# TrackStar:
Motion Tracking Stagelight Mount

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Abstract

We introduce TrackStar, a mount that allows a stagelight to become a real-time, autonomous spotlight that can track an actor on stage. An actor wears an IR beacon in order to be detected and tracked by the IR camera on the mount. The IR beacon can transmit up to 8 unique signals, allowing multiple actors to be tracked simultaneously. The mount features an adjustable harness, designed to allow a range of standard lights to fit into the system. The tracking algorithm uses a reactive, proportional controller to keep the actor centered within the beam of the spotlight. Two stepper motors allow for 160 degrees of panning motion and 75 degrees of tilting motion.

System Overview
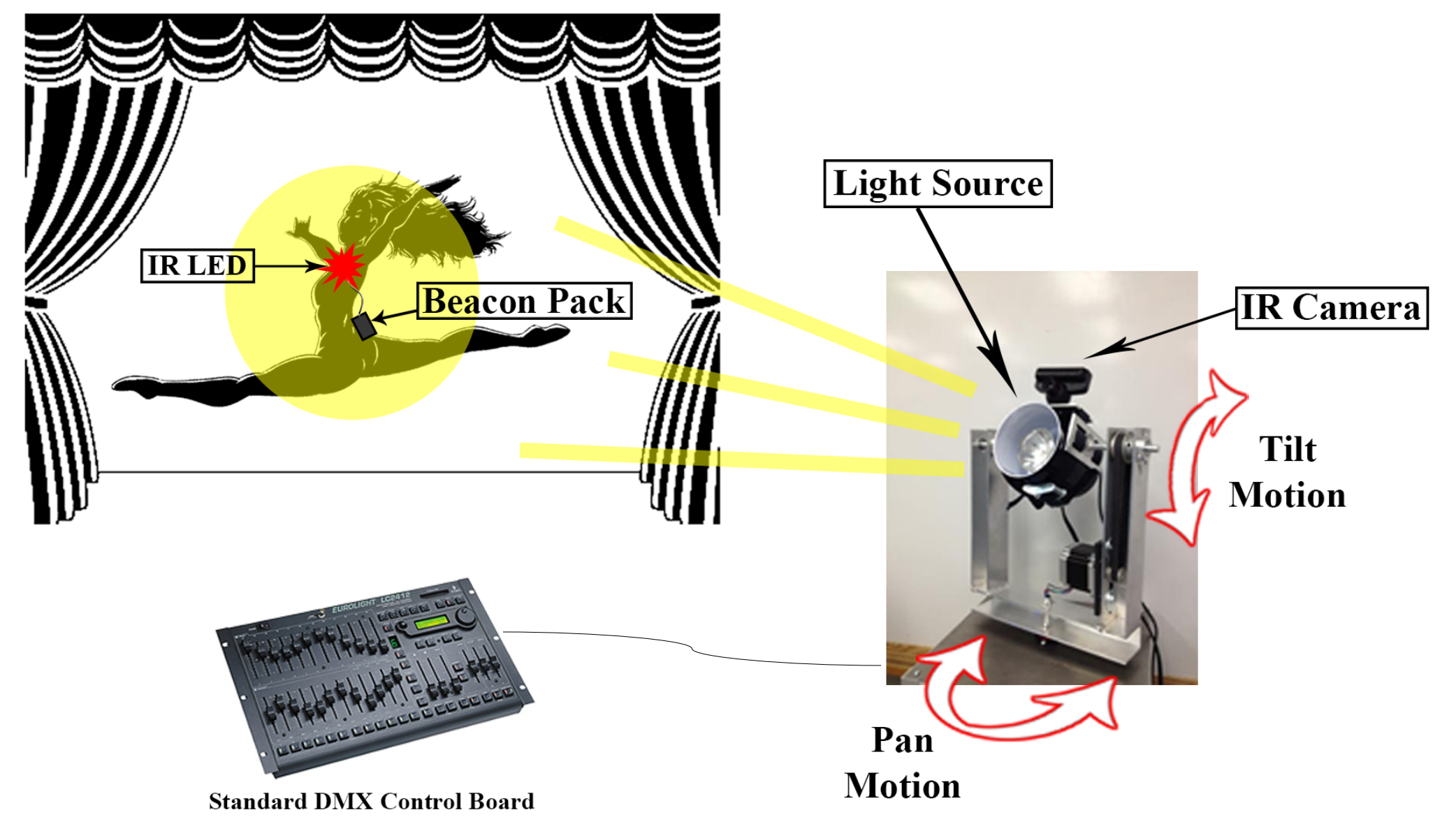
Block Diagram
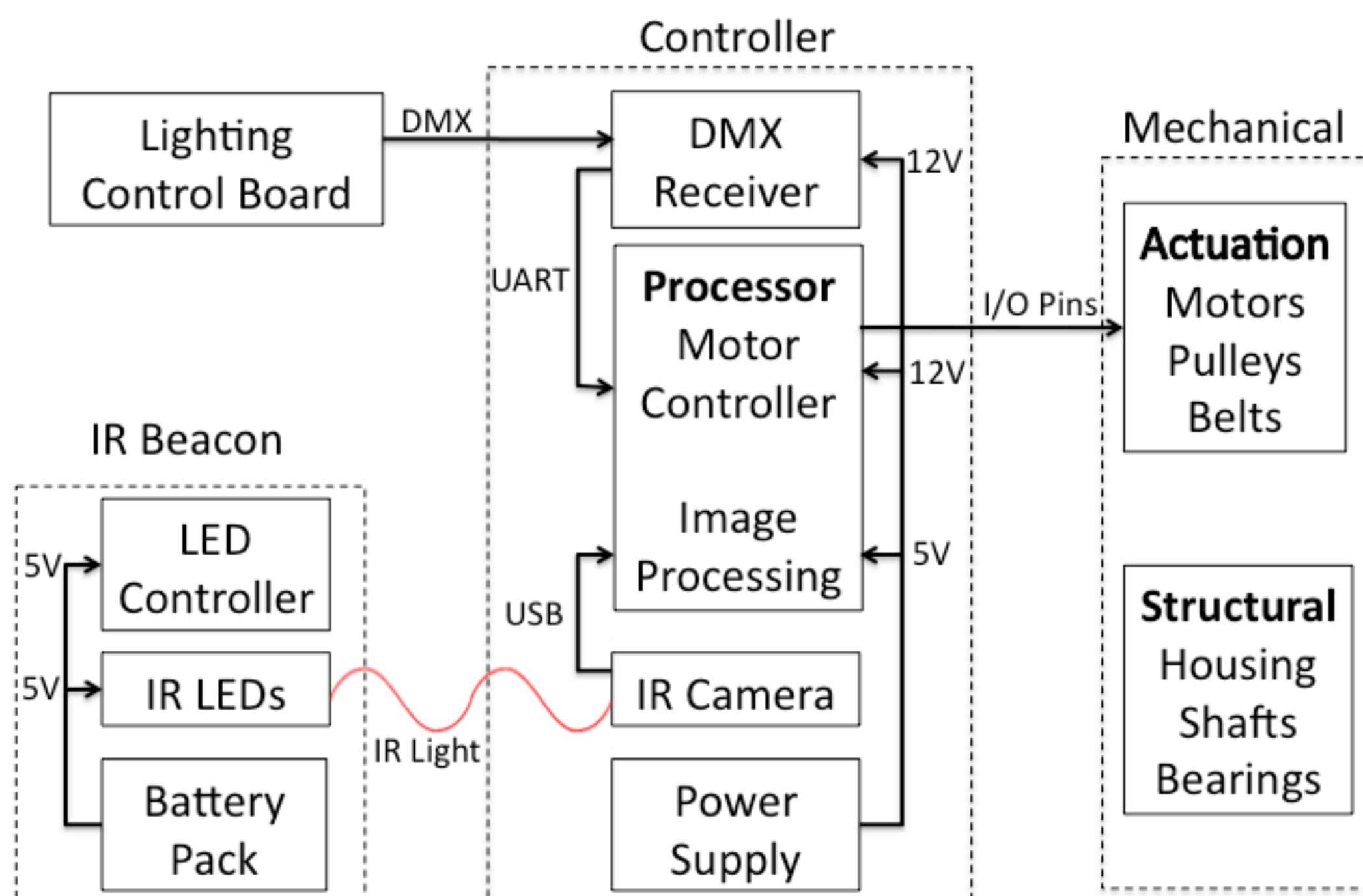
A lighting crew member sends controls to the system via DMX. The beacon broadcasts an 880nm IR signal to the IR camera. The image processing algorithm drives the motor controller, which actuates the motors via GPIO pins. The motors then pan and tilt the light using a timing belt and pulley system.

