Skylight Glass

Group 13

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Goals/Objectives

Problems: Blind Automation

- Heating/Cooling is very expensive
- Sunlight (not) entering the house makes things worse.
- Traditional blinds don't work with your AC system and still absorb heat
- Traditional blinds don't compensate for the light lost when they're shut
- Traditional lighting doesn't replicate the sun's color temperature
- Very important for circadian rhythm

SkyLight Glass

Specifications / Requirements

Component	Parameter	Design Specification
Smart Film	Light Blocked	70%
Bluetooth Module	Minimum Range	10 feet
LEDs	Full Duty Cycle Brightness	1000 Lumens
LEDs	Color Temperature	3000K-5000K
Temperature Sensor	Accuracy	1 degree
Light Sensor	Accuracy	10 Lumens
Time (software)	Accuracy	10 seconds

Features

Privacy

- Tint, when you want it
- Or none if you prefer

App control

- I/O
- Alarm Mode
- Sensor Data
- LED Control

Savings

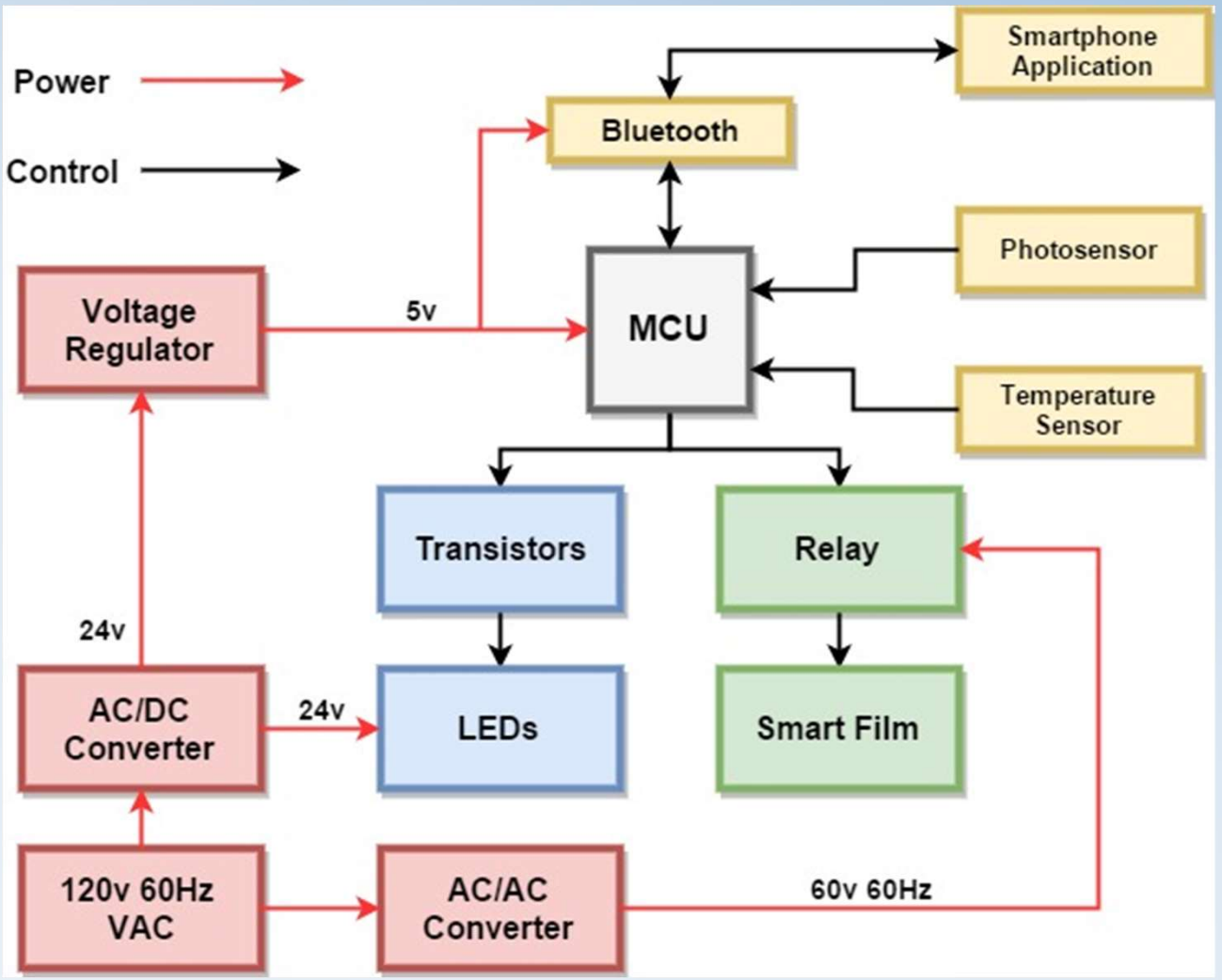
- Temperature control of household
- Less power used by A/C unit

Smart Control

- Temperature Sensor helps with auto tinting
- LEDs mimic sunlight

Block Diagram

LED Subsystem	Paul/Blake
Power Subsystem	Blake
Smart Film Subsystem	Paul
Control/Feedback Subsystem	Ben/Will



Design and Hardware Implementation

- Decentralized design approach
  - We designed individual subsystems and then designed the architecture that integrated the subsystems into a coherent system
- Implementation: The team created a breadboard prototype for each subsystem and tested functionality individually
- Integration: Each subsystem was integrated into the overall system as a breadboard prototype to verify complete system functionality. This was used as a basis for the PCB design.

