SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

ENSC 440W/305W: Capstone Project Presentation

Sun Crest Inc.

ENSC 440W/305W-CAPSTONE PROJECT

Group Members:

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Owen Au

Imtiaz Charania

OUTLINE

- Introduction
- Team Members
- Inspiration
- Why Solar Cook
- Market
- Competition
- Budget
- Timeline

OUTLINE

- System design
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  - Light-Sensor-based Sun tracker
  - Support structure
  - Umbrella Dish
- Failures
- Accomplishments

OUTLINE

- Future objectives
- Acknowledgements
- References
- QA
- Demo

INTRODUCTION

- Today's energy source is electricity and tomorrow's _____ ?
- Sun is the most abundant source of energy
- Design a solar cooker using recyclable and cheap materials
- Make cooking easier, time saving and healthier
- Sun tracking for more efficiency

TEAM MEMBERS

Tenzin Sherpa, Team Leader

- Inspired and organized the team
- Built most of the support structure
- Troubleshooting and integration
- Brought necessary components

Imtiaz Charania, Design Engineer

- Support structure design

TEAM MEMBERS

- Weight support calculations
- Assisted with support structure
- Troubleshooting and integration

Owen Au, Software Engineer

- Sun tracker circuit design
- Supplied sun tracker and support material
- Arduino programming

INSPIRATION

- Solar energy should be used now before oil and coal supplies diminish

- "Today, nearly half the world's population - close to 3 billion people – will eat meals cooked over fires that use charcoal, wood, or even animal waste for fuel. A year from now, 1.9 million of those people will be dead "

Thomas Eddison

WHY SOLAR COOK

- Solar cooking is simple, safe and doesn't require any external source of energy

- Millions of people who lack access to safe drinking, pasteurization done by solar cooking is a life-saving process

Source: Solarcooking.org

WHY SOLAR COOK

- Smoke and fire can damage lungs and eyes and can cause asthma, cancer and cataract
- Cataracts are the leading cause of blindness and visual impairment worldwide
- Many poverty-stricken families worldwide spend 25% or more of their income on cooking fuel

Source:solarcooker.org

MARKET

- Production of solar cooker using an umbrella can be cheap, easy to build making it a profitable business
- There is a constant demand for alternative energy sources since liquid purified gas and natural gas is expensive
- Countries in the Asia-Pacific and Latin America which have large rural populations are also prospective markets for these cookers

MARKET

- Not many companies produce solar cookers, leaving room for SunCrest Inc to grow.
- With proper credit provided, an estimated 50% of the world's population, approximately, 333,000,0000 fuelwood-using families would buy a solar cooker
- India and Africa are the largest user of solar cookers
- Target rest of the rural areas in Asia

COMPETITION

SolSource

- Designs a parabolic solar cooker weighing 4.5 kgs and provides a cooking temperature of 750 degrees Fahrenheit Costs $ 499

All American Sun

- A Solar powered box cooker constructed using fiberglass, raises temperature up to 300 degrees Celsius.

Source: oneearthdesigns.com

COMPETITION

Company	Cost ($)	Tracking
SolSource	499	Manual
AllSource	399	Manual
SunCrest Inc	199	Semi-automatic

BUDGET

Item	Quantity	Cost ($)/ item
Servo Motor from ServoCity (SPG785A)	1	290
Small Servo Motors (SM-S4303R)	2	34.5
Hitec Hs - 645MG Servo	1	45
Arduino Uno	1	50
LDR (Light-dependant resistor) and 55000 lux Analog Light Sensors	4+4	35
ENERGIZER Lantern Battery 6V (No.529)	1	9.99
ENERGIZER Battery 9V (522BP-2)	2	8.99

