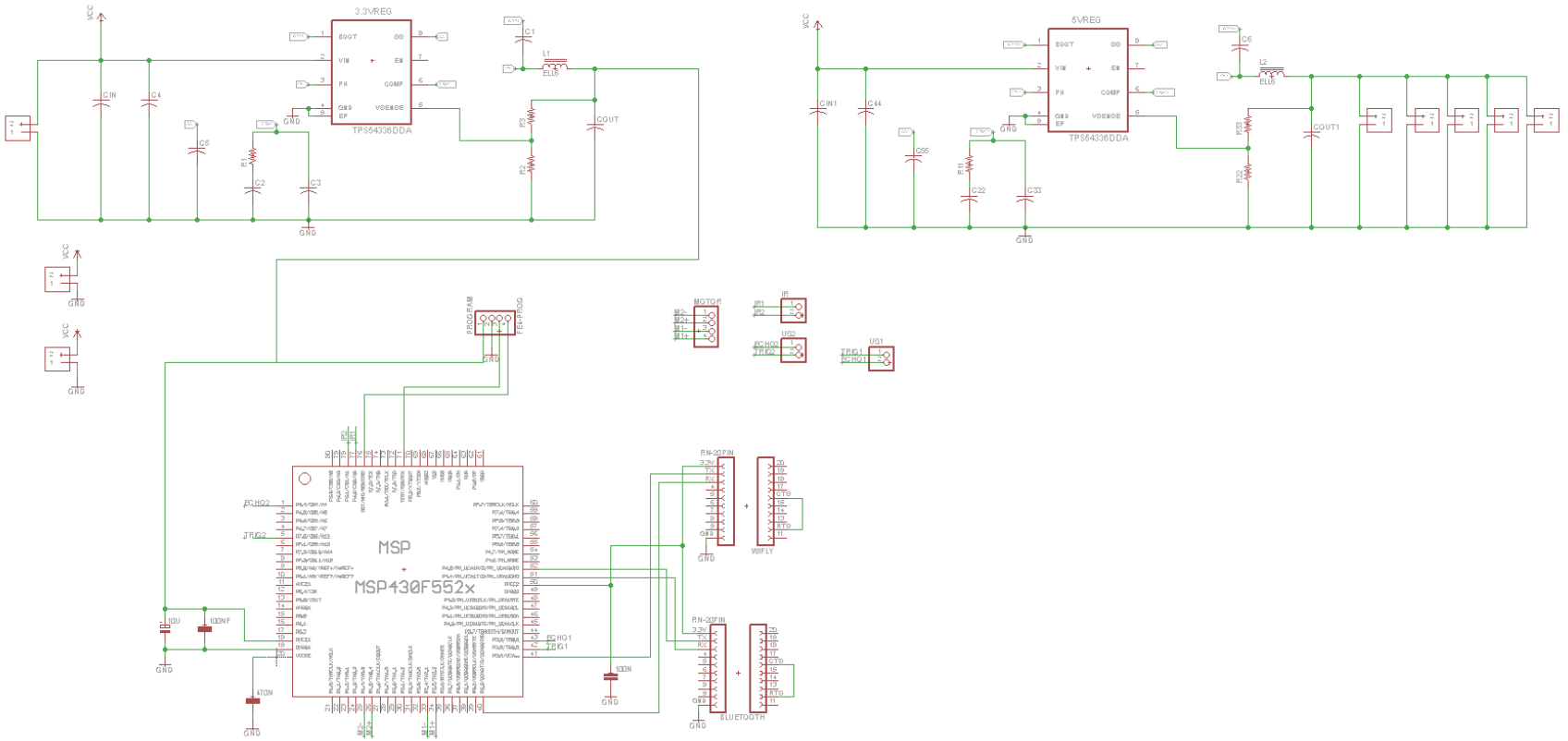


Manual And Autonomous Modes - Design

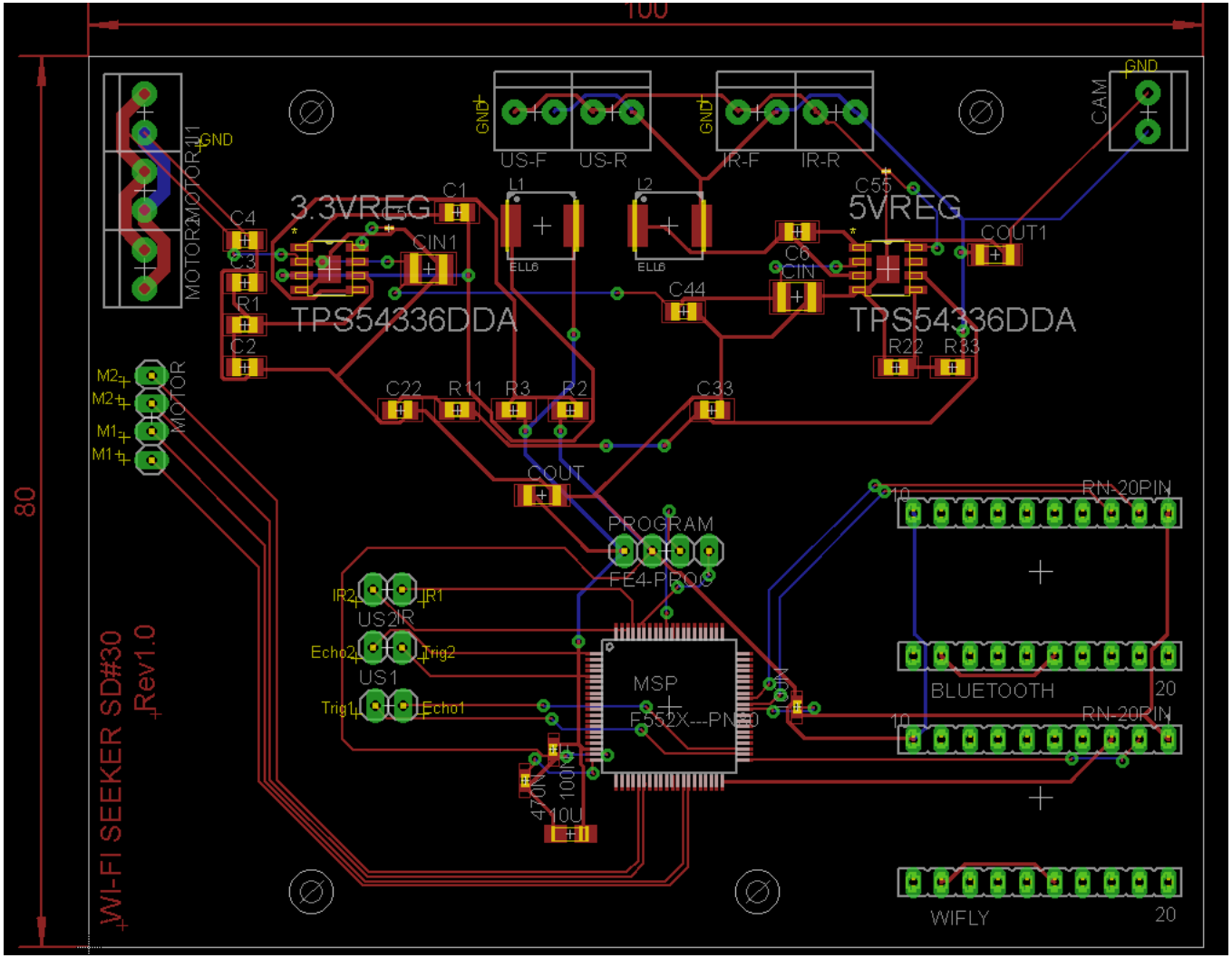

BluetoothFragment
- bt_start_scanning:Button
- bt_stop_scanning:Button
+ onCreateView(LayoutInflater, ViewGroup, Bundle):View
MainActivity
+ mBluetoothAdapter:BluetoothAdapter
+ btDeviceList:ListView
+ btArrayAdapter:ArrayAdapter<String>
+ mConnectingDevices:ConnectingDevices = null
+ device:BluetoothDevice = null
+ btDeviceName:String = null
+ availableWifiNetworks:String = null
+ userSelectedNetwork:String = null
+ userSelectedNetworkPos:String = null
+ commandFrag:CommandFragment
+ connectionStatus:TextView
- ActionFoundReceiver:BroadcastReceiver
- mHandler:Handler
+ onCreate(Bundle)
+ onResume()
+ onDestroy()
+ onCreateOptionsMenu(Menu):boolean
+ onOptionsItemSelected(MenuItem):boolean
# onActivityResult(int, int, Intent)
+ wifiNetworkSelected(String, String)
+ updatePassword(String)-
setupBluetoothFragment()
- enterCommandMode()
- selectANetwork()
SelectNetworkDialog
wifiArrayAdapter:ArrayAdapter<String>
networks:ArrayList<String>
allNetworks:ListView
mListener:NetworkSelectListener
+ onAttach(Activity)
+ onCreateView(LayoutInflater, ViewGroup, Bundle):View
+ onCreateDialog(Bundle):Dialog
