The Do-Pro: A Minimalistic Stereo Vision Camera

Proposed by Timothy Do, Daniel Jilani, Zaya Lazar, Harrison Nguyen

Why care about depth?

- In the near future, data will become one of the most important commodities in the world – industries and innovations will become significantly data-driven
- Machine learning and image processing almost go hand-in-hand with significant applications in almost every field, such as autonomous vehicles
- Creating a commercial camera that can segment an image into various depths will be highly valuable for machine learning applications in imaging
    - We want to generalize the technology and remove the need for specialized equipment

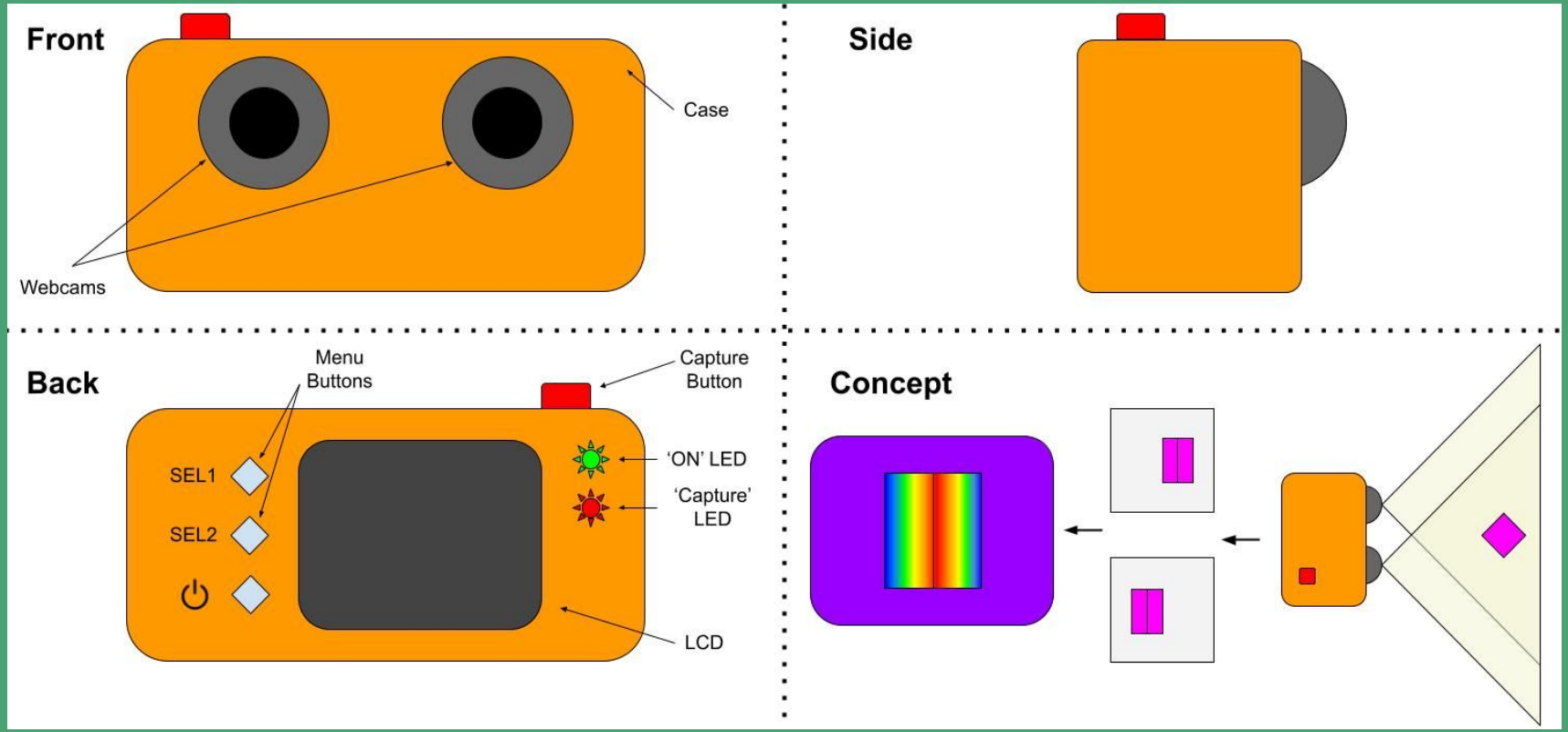
Introduction

- Cameras have become ubiquitous with various applications from iPhones to CC-TV cameras to dash cams
- However, normal cameras by themselves do not have the capability to denote depth in an image
- To quantify depth in an image, at least two cameras are required
    - Image processing methods exist to detect depth require complex models or very largely data-driven
    - Lidar can be use in tandem with a camera to detect depth more accurately (i.e. iPhone XIV), but the technology is expensive

