UCF Senior Design 1

Motion Controlled Lighting System

Department of Electrical Engineering and Computer Science

University of Central Florida

Dr. Lei Wei

Initial Project Document and Group Identification

Divide and Conquer

Group 9

Benjamin Simms	Computer Engineering	bensimms@knights.ucf.edu
Michael Taub	Electrical Engineering	michaeltaub@knights.ucf.edu
Keng Chu	Electrical Engineering	Keng1135@knights.ucf.edu
Scott Bell	Electrical Engineering	schebe4@knights.ucf.edu

Project Narrative

The introduction of electric power has led to many advancements in the modern home. One of these advancements is the use of light bulbs to illuminate an area while it is being used. While lighting is widely used for general illumination, it is also imperative to have a good point source light for certain activities such as mechanical work, wood working, electronics soldering, etc. As such, some activities may also require reorienting a point source light to highly illuminate a specific area that requires detail. The purpose of this project is to facilitate this need by designing a fully functional articulating light system with the ability to reorientate to a gesture-controlled location. The light system will also be expandable, allowing more lights to form an array that work together to illuminate an area.

The lighting system will perform gesture-controlled tasks using computer vision. The software will intake an image of the user and identify the hands of the user. When a gesture is performed, the software will recognize the gesture and issue commands for the gesture such as reorienting the position, turning the light off, and resetting the position of the light to the default setting. The timing between a user's gesture and the action that is mapped to the gesture will be reasonable, within a few seconds. There will also be physical buttons/switches that perform tasks that don't require a parameter such as a position to shine (turning on/off, resetting position of light, etc). Each light will have its pitch and yaw controlled by a pair of servo motors connected to an articulating arm and gear system which will allow for a wide range of motion. The available range of motion should allow the system to light up anywhere in range of the camera. The light arm will have many joints that form a spine so that the light can angle itself without moving the whole system. Materials chosen for the light should be light enough to be considered portable but heavy enough to be sturdy. The light will feature a modular mount that allows wall, ceiling, and stand mounting with appropriate equipment.

The lighting system should be robust enough that it can withstand the humidity and heat of a Central Floridian garage.

Specifications

- Weight
    - No more than 5 lbs
- Power Input
    - 120V AC, 60 Hz
- Power Output
    - 120V AC, 60 Hz LED light socket
    - 5V USB Camera
- Footprint (base and length)
    - 8x8 inch base
    - 4x4x4 inch gear box
    - 2 feet length
- Pitch/Yaw Angle/Degrees of Freedom
    - Up to +/- 90 degrees of movement left and right (yaw)
    - Up to +/- 90 degrees of movement up and down (pitch)
- Price
    - under $350
- Robot Vision
    - Will use a camera to identify hand gestures to control the movement of the actuators
- Stand
    - The mount will be modular
        - Mountable
        - scalable by adding additional lights
- Environmental robustness
    - Able to handle temperature and humidity variation
        - 20 - 100 degree temperature range
        - waterproof
        - dust proof
- Response Time?
    - Software to hardware interface will have a response time less than 3 sec
- Manual reset/zeroize
    - Device will have a way to manually stop and reset the system