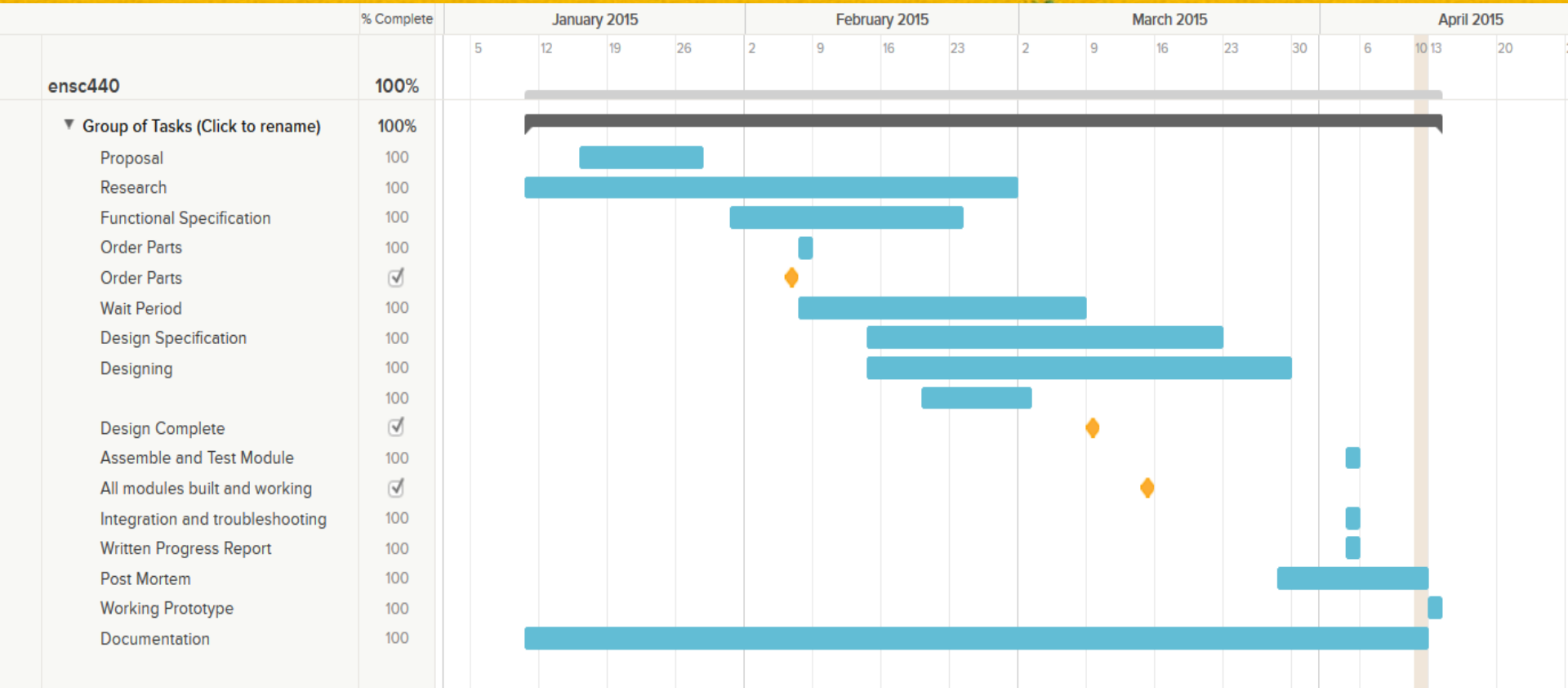
BUDGET

Item	Quantity	Cost ($)/Item
Support material (plywood,½ " x 48" metal rod,hinges and nails,base with wheels)	N/A	55
Aluminum tape	1	15
Electronic parts(diodes,BJTs, and 555 timer)	2	30
Pizza	2	30
Total	N/A	$ 594

BUDGET

- Estimated Cost : $800
- Actual Cost : $594
- ESSEF Funding : $500
- Group : $94