Results

At a distance of 50 feet, TrackStar is able to distinguish between multiple actors wearing beacons and track them in real-time as they move across the stage. During crossing and after separation, TrackStar lights the correct actor.

Specifications

| Specification	Goal	Actual
Range of Motion	Pan 160 °, Tilt 75°	Pan 160 °, Tilt 75°
DMX Compatible	Yes	Yes
Lights Compatible	Standard	Standard
Camera Frame Rate	80 FPS	25 FPS
Mounting	Hang from pipe	Upright operation
Overall Size	2' x 1' x 2'	1' x 1' x 1.5'
Battery Life	8 hours	14 hours
Number of Patterns	8	8

Acknowledgement

Department of Electrical and Computer Engineering

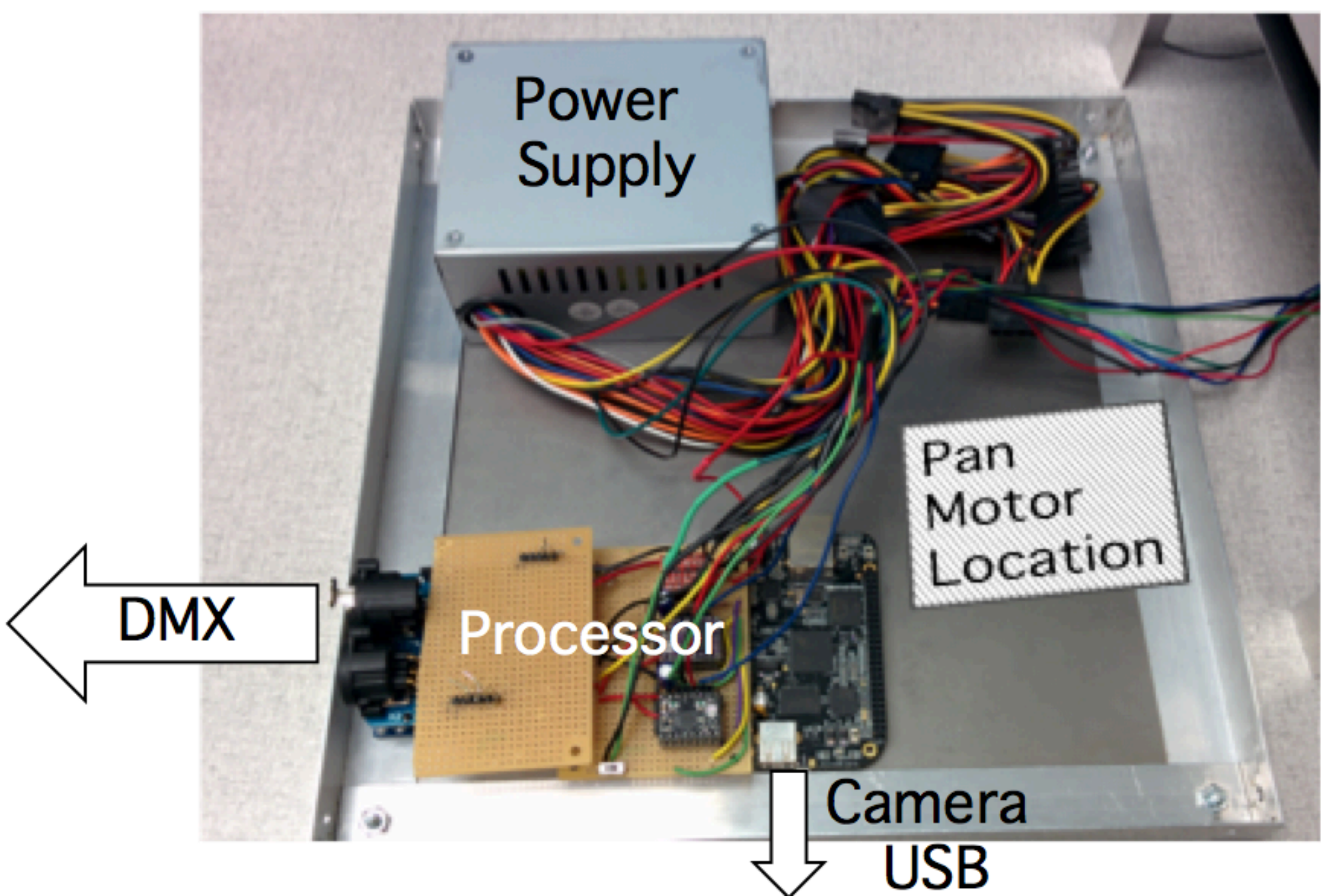**ECE 415/ECE 416 – SENIOR DESIGN PROJECT 2015**