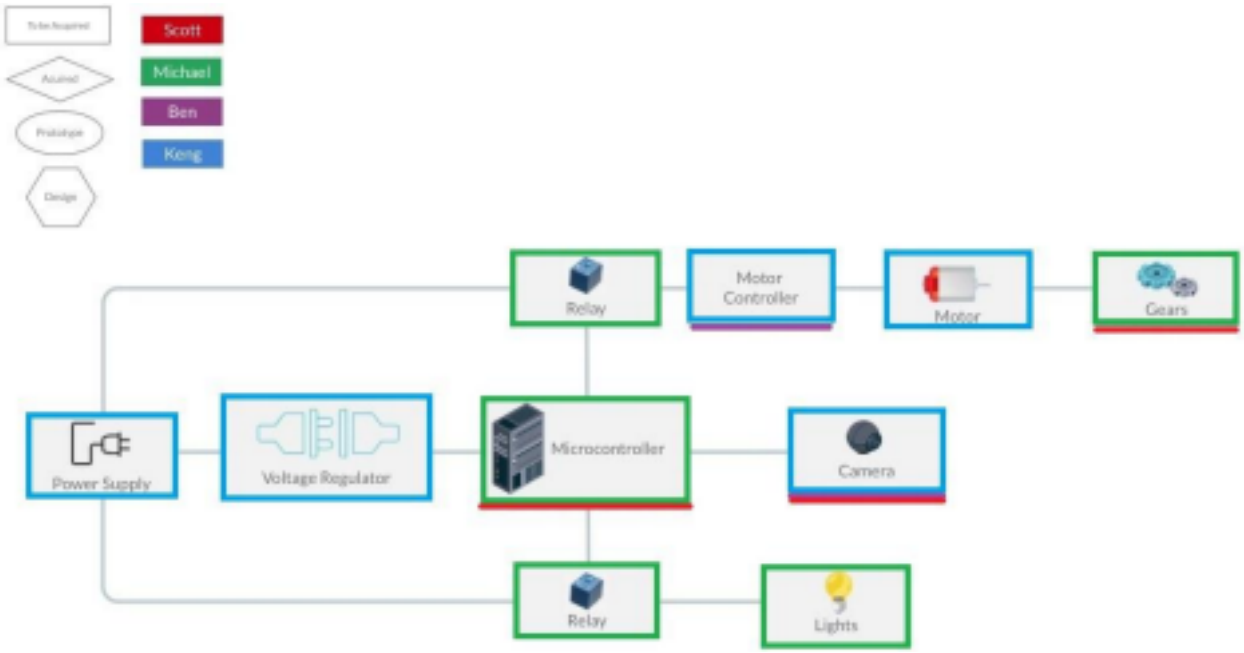
House of Quality

Correlations	
Positive	+
Negative	–
No Correlation	o

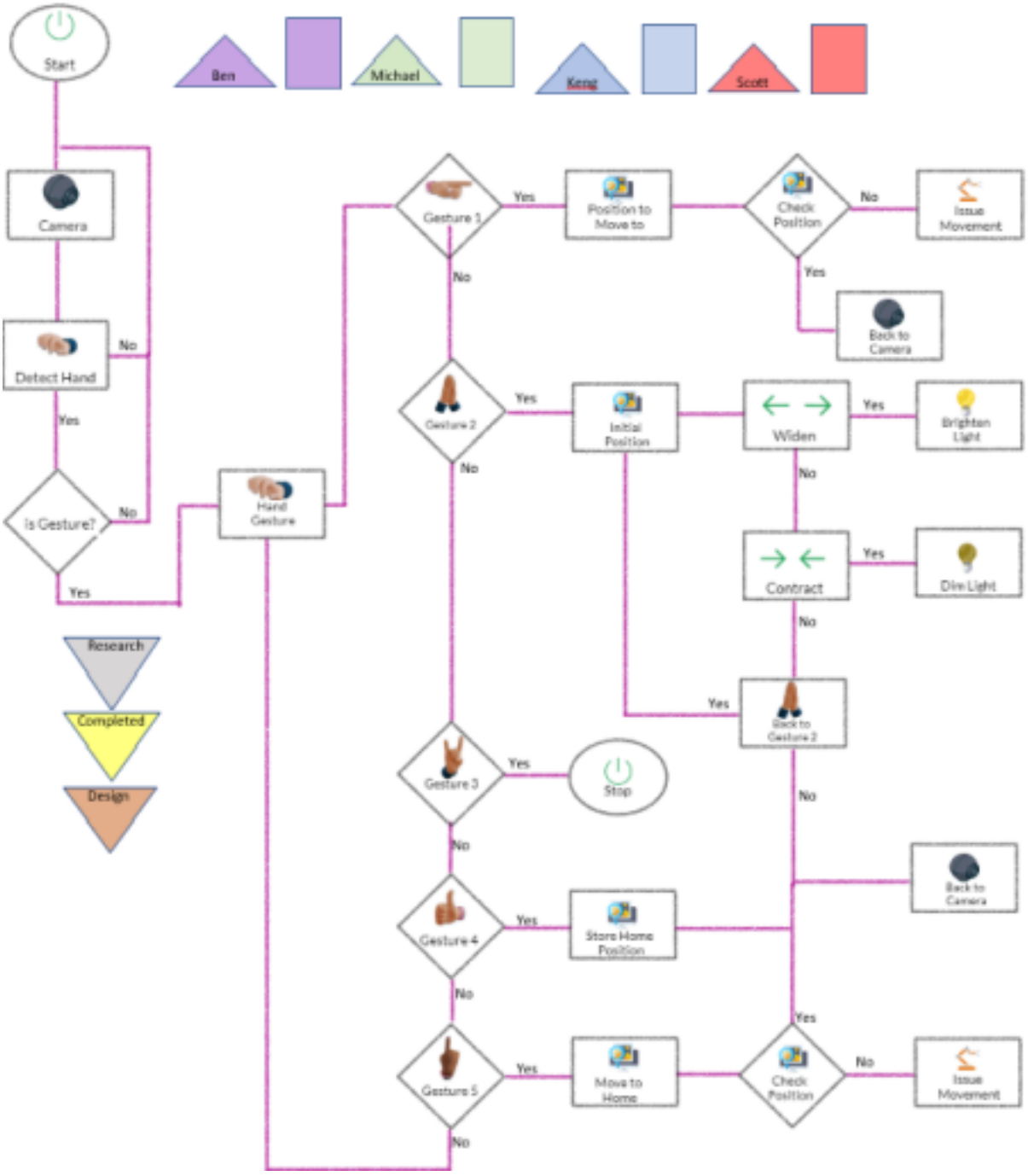
Relationships	
Strong	●
Moderate	○
Weak	▽