TIMELINE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January 2015
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5
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Group of Tasks (Click to rename)
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Proposal
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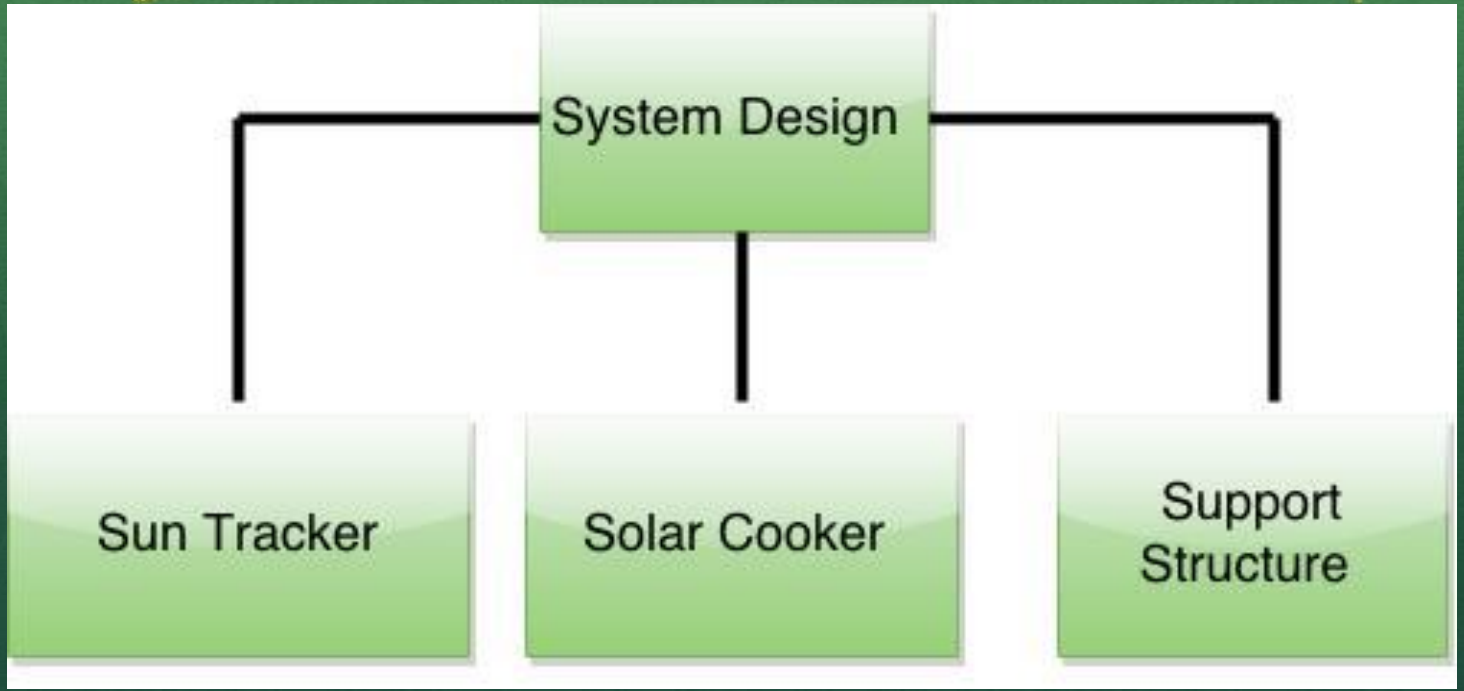
