Lightning Talks

Week 4: Design - Part 1

Team Information

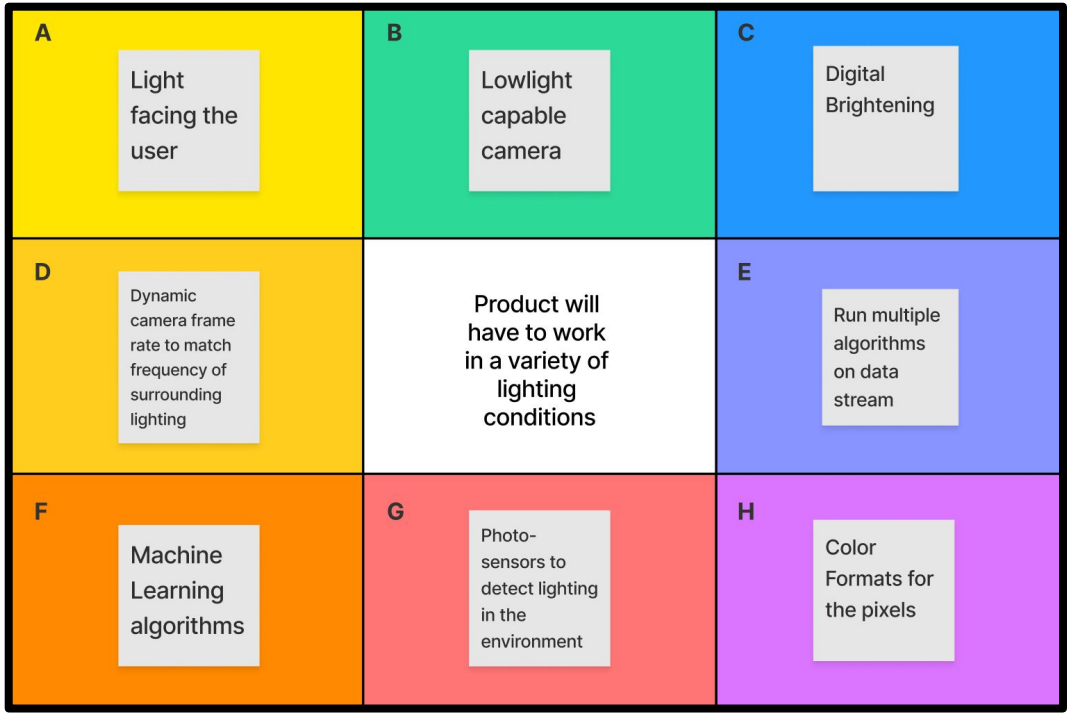
- **Project ID:** ssddec24-proj006
- **Team members:** Deniz Tazegul, Liam Janda, Taylor Johnson, Ritwesh Kumar
- **Client:** JR Spidell
- **Faculty Advisors:**
  - Dr. Mohammad Tayeb Al Qaseer
  - Dr. Phillip Jones

Project Overview

- We will be developing a video pipeline from a MIPI-connected COTS camera module to a video monitor
- The MIPI video data will be sent through a custom FPGA-based video pipeline
- The augmented video will be sent to a monitor connected via an active displayport cable
- The software will execute within a Linux operating system
- STRETCH GOAL: Video may be passed into a machine learning algorithm and the output of the ML algorithm will be used to augment the video sent to the monitor

Ideation: Lotus Blossom Tool

- Product must work in a variety of lighting conditions
- 8 potential design approaches have been identified