Row #	Customer Importance 1-5 (5 Being most important)	Engineering Requirements / Customer Requirements	Column #	1	2	3	4	5	6	7	8
				Cost	Dimension of design	Accuracy	Reliability	Programming Complexity	Speed / Performance	Design Complexity	Power Draw
1	5	Durable		●	▽	▽	●	▽	▽	●	▽
2	3	Easy Maintenance		▽	▽	▽	▽	▽	▽	●	▽
3	4	Easy to Operate		▽	▽	▽	▽	●	▽	●	▽
5	2	Low Noise		○	▽	▽	▽	▽	○	●	▽
6	4	Accurate		▽	▽	●	●	●	●	▽	▽
7	5	Low Cost		●	○	▽	○	▽	○	●	●
8	3	Resonable Weight		●	○	▽	▽	▽	▽	●	▽
9	4	Stable		○	○	▽	●	▽	●	●	▽
10	4	Visually Appealing		○	○	▽	▽	▽	▽	●	▽
11	2	Scalable		○	○	▽	▽	●	●	●	●
		Product Targets		<= $200	Base: 8x8 inches ar Box: 4x4x4 inches Length: 2 feet	Less than 2cm accuracy from target location	Functioning without mistakes and ability to reset if errors occur	Able to be easily modified and with O(nlogn)	Should be on target within 5 sec amount of second	Least amount of complexity with reliable and sustainable output	Operate with 120V AC With as low as reasonable outputs to minimize degradation of components

Hardware Block Diagram



Software Block Diagram



Gesture 1	Reorient light to a position	**Gesture 4** Set home position
Gesture 2	Adjust brightness	**Gesture 5** Reset light to the home position
Gesture 3	Power down	

Budget

Part	Quantity Price
Microcontroller	0 - 1 $34.91
Camera	0 - 1 $25 - $29.15
Computer vision module (OpenMV includes camera)	0 - 1 $45 - $99
Motors	2 - 4 $11.99ea to 29.99 (4pack)
Motor Controller Wire Loom Gear/Wheel Wire Guide	0 - 4 $6.89 - $9.99 2 feet 12.60 (39 inches) 2 - 4 $8.98 - 17.96
Light Socket Power Regulator Relay LED Light	1 $3.88 1 $9.90 2 $18.79 1 $12.98 (4-pack)
Wire (electrical, 24AWG)	4 feet $11.98 (50 feet)
Wire (mechanical, 3mm)	2 feet $8.99 (7 feet)
Frame/Case (material)	Unknown at this time N/A
PCB	0 - 1 $0 - 15.89
Memory Card	0 - 1 $0 - 6.66
TOTAL	N/A $186.06 - $322.67

