BABY BUOY

Group 22
Fernando Bilbao - CpE
Harold Grafe - EE
Neysha Irizarry-Cardoza - CpE

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

- System shall have an IP58 rating
- System shall have 2-step verification
    - PIR Sensor and Accelerometer
- System shall have a mobile application to control the system
- System shall sound an alarm when triggered
- System shall capture an image and send it to the user via the mobile application
- System shall have solar power capabilities to sustain battery life

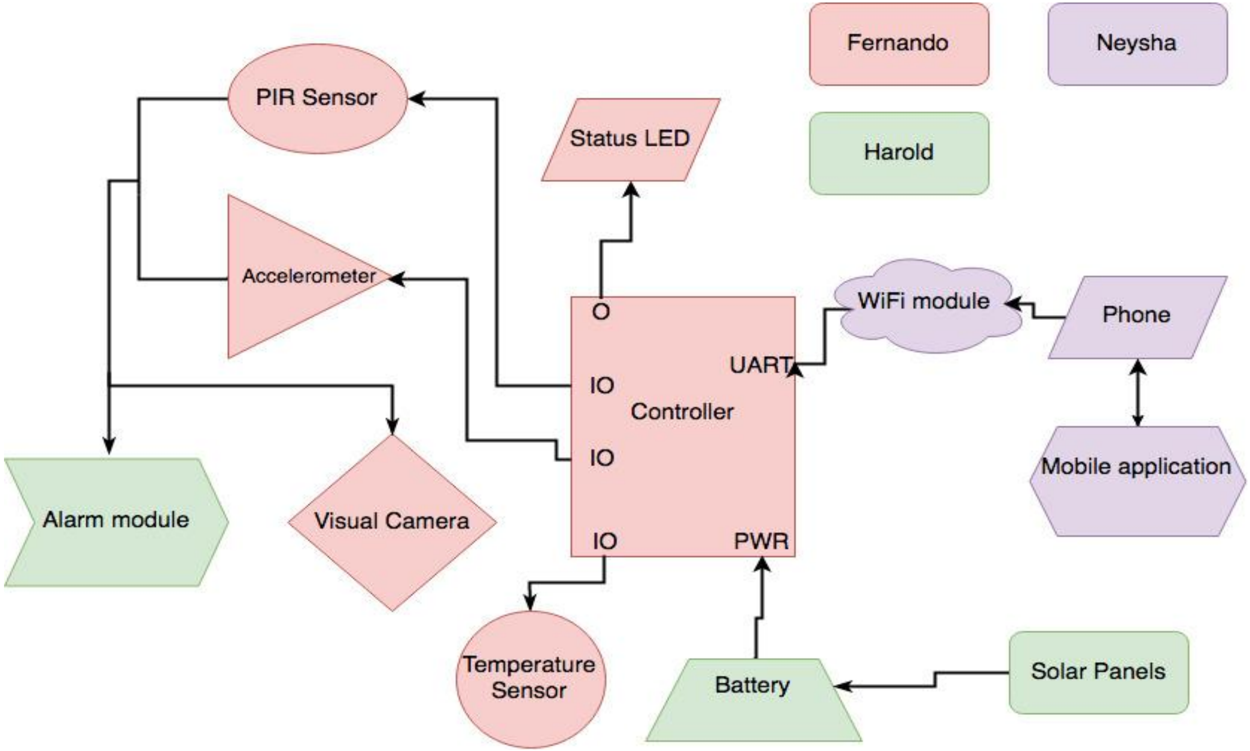
Specifications

- System shall have a maximum power consumption of ≤ 5W
- System shall cost ≤ $250
- System shall have an electronics housing no larger than 23*10*7 in. (L*W*H)
- System shall have a wireless communication range of ≤ 115 ft
- System shall have 16 hours of battery life between charging

Work Distribution

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

Overall Block Diagram



Microcontroller and WiFi Comparison

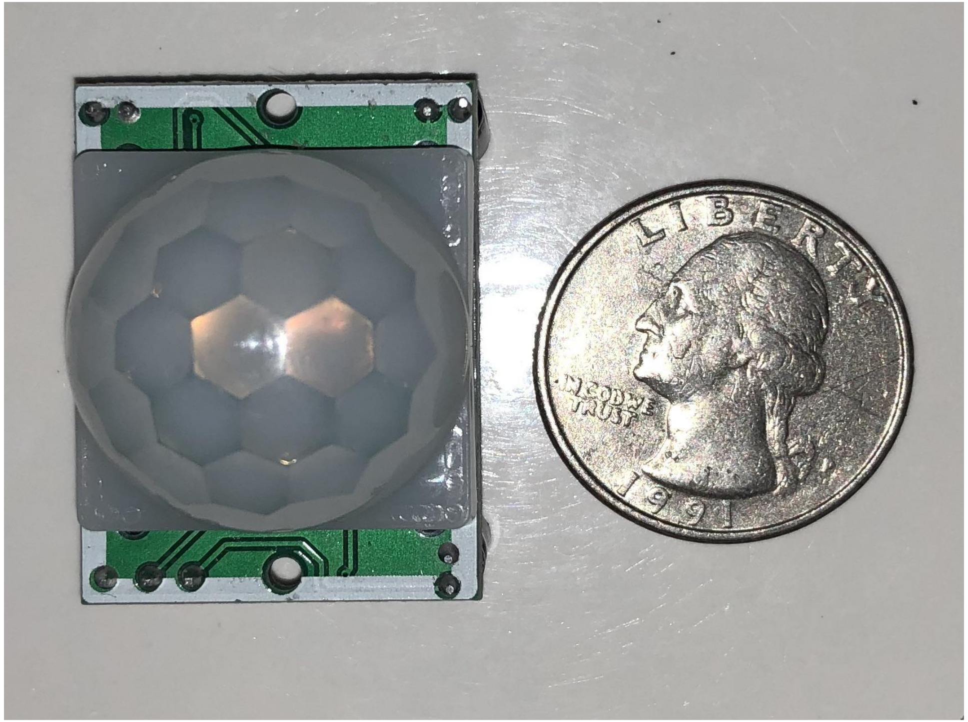
- Why did we choose the ESP-WROOM-32U?
  - Price
  - Clock frequency
  - SRAM
  - Energy efficient