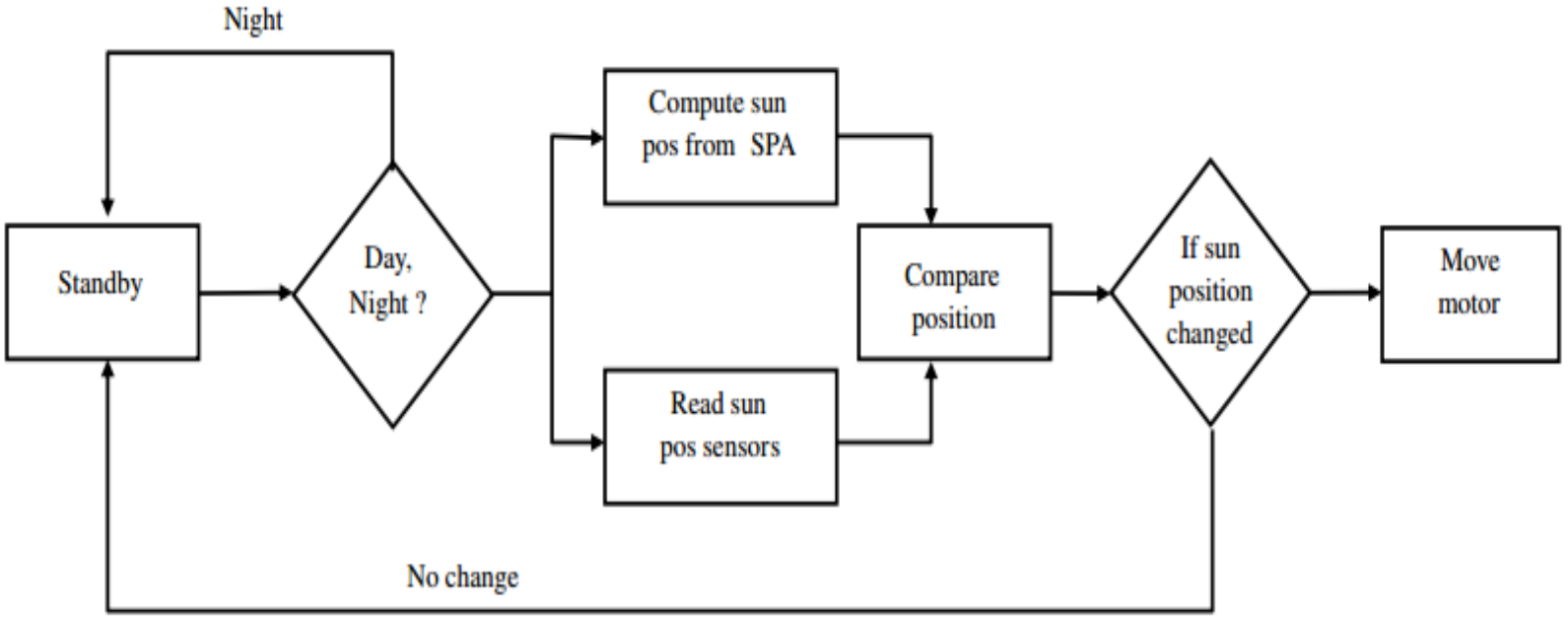
Research
100
Functional Specification
100
Order Parts
100
Order Parts
Wait Period
100
Design Specification
100
Designing
100
100
Design Complete
Assemble and Test Module
100
All modules built and working
Integration and troubleshooting
100
Written Progress Report
100
Post Mortem
100
Working Prototype
100
Documentation
100