Smart Film Subsystem

Smart Film Market Research

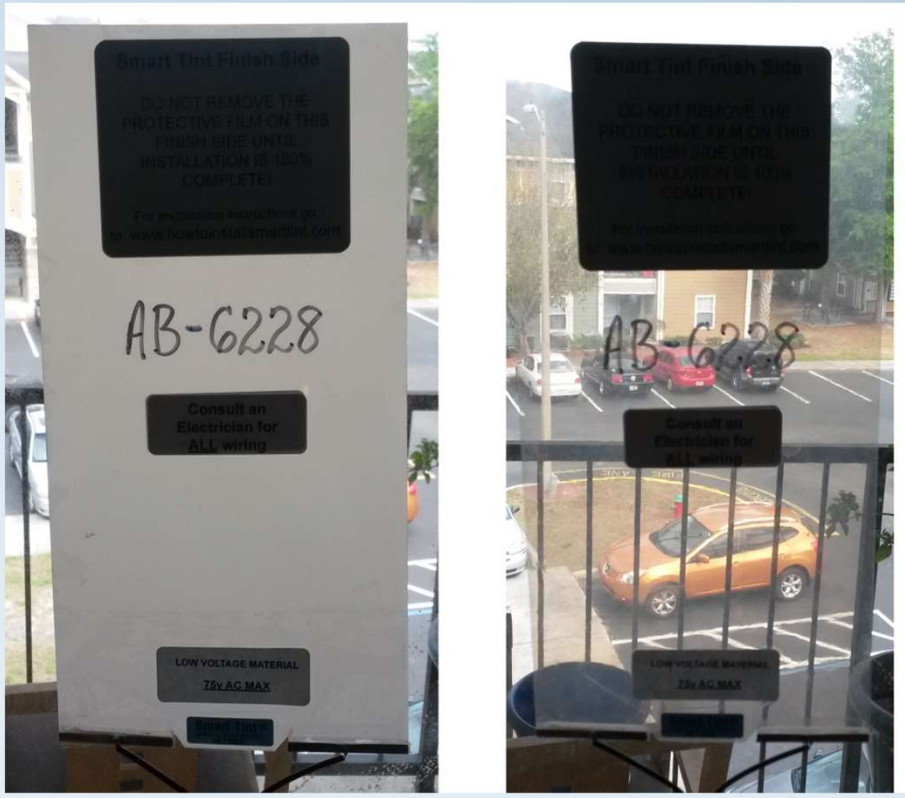
Requirement: Visible light transmission < 30% when opaque
Smart Film Technologies:

1. Electrochromic - slow transition time
2. **Polymer Disperse Liquid Crystal (PDLC)** - fast transition, industry standard
3. Suspended Particle Device (SPD) - few vendors sell film variant
4. Micro-blinds - patented and not on the market currently

Smart Film Subsystem Components

Smart Film selected

Product Attributes	Smart Tint®
Light Transmittance (opaque state)	4% ± 2%
Switching Speed	50-100 ms
Operational Temperature Range	-10° to 60° C
Coefficient of Haze (transparent)	0.03 ± 0.01
UV Absorption Index (opaque)	99%
IR Absorption Index (opaque)	20% (regular) 90% (LV-NF)
Solar Heat Gain Coefficient	0.71
Energy Consumption (W/ft²)	0.3-0.49



LED Subsystem

LED Requirements

Requirements:

1) Illuminates a 10ft x 10ft room.
2) LED color temperature can vary between 3000K-5000K

LED Products:

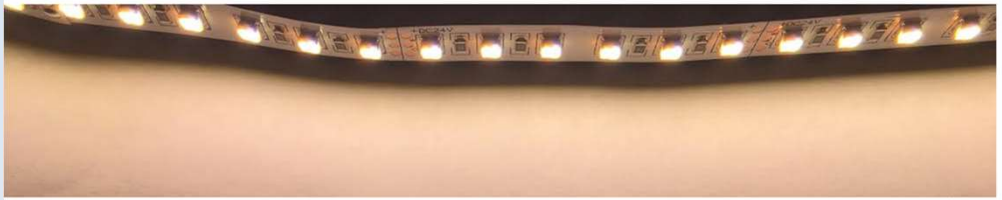
1. LED bulbs - meets the requirements but bulky and costly
2. **Surface Mounted Device** - LED strip, meets both requirements
3. Chips on Board - Maglite, will light the room but blind everyone

LED Color Temperature

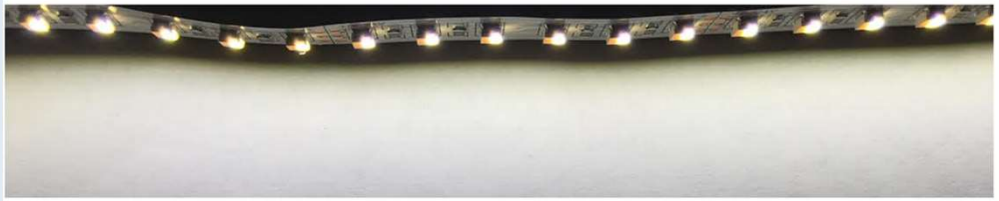
3528 SMD LED strip (3.5 mm by 2.8 mm) demonstrating varying color temperature.