Module	ATWINC1500-MR210PB	ESP-WROOM-02U	ESP32-WROOM-32U
Board	ATWINC1500	ESP8266	ESP32
CPU	Cortus APS6	Tensilica L106	Xtensa LX6
Wireless Frequency	2.4 GHz	2.4 GHz	2.4 GHz
SRAM	64KB	50 KB	520 KB
General I/O Pins Count	28	17	34
Maximum Clock Frequency	48 MHz	160 MHz	240 MHz
Operating Volatge	2.7V - 3.6V	2.5V - 3.6V	1.8V - 3.6V
Temperature Ranges	-40°C - 85°C	-40°C - 125°C	-40°C - 125°C
Maximum Power Consumption	1008 mW	612 mW	4320 mW
Price	$8.08	$2.80	$3.80

Microcontroller Size

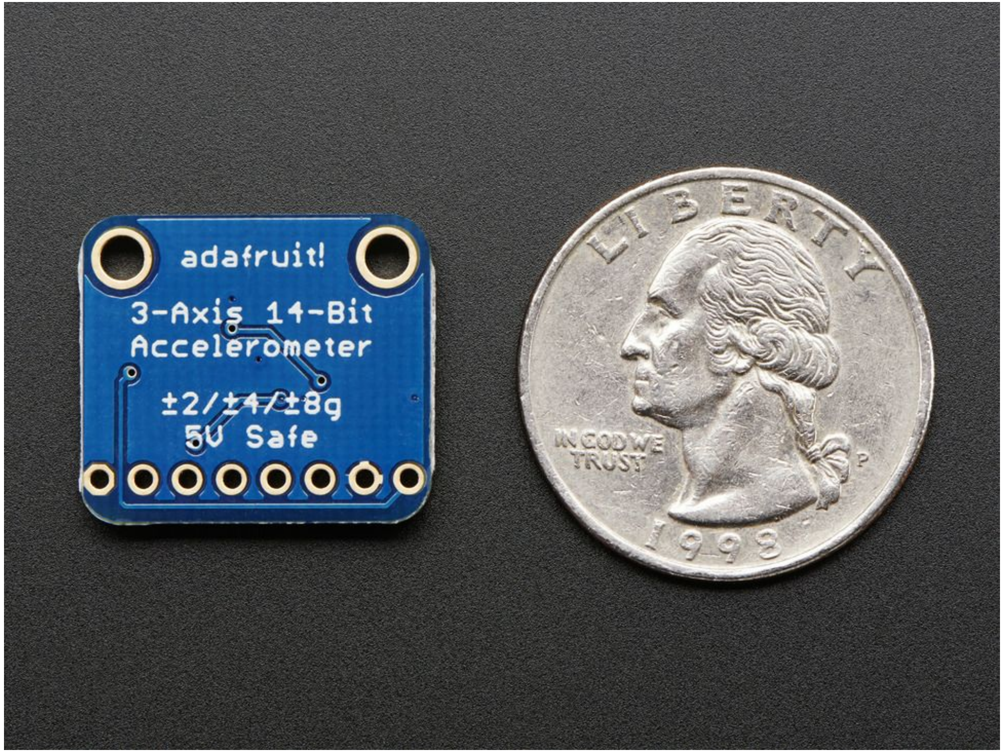
PIR Sensor

- 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
- Price: $1.72



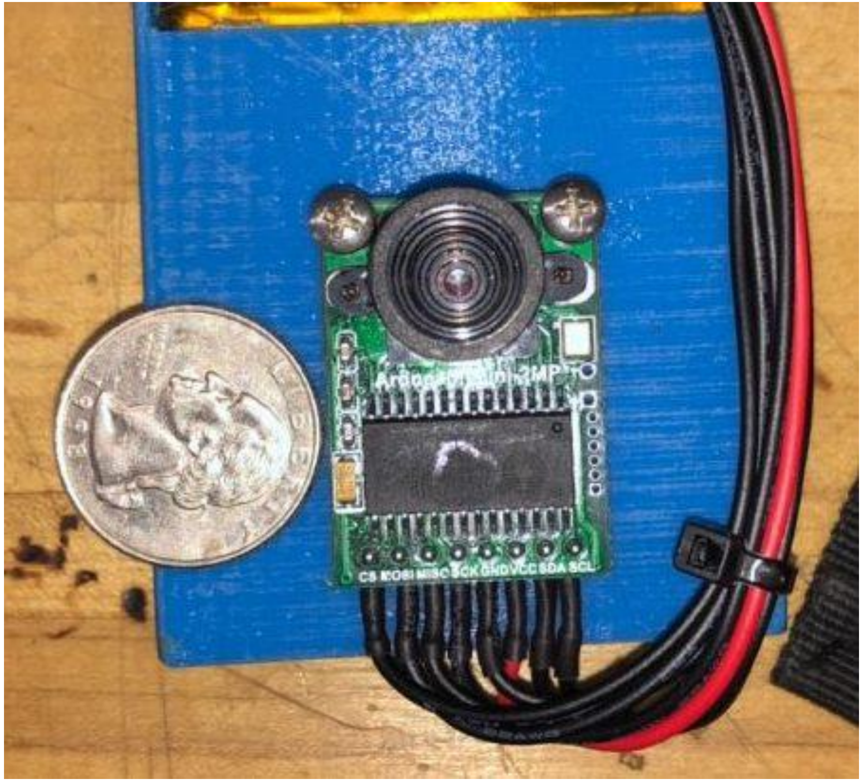
Accelerometer

- 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
- Price: $7.95



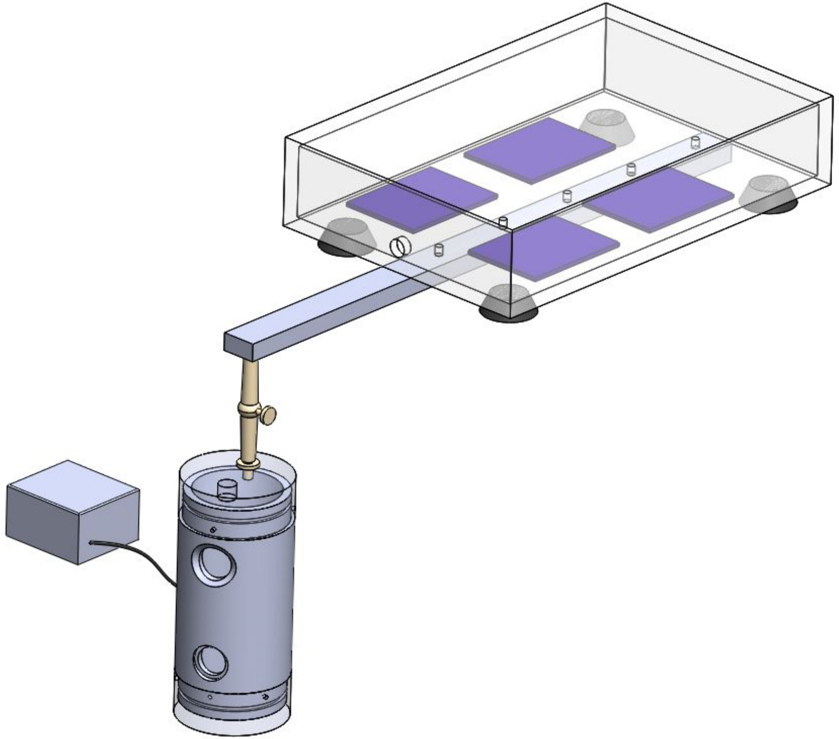
ArduCAM OV2640 2MP

- High definition SPI camera that takes pictures
- P/N: ArduCAM OV2640
- Open source library usable amongst various different platforms
  - Raspberry Pi, Arduino, etc...
- 8 pins
  - Communicates via I2C and SPI bus