HIGH LEVEL DESIGN



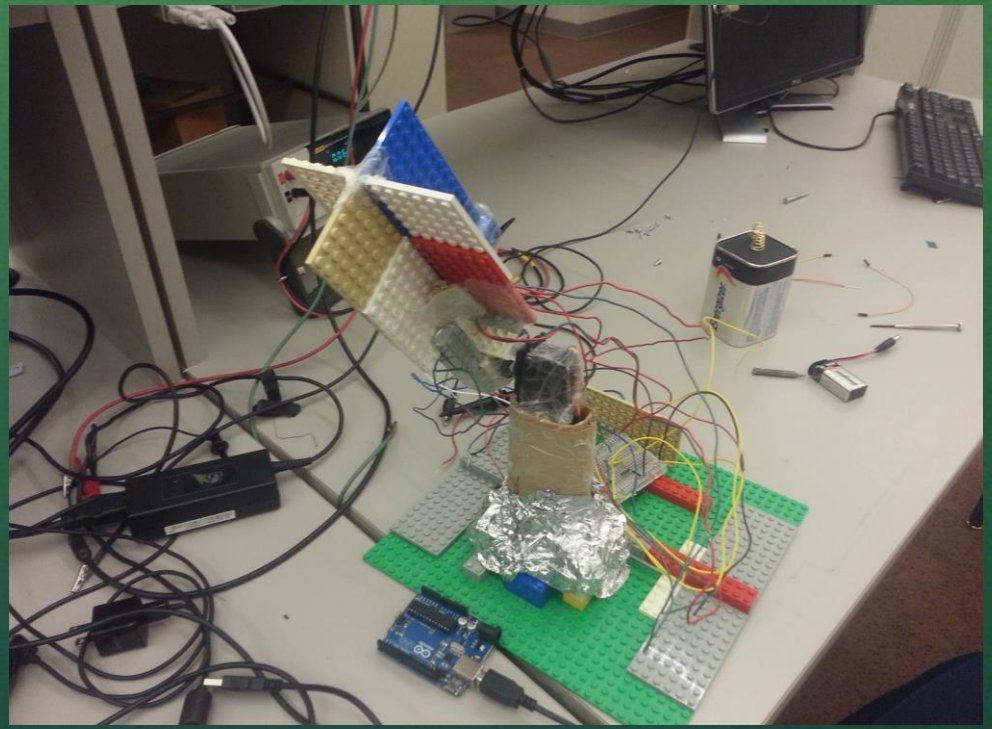
SUN TRACKER


Night
Standby
Day,
Night ?
Compute sun
pos from SPA
Read sun
pos sensors
Compare
position
If sun
position
changed
Move
motor
No change

SUN TRACKER

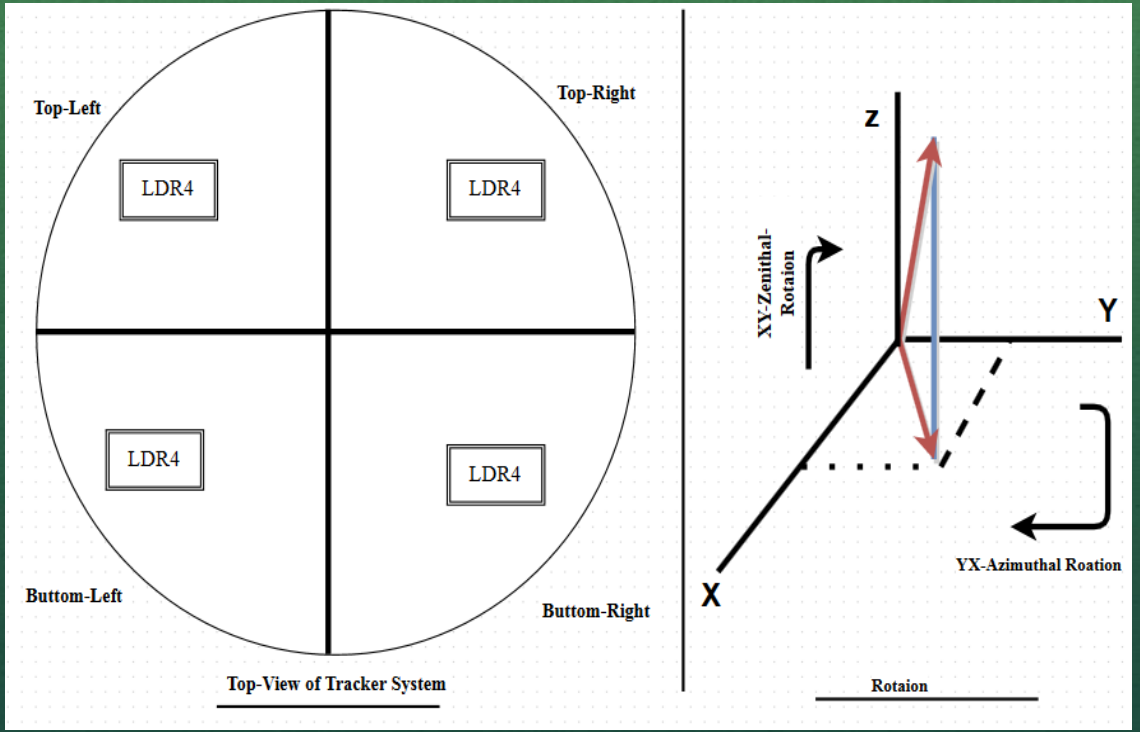
Properties :