+ newInstance(String):SelectNetworkDialog
- parseScanData(String):ArrayList<String>
<<interface>>
NetworkSelectListener
+ wifiNetwokSelected(String, String)
ConnectingDevices
bconnectedthread:boolean = false
bconnectthread:boolean = false
bconnectedthreadstart:boolean = false
bconnectthreadstart:boolean = false
brun:boolean = false
bconnectedsynchronized:boolean = false
- mBluetoothAdapter:BluetoothAdapter = null
- MY_UUID:UUID
- mConnectedThread:ConnectedThread
- mConnectThread:ConnectThread
- mHandler:Handler
+ ConnectingDevices(Handler)
+ write(byte[])
+ connect(BluetoothDevice)
+ connected(BluetoothSocket)
+ disconnect()
ConnectThread
ConnectedThread
CommandFragment
+ obtain_sd:boolean = false
- enterCM:Button
- exitCM:Button
- reboot:Button
- scan:Button
- rssi:Button
- show:Button
- setup:Button
- command_log:TextView
- scan_data:StringBuilder
+ onCreateView(LayoutInflater, ViewGroup, Bundle):View
+ determineIfDoneCollecting():boolean
PasswordDialog
- password:EditText
- noPw:Button
- pw:Button
mListener:PasswordListener
+ newInstance(String):PasswordDialog
+ onAttach(Activity)
+ onCreateView(LayoutInflater, ViewGroup, Bundle):View
<<interface>>
PasswordListener
+ updatePassword(String)

