Photovoltaic Martian Bugs

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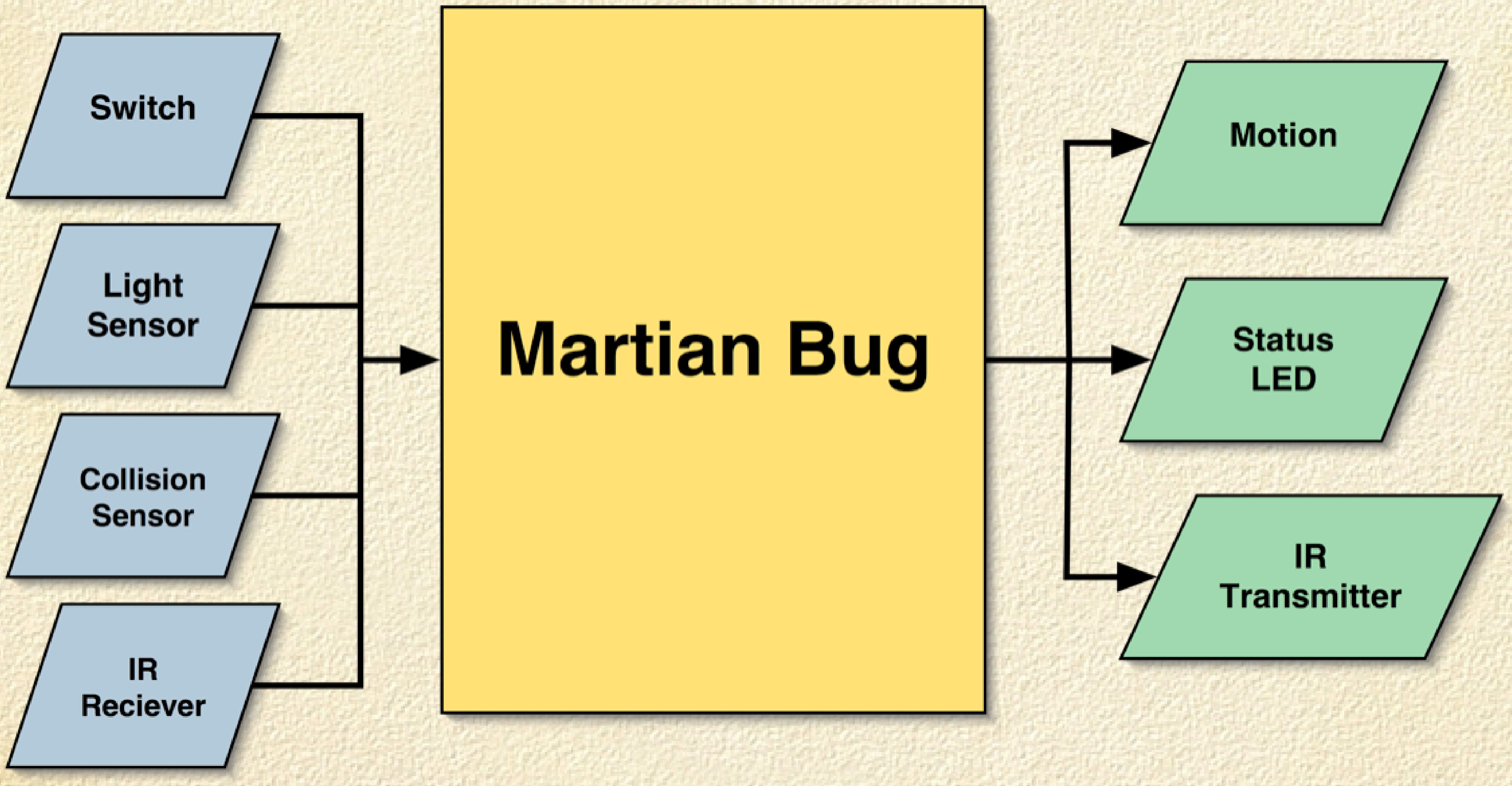