- 4 LDRs in each corner
- Analogue voltage is read by the micro-controller
- Arduino driving the servos if LDR readings are different



SUN TRACKER

LDR Sun Tracker



SUN TRACKER

Time Controlled Sun Tracker

- Tracking Sum of the resistances < 70 % of (Total resistance) switch to time control

- Base motor (Hitec) rotates at 2.5^{o}/10mins

SUN TRACKER

Illuminance	Example
0.002 lux	Moonless clear night sky
0.2 lux	Design minimum for emergency lighting (AS2293).
0.27 - 1 lux	Full moon on a clear night
3.4 lux	Dark limit of civil twilight under a clear sky
50 lux	Family living room
80 lux	Hallway/toilet
100 lux	Very dark overcast day
300 - 500 lux	Sunrise or sunset on a clear day. Well-lit office area.
1,000 lux	Overcast day; typical TV studio lighting
10,000 - 25,000 lux	Full daylight (not direct sun)
32,000 - 130,000 lux	Direct sunlight

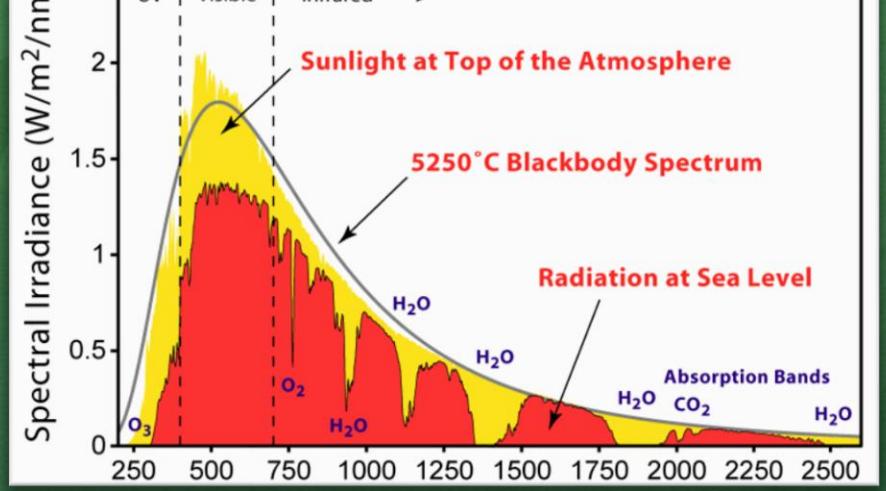
SOLAR COOKER

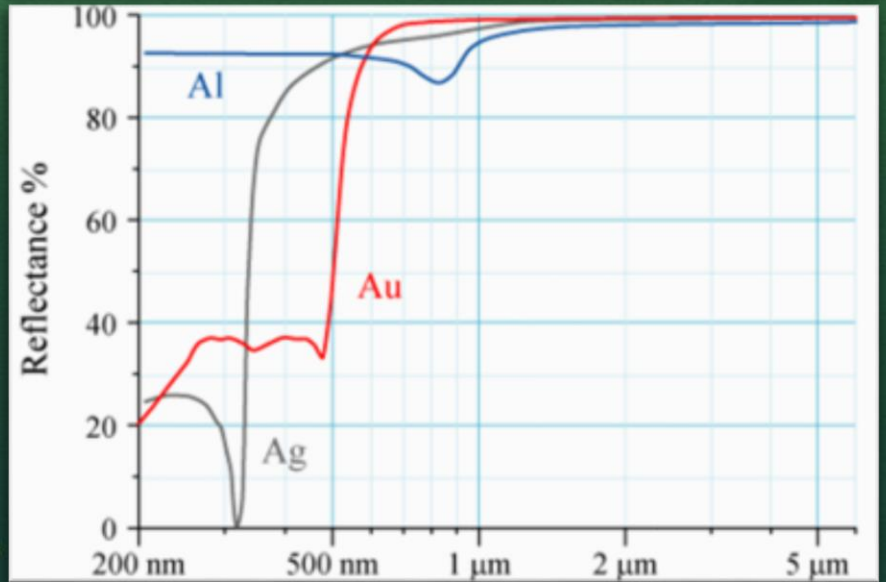
- Umbrella coated with Alluminum tape
- Chose Alluminum because approximately 80% reflectivity, cheap and light
- Umbrella focal point to diameter ratio F/D is 0.6m
- Ideal focal point should be approximately at 0.57m
- Focal point of Umbrella dish is at approximately 0.45m