Warm

Mix



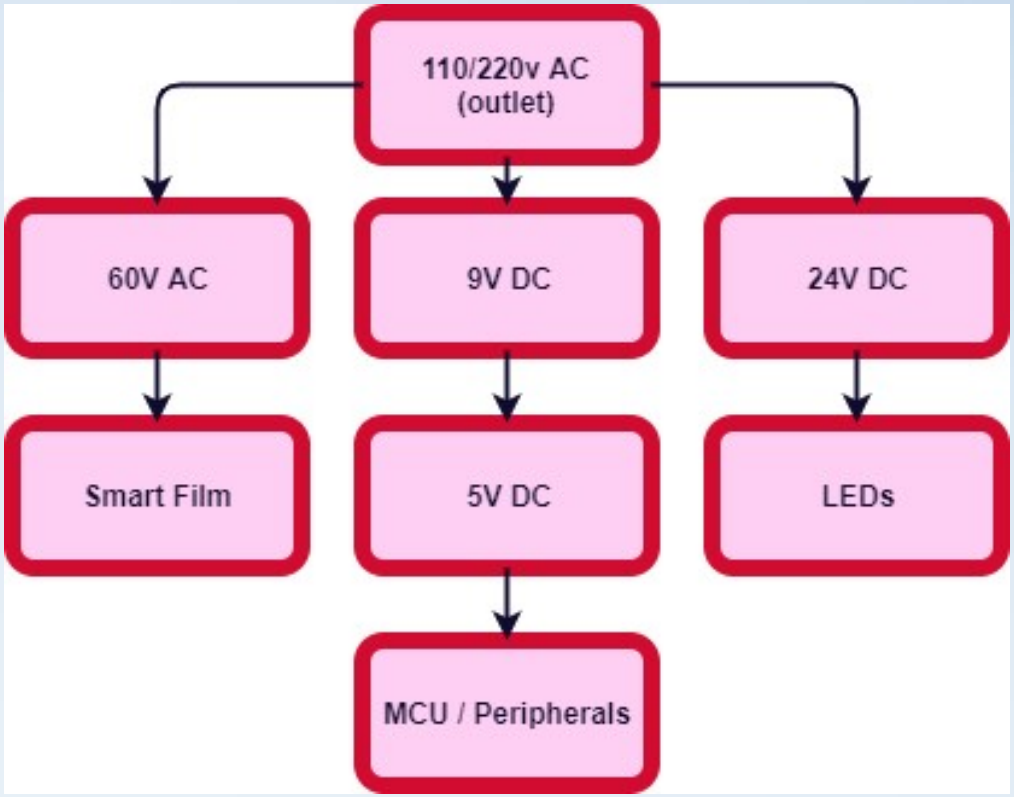
Cool



Mix
Low Intensity

Power

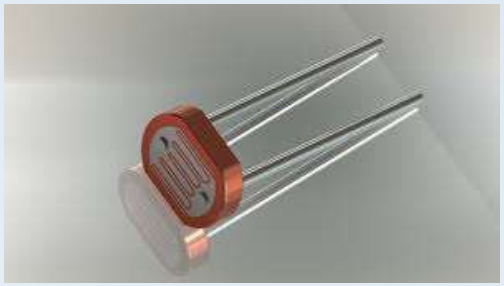
System	Part	Requirement
Output	Smart Film	60v AC
Output	LEDs	24V DC
Main	MCU	5v



Feedback Subsystem

Light Sensor

Photoresistors



Photodiode

Phototransistor

Light Sensor

Part no: LTR-4206E

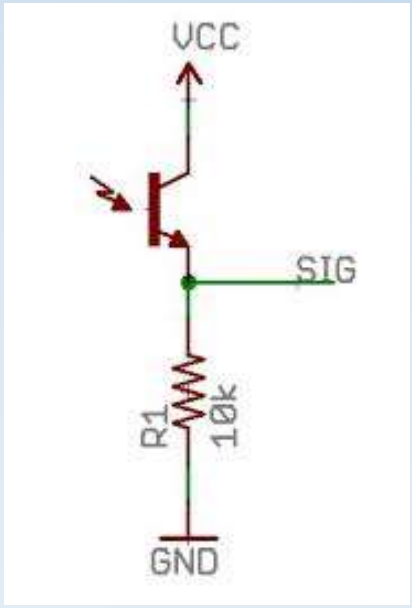
Resolution

- Can be varied by changing resistance

Easy of Use

- Output is easily accessible

Cost Effective



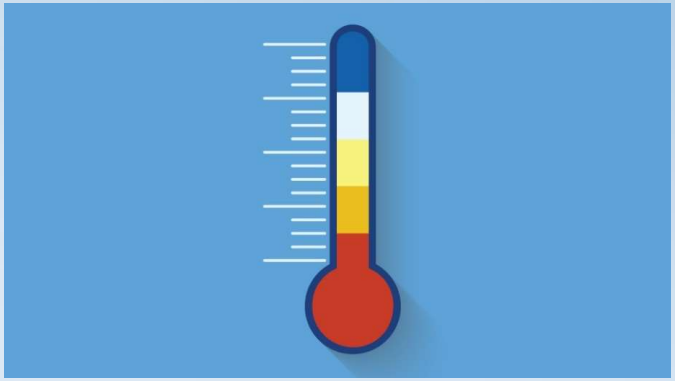
Temperature

Seasonal

- Adapt to conditions automatically

Efficiency

- Help improve energy consumption



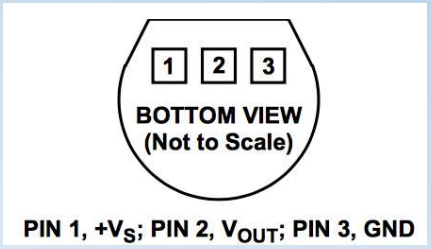
Temperature

MCP9700T

- ± 2°C
- Surface Mount

LM75B

- ± 2°C
- Surface Mount



TMP36

Accuracy

- Precise for our needs ± 1°C (+25°C)

Integration

- 3 pins allows simple integration.