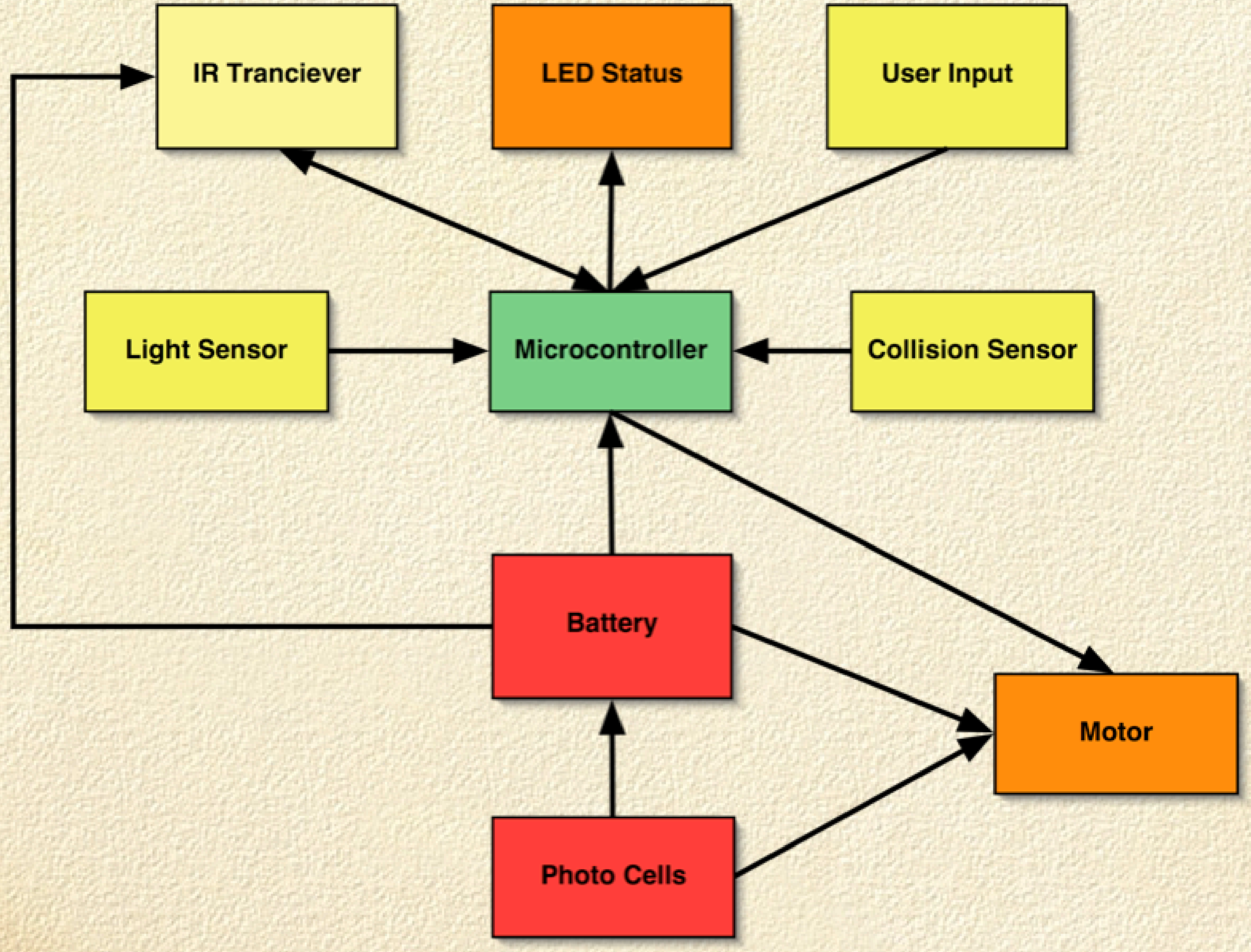
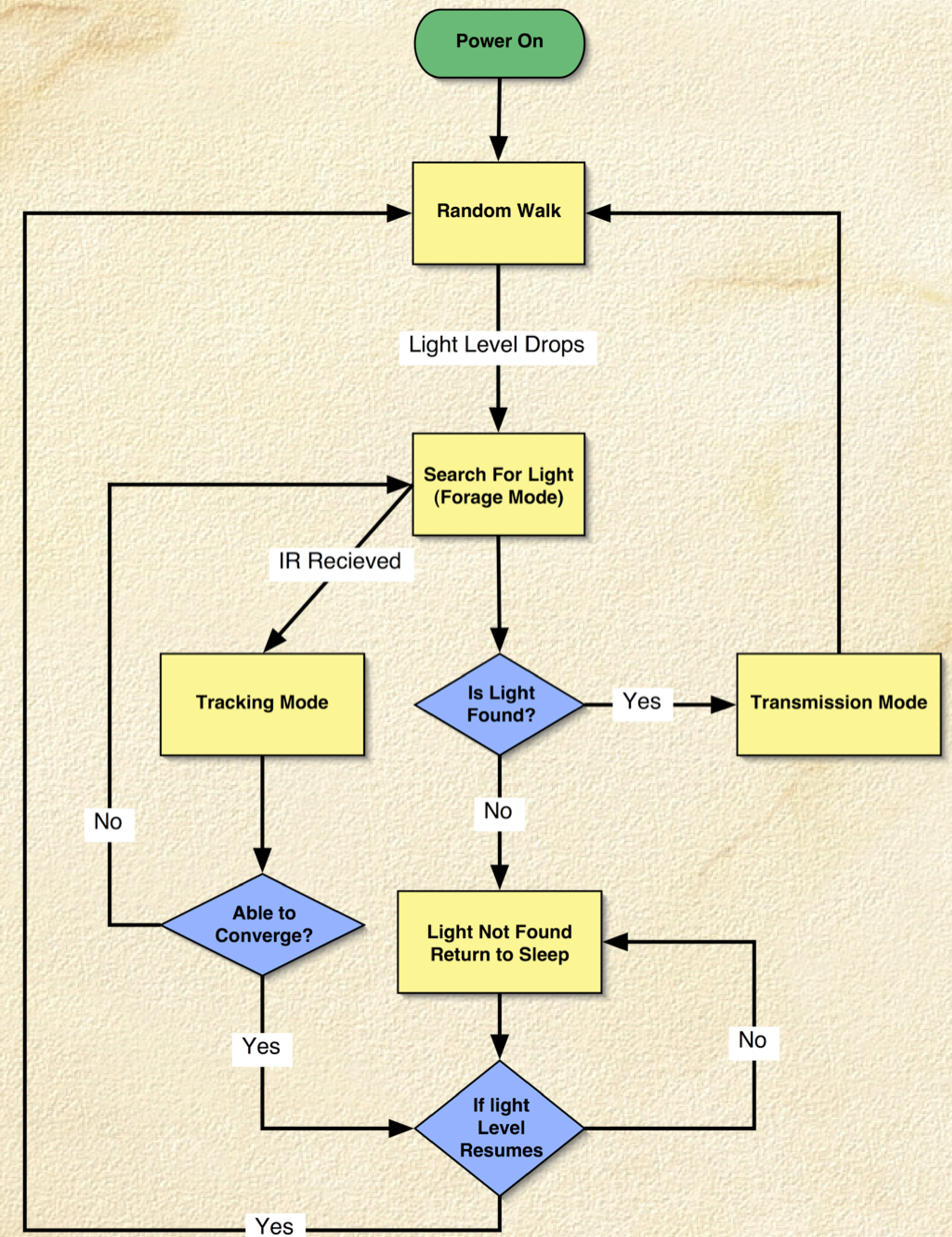
Overall Block Diagram



