Smartphone Solar Tracker

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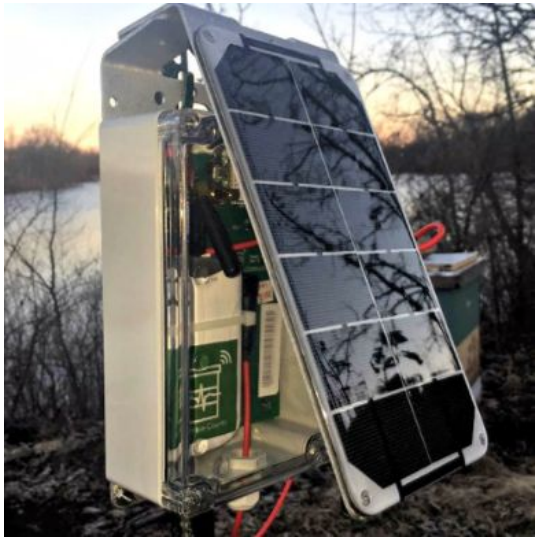
Introduction

- According to the EPA, 141 million mobile phones were discarded in 2009 and only 12 million of those were collected for recycling.
- Old smartphones in most cases end up on an offshore landfill, according to a study from the Basel Action Network, a nonprofit that opposes shipping waste from rich to poor countries. More than 80% of e-waste is exported to Asia where workers break down electronic devices for metals, particularly gold and silver.

Smartphone Solar Tracker

- What is Smartphone solar Tracker ?
- Why do we need this product?
    - Homeowners
    - Promoting Sustainability and reuse
- Reengineering



Qualitative Goals

- An Android OS application:
  - Reads in ambient light sensor and camera data
  - Locates the sun with sensor data
  - Calculates azimuth and zenith angles for the location
  - Sends manual data or manual move commands to the panel

- A motor/servo controller system:
  - Receives commands from the Android OS application
  - Moves the solar panels to desired azimuth and zenith angles

Qualitative Goals

- A wood structure:
  - Rigorous frame that houses the motors, solar panel and smartphone
  - Gears that allow motion of azimuth and zenith angles
- Solar panel:
  - Output of the solar panel powers a circuit: charges the smartphone or lights a LED.

Quantitative Specifications

- Physical attributes and output:

Specification	Value
Weight	20 lbs
Dimensions	15” x 15” 15”
Solar panel size	11” X 8.5”
Solar panel output	1 W at 6 V (average day-long insolation)

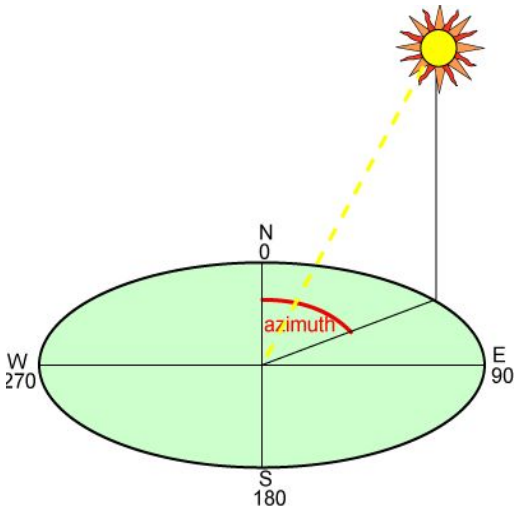
Quantitative Specifications

- Motion range, accuracy, device requirements:

Specification	Value
Azimuth range*	0° - 360°
Zenith range**	0° - 90°
Pointing accuracy	±0.5°
Operating System	Android 4.4 (KitKat) or above
Sensors	Ambient light sensor, Camera (> 5 MP), Accelerometer

Quantitative Specifications

- *: North is 0° , East is 90°, South is 180° and West is 270°.
- **: 0° is plane parallel to ground and 90° is plane normal to ground.



Design Approach

Frame Design

- Dual Axis for effective tracking
- Linear actuators or motors ?