- Maximum camera resolution of 2MP
- Operating power consumption @ 3.3V
  - 231 mW | 70 mA
- Price: $25.99

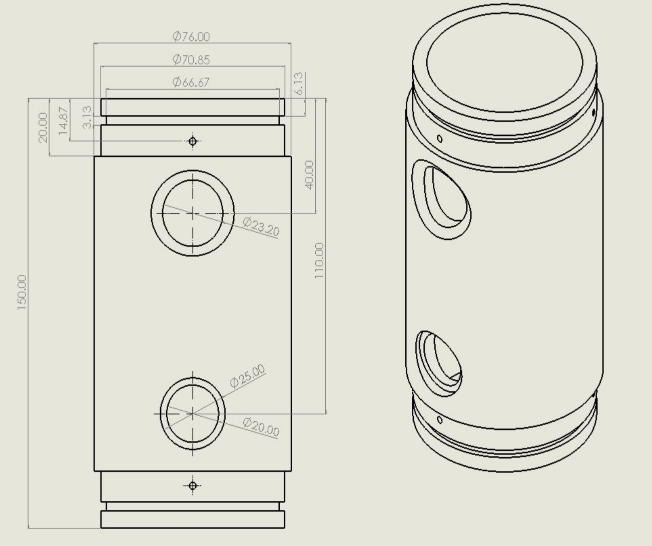


Physical Design

- Water resistant solar cell and water proof 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 cable
- Aluminum rod suspends electronics housing over the edge of the pool

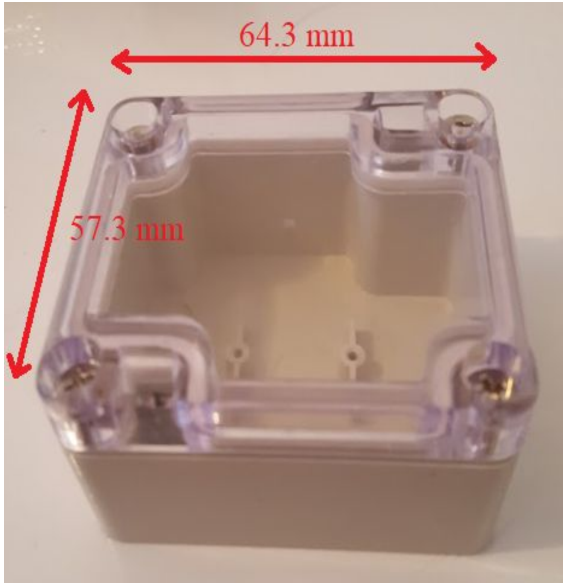


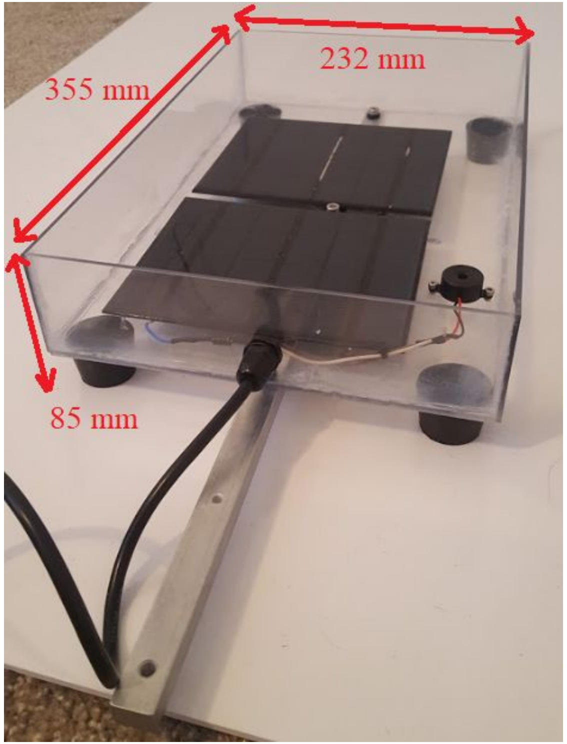
Electronics Housing



- 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
- 3D printed base to hold PCB, battery, and camera
- Top Cap includes WiFi antenna and LED
- Bottom Cap includes the temperature sensor

Accelerometer & Solar Cell Housing

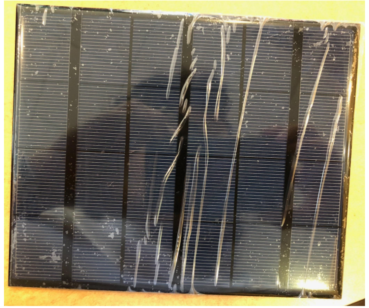


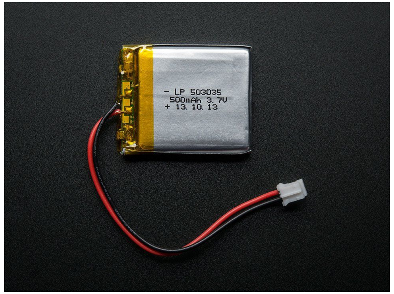


- Solar cell housing made to fit panels and buzzer
- Rubber legs to prevent slipping
- Buzzer is included here to increase the range of the alarm
- Accelerometer buoy is waterproofed with gasket
- Counterweights under housing balance center of mass