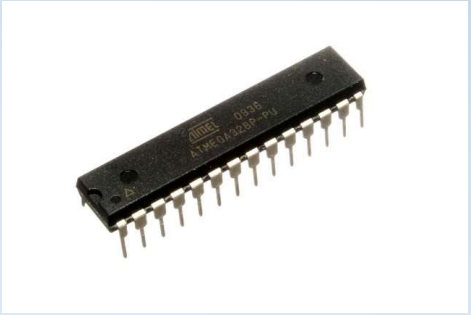
Cost Effective

Microcontroller

TI CC3200

MSP430

ATMega328P



ATmega328P

Analog

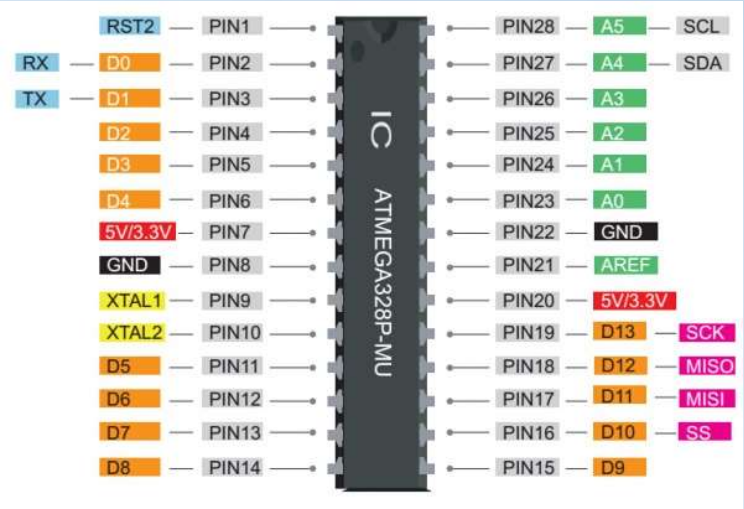
- Feedback System (6 A/D Pins)

Digital

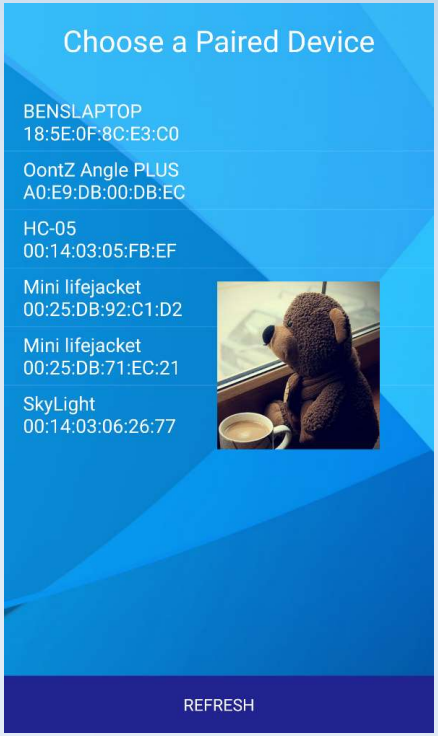
- Controlling LEDs (6 PWM Pins)

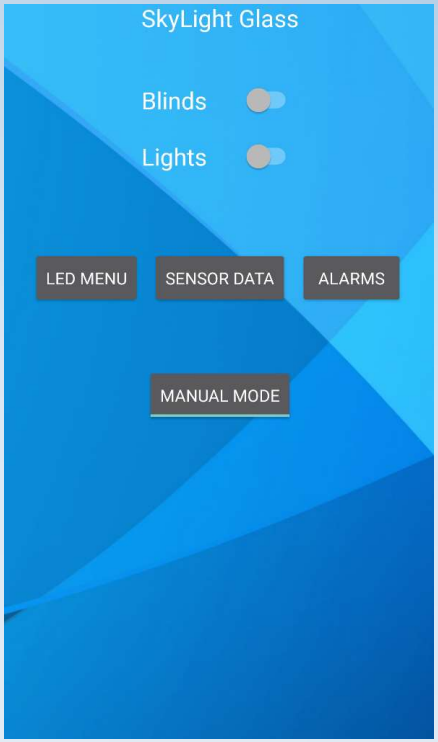
Digital

- Communication (TX/RX)