SOLAR COOKER

ALUMINUM

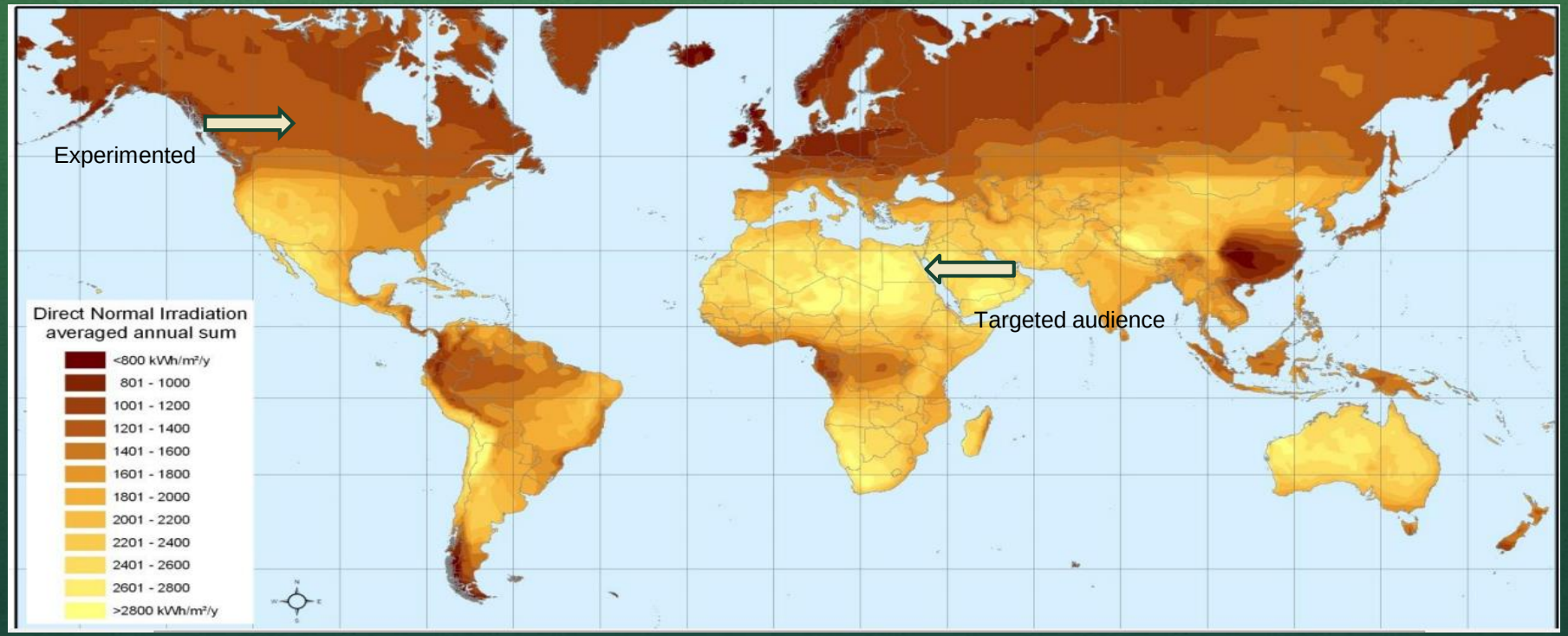
- Visible light wavelengths between 450 - 730 nm
- Aluminium is 90% reflective across the wavelengths (200 nanometres - 5 micrometres)