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SDP15

Mechanical Design
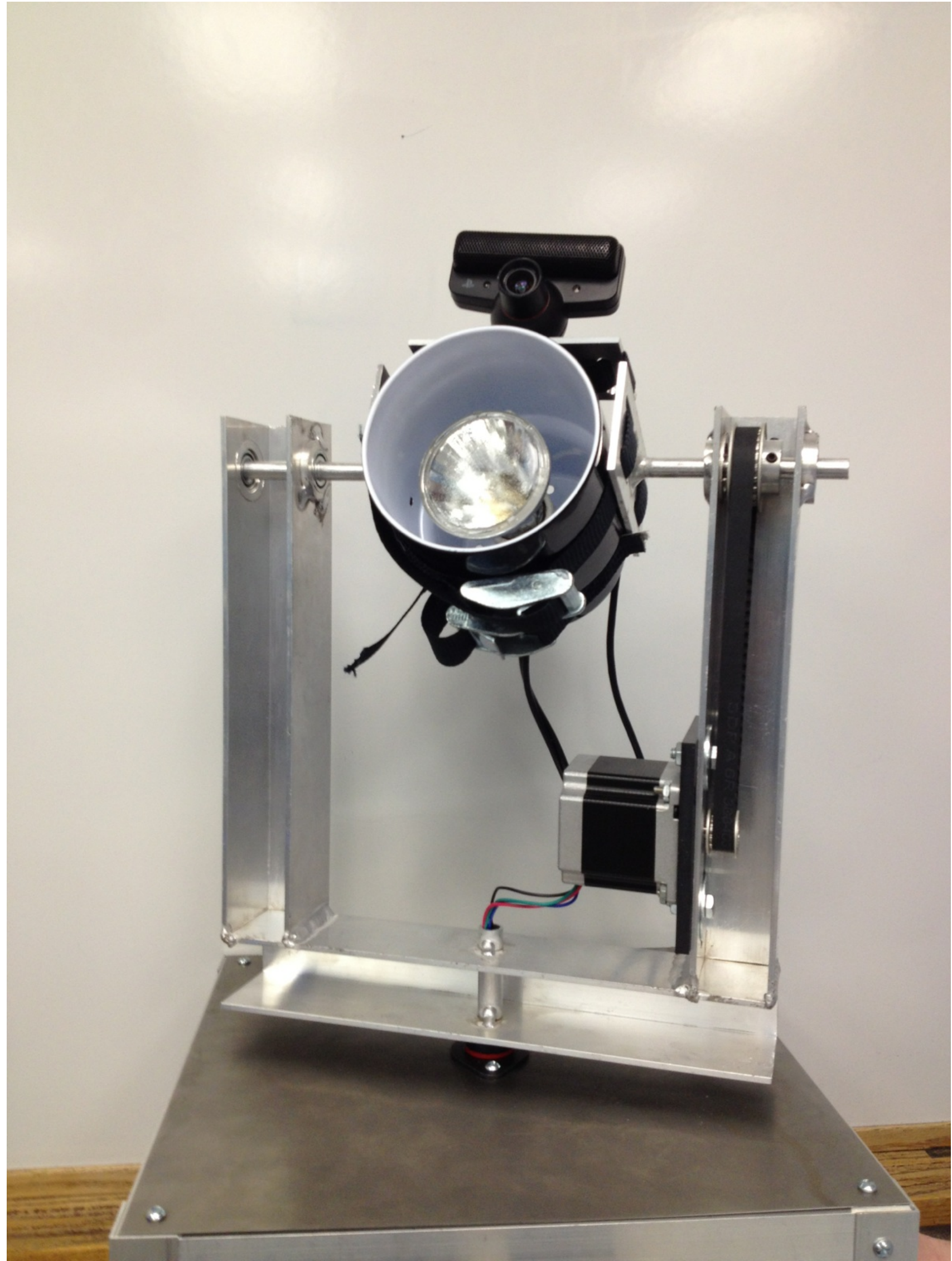
- A U-shaped aluminum frame supports the light and the tilt motor.
- The tilt stepper motor connects to the tilt shaft through a 2:1 pulley reduction.
- Adjustable straps secure the camera and allow for multiple sized lights.