Application





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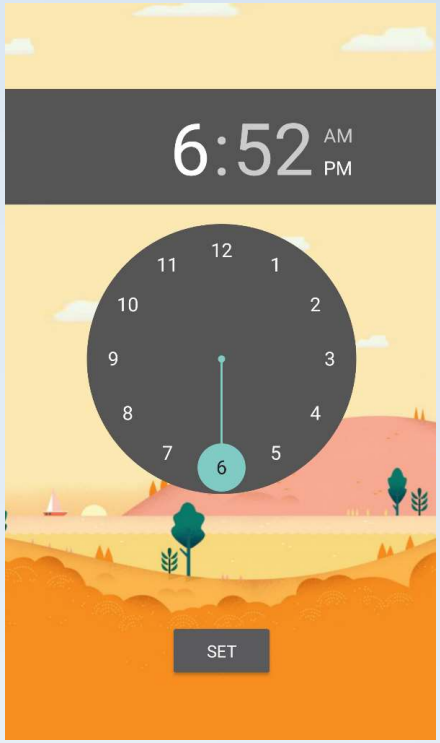
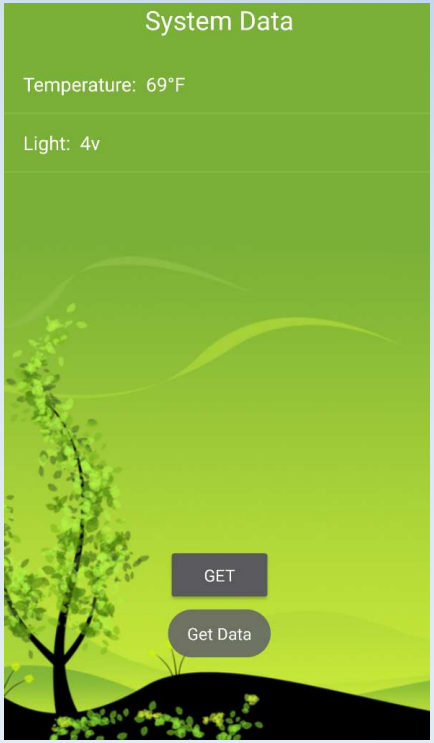
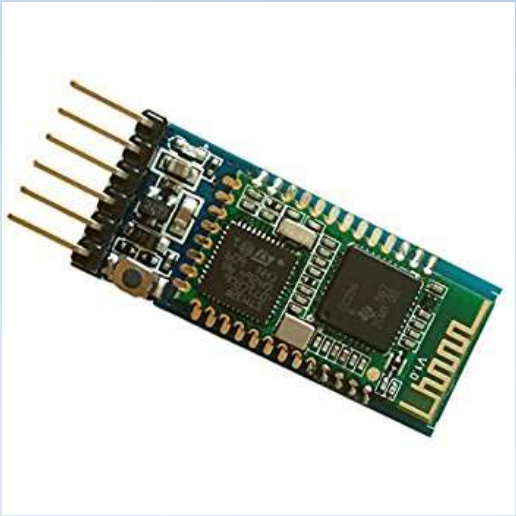




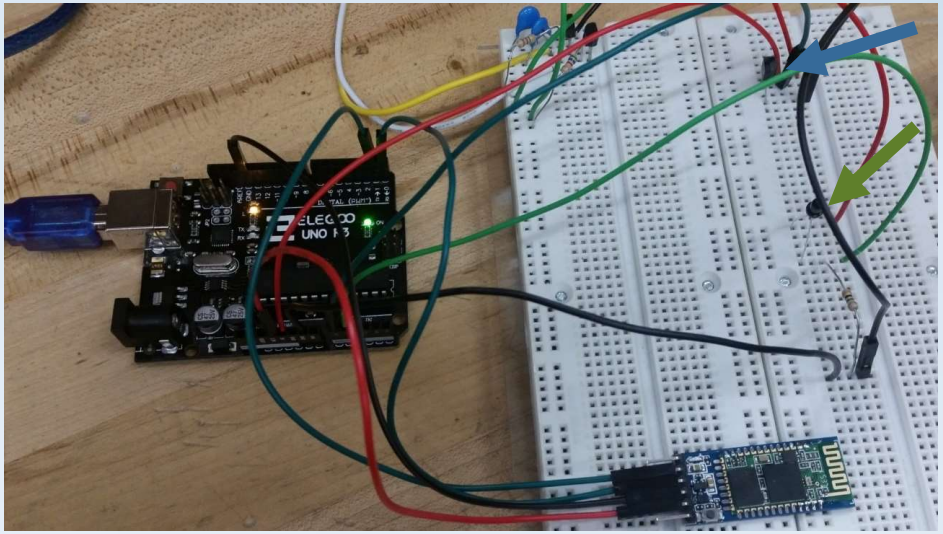
Bluetooth Communication

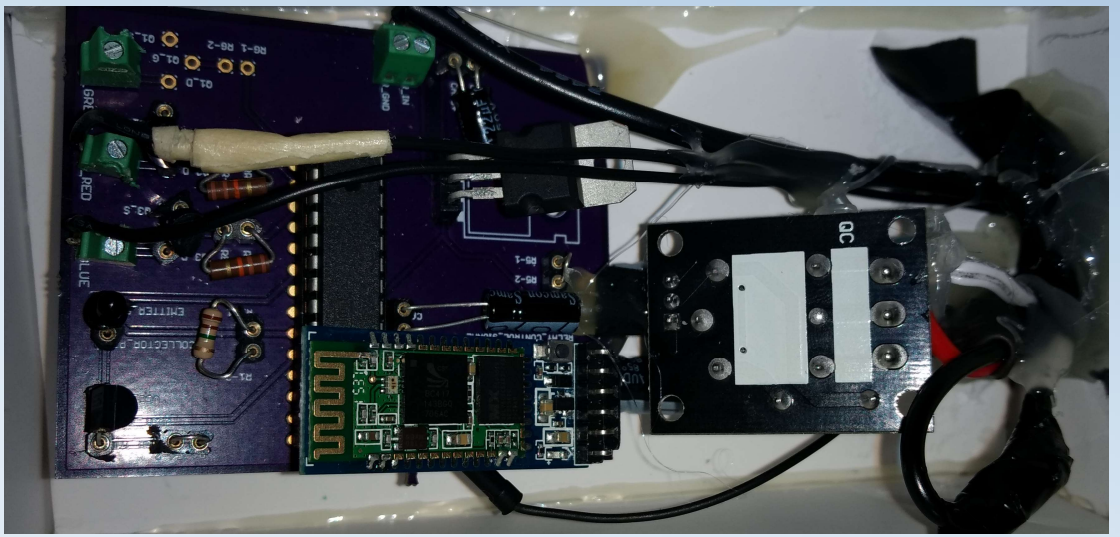
- Bluetooth module makes use of Serial Communication
- Communication happens via PCB
- Controls all major components
  - Major Features (I/O, LEDs, Alarm and Seasonal Modes, Manual/Auto)
  - Coincide with Application from Android Studio
- Range at 10 meters is fine for this project
- Will be embedded within the frame along with the rest of the components
- Difficulty with first Bluetooth module, possible shorted or burnt AGND
- For future applications a stronger Bluetooth module could be used for larger families moving from room to room.



