BABY BUOY

Group 22
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Motivation

- Florida takes lead in the nation for the number of child fatalities due to drowning.
- In 2017 there was a total of 51 that passed away from drowning. A 20% increase from 2016.
- 80% of fatalities reported, are from children of the ages 1-4 and 20% from children of the 15 and younger.

*Statistic are taken from the USA Swimming Foundation published by the Miami Herald.

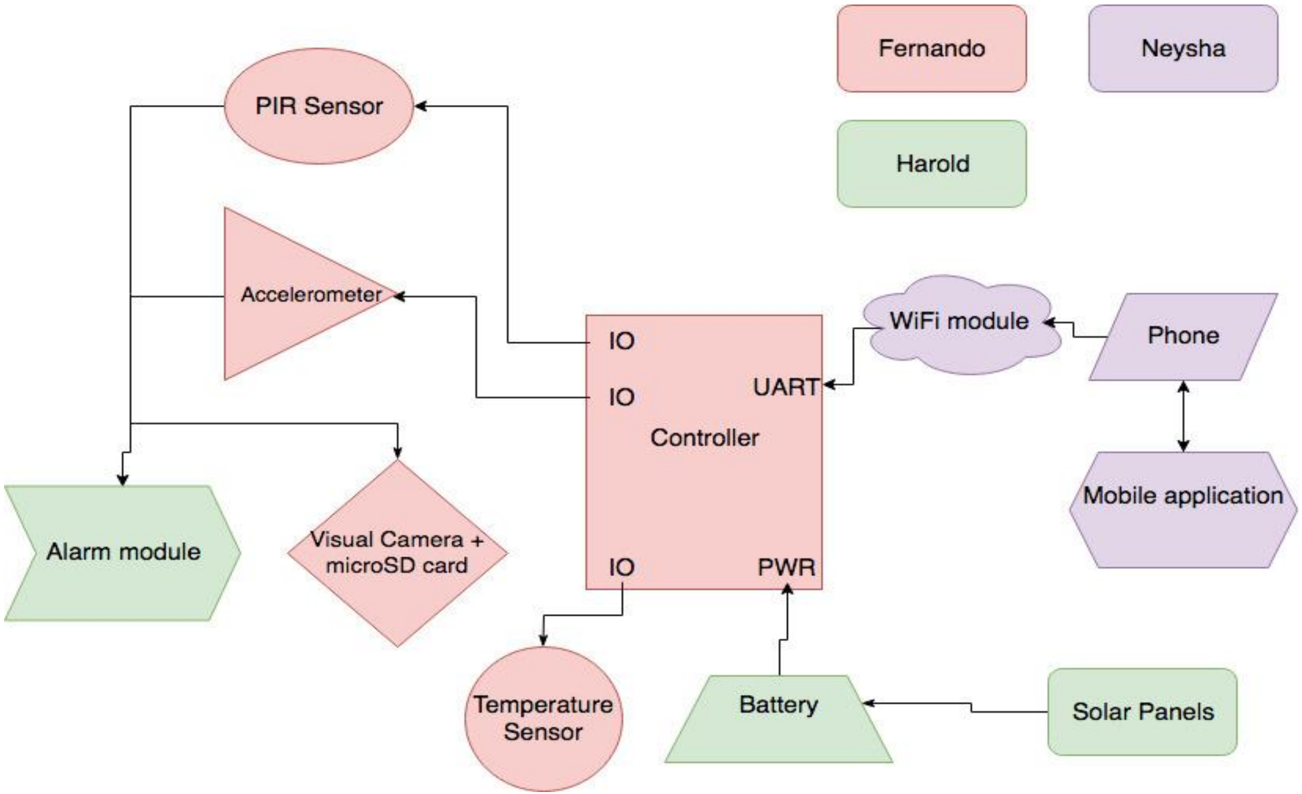
Requirements Specifications

- System shall be portable, durable and have a waterproof housing
  - Up to 10 lbs
- System shall have solar power capabilities to sustain battery life
  - 16 hours between charges
- System shall have wireless communication capabilities
  - Communicate with mobile application
- System shall be triggered when PIR sensor and/or accelerometer are tripped
  - Audible alarm when triggered
  - Visual verification through a camera when triggered

Work Distribution

NAME	POWER	MECHANICAL DESIGN	MOBILE APPLICATION	CONTROLLER
Fernando		**Secondary**	**Secondary**	**Primary**
Harold	**Primary**	**Primary**		
Neysha			**Primary**	**Secondary**

Overall Block Diagram



Microcontroller Comparison

Why did we choose the ATmega644PA?

- Low power consumption
- Price
- Memory & RAM
- Based on Arduino platform

Microcontroller	Broadcon BCM2837	MSP430FG4618 & MSP430F2013	ATmega328P	ATmega644PA
Development Board	Raspberry Pi 3B	MSP430FG4618/F2013	Arduino Uno R3	N/A
Operating Voltages	4.75V - 5.25V	1.8V - 3.6V	1.8V - 5.5V	1.8V - 5.5V
Temperature Ranges	-40°C - 85°C	-40°C - 85°C	-40°C - 105°C	-40°C - 105°C
Maximum Clock Frequency	1.2 GHz	8 MHz	20 MHz	20MHz
Memory	512 KB L2 Cache	116 KB Flash	32 KB Flash	64 KB Flash
RAM	1 GB	8 KB	2 KB	4 KB
GPU	Videocore 4 GPU	None	None	None
General I/O Pins Count	40	80	23	32
Active Power Consumption	3500 mW 700 mA @ 5V	0.88 mW 0.267 mA @ 3.3V	0.36 mW 0.072 mA @ 5V	0.72 mW 0.144 mA @ 5V
Microcontroller Price	N/A ($29.99 per Dev. board)	$13.59 & $2.33 ($117.00 per Dev. board)	$0.56 ($22.00 per Dev. board)	$5.25 (Dev. board N/A)