Hardware Flow Chart



Software Flow



Motor Torque Derivation

- The total force needed is the sum of the forces needed to move its individual parts.
- $F_{total} = F_{bug} + 2*F_{wheel}$
- $T = F * R$
- r/R is the mechanical advantage of a wheel
- $T_{motor} = T_{wheel\,*} (R/r)$
- Tmotor = [(Mbug*a*R^2)/r] + 2 * (R*m*g*uk)

Motor Assumptions

Variables	Value	Units
Wheel Radius	0.02	Meter
Wheel Mass	0.01	Kg
Acceleration	0.154	m/s
Shaft Radius	0.002	Meter
Uk	0.4	

Motor Torque (Mass)

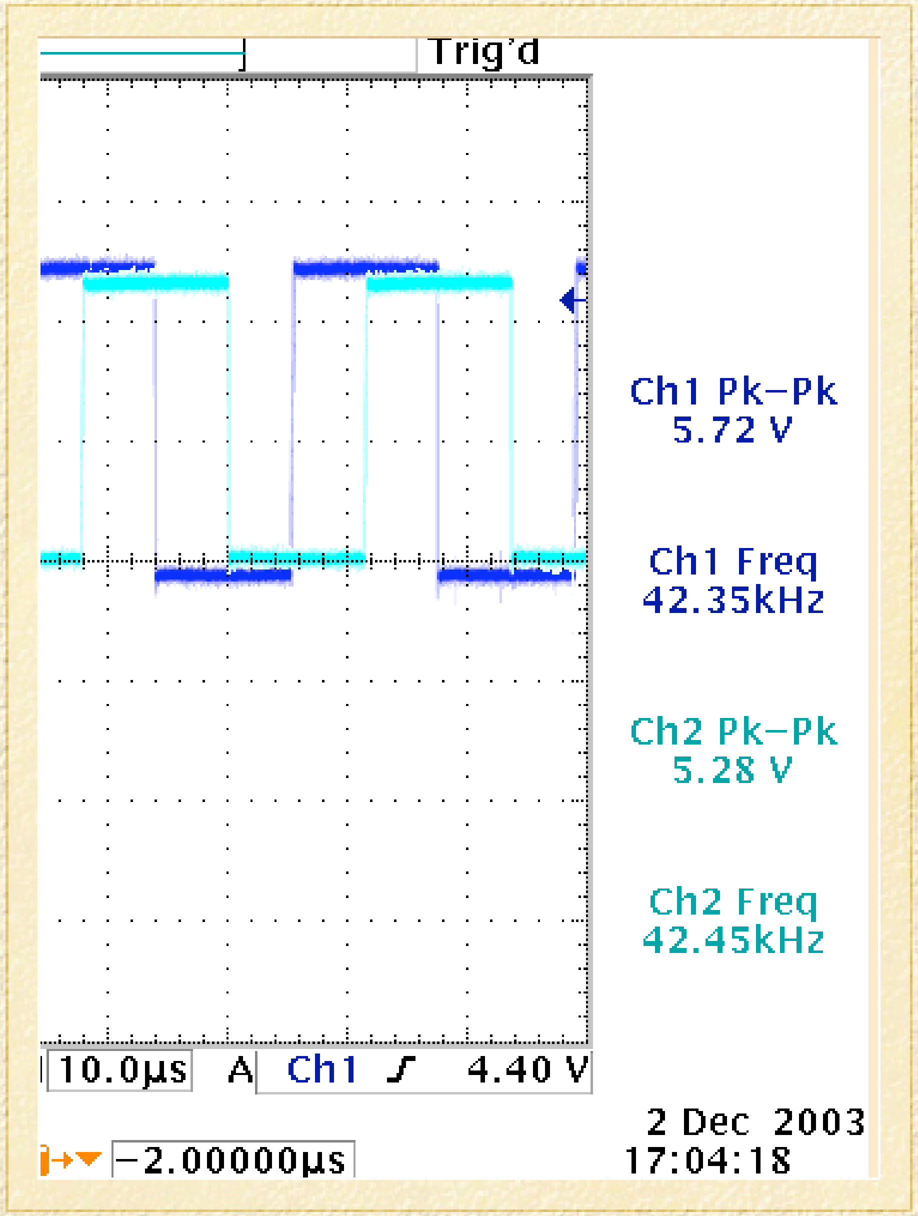
Mass	Motor Torque	
[kg]	[mNm]	[oz in]
.1	4.6496	0.6584
.2	7.7296	1.0946
.3	10.8096	1.5308
.4	13.8896	1.9669
.5	**16.9696**	**2.4031**
.6	20.0496	2.8393
.7	23.1296	3.2754
.8	26.2096	3.7116
.9	29.2896	4.1478
1.0	32.3696	4.5839

Gears & Torque

- Torque needed with the motor alone is very high at 17 mNm.
- The solution is to add a planetary gear set.
- $T_{geared} = T_{motor}$ * (Gear Ratio) * (Gear Efficiency)
- Motor torque is a function of current
- $I = [T_{desired}/GR]*[Ap/mNm]*[1+(1- efficiency)]$

Motor Control

- Direction will be controlled by an H bridge like device.
- The motors will be single speed standard electric motors.
- A motor encoder will be used to provide feedback to the control unit.



Power Supply: Design

- Solar panel array size is constrained by:
  - Power requirements
  - Desired operating conditions
  - Cell efficiency
  - Platform size

Power Supply: Load

- Continuous elements