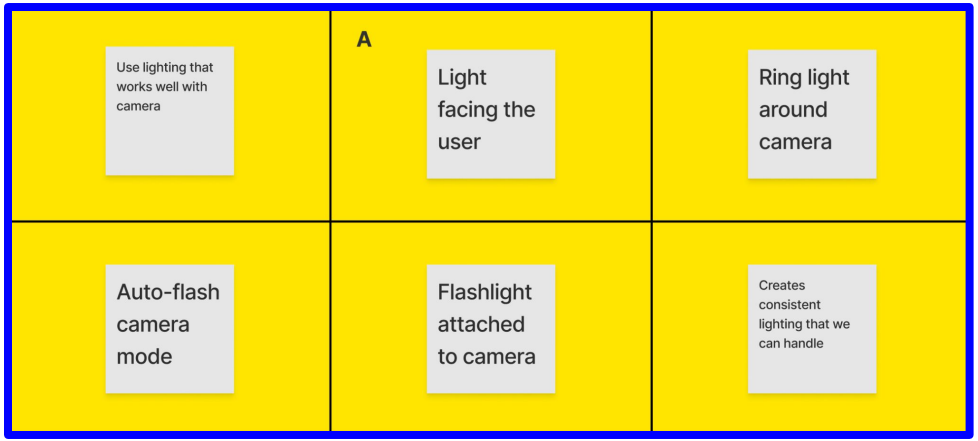


Design Approach A

- **Design Approach A:**

  Direct light towards user for improved output visibility on monitor

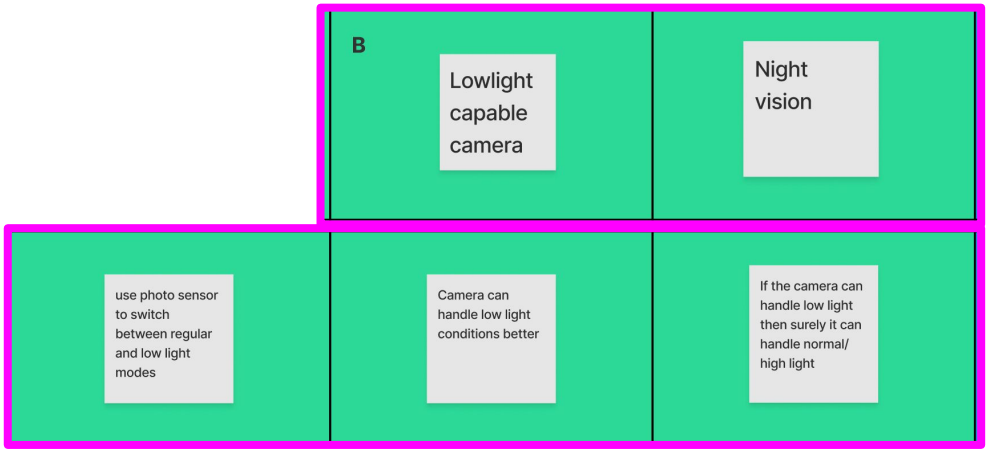
- 5 potential specific design implementations have been proposed



Design Approach B

- **Design Approach B:**
  A way to capture video data under low light conditions

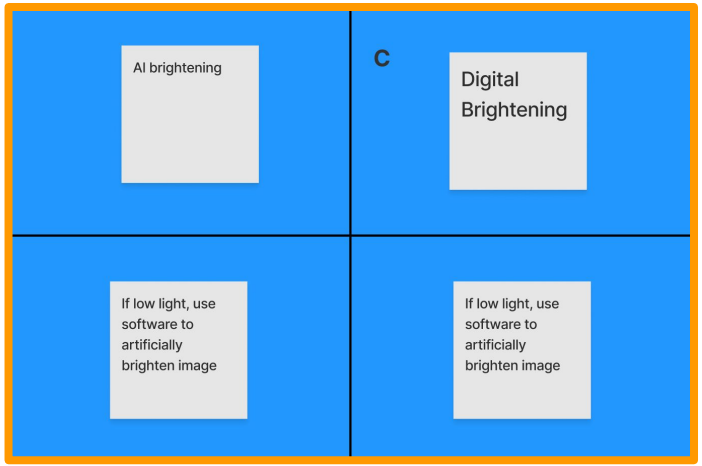
- 4 potential specific design implementations have been proposed



Design Approach C

- **Design Approach C:**
  Enhance the brightness of the video data digitally through software

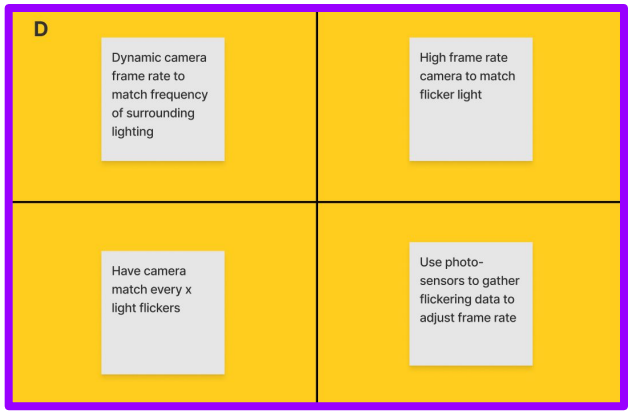
- 3 potential specific design implementations have been proposed