Wireless Communication Comparison

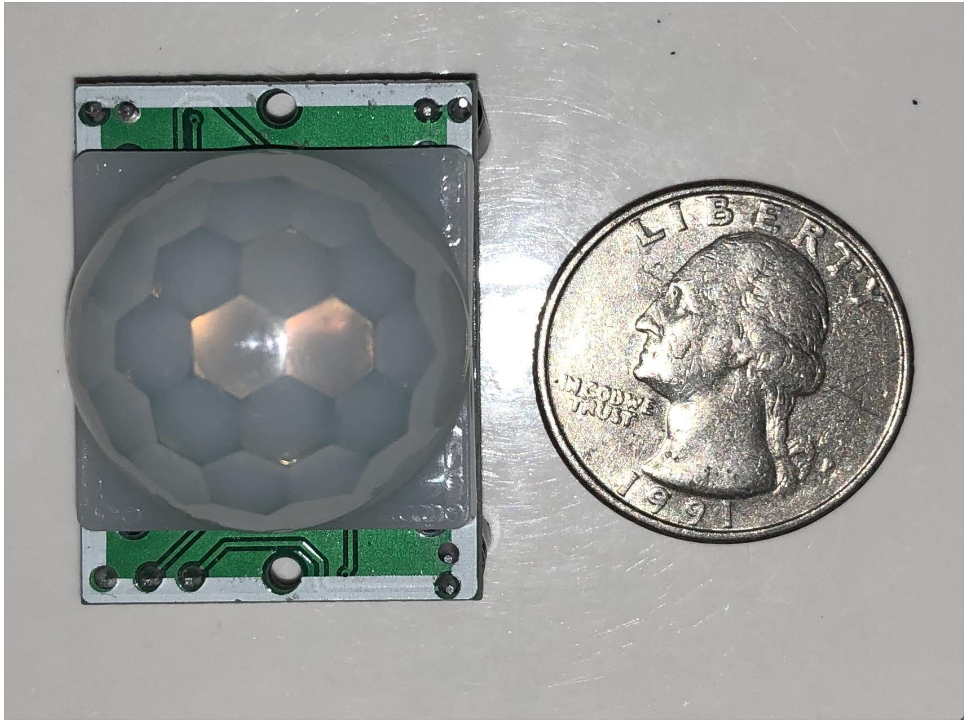
- Why did we choose the ESP8266?
  - Maximum power consumption is the lowest compared to the others
  - Operates with 2.4 GHz wireless frequency
  - Price

Board	ATWINC1500	ESP32	ESP8266
MCU	Cortus APS3	Xtensa LX6	Tensilica L106
SRAM	128 KB	520 KB	50 KB
General I/O Pins Count	28	34	17
Maximum Clock Frequency	48 MHz	60 MH	52 MHz
Operating Volatge	2.7V - 3.6V	1.8V - 3.6V	2.5V - 3.6V
Temperature Ranges	-40°C - 85°C	-40°C - 125°C	-40°C - 125°C
Maximum Power	1008 mW	4320 mW	612 mW
Price	$18.56	$9.95	$3.99

Wireless Board and Microcontroller Size

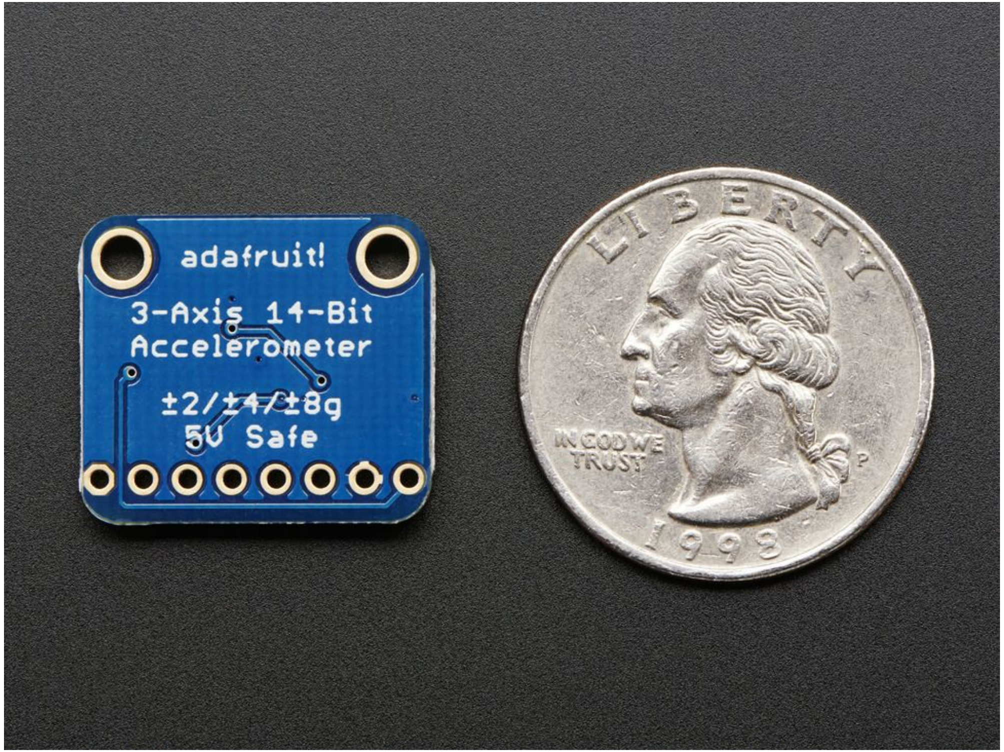
PIR Sensor

- Passive sensor that catches energy (IR) emitted from bodies
- P/N: HC-SR501
- 3 pins
  - VCC
  - OUTPUT
  - GND
- Operating power consumption @ 5V
  - 325 mW | 65 mA



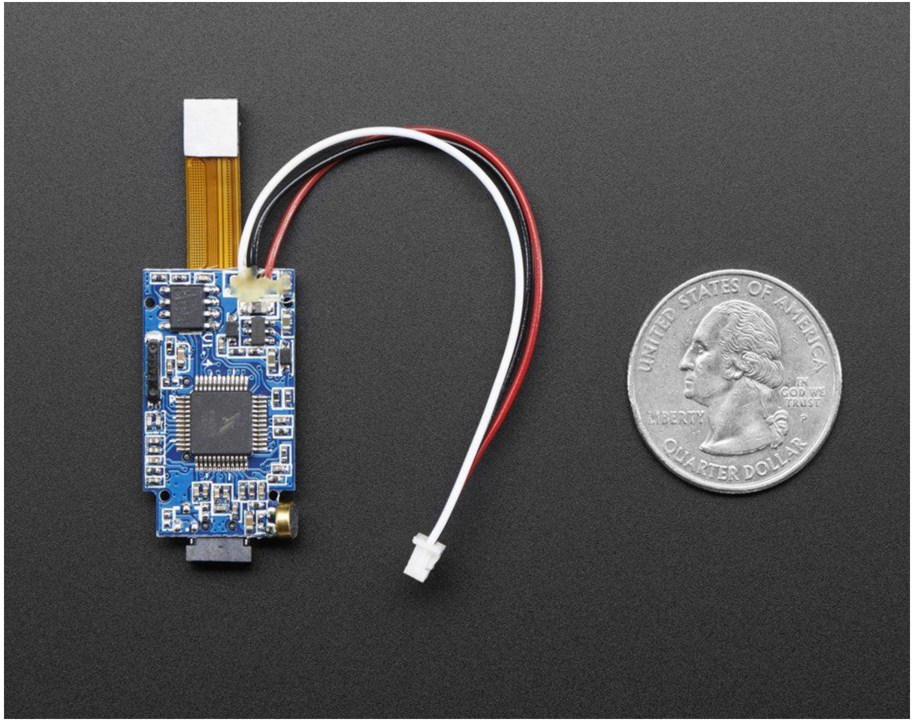
Accelerometer

- Smart 3-axis accelerometer to detect motion, tilt and orientation
- P/N: MMA8451
- 8 pins
- Communicates via I2C
- Operating power consumption @ 5V
  - 425 μW | 85 μA