SOLAR COOKER

Solar Irradiance with Respect to Geographic Location



SOLAR COOKER

Solar Irradiance Calculations

- For places near the Equator, Solar irradiance = area x avg. Solar Irradiance = 0.816 m^2 x 700 W/m^2= 571 Watts

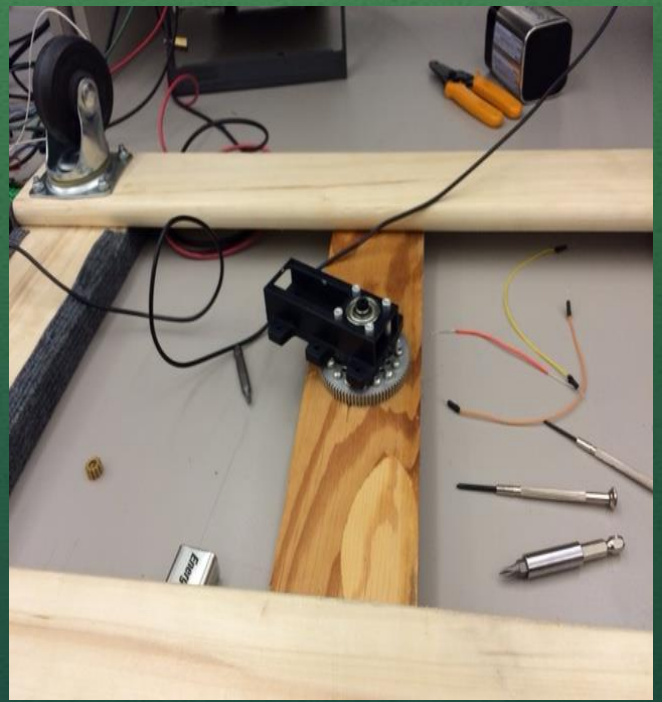
- Vancouver, Power = 0.816 m^2 x 137 W/m^2= 111.8 Watts

SUPPORT STRUCTURE

- Function of the support structure is to hold all the components together
- Strong enough to support the weight of the food and other forces
- Basic support structure displaying the dish connection
- The wheels reduce the stress on HS - 645MG motor

SUPPORT STRUCTURE

- Hi-Tec Servo motor connected to the base of the support structure for dish and food rotation.
- Controlled using an Arduino
- Contains a gear ratio of 7:1, increasing the torque from to 107 oz-in to 742 oz-in



MISTAKES/CHALLENGES

- Hitec Servo failed due to overload, reaching the stall torque limit of the motor causing it to burn
- Solar energy generated using umbrella was only able to produce 30^{o} C whereas expected was 50^{o} C
- Imperfect Alluminum lining reflected light in unpredictable directions

ACCOMPLISHMENTS

- Constructed a working LDR- Arduino sun tracker
- Assembled a sturdy support structure for the umbrella dish, food and the sun tracker
- Total control of all the servos
- Able to rotate the entire structure following the sun tracker

FUTURE OBJECTIVES

- Implement more effective light sensors
- Design an analogue to implement intensity and time control sun tracking
- Analogue circuit should be able to disconnect power during motor idle time using a PWM
- Design a structure that can be easily transported and light weight
- Implement a better user interface

CONCLUSION

What We Learned

- Programming with Arduino Uno
- Soldering and wood work skills
- Teamwork, organization and group dynamics
- Time and budget management
- Thinking ahead and planning in advance
- Always keep a plan B

AKNOWLEDGEMENTS

Thanks to

- Senior Lecturer Steve Whitmore
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- Professor Ash M. Parameswaran

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QUESTIONS