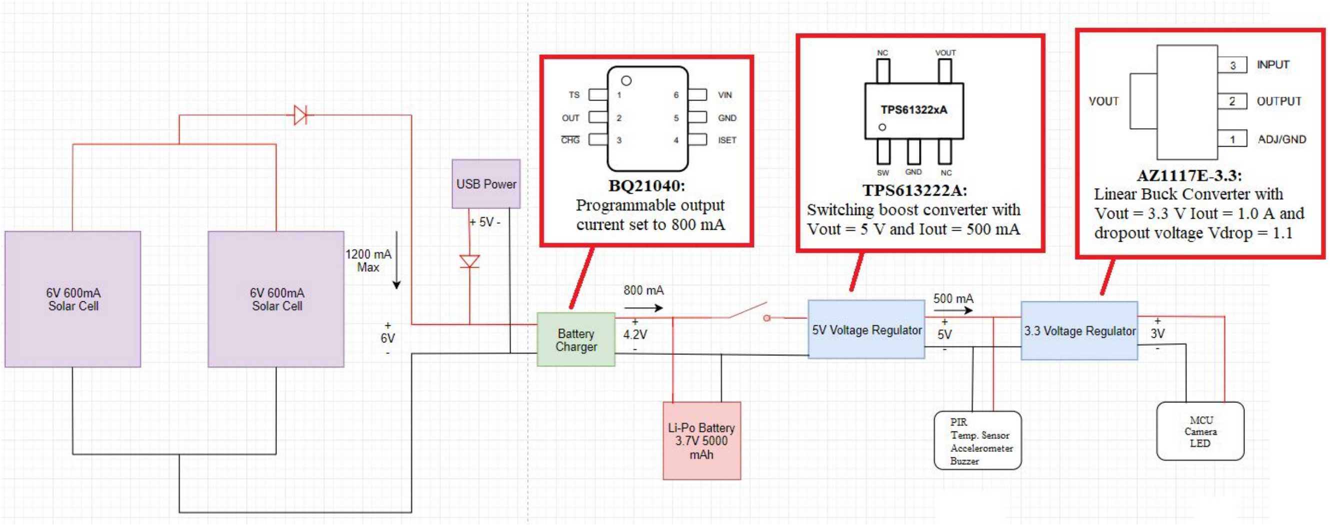
Power Management

- Either USB or Solar cells can be used to charge battery
- Power switch saves battery life when device is not in use
- LiPo battery was selected due to space constraints
- Camera on sleep mode and buzzer only turn on when both the PIR and accelerometer give signal
- 195 mA is needed under normal operation, assuming system runs on battery for 16 hrs a day, capacity of 3120 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 PIR, temperature sensor, buzzer, and accelerometer
- 3.3V linear buck converter powers ESP32, LED, and camera