Commercial Stereo Vision Cameras

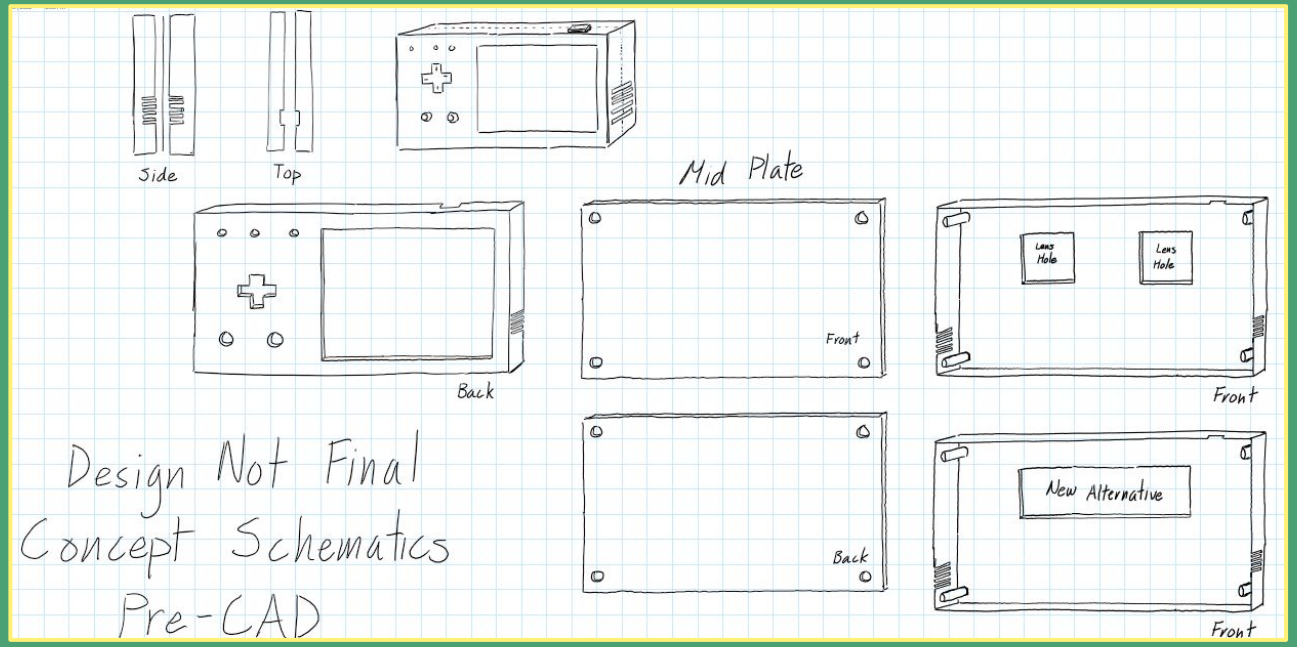
- Zed 2
  - Price: $499
  - State-of-the-art
    - Implements neural network for improved depth sensing and other spatial detection

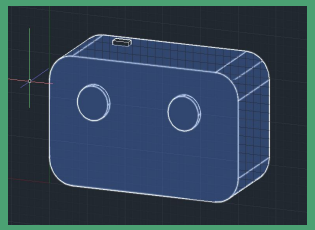
- Bumblebee 2 / XB3
  - Discontinued
  - Varying price depending on seller