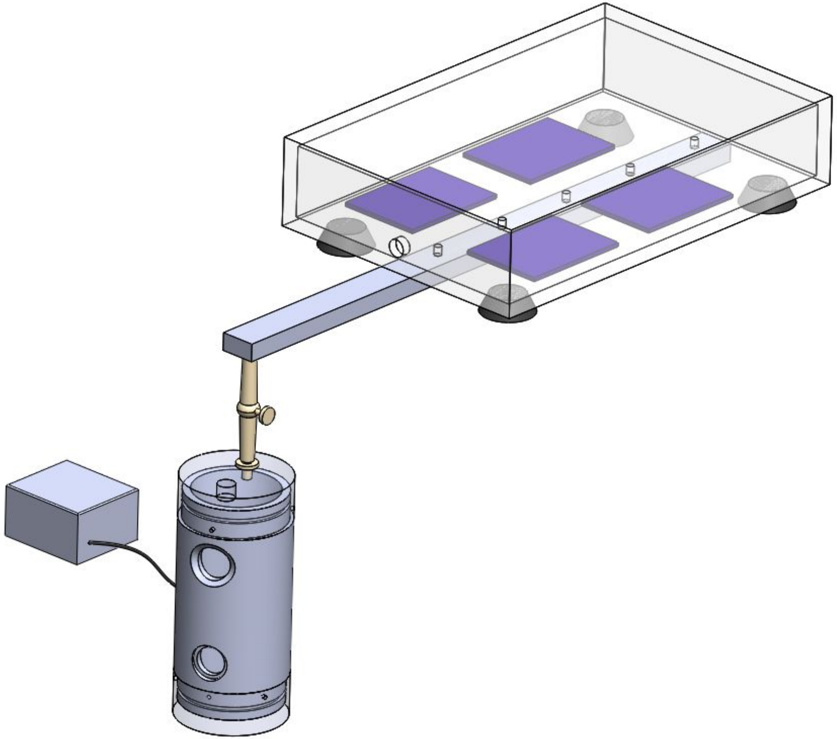
Mini Spy Camera

- Takes pictures or videos and stores them to integrated microSD card
- P/N: Adafruit 3202
- 3 pins
  - VCC
  - OUTPUT
  - GND
- Camera resolution
  - 1280 x 720 for pictures (JPEG)
  - 640 x 480 for videos (AVI)
- 32 GB maximum microSD card support
- Operating power consumption @ 5V
  - 550 mW | 110 mA

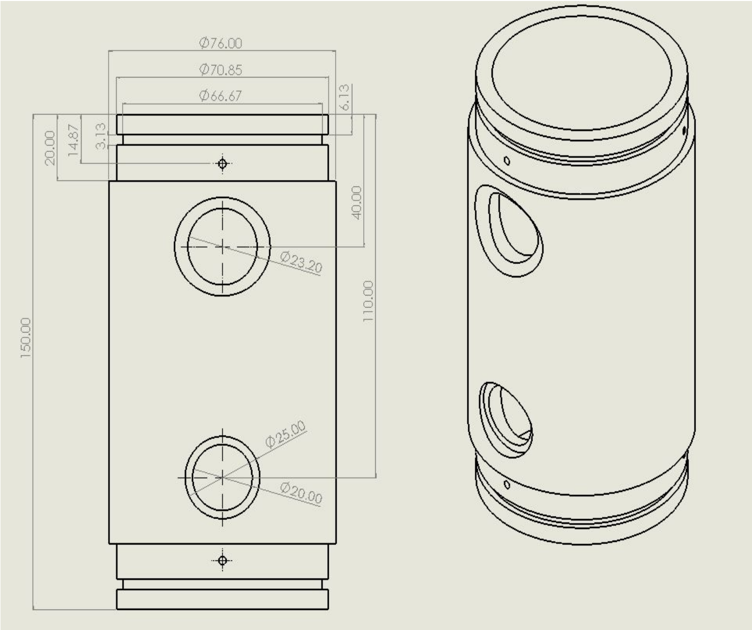


Physical Design/Prototyping

- Waterproof solar cell and electronics housings
- Clear acrylic for solar cell housing to allow sunlight through
- Anodized aluminum electronics housing to prevent oxidation
- Two windows for the PIR sensor and camera
- Articulated arm to adjust electronics housing in the water
- Accelerometer buoy attached to the side via wire
- Aluminum rod suspends electronics housing over the edge of the pool