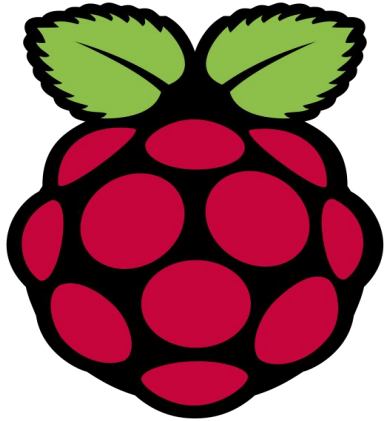
Motors

- Less degrees of freedom

Design Approach

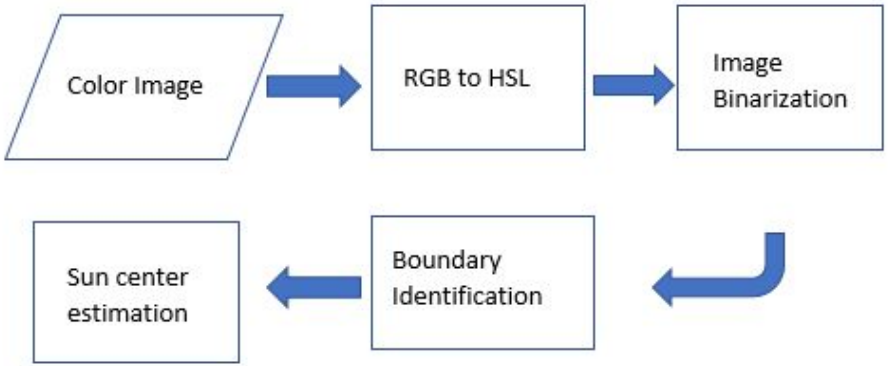
Micro-Controller Choice

- Task Complexity ; Memory, Processing speed
- Prototyping / Scalability



Design Approach

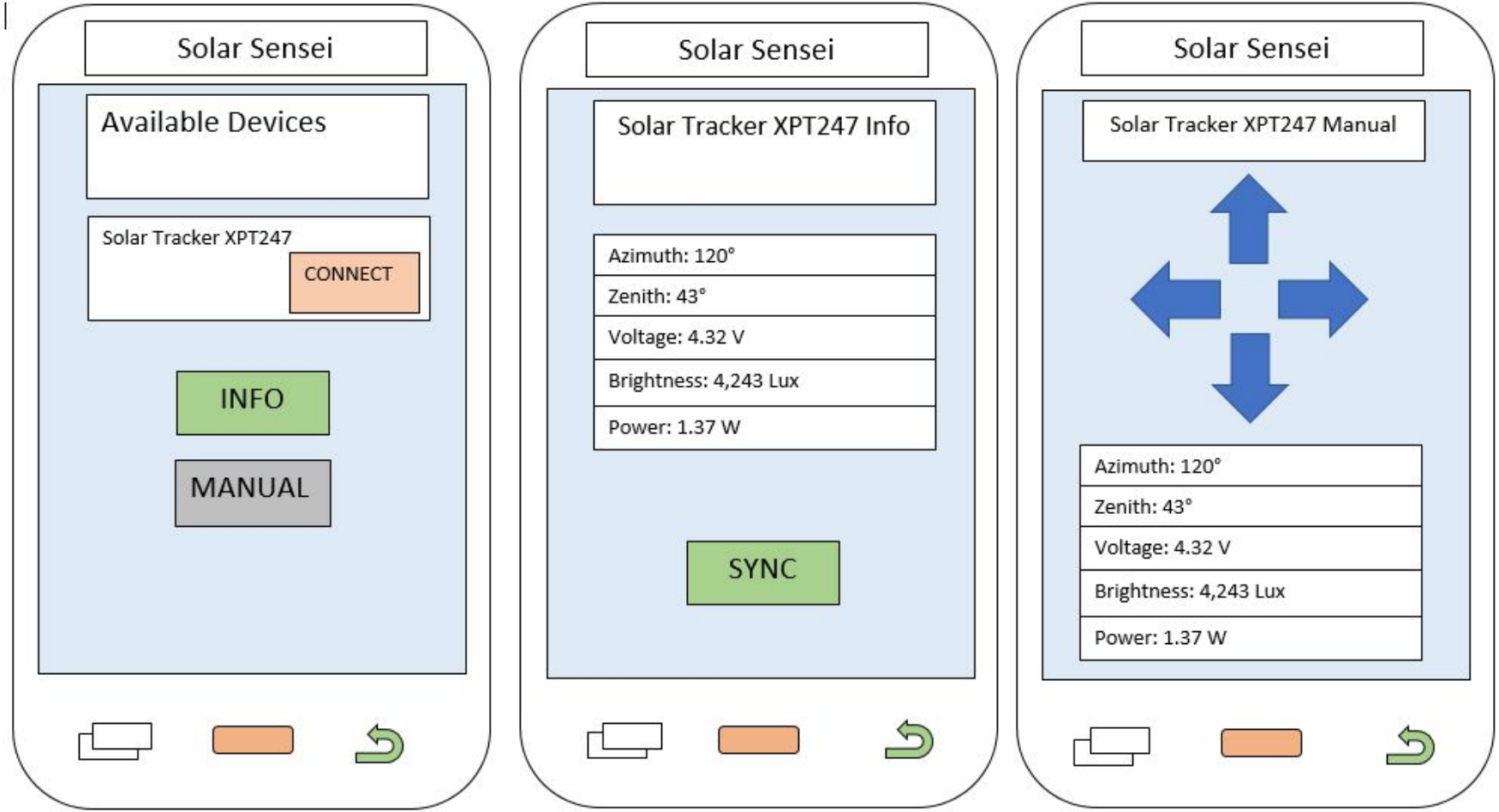
- Ambient light sensor to constrain sun’s location
- Camera to improve accuracy of the estimated sun location