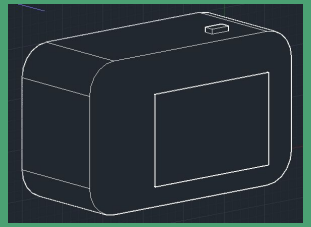
Conceptual Drawing of Camera

Conceptual Design



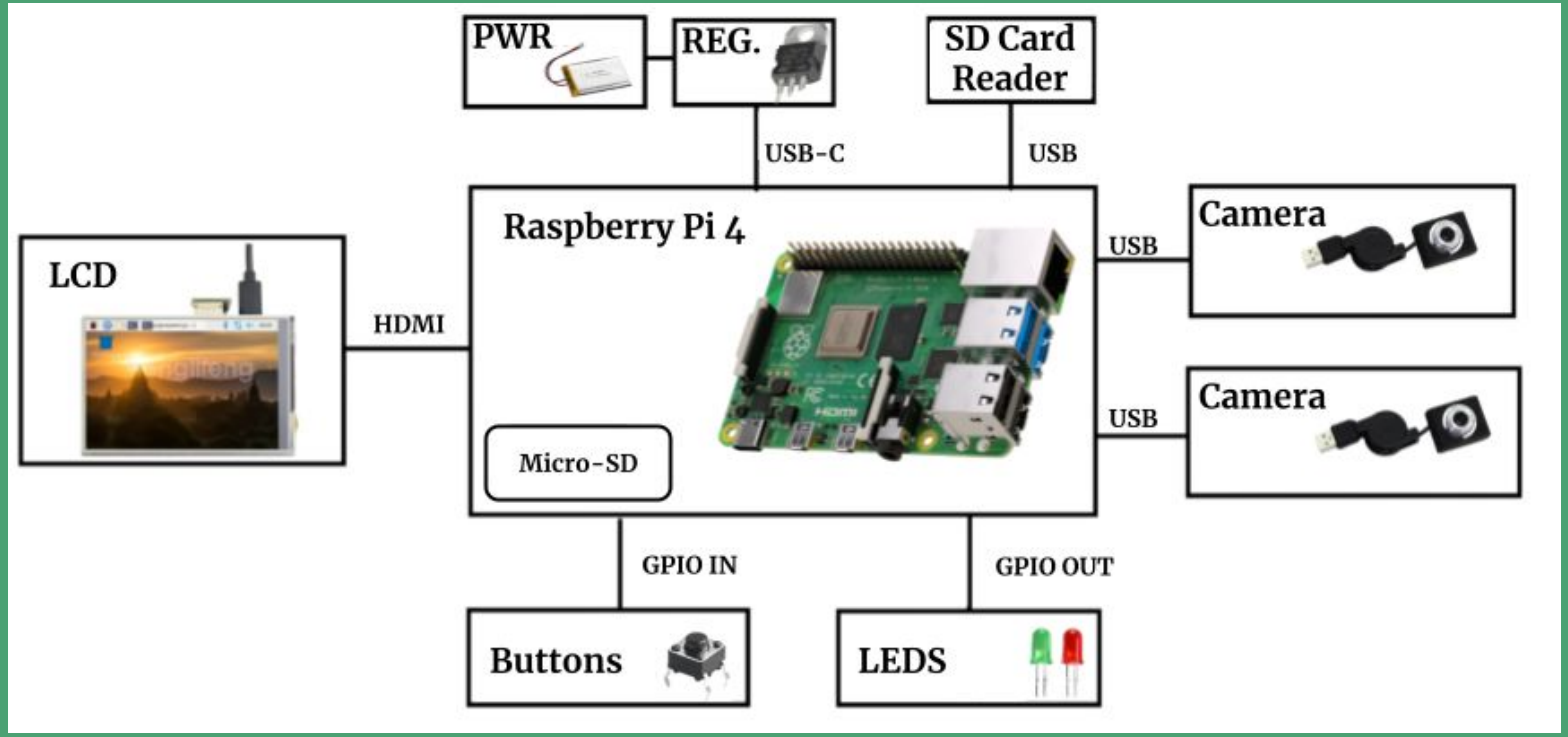


CAD Prototype 3D Design Front View



CAD Prototype 3D Design Back View

Concept Elaboration Updates



High-level Wiring Schematic

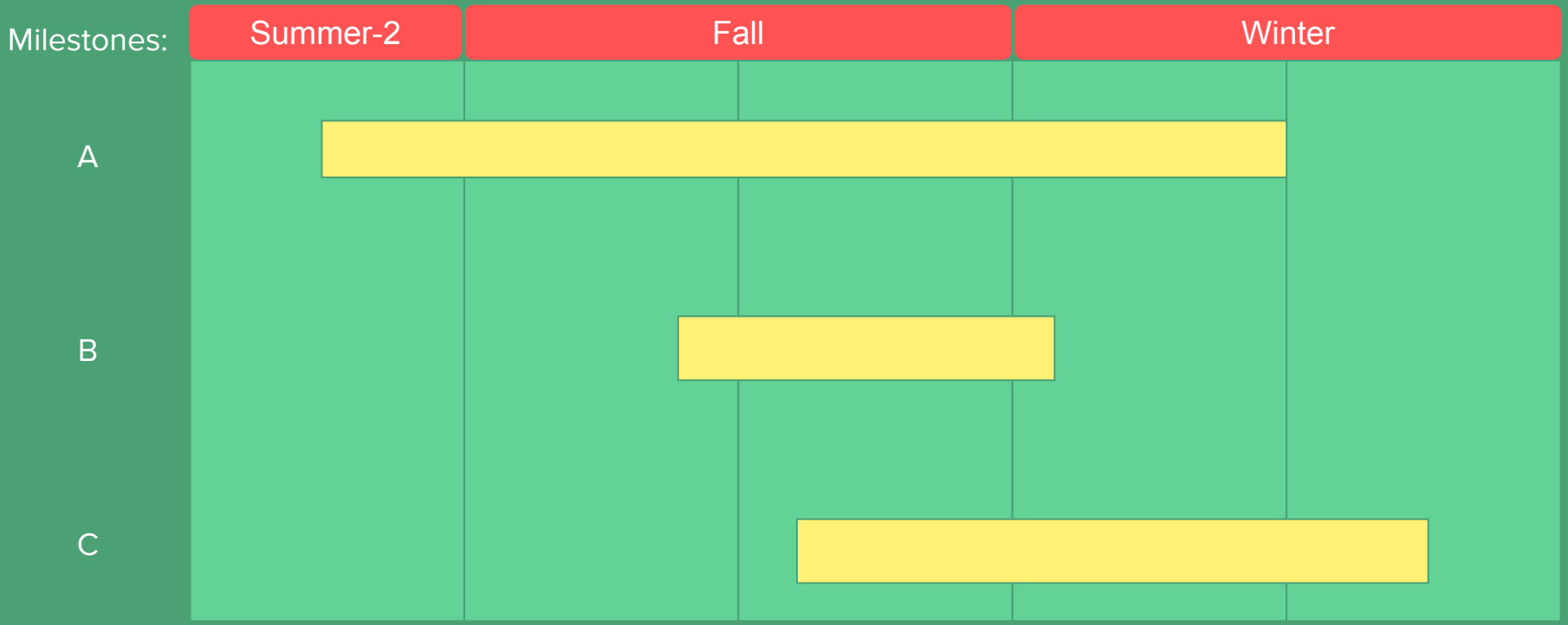
Milestones

- Milestone A - Develop simple camera model
  - Design chassis for camera
  - Design wiring schematic for electronic components
  - Produce PCB and connect camera components
  - Test basic functionality
  - Optional: Adjustable distance between cameras

- Milestone B - Calibrate stereo vision cameras
  - Test camera calibration outside of camera chassis
  - Implement camera calibration on raspberry pi with chassis