- The base of the mount is designed with three layers of sheet metal.
- The pan motor, power source and processing units are mounted in between the bottom two layers.
- Ports for the camera USB, DMX control and power supply are located on perimeter of the base.

Cost

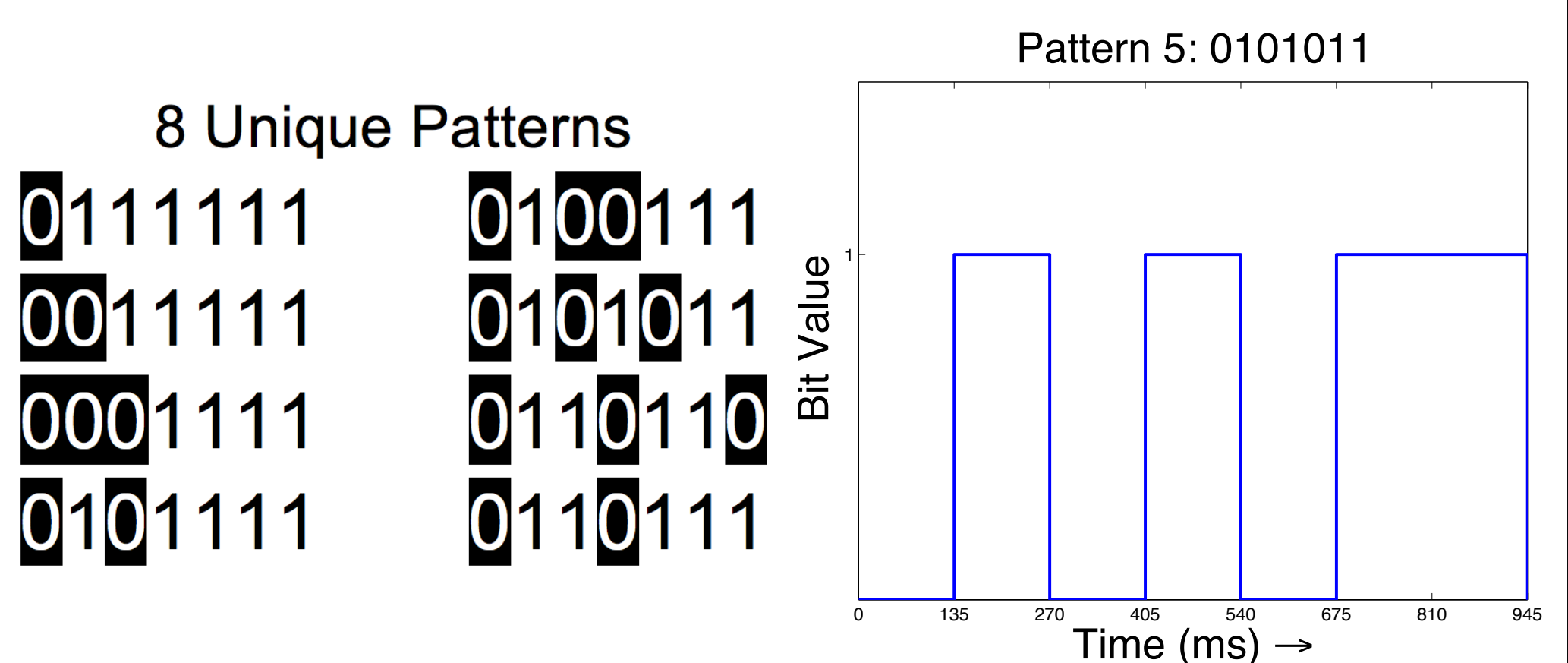| Part	Development	Production
Motors & Drivers	109.33	98.40
Embedded System	73.30	137.50
Mechanical	152.20	106.54
Beacon	10.27	6.34
Total	**345.10**	**348.77**