Design Approach

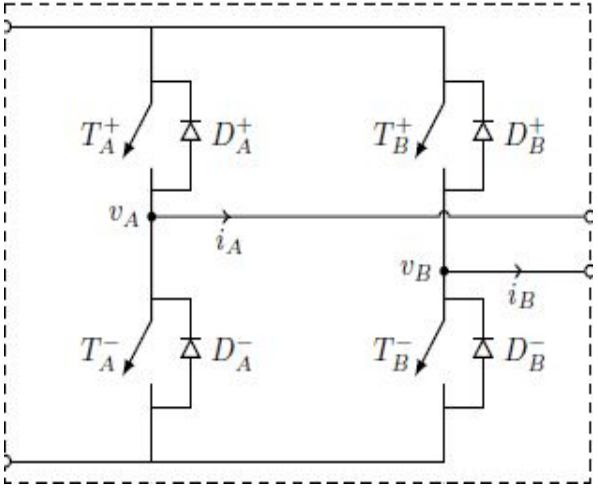
- Smartphone application
  - Interface for manual and automatic control of solar panel using sensors
  - Android based app (Java)
  - Bluetooth capability for sending data

- Smartphone sensors
  - Ambient light sensor
  - Camera


Solar Sensei
Available Devices
Solar Tracker XPT247
CONNECT
INFO
MANUAL
Solar Sensei
Solar Tracker XPT247 Info
Azimuth: 120°
Zenith: 43°
Voltage: 4.32 V
Brightness: 4,243 Lux
Power: 1.37 W
SYNC
Solar Sensei
Solar Tracker XPT247 Manual
Azimuth: 120°
Zenith: 43°
Voltage: 4.32 V
Brightness: 4,243 Lux
Power: 1.37 W

Design Approach

- Motor and motor controller
  - Stepper motor or Brushless DC motor
    Closed loop control or open loop control ?
  - Motor controller or H-bridge ; Dependent on type of motor



Design Approach

Gear Boxes

- High Torque required to move motors
- Most motors deliver high speed and relatively low torque
- Use gearbox to increase torque

Design Approach

Constraints

- Energy Efficient
- Low Cost
- Portable

Trade Offs

- Power Consumption vs Accuracy
- Cost vs Durability (Materials)

Cost Analysis

Table 5. Cost of Components			
Product components	Quantity	Price ($)	Total Price ($)
Motor driver circuit	1	300	300
Phone	1	150	150
Micro- Controller	1	60	60
Wooden Frame	20 board feet	3.25/board foot	64
Motors	2	56	112
Gear Boxes	2	49	98
Total Cost			**784**