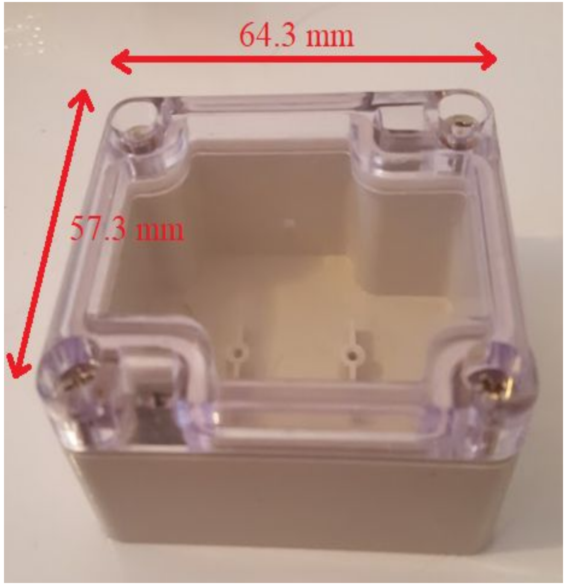


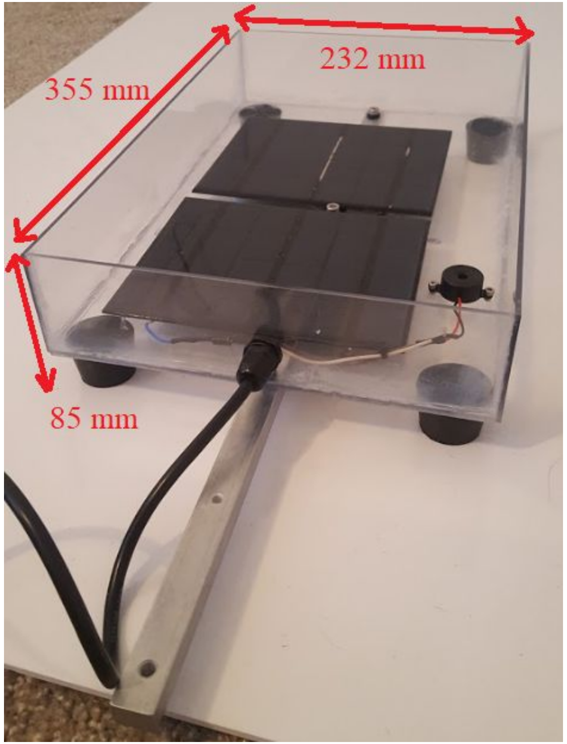
Electronics Housing



- Sturdy aluminum construction
- Waterproofed by 0.1mm tolerance between caps and body plus neoprene gasket
- Caps are fastened with screws
- Acrylic window at the bottom for camera
- Top window is PIR lense included with the sensor
- Cable glands to pass wires from solar cell housing

Accelerometer & Solar Cell Housing

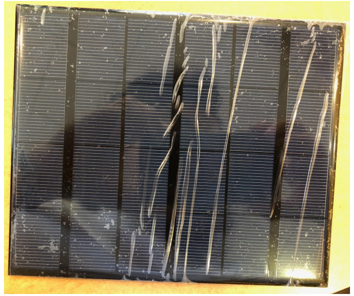


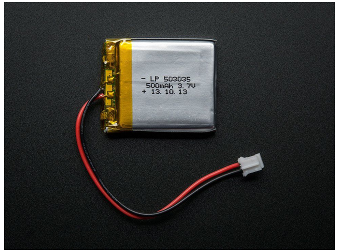


- Solar cell housing made to fit panels, buzzer, and WiFi antenna
- Rubber legs to prevent slipping
- Buzzer is included here to expand the range of the alarm
- WiFi antenna need to be outside electronics housing
- Accelerometer buoy is waterproofed with gasket

Power Management

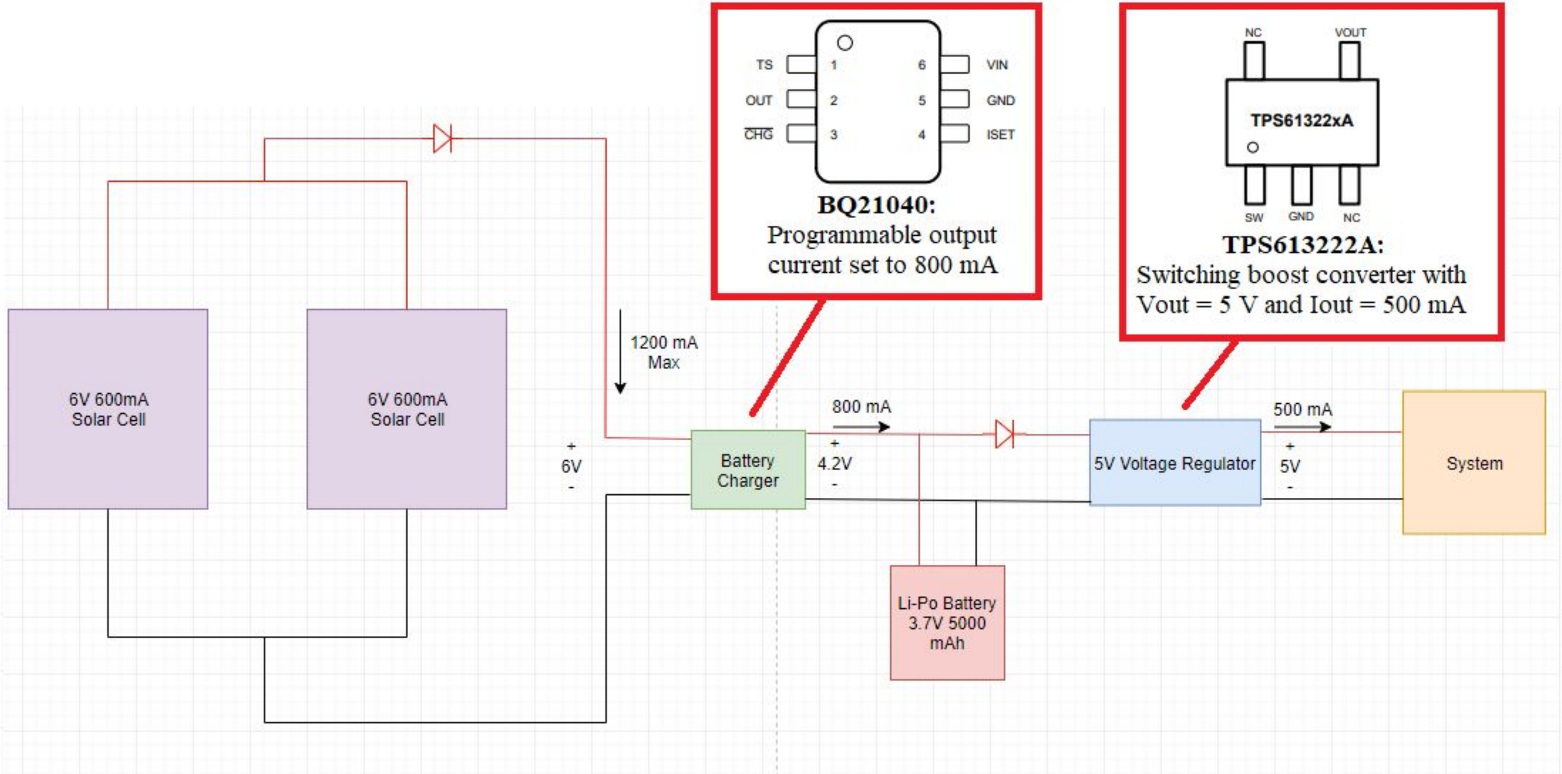
- MCU and other components run on 5V
- LiPo battery was used due to space constraints
- Camera, WiFi, and buzzer only turn on when both the PIR and accelerometer give signal
- 235 mA/hr is needed under normal operation, assuming system runs on battery for 16 hrs a day, capacity of 3760 mAh is needed, 5000 mAh was chosen
- Two solar cells with 600mA output in parallel were chosen to charge battery
- 5V switching boost converter was used to power system from 3.7V battery