SCHEMATICS AND PCB DESIGN

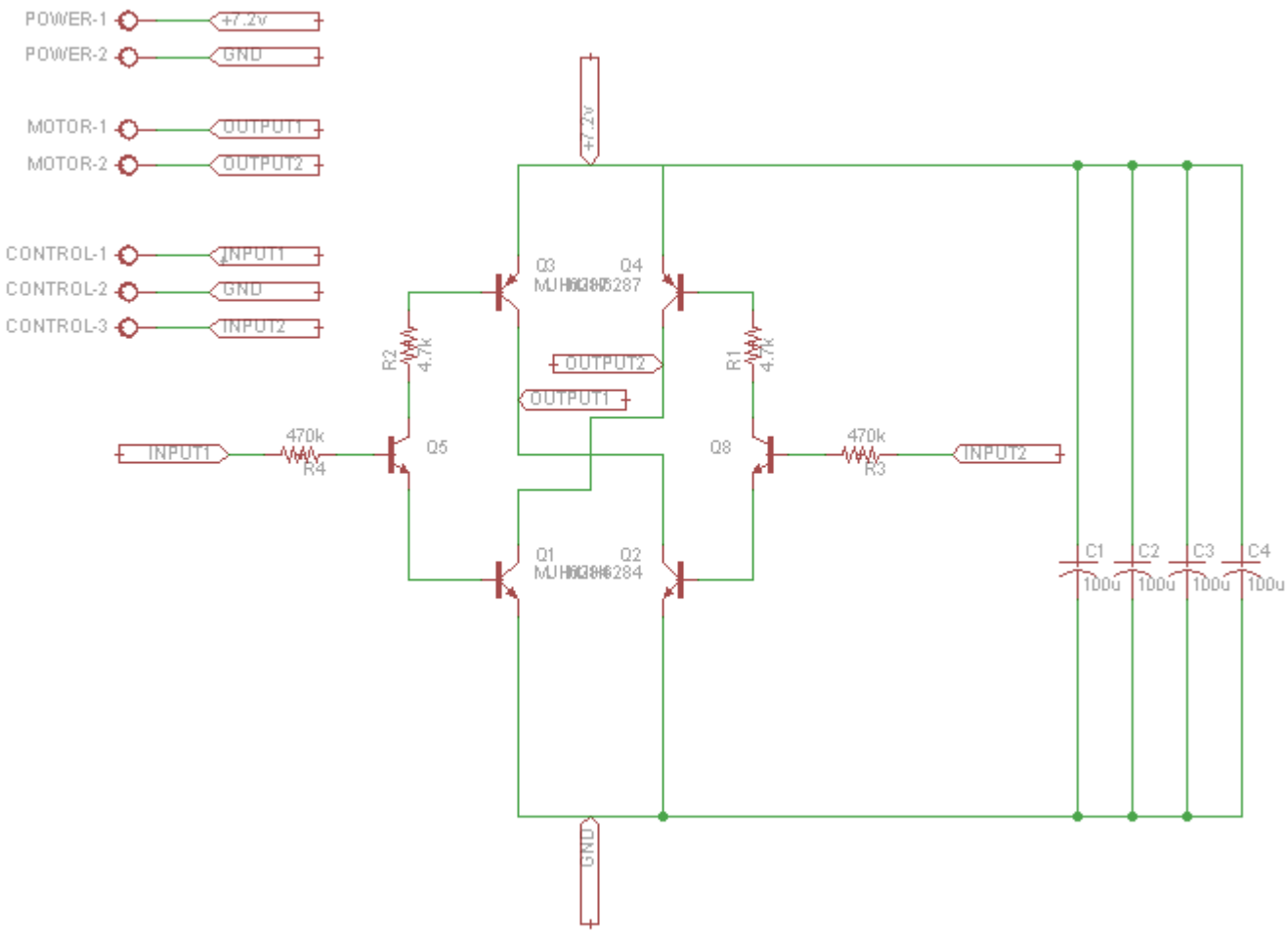
SCHEMATIC 1 - MAIN



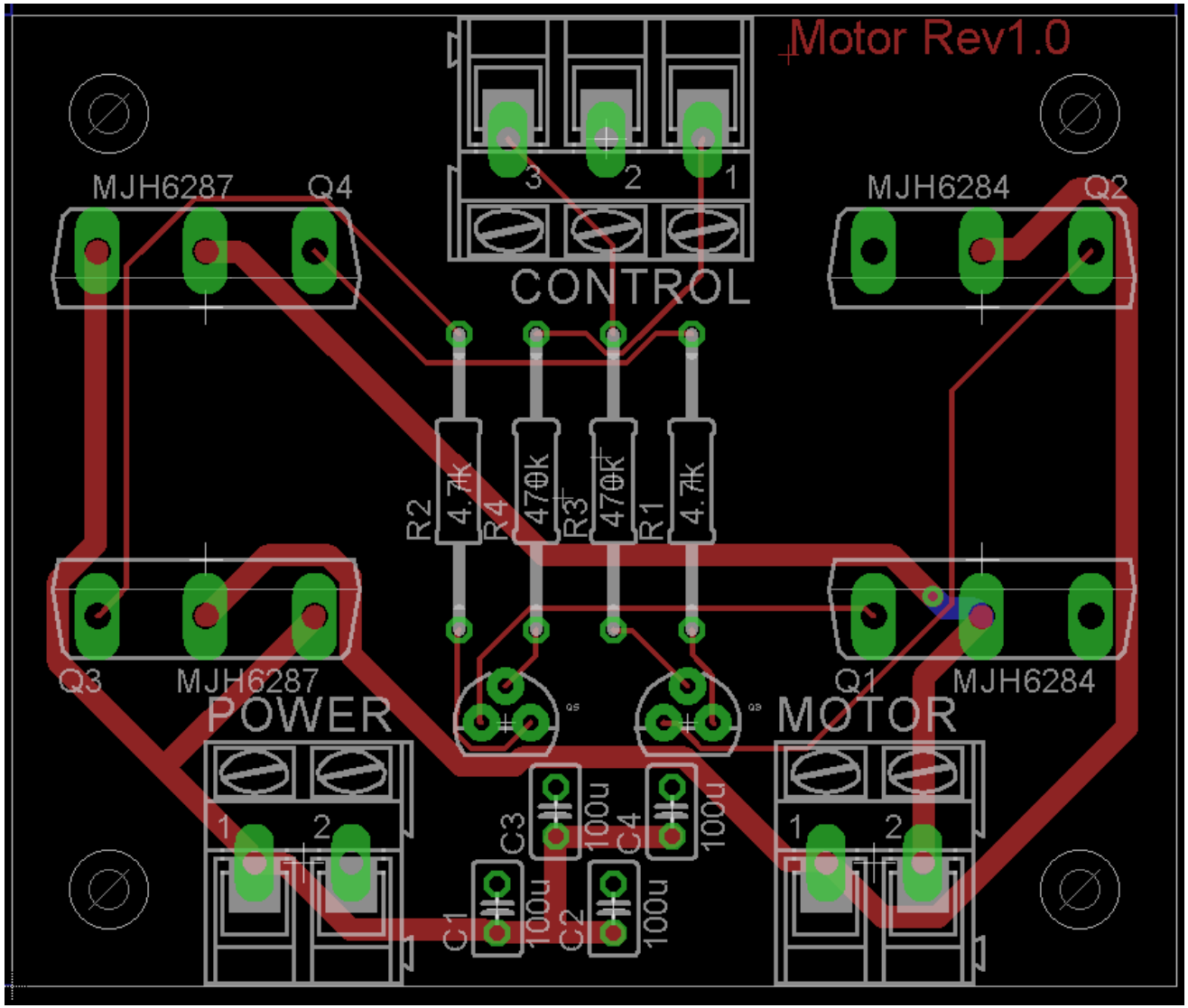
PCB - MAIN


100
80
MOTOR1
MOTOR2
GND
US-F
US-R
IR-F
IR-R
CAM
3.3VREG
5VREG
TPS54336DDA
TPS54336DDA
C1
C4
C3
R1
C2
CIN1
L1
L2
C55
C6
CIN
COUT1
C44
R22
R33
C22
R11
R3
R2
C33
COUT
MOTOR
M2
M2
M1
M1
PROGRAM
FE4-PROG
IR2
IR1
US2IR
Echo2
Trig2
US1
Trig1
Echo1
MSP
F552X---PN80
RN-20PIN
BLUETOOTH
RN-20PIN
WIFLY
20
20
WI-FI SEEKER SD#30
Rev1.0