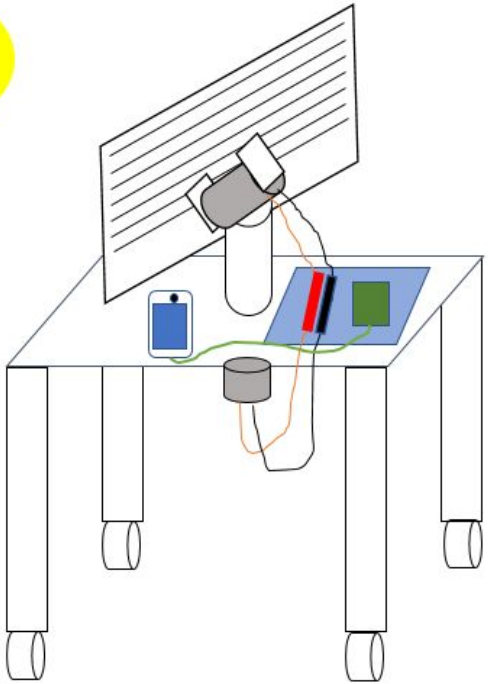
Project Demonstration

- Exterior testing ; Moveable frame

  Solar panel moves with change in frame position in order to orient itself in direction of sun

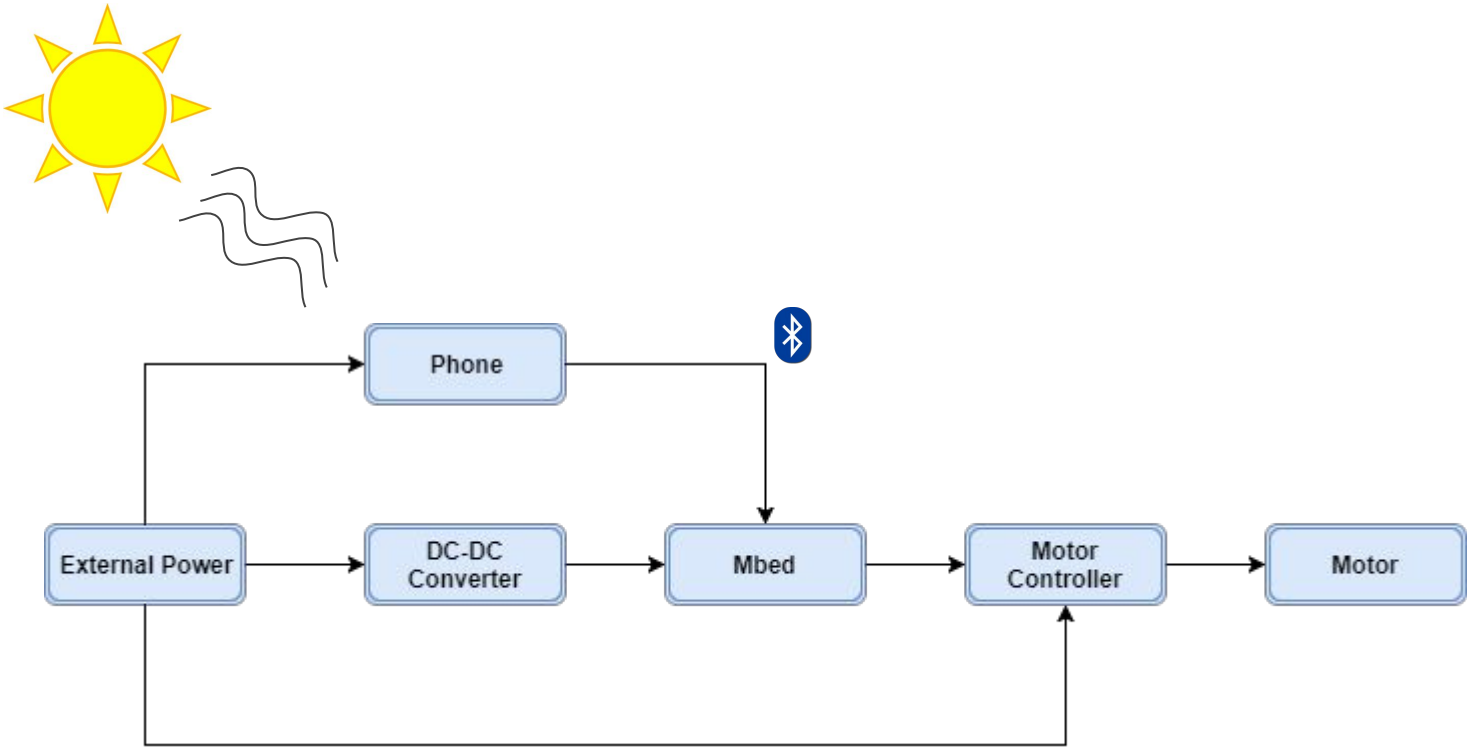
- Internal testing ; Moveable light source
  Solar Panel moves with change in position of lighting.