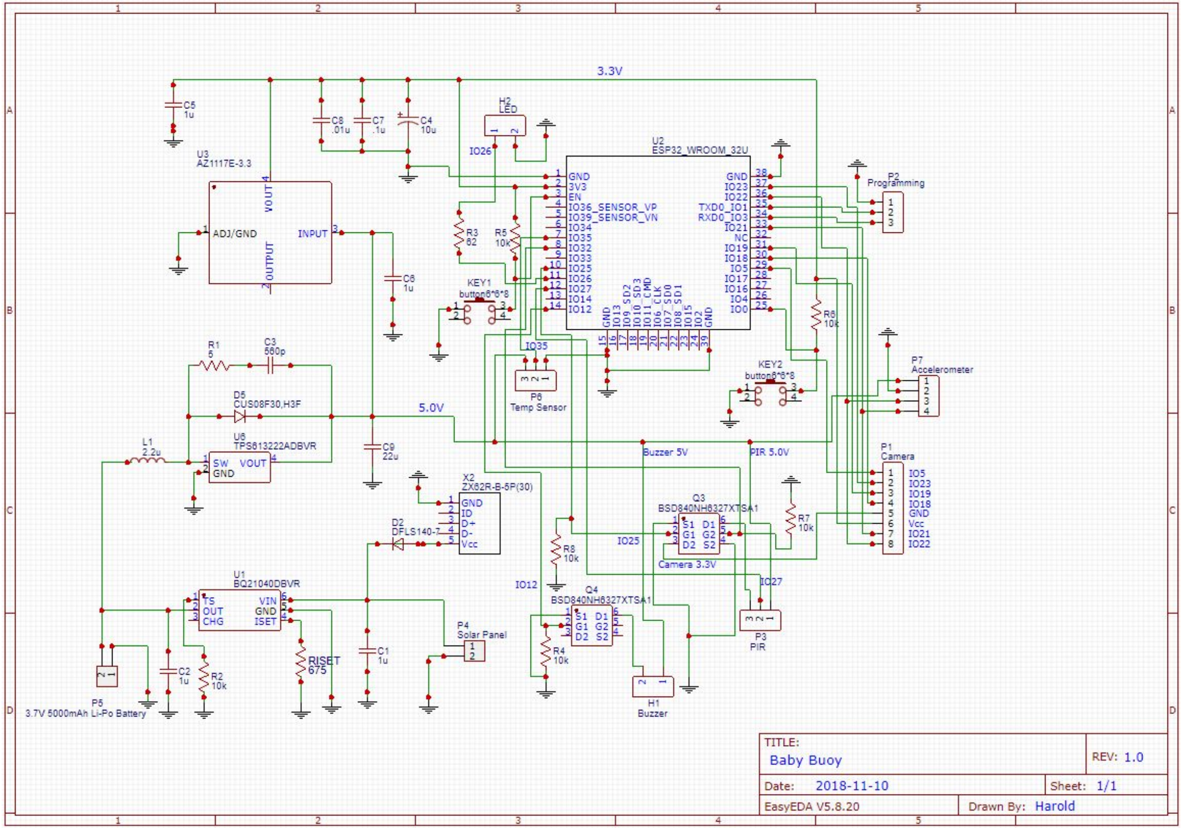


Power System Design

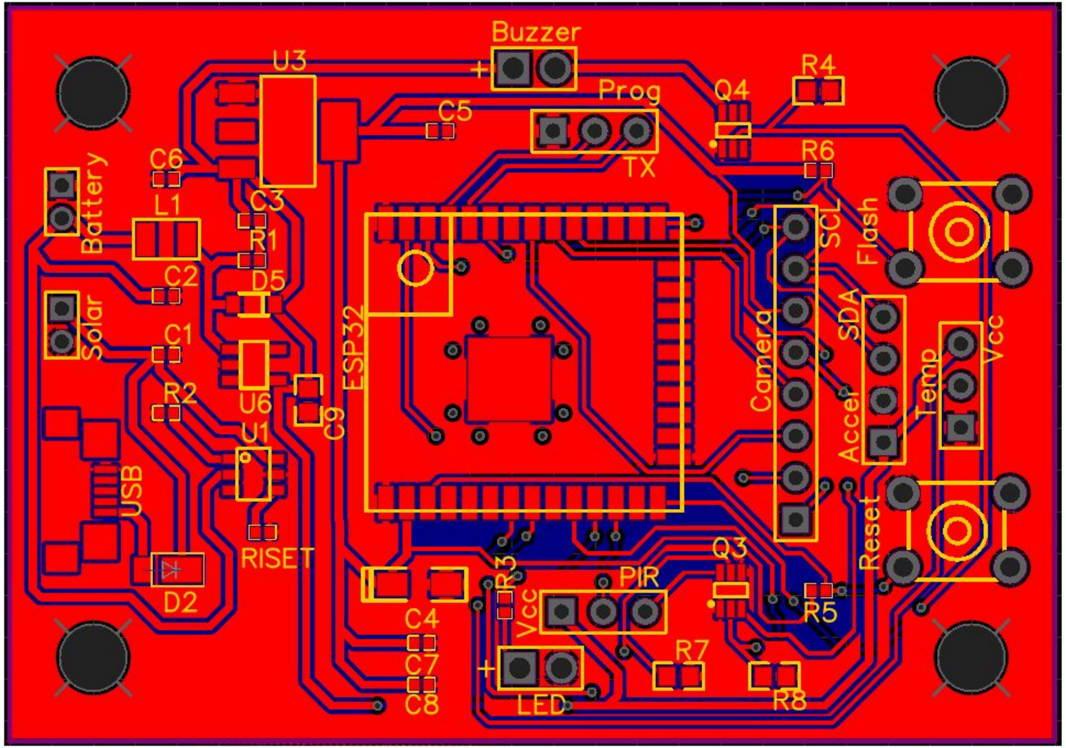


Component	Max Current Draw (mA)
PIR Sensor	65
Camera	70
MCU	80
Temp. Sensor	0.05
Buzzer	30
Accelerometer	0.165
Total	**245.22**

PCB Schematic



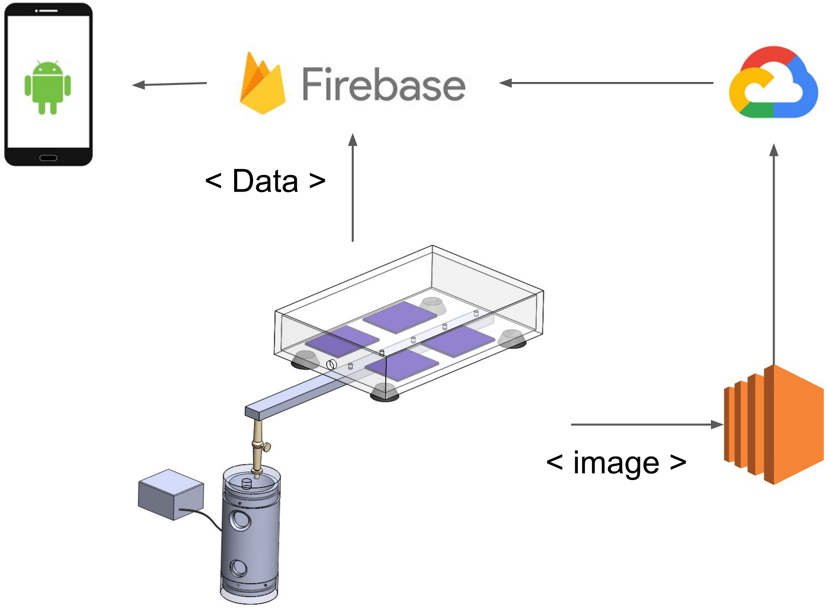
PCB Layout


Buzzer
U3
C5
Prog
TX
Q4
R4
R6
C6
Battery
L1
C3
R1
C2
D5
Solar
C1
U6
C9
ESP32
R2
U1
USB
RISET
D2
SCL
Flash
SDA
Camera
Accel
Temp
Vcc
Reset
Q3
PIR
R3
Vcc
C4
C7
C8
LED
R7
R8
R5

Software Design & Implementation

Main Software Components

- Firebase Realtime Database
- Amazon EC2 Server
- Google Cloud API
- Mobile Application
- Physical Unit



Device to App Communication

- Arduino Firebase libraries.

- Easy transfer of data:
  - Temperature
  - PIR Sensor
  - Accelerometer

Device to App Communication

<u>Capturing an Image</u>

- Underwater camera will upload to the Amazon EC2 server.
- Amazon EC2 will communicate with Google API and store images to Google cloud storage.
- From cloud storage it is a much easier transfer to Google Firebase realtime database, to receive the image instantly.

Realtime Firebase Outputs

Logs of Tripped Sensors

Output Data From Device

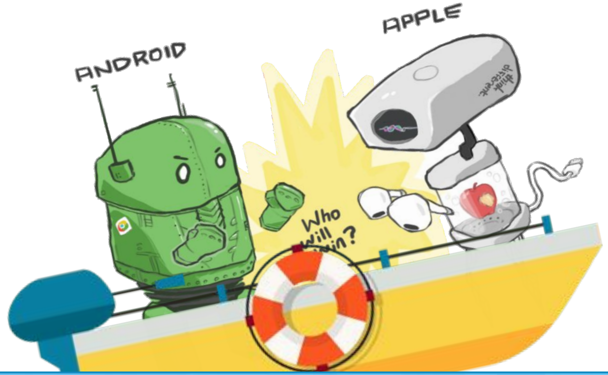
Stored User Information

Captured Images

- Alarm
  - 2019-04-15 11:51:06
    - Alarm_Time_Date: "Alarm triggered at: 2019-04-15 11:51:06
  - 2019-04-15 11:51:26
    - Alarm_Time_Date: "Alarm triggered at: 2019-04-15 11:51:26
- Flags_Temp
  - AlarmFlag: 0
  - TempFlag: 0
  - Temperature: 80
  - buzzerFlag: 0
  - pirFlag: 1
- HFd2wVrAnAQqeKB2q4V9STsWkfj2
  - userEmail: "n.irizarry143@hotmail.com"
  - userName: "neysha"
- Images
  - 04-15-2019-155112 PM UTC_CAM_131
    - image: "http://13.58.85.183/phpToFirebase/uploads/CAM_1..."
  - 04-15-2019-155605 PM UTC_CAM_132
    - image: "http://13.58.85.183/phpToFirebase/uploads/CAM_1..."
  - 04-15-2019-155732 PM UTC_CAM_133