Design Approach D

- **Design Approach D:**
  Utilizing a synchronized camera frame rate with the surrounding lighting frequency to reduce flickering effect

- 3 potential specific design implementations have been proposed



Design Approach E

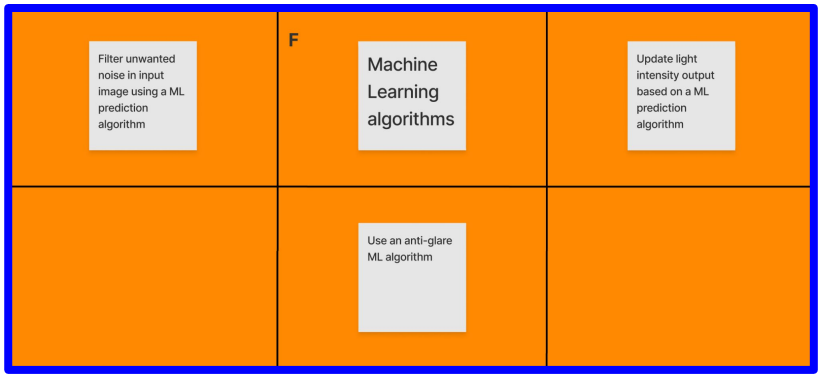
- **Design Approach E:**
  Running multiple algorithms on the video data to enhance output visibility on monitor given different lighting conditions

- 2 potential specific design implementations have been proposed

Design Approach F

- **Design Approach F:**
  Use Machine Learning (ML) algorithms for enhanced output visibility on a monitor

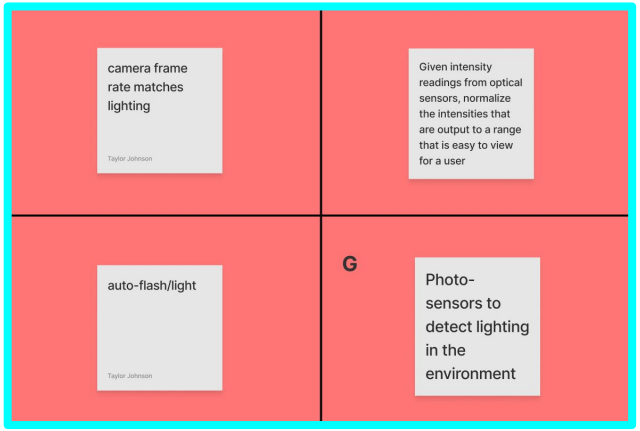
- 3 potential specific design Implementations have been proposed



Design Approach G

- **Design Approach G:**
  Utilize photo-sensors to detect lighting in the environment to configure the camera properly for enhanced output visibility on a monitor

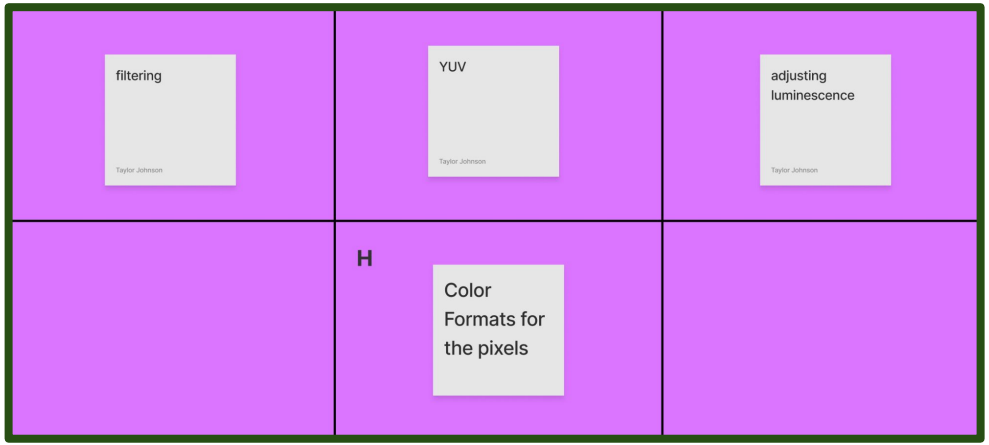
- 3 potential specific design implementations have been proposed