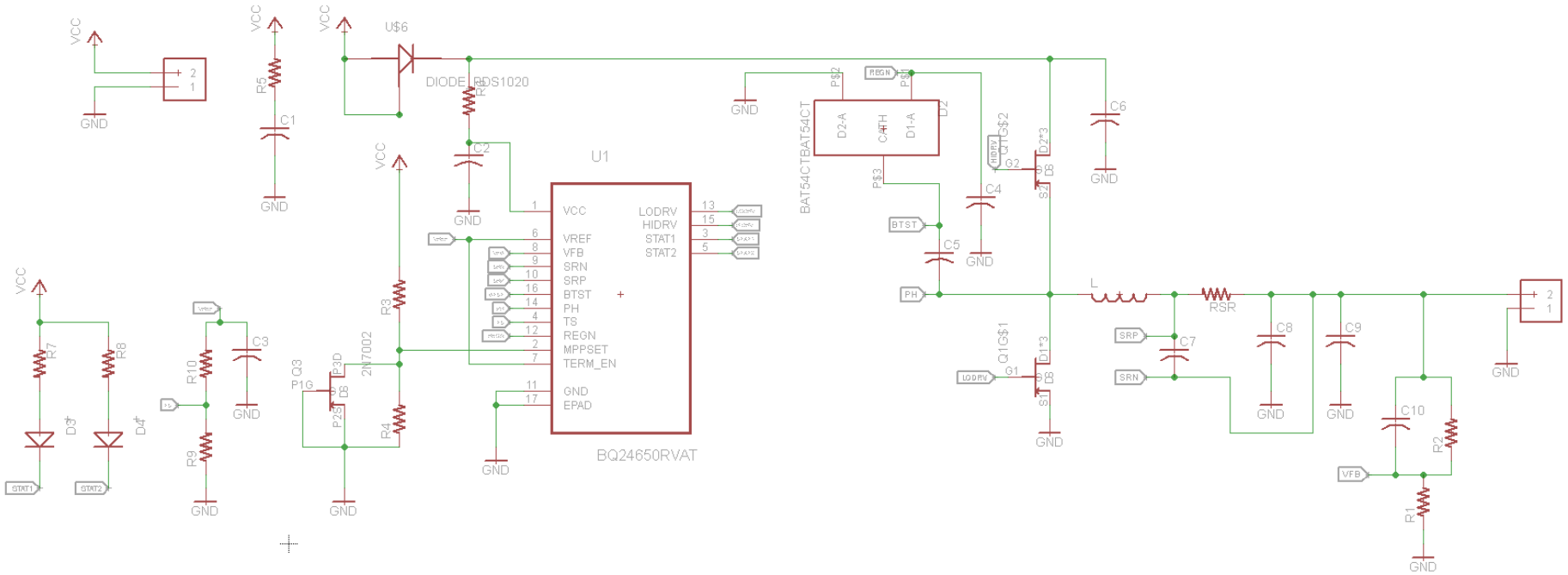
SCHEMATIC 2 - MOTOR CONTROLLER



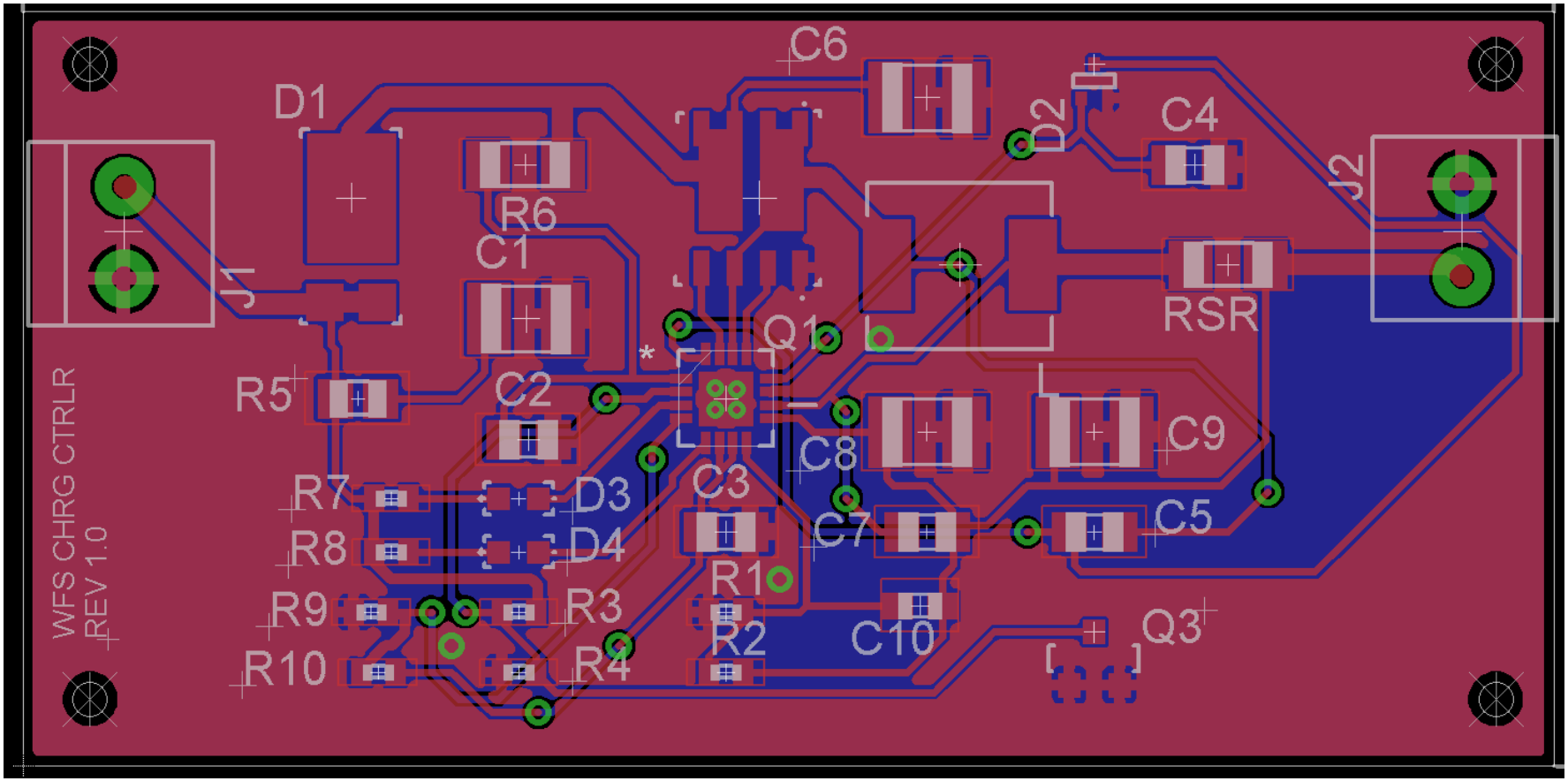
PCB – MOTOR CONTROLLER



SCHEMATIC 3 – CHARGE CONTROLLER



PCB – CHARGE CONTROLLER



ADMINISTRATIVE CONTENT

WORK DISTRIBUTION

	Christina	Adrian	Jimmy
Wireless Communication	X		
Android Application	X		
Motor Control			X
Obstacle Avoidance			X
Autonomous Algorithm	X		X
Power		X	
Battery Charging		X	
Video Streaming	X		