IR Beacon
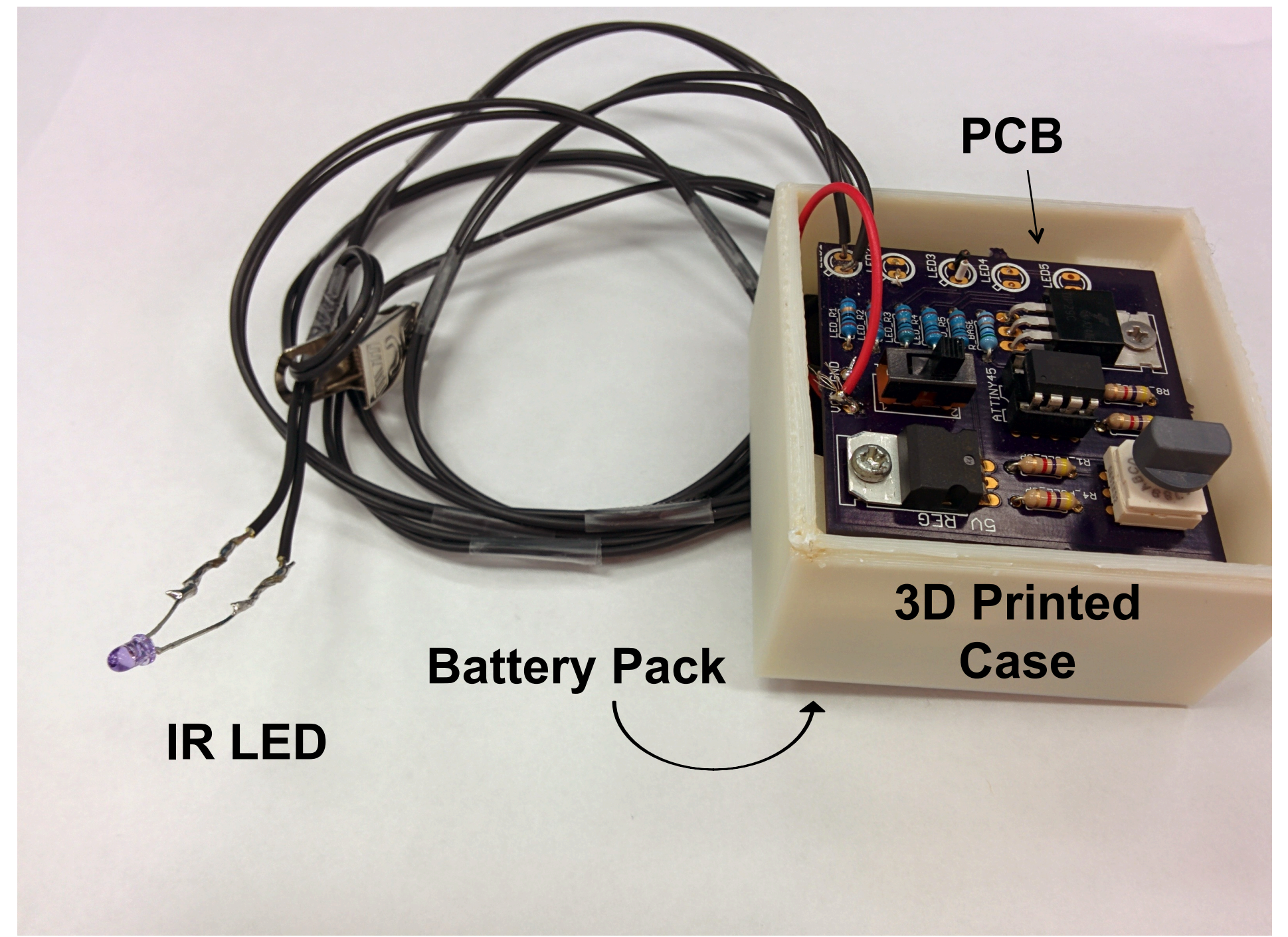
The user wears the beacon pack on their hip and clips the IR LEDs to their front, back, and shoulders. A switch allows the user to select between 8 unique signals for tracking.