Mobile Operating System

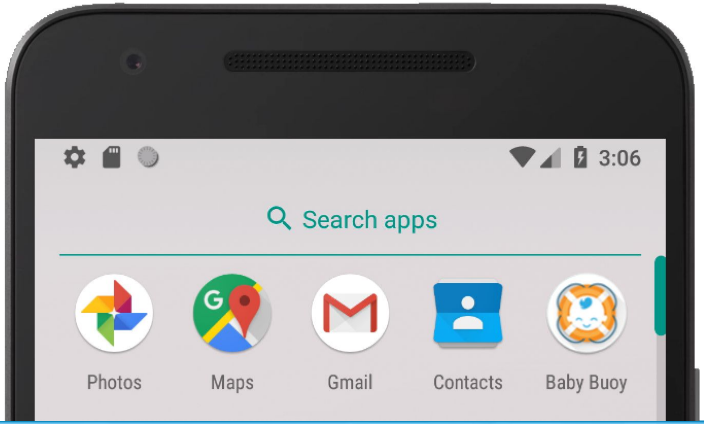
- iOS apps: Developed on Xcode and written using Swift language. Developer would need a Mac product (Desktop or Laptop). Development on Windows is possible but strenuous.
- Android apps: Constructed on Android Studios. Written in Java. Developer would need just a basic desktop or laptop. Android development is known to be more straightforward.



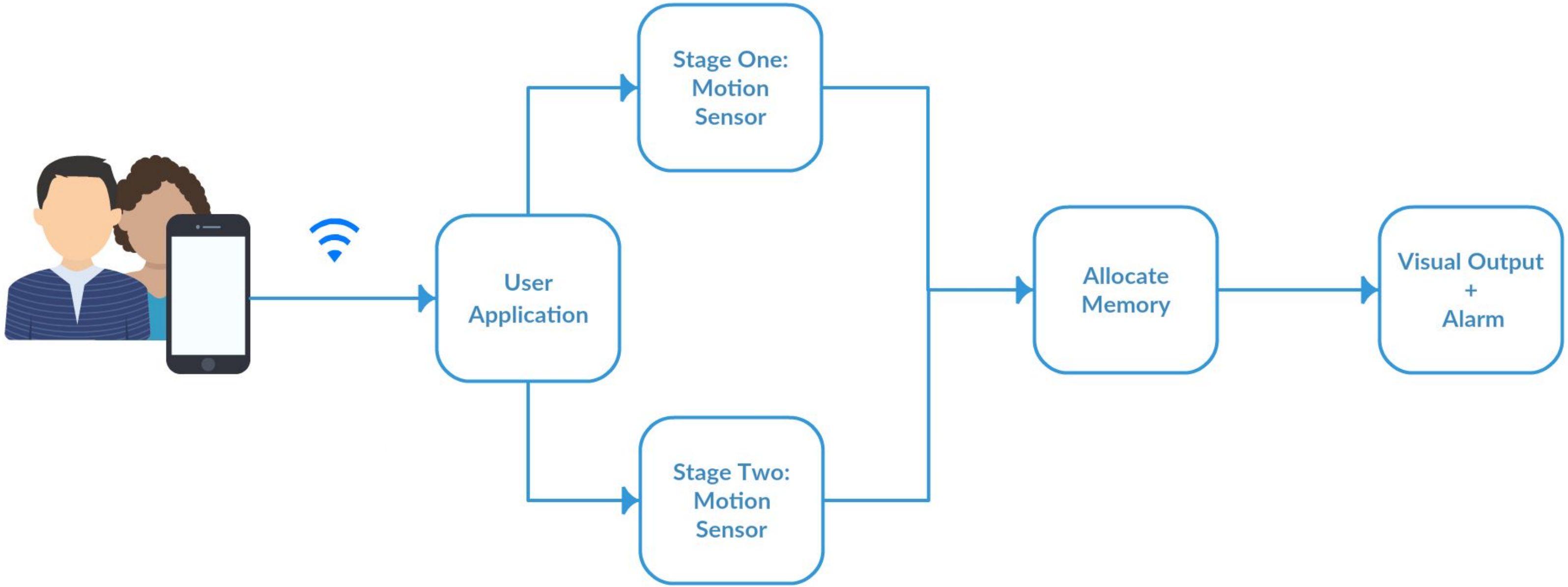
Mobile Application Features

Monitoring

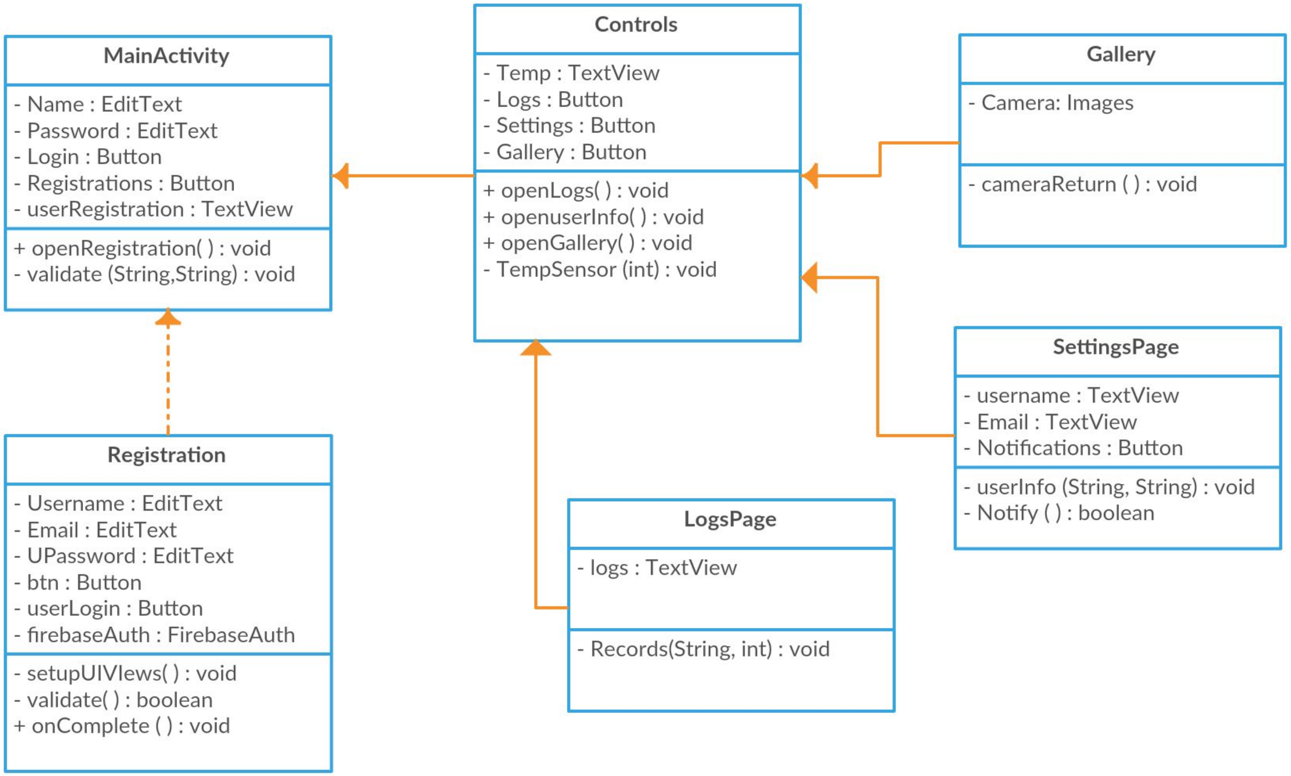
- Output logs of when sensors are activated do to motion detection.
- Gallery of images captured from underwater camera.
- Water temperature