Design Approach H

- **Design Approach H:**
  Selecting an optimal color format for enhanced output visibility on a monitor

- 3 potential specific design implementations have been proposed

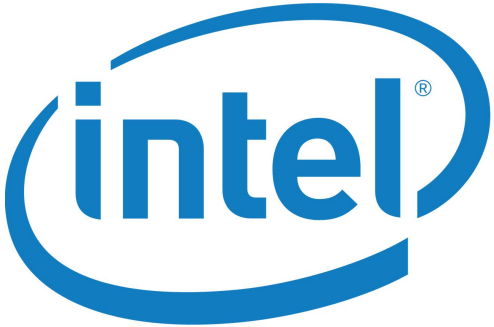


Potential promising project solutions

- **Enable flash strobe** of the camera for low lighting environments to provide additional light for better exposure and lighting
- Adjust the exposure time via the **electronic shutter function** of the camera
- Do internal signal processing through the **test pattern generator (TPG)** to configure the video data output in an optimal color format (100% solid color, fade to grey, split color, inverted, etc.)
- **Black level control:** Make sure darkest part of video data is calibrated correctly
- **Analog gain:** Increase the camera's sensitivity
- **Digital gain:** Increase the brightness of the output video data

Intel: Value Proposition

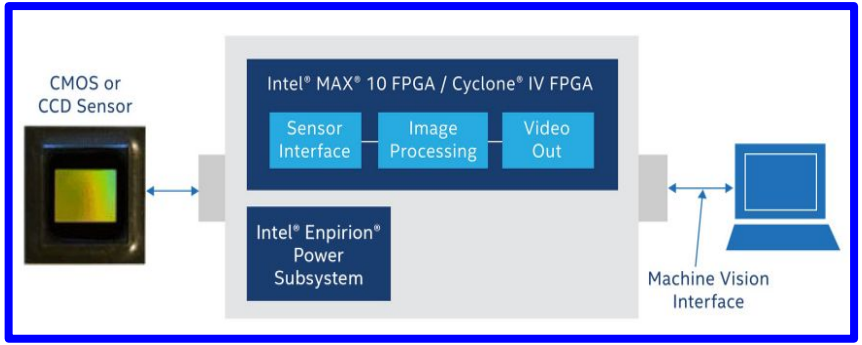
- Intel is a goliath in the hardware design industry, they have top of the line production line, products, and processes so they can create really great custom products



- Since all the parts (processor, memory, graphics processor, etc.) are made in house, they can dial in the capabilities of the system

Intel: Advantages/Disadvantages

- **Advantages:**
  - Flexibility in image sensor choice
  - Low latency, energy efficiency, and high versatility



- **Disadvantages:**
  - Everything comes from Intel
  - Specialized parts can cost more than off-the-shelf

LUCI: Value Proposition

- LUCI creates a software/hardware product combination that aids in environment hazard detection for electric wheelchairs
- LUCI is creating a product for people with physical disabilities

LUCI: Advantages/Disadvantages

- **Advantages:**
  - Solves a very important problem regarding wheelchair-user safety
  - The company's product can be attached to an existing wheelchair, increasing the amount of people who can utilize this product

- **Disadvantages:**
  - More of a niche market
  - Potentially difficult scalability due to specific purpose and audience

EyesOnIt: Value Proposition

- Custom configuration capabilities without any necessary programming knowledge

- Can be integrated into surveillance systems

EyesOnIt: Advantages/Disadvantages

- **Advantages:**
  - Configurable using “natural language” text
  - No programming skills required
  - No UI or simple API
  - Surveillance system is pre-trained to detect thousands of everyday objects

- **Disadvantages:**
  - There could be limitations on how much customization the system can have
  - The main focus appears to be with alerts and types of objects detected
  - Could be pretty easy to duplicate

Conclusions

This product implements a video pipeline for a computer vision system in C and Python code working on a Linux image. The hardware is off-the-shelf, commonly available components and sensors designed to aid disabled or injured users. As part of our project planning, we utilized a Lotus Blossom diagram to visualize potential design approaches and specific solution implementations, ensuring our product functions effectively in various lighting conditions.

We identified three companies working on similar products (to ours) and evaluated each based on their value proposition, advantages, and disadvantages. After conducting our research, we have identified how we can add value to the market by using off-the-shelf components that are relatively cost-effective and can provide scalability for our design and use code that is customizable for programmers and disabled or injured users.