BUDGET – DEVELOPMENT COST

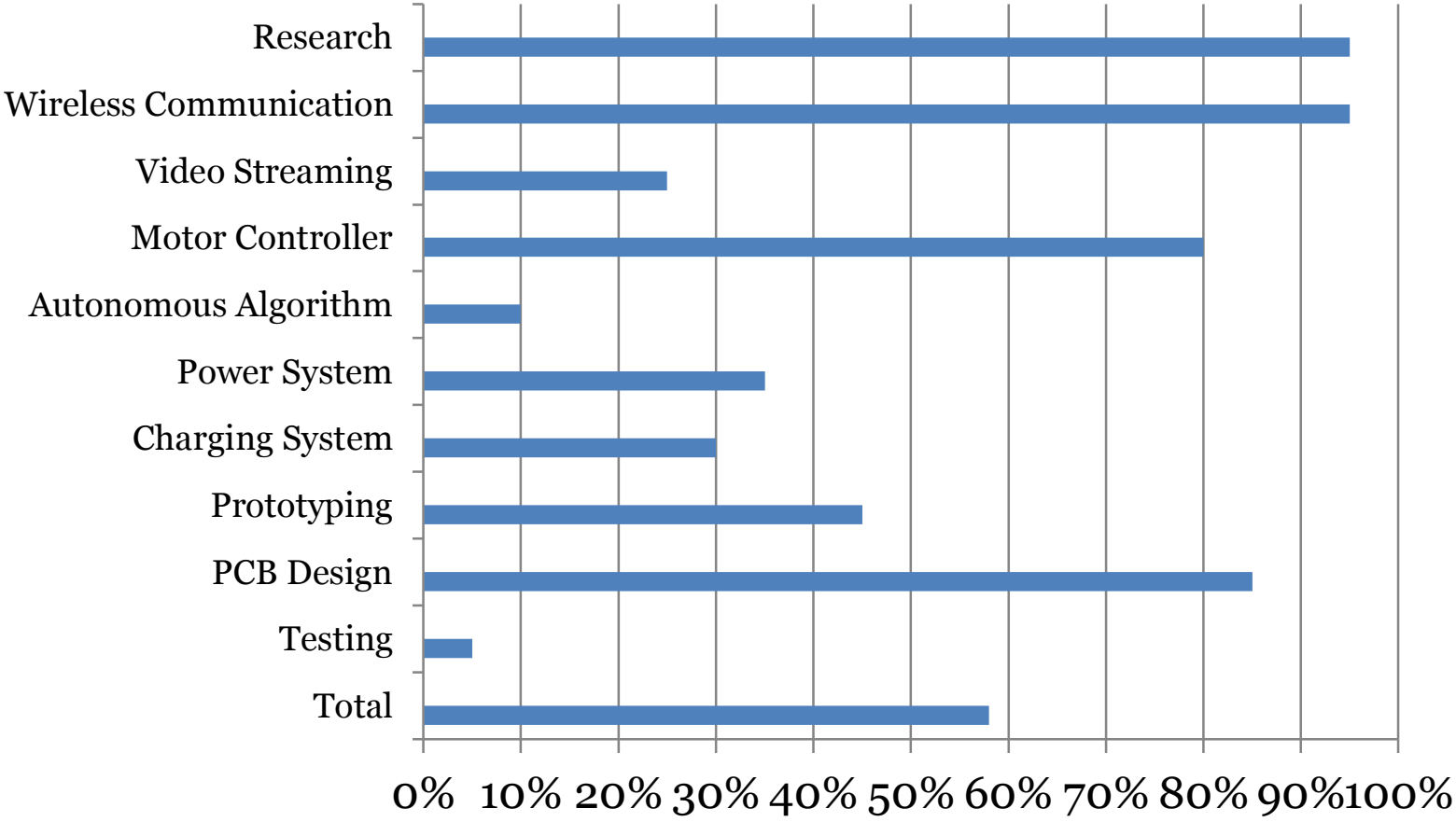
Part	Cost Per Unit	Quantity	Total Cost
MSP430-F5529 Development Board	$13	2	$26.00
MSP430-F5529 Chip	$8.06	1	$8.06
Wi-Fi Module	$34.95	1	$34.95
Bluetooth Module	$29.95	1	$29.95
Voltage Regulators (TPS54336)	$1.18	2	$2.36
TPS54336 EVMs	$25.00	2	$50.00
Android Device	*Pre-owned	1	*$0.00
Lithium-Polymer Battery Pack	$26.99	1	$ 26.99
Lithium-Polymer Battery Charger	$20.00	1	$20.00
Solar Panel	$160	1	$160.00
Robot Base and Motors	$174.95	1	$174.95
Infrared Sensors	$13.95	2	$27.90
Ultrasonic Distance Sensors	$5.63	2	$11.26
MPPT (BQ24560)	$5.96	1	$5.96
BQ24560 EVM	$100.00	1	$100.00
IP Camera	$53.24	1	$53.24
Wiring	$20	1	$20.00
Breadboards	$8.00	3	$24.00
Estimated PCB Manufacturing	$80	1	$80.00
Total Cost			$855.62

Leidos and Duke Energy Funding: $1101.00
Currently $245.38 under budget

BUDGET – BILL OF MATERIALS

Part	Cost Per Unit	Quantity	Total Cost
MSP430-F5529 Chip	$8.06	1	$8.06
Wi-Fi Module	$34.95	1	$34.95
Bluetooth Module	$29.95	1	$29.95
Voltage Regulators (TPS54336)	$1.18	2	$2.36
Android Device	*Pre-owned	1	*$0.00
Lithium-Polymer Battery Pack	$26.99	1	$26.99
Solar Panel	160.00	1	$160.00
Robot Base and Motors	$174.95	1	$174.95
Infrared Sensors	$13.95	2	$27.90
Ultrasonic Distance Sensors	$5.63	2	$11.26
MPPT (BQ24560)	$5.96	1	$5.96
IP Camera	$53.24	1	$53.24
Various Circuit Components	$125.00	1	$125.00
Estimated PCB Manufacturing	$80	1	$80.00
Total Cost			$740.62

PROGRESS


Research
Wireless Communication
Video Streaming
Motor Controller
Autonomous Algorithm
Power System
Charging System
Prototyping
PCB Design
Testing
Total
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ISSUES

- **UCF Wireless: cannot stream a IP camera on UCF_WPA.**
  - Therefore we need to bring our own router to campus; however UCF is blocking the router.
    - Solution: technical support workaround
- **Android doesn't natively support mjpeg video format**
  - Initial StackOverflow responses were unsuccessful
- **Open to suggestions for ideas for the autonomous algorithm.**

QUESTIONS?