Component	Max Current Draw (mA)
PIR Sensor	65
Camera	110
MCU	0.4
WiFi Module	170
Temp. Sensor	0.05
Buzzer	30
Accelerometer	0.165
Total	**375.46**

Power System Design



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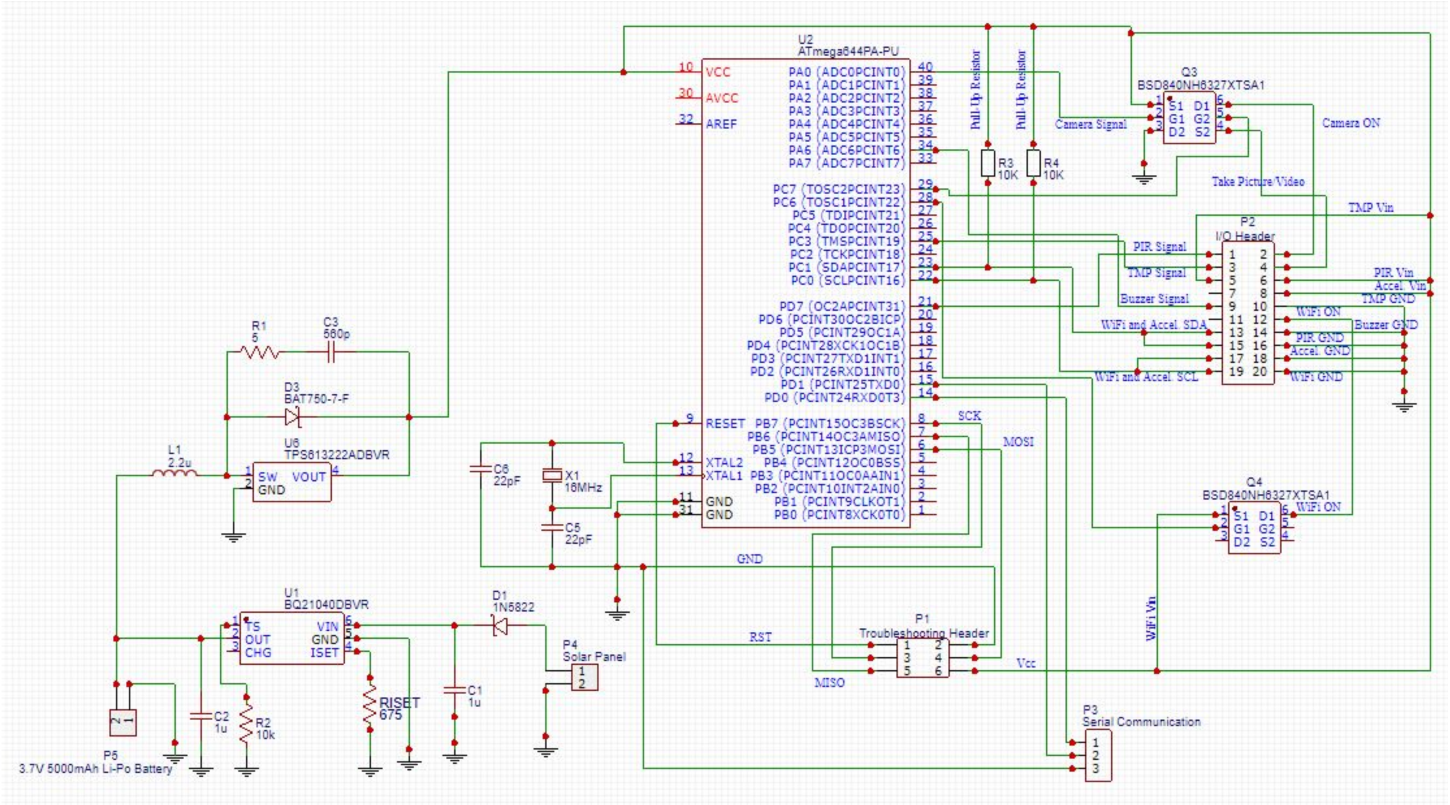
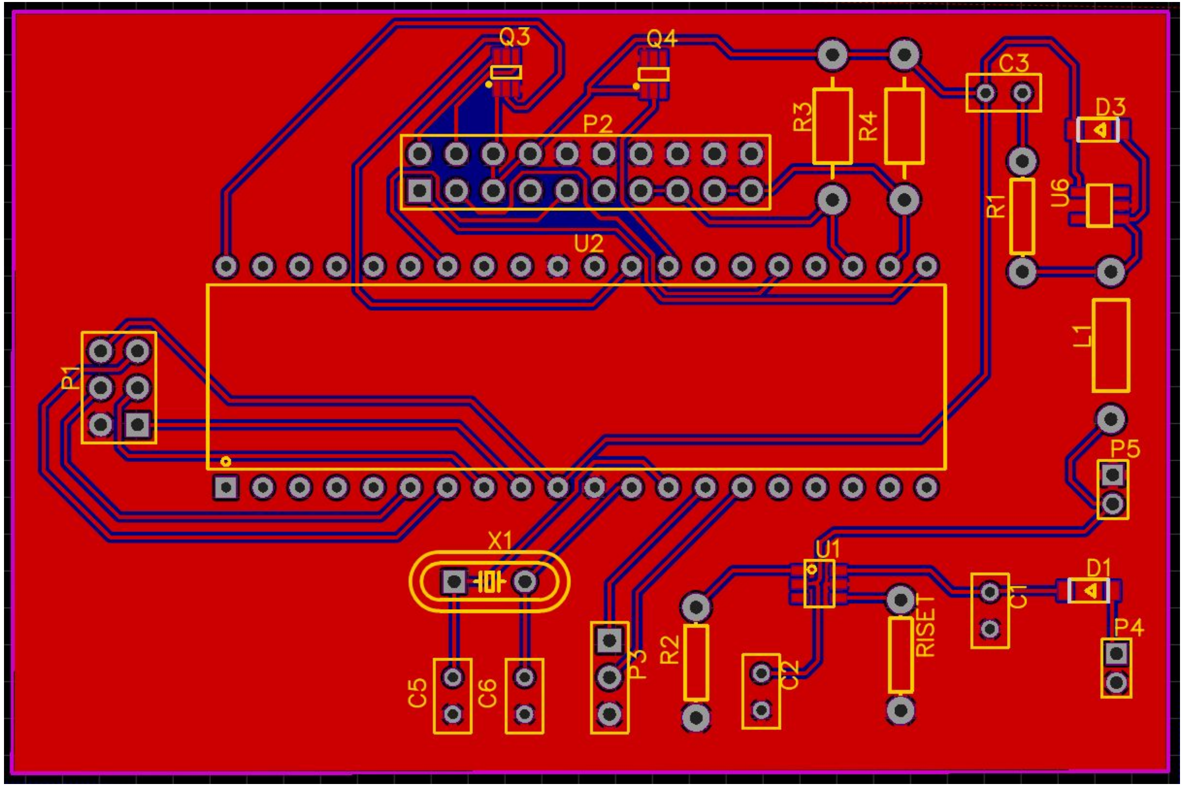
PCB Schematic