Project Demonstration



Part	Description
Motors	Gray cylinder
Circuitry	Blue parallelogram
Phone	Blue screen
Solar panel	Striped parallelogram
Structure	White shapes

Flow Diagram



Schedule

- What have we done?
  - Android Application design.
  - Create UI that displays sensor output.
- Present status
  - Exploring algorithms to calculate the sun’s intensity.
  - Creating solid work design.
- Challenges and Solutions
  - Android Application design.
  - Solid work design.

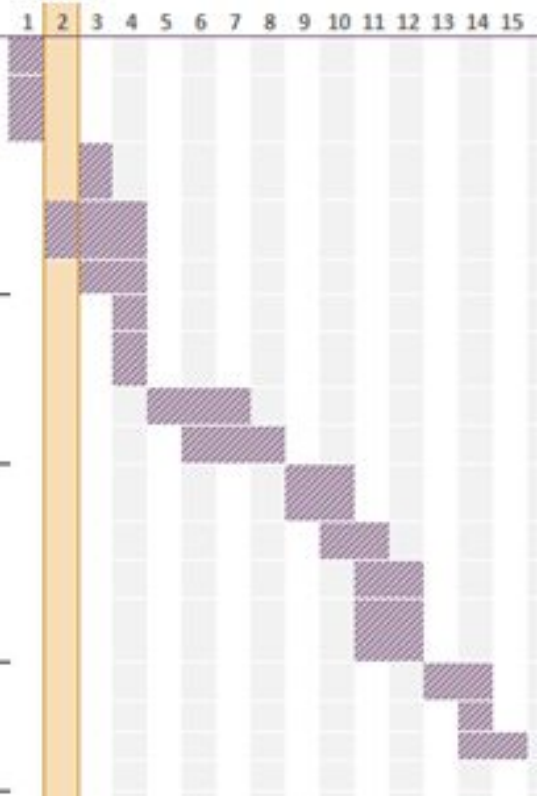
Solar Sensei Gantt Chart

1 Period = 1 week

Period Highlight: 2

Plan Duration | Actual Start | % Co

ACTIVITY	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Android application design	1	1	1	1	
Create UI layout that displays sensor output	1	1	1	1	
Oral Presentation (Tues 9/5) & Proposal	3	1	3	1	
Exploring algorithms to calculate Sun's intensity	2	3	2	3	
Create Solidworks Design	3	2	3	2	
Identification of necessary motors	4	1	4	1	
Purchase of motor and frame design parts	4	1	4	1	
Build circuits	5	3	5	3	
Circuit testing and validation	6	3	6	3	
Fabricating the framework for the system	9	2	9	2	
Build structure	10	2	10	2	
Motor control implementation	11	2	11	2	
Implementing feedback control technique	11	2	11	2	
Motor testing	13	2	13	2	
Feedback control testing	14	1	14	1	
Android application testing	14	2	14	2	
Capstone Design Expo (Dec 5)	16	1	16	1	



Status

- Chidi
  - Researching algorithms for estimation of sun direction using camera image
- Asier
  - Configuring bluetooth connectivity between Android device and mBed

Status

- Gideon
  - Learning CAD to design the wood structure
  - Researching power electronics to implement in the solar panel circuitry
- Yusuf
  - Prototyping a mBed demo that uses a servo and C++ code

Thank you!
Any Questions?