Initial Project Milestones

Number	Task	Start date	End date	Status	Responsible
Senior Design I					
1	**Ideas**	1/11/2022	1/14/2022	Completed	Group 9
2	**Project Selection & Role Assignments**	1/11/2022	2/4/2022	Completed	Group 9
	Project Report				
3	Initial Document - Divide and Conquer	1/18/2022	2/4/2022	In Progress	Group 9
4	Table of Contents	2/4/2022	2/18/2022	In Progress	Group 9
5	First draft	2/4/2022	3/29/2022	In Progress	Group 9
6	Final Document	2/4/2022	4/26/2022	In Progress	Group 9
	Research, Documentation, and Design				
7	Power Supply (wall plug-in or batteries)	2/4/2022	2/11/2022	Researching	Keng/Michael
8	Robot Vision	2/4/2022	2/18/2022	Researching	Ben/Scott
9	Schematic	2/11/2022	2/25/2022	Researching	Keng/Michael
10	Microcontroller	2/21/2022	2/25/2022	Researching	Ben/Scott
11	Reset Button	2/25/2022	3/4/2022	Researching	Group 9
12	PCB Layout	3/4/2022	3/11/2022	Researching	Keng/Michael
13	**Order & Test Parts**	3/15/2022	TBA	Researching	Group 9
Senior Design II					
14	Build Prototype	TBA	TBA		Group 9
15	Test & Redesign	TBA	TBA		Group 9
16	Finalize Prototype	TBA	TBA		Group 9
17	Group presentation to friends/family	TBA	TBA		Group 9
18	Final Report	TBA	TBA		Group 9
19	Presentation to judges	TBA	TBA		Group 9

Citations

Microcontroller:
Arduino Mega 2560 REV3

Camera:
Raspberry Pi Camera V2.1
or
Compatible with NVIDIA Jetson Nano Camera
or
OpenMV Cam H7 R2

Computer Vision Module:
Raspberry Pi 4 Model B
or
OpenMV Cam H7 R2 (includes camera)
or
NVIDIA Jetson Nano Developer Kit-B01

Motors:
Short Body Nema 17 Bipolar Stepper Motor
or
(Pack of 4pcs) Stepper Motor High Torque Bipolar DC Step Motor Kit

Motor controller:
DC Motor Drive Shield Stepper Motor Drive Shield Expansion Board

Gear/Wheel Wire Guide:
Wire Rope Wheel, Deep U Groove Pulley, Double Bearing Wheel Block Wire Rope Lifting Guide (diameter28mm)

Light Socket:
Project Source Plastic Keyless Lamp Socket, Black in the Light Sockets department at Lowes.com

Power Regulator:
DC 5V 2A 10W Power Supply Module AC110V 85V-265V 50 60Hz to 5V output

Relay:
AC100V-250V 30A High Power 2-Channel Relay DC5V High-Low Level Trigger Switch Module

LED Light:
GE Basic 100-Watt EQ A19 Daylight LED Light Bulb (4-Pack) in the General Purpose LED Light Bulbs department at Lowes.com

Wire (electrical, 24AWG):
50 feet 24AWG Stranded Electrical Wire, red and black

Wire (mechanical, 3mm):
Lumintrail 3mm Braided Steel Coated Security Cable Luggage Lock Safety Cable Wire Double Loop

Wire Loom:
Wire Loom - 1/4" diameter and 39" length
PCB Board:
Amazon.com: Smraza 100pcs Double Sided PCB Board Kit, Prototype Boards for DIY Soldering and Electronic Project Circuit Boards Compatible with Arduino Kits, 30PCS 40 Pin 2.54mm Male and Female Header Connector : Industrial & Scientific

Memory Card:
8GB SD Card