PCB Layout


Q3
Q4
C3
D3
P2
R3
R4
R1
U6
U2
L1
P1
P5
X1
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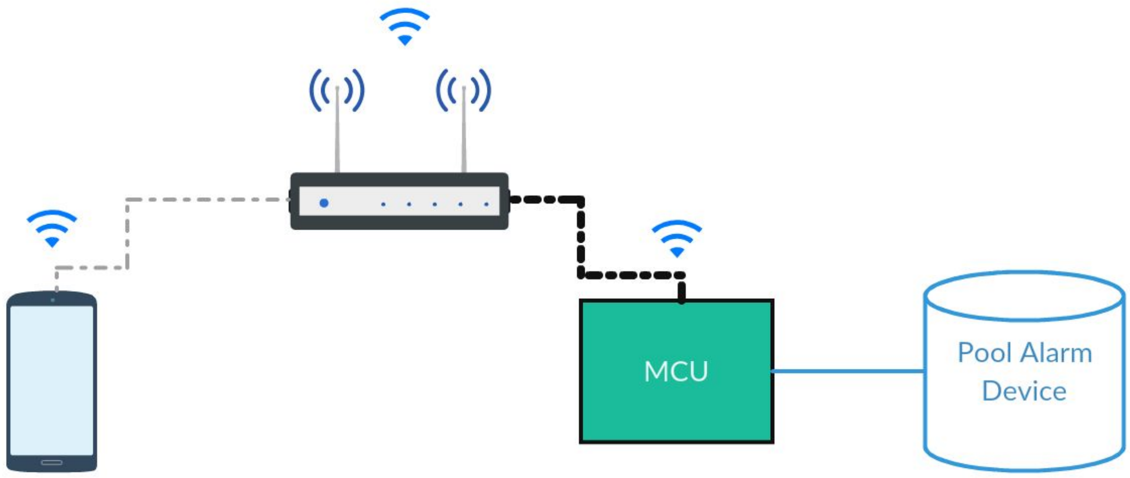
D1
C1
P4
RISET
R2
P3
C2
C5
C6

Mobile Application



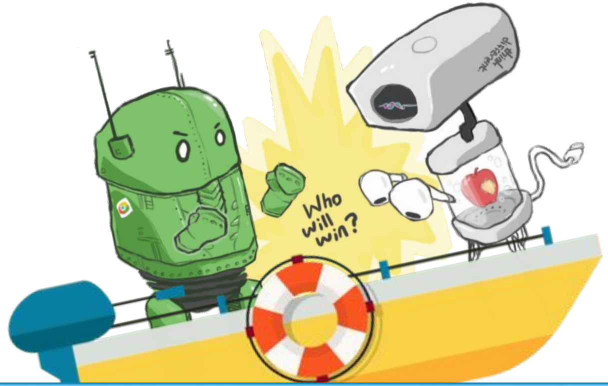
The mobile application will serve as an extra beacon. Sending notification alerts, based on the activities being reported from the pool alarm.

Mobile Operating System

- iOS apps: Developed on Xcode and written using Swift language. Developer would need a Mac product (Desktop or Laptop). Development on Windows is possible but strenuous.

- Android apps: Constructed on Android Studios. Written in Java. Developer would need just a basic computer or laptop. Android development is known to be more straightforward.

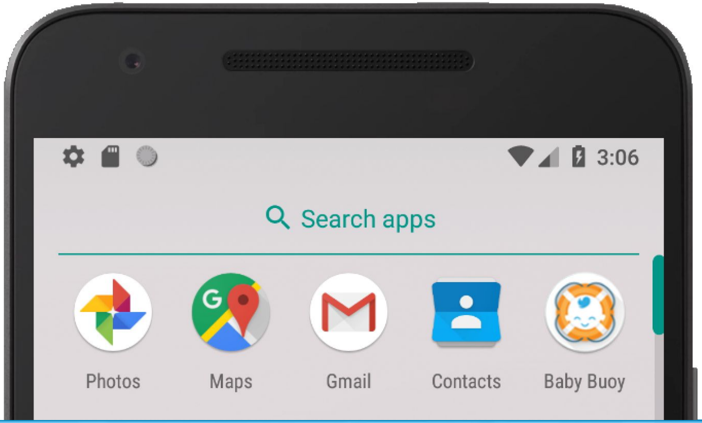
- Fantasy: If time permits; development of mobile application in both platforms. Although Android is simpler, we would not want to limit our users to one possible operating system.