Use Case Diagram

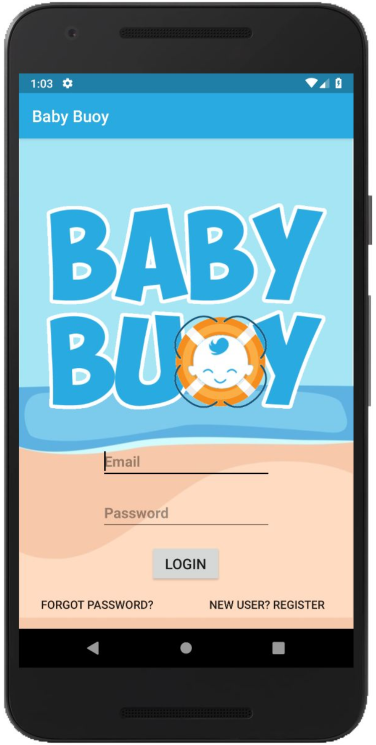


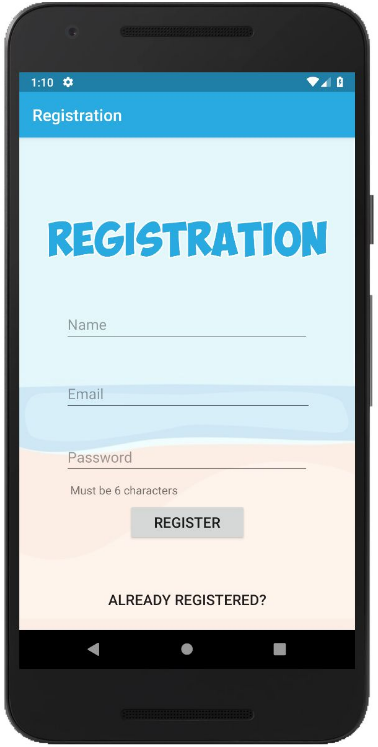
UML Diagram

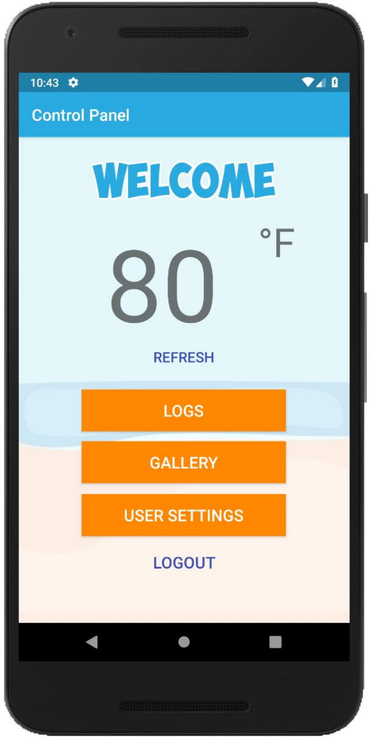


MainActivity
- Name : EditText
- Password : EditText
- Login : Button
- Registrations : Button
- userRegistration : TextView
+ openRegistration( ) : void
- validate (String,String) : void
Controls
- Temp : TextView
- Logs : Button
- Settings : Button
- Gallery : Button
+ openLogs( ) : void
+ openuserInfo( ) : void
+ openGallery( ) : void
- TempSensor (int) : void
Gallery
- Camera: Images
- cameraReturn ( ) : void
SettingsPage
- username : TextView
- Email : TextView
- Notifications : Button
- userInfo (String, String) : void
- Notify ( ) : boolean
Registration
- Username : EditText
- Email : EditText
- UPassword : EditText
- btn : Button
- userLogin : Button
- firebaseAuth : FirebaseAuth
- setupUIVIews( ) : void
- validate( ) : boolean
+ onComplete ( ) : void
LogsPage
- logs : TextView
- Records(String, int) : void