  - Motors, IR transmitters, sensors
  - Shortages compensated by backup battery
- Intermittent elements
  - Motors, microcontroller
  - Shortages compensated by capacitor

Power Supply: Input

- $P_I \approx 1367 * 0.7^{AM^{0.678}}$
  - 1367 W/m^2 at AM0, 844 W/m^2 at AM1.5
- AM1.5 * 70%-20% for overcast weather
- AM1.5 * 2% - 0.2% for indoor lighting
- Also depends on color spectrum

Power Supply: Efficiency

- Specified at 1000 W/m^2, 5600K, 25°C
- 36% max, 20% high quality, 5% cheap.
- ... but it's a lie anyways (spectral efficiency)
- Losses with temperature
- Losses in regulator

Power Supply: Reality

- Shoebox-sized bug, 8” x 12”
- Won’t work continuously indoors
- Battery will charge in excess light
- Duty cycle ideally 100%, 20% indoors

Schedule

Week 1	Solar Panel Testing	Motor Testing
Week 2	Power Regulation	Motor Control Hardware
Week 3	Power Regulation	Motor Control Hardware
Week 4	Power Regulation	Motor Hardware Testing
Week 5	Solar Panel and Battery Integration	Motor Power System Integration
Week 6	Optoelectronic Testing Microcontroller setup	Optoelectronic Testing Microcontroller setup
Week 7	Software Modules	Software Modules
Week 8	Software Modules	Software Modules
Week 9	Software Modules	Software Modules
Week 10	Software Testing	Software Testing
Week 11	Final Product Assembly	Final Product Assembly
Week 12	Product Testing	Product Testing
Week 13	Product Testing	Product Testing
Week 14	Finishing Touches	Finishing Touches

Questions?