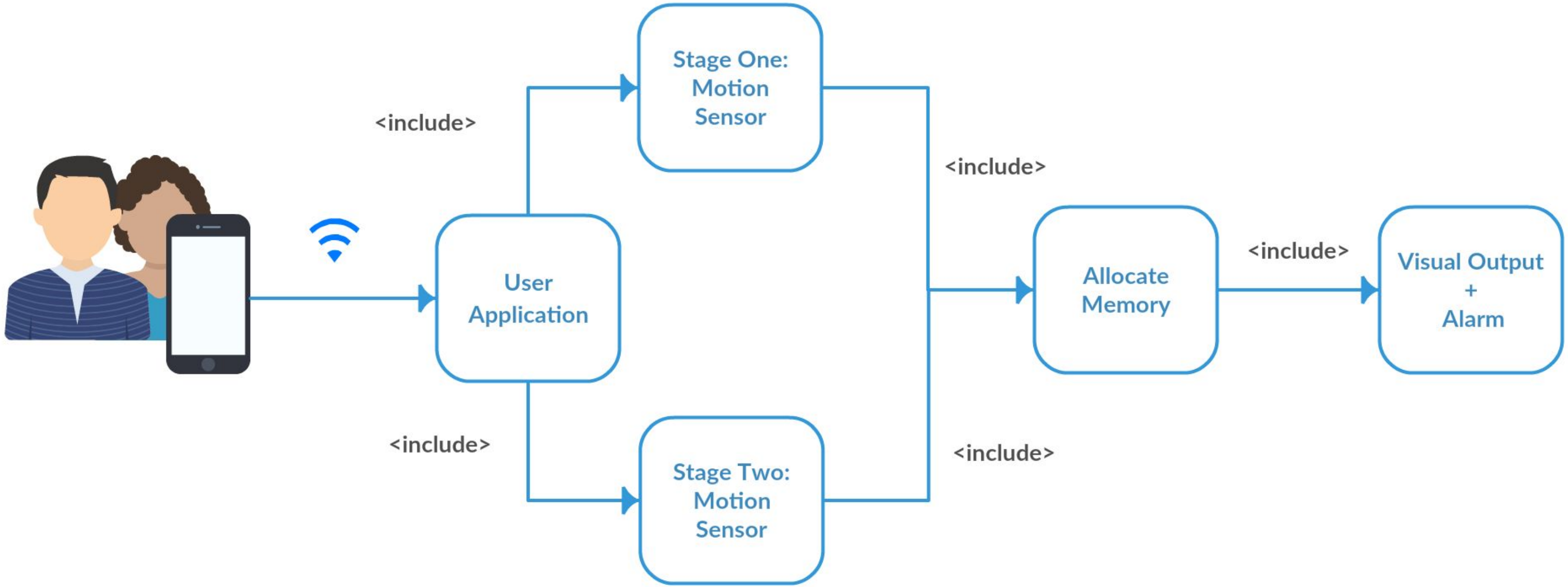
Mobile Application Features

Monitoring

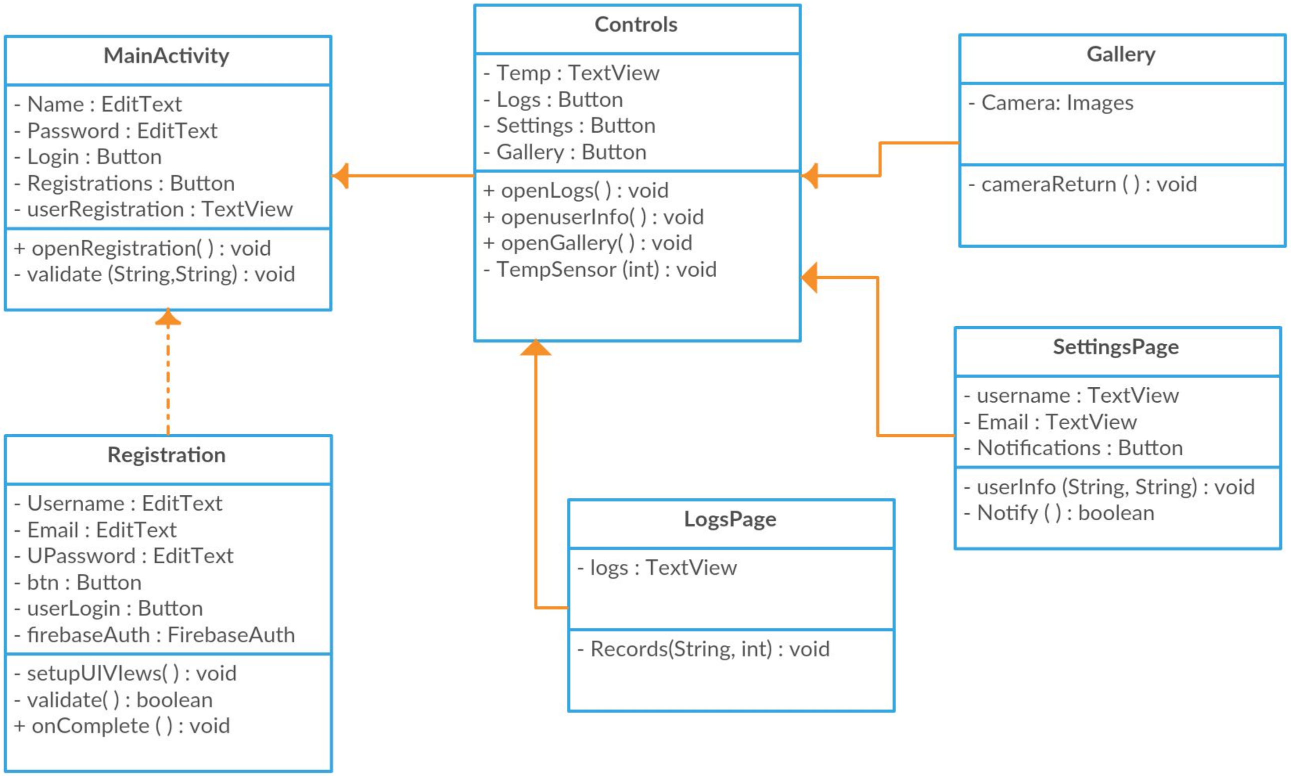
- Output logs of when sensors are activated do to motion detection.
- Gallery of images captured from underwater camera.
- Water temperature
- Emergency push notification