Tracking Algorithm
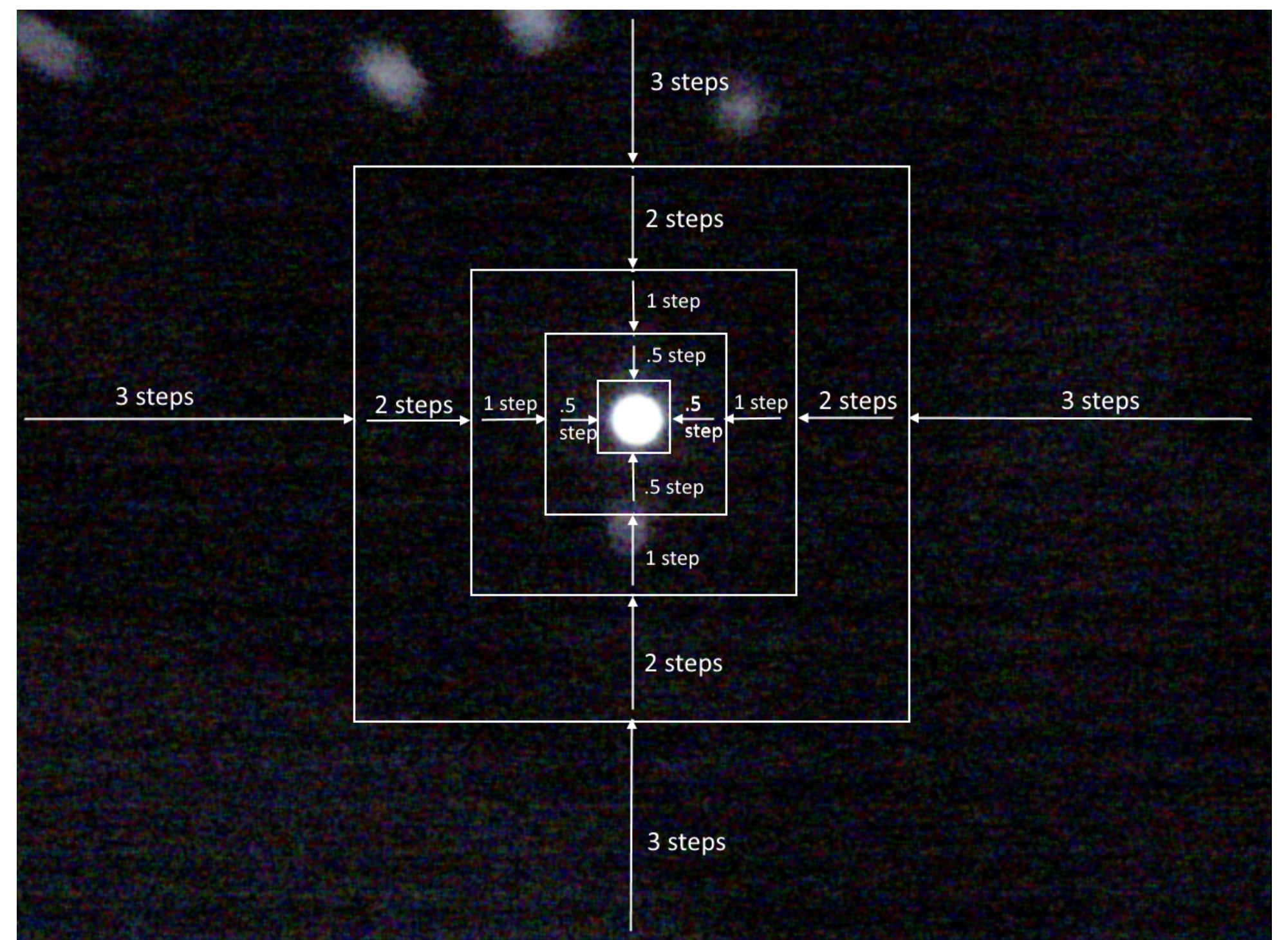
The proportional motor controller actuates the pan and tilt motors based on how far the beacon is from the center of the image. The IR camera creates a closed loop system for the controller.

Patterns

8 Unique Patterns


```
0111111    0100111
0011111    0101011
0001111    0110110
0101111    0110111
```

Pattern 5: 0101011

- Each pattern is on at least half of the time, to aid with tracking.
- Patterns are unique with respect to rotational shifts, since the camera and beacon are not synchronized.
- There is a tradeoff between the number of patterns, detection accuracy, and tracking delay.