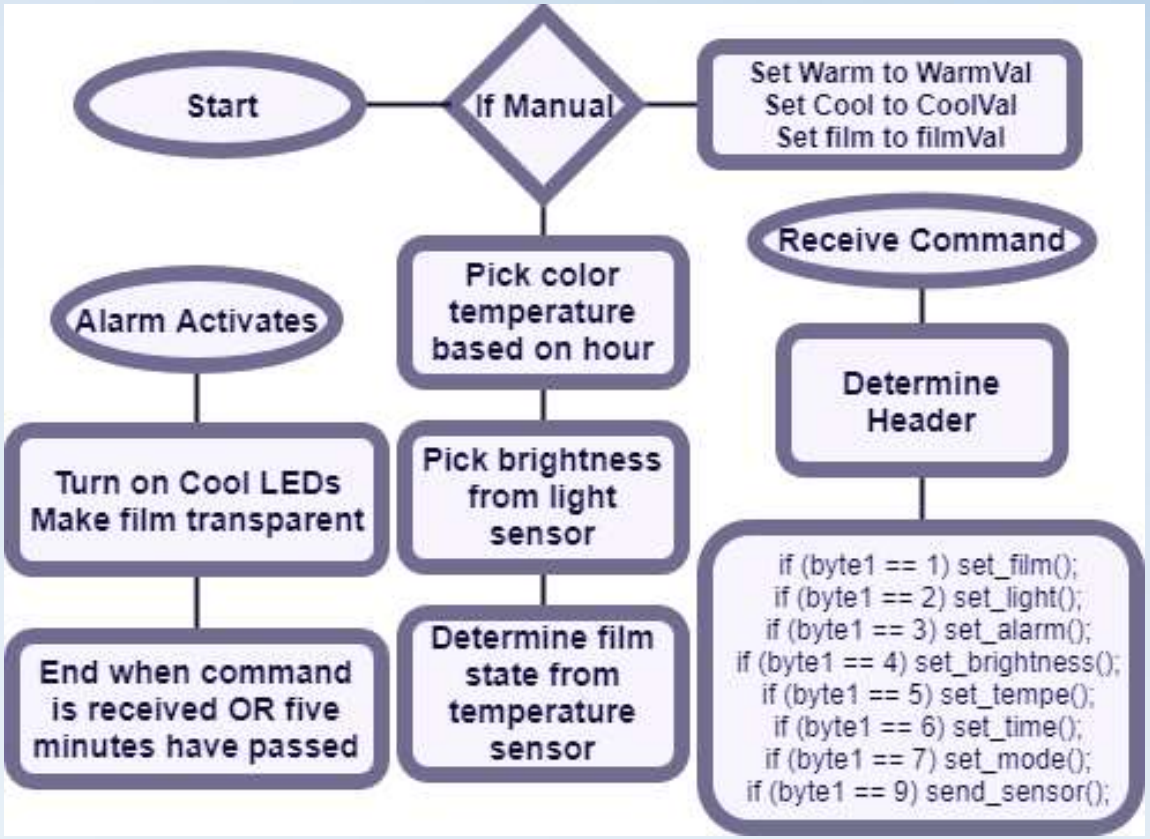
Description	Spec
Baud Rate	9600
Range	10 meters
Frequency	2.4GHz
Voltage	3.3V