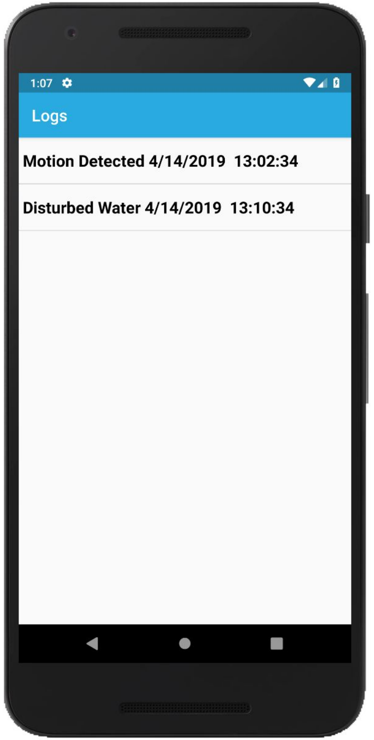
Mobile Application UI

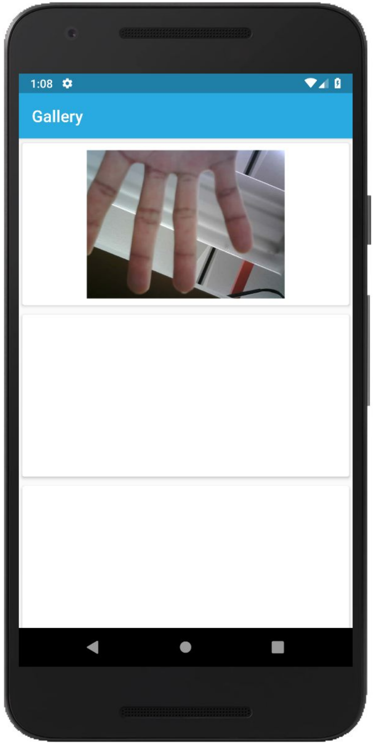


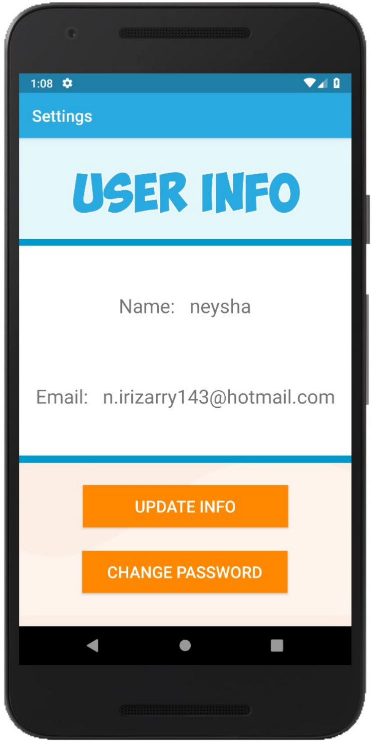




Mobile Application UI







Pool Test Video

Constraints & Standards

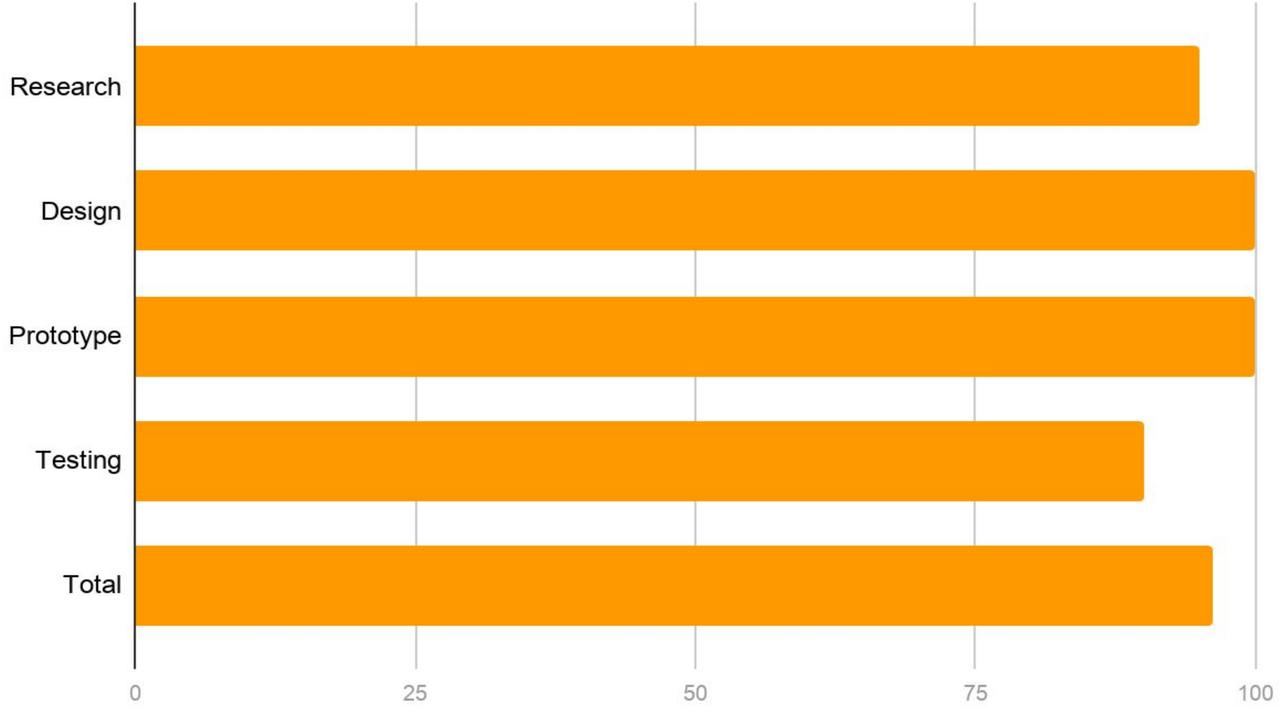
- Economic Constraint: Self funded project. Keeping it cost friendly and competitive with other similar products out in the market.
- Health and Safety Constraint: Child safety is our #1 concern. Keeping any dangerous and hazardous material sealed, covered and away from small rugrats.
- IEC 60529 standard: Goes over what would classify an object to be protected from environmental elements. Based on their rating scale our project is scaled as a IP58. Meaning, dust resistant 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
ESP-WROOM-32U	1	$3.80
PIR Sensor	1	$1.72
Camera Module	1	$25.99
Alarm Module	1	$1.96
PCB	1	$2.00
BQ21040	1	$1.26
TPS613222A	1	$2.85
AZ111EH-3.3	1	$0.44
TMP36	1	$1.50
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
Switch	1	$0.46
External Antenna	1	$5.00
LEDs, resistors, inductors, etc...	1	$6.00
Single Unit Subtotal:		$181.23

Progress



Issues Encountered

- Calibrating sensitivity of accelerometer.
  - Various tests had to be done to find the appropriate sensitivity
- Electronics Housing creates a Faraday cage for WiFi signal.
  - IPEX connector to WiFi chip and external antenna
- Receiving the images on the mobile application close to real-time
  - Integrated Amazon EC2 server and Firebase Realtime Database
- Analog Reader on ESP32 has a lot of noise
  - Average out values over time
- Device was slightly off-balance
  - Counterweights under solar housing were used
- Difficult to fit all components into Electronics Housing

LIVE DEMO