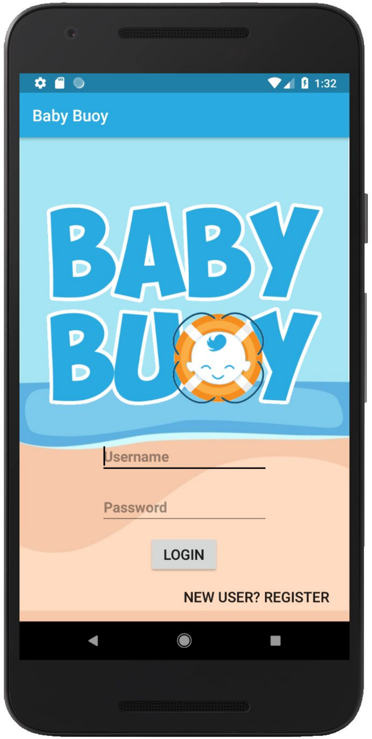
Use Case Diagram

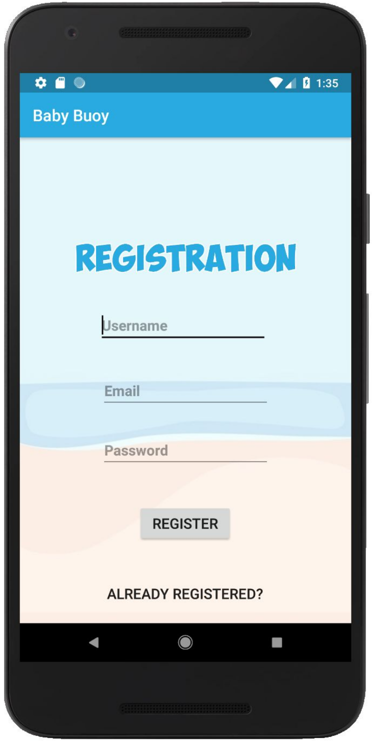


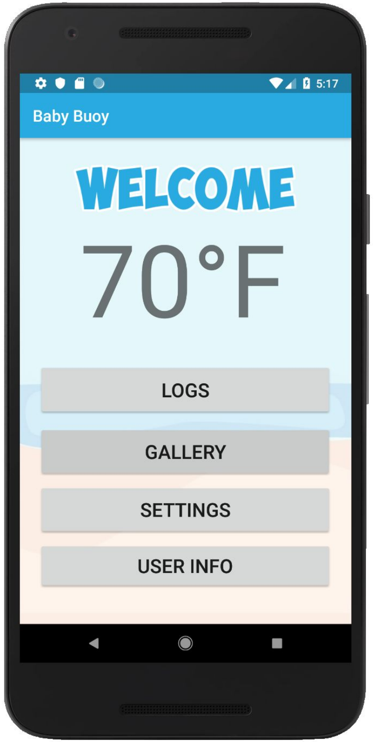
Class Diagram



Mobile Application UI







Constraints & Standards

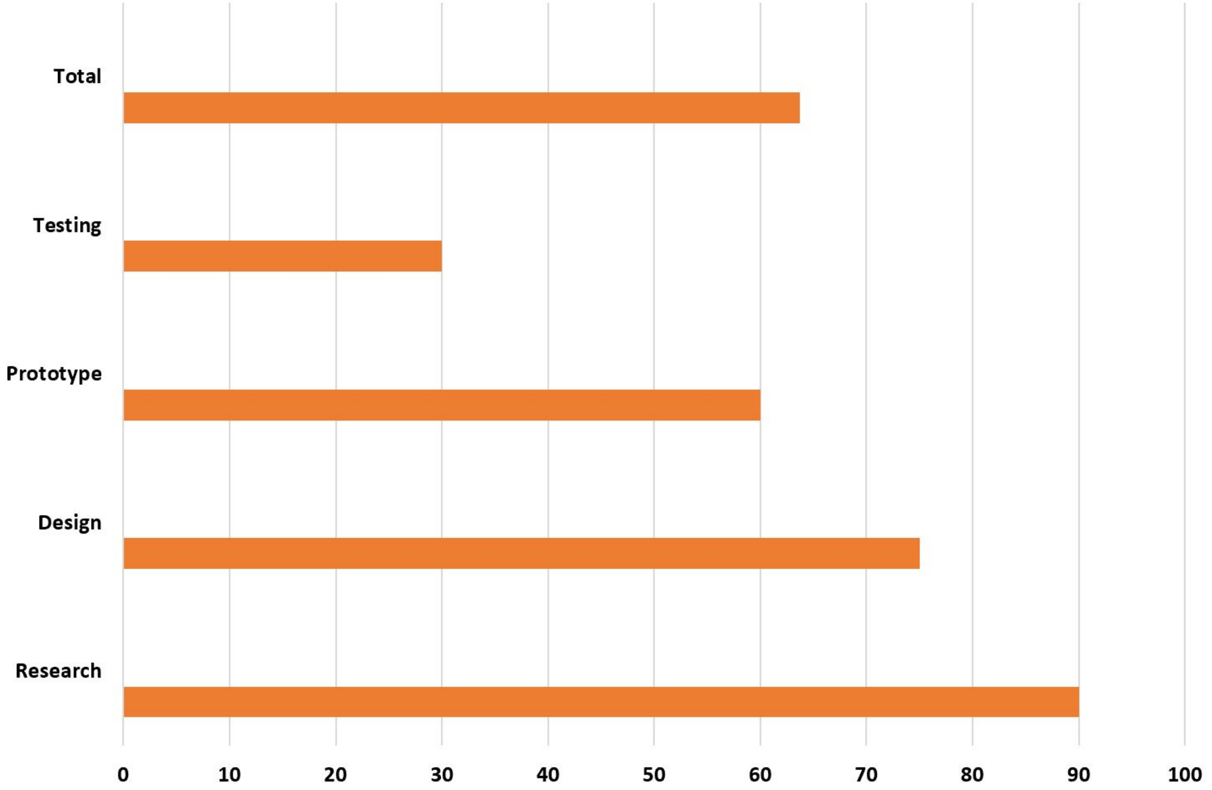
- Economic Constraint: Self funded project. Keeping it cost friendly and competitive with other similar products out in the market.
- Health and Safety Constraint: Child safety is our #1 concern. Keeping any dangerous and hazardous material sealed, covered and away from small rugrats.
- IEC 60529 standard: Goes over what would classify an object to be protected from environmental elements. Based on their rating scale our project is scaled as a IP68. Meaning, dust tight and protected against immersion in water for long periods of time.

Budget

- Self-sponsored project
  - Overall budget of $500 for research & development purposes
- Retail price of $300
  - Similar devices are retailed at $300 to $420

Part	Quantity	Actual Price
PIR Sensor	1	$1.72
Camera Module	1	$12.50
WiFi Module	1	$10.00
Alarm Module	1	$1.96
ATmega644PA-PU	1	$5.25
16 MHz Crystal	1	$1.38
PCB	1	$2.00
BQ21040	1	$1.26
TPS613222A	1	$2.85
TMPS6302	1	$1.54
Rechargeable Battery	1	$15.99
Main Housing	1	$40.00
Solar Cell Housing	1	$21.98
Articulating Arm	1	$14.98
Solar Panel	2	$21.00
Accelerometer	1	$7.95
ABS Junction Box	1	$6.35
32GB MicroSD	1	$7.99
Single Unit Subtotal:		$168.71

Progress



Total
Testing
Prototype
Design
Research
0
10
20
30
40
50
60
70
80
90
100

Issues

- PIR sensor incapable of accurately detecting motion underwater.
- Calibrating sensitivity of accelerometer.
- Housing creates a Faraday cage for WiFi signal.

Questions?