Bluetooth Integrated Prototype

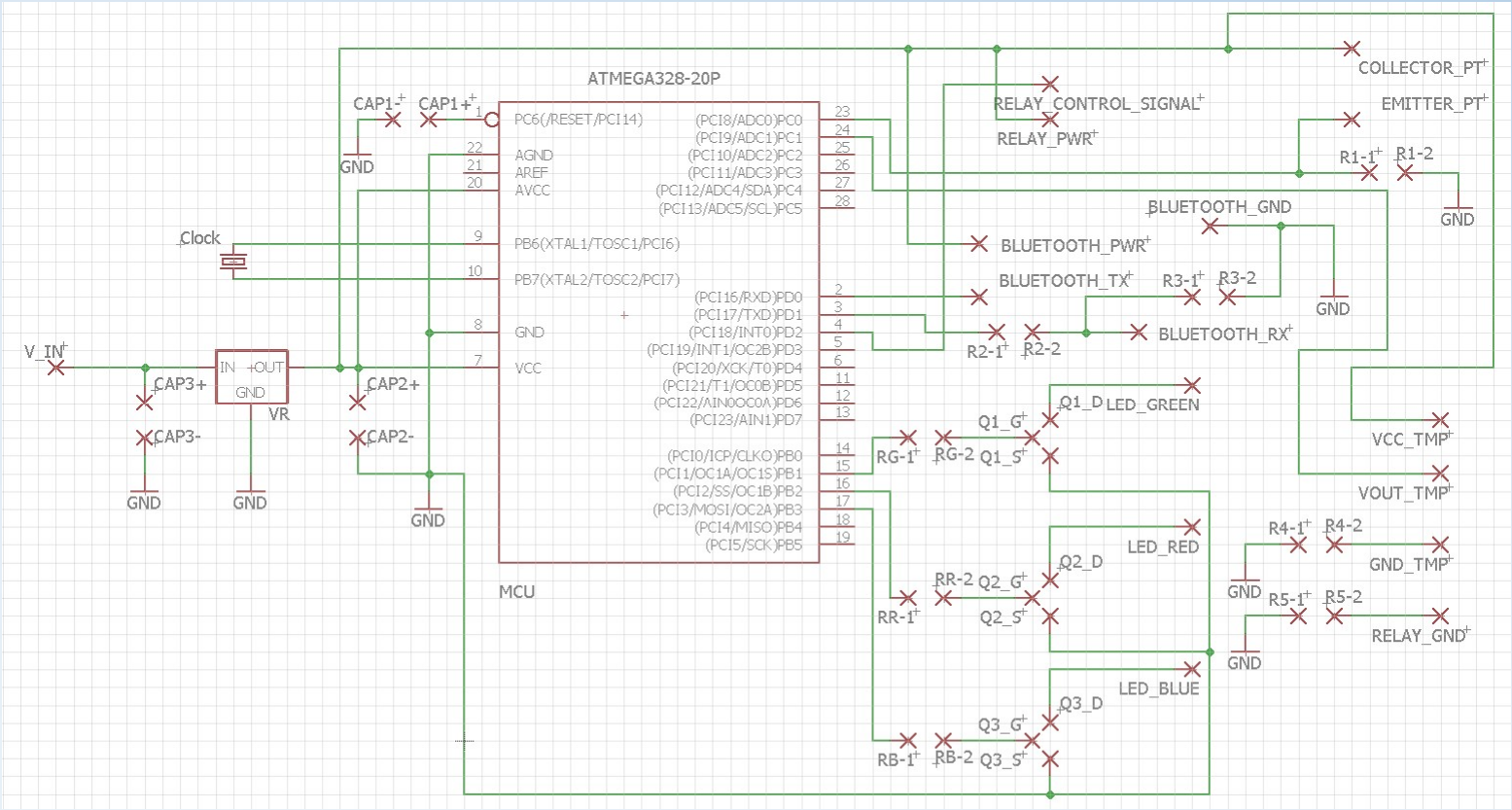




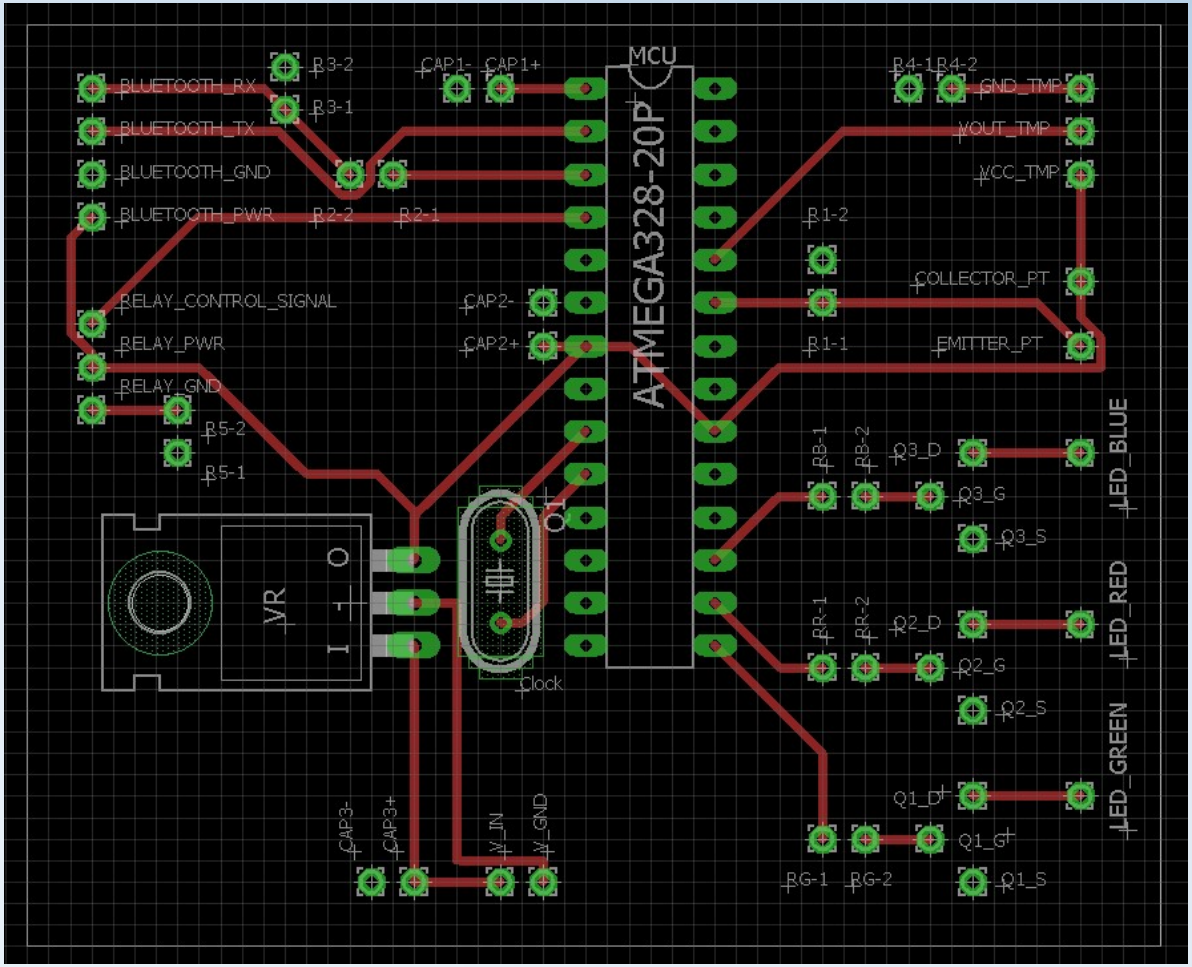
Embedded Logic



Overall System Schematic



PCB


MCU
ATMEGA328-20P
BLUETOOTH_RX
BLUETOOTH_TX
BLUETOOTH_GND
BLUETOOTH_PWR
R3-2
R3-1
R2-2
R2-1
CAP1-
CAP1+
RELAY_CONTROL_SIGNAL
RELAY_PWR
RELAY_GND
R5-2
R5-1
CAP2-
CAP2+
VR
Clock
CAP3-
CAP3+
V_IN
V_GND
R4-1
R4-2
GND_TMP
VOUT_TMP
VCC_TMP
R1-2
R1-1
COLLECTOR_PT
EMITTER_PT
RB-1
RB-2
Q3_D
Q3_G
Q3_S
LED_BLUE
RR-1
RR-2
Q2_D
Q2_G
Q2_S
LED_RED
RG-1
RG-2
Q1_D
Q1_G
Q1_S
LED_GREEN

Hardware Challenges

LED Challenges

- **Too Bright**
- **Unequal Duty Cycle causes flickering**
- **Limited BJT current gain requires a base resistor that limited brightness**
- **Capacitors needed to reduce MCU strain**

Mixed Duty Cycles

PCB Challenges

- Initially clock forgotten and two nodes not on ground pour
- Sheer force on through hole components can connect to ground pour
- Power Supply tolerates less amperage than test battery

Administrative Content

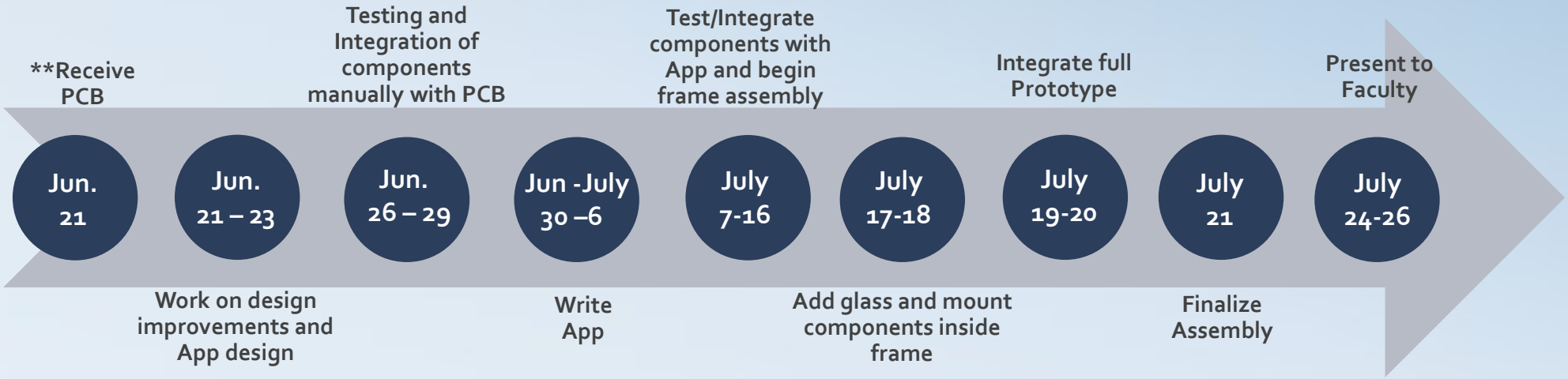
Work Distribution

Task	Primary	Secondary
LED Subsystem	Blake	Paul
Power Subsystem	Blake	Paul
Smart Film Subsystem	Paul	Blake
Feedback Subsystem	William	Ben
Application Software	Ben	William
Embedded Software	Blake	William
PCB Integration	Paul	Blake
Software Integration	Ben	William

Budget

Item	Quantity	Price/Unit	Projected Cost	Actual Cost
Window Film	2	$145.07	$100.00	$145.07
Color Temp LED Strip	1	$24.95	$50.00	$24.95
Microcontroller Chip	3	$5.05	$1.00	$15.14
Voltage Regulators	5	$1.19	$1.50	$5.95
Relay for film control	2	$3.39	$30.00	$6.79
Power Supply (60 VAC)	1	$0.00	$0.00	$0.00
Power Supply (24VDC)	1	$19.95	$20.00	$19.95
Lux Sensor	3	$0.43	$6.00	$1.49
Bluetooth Module	1	$7.99	$10.00	$7.99
Polycarbonate Window	1	$0.00	$0.00	$0.00
Frame	1	$29.17	$35.00	$40.17
PCB Costs	3	$23.35	$150.00	$70.05
Temp Sensor	3	$1.48	$5.00	$4.44
Potentiometer	1	$3.25	$0.95	$6.50
Transistors	10	$1.60	$10.00	$16.00
Total	36		$365.95	$364.49

Schedule Towards Completion



- **Ideal Schedule, approximate date for PCB shown
- Some padding added to dates for any extensive troubleshooting that may occur

SkyLight 2.0

- Multiple Integration and Communication
- Dimming Tint ability as an effect of the surroundings instead of using times and dates i.e. more dynamic
- Multi connect Bluetooth module
- Offer different color films
- LED features, adding music listening LEDs, or party mode

Questions/Comments?