  - Implement procedure to calibrate cameras as a user function

- Milestone C - Create depth heat map / 3D point cloud
  - In parallel with camera calibration, experiment with disparity map and 3D point cloud
  - Test display on LCD and create GUI

Timeline



Materials List

- Regulator ICs
- Various resistors and capacitors
- Diodes
- Fuse(s)
- LCD Display
- Custom PCB
- Embedded Cameras (x2)
- LEDs
- Buttons
- Capture Button
- Raspberry Pi 4

The Do-Pro: A Minimalistic Stereo Vision Camera

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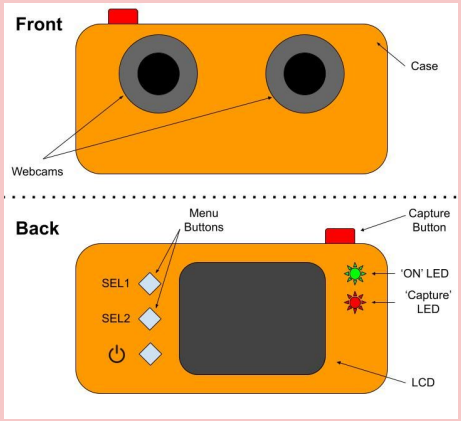
Background:

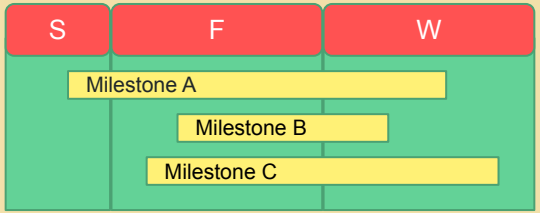
To perceive depth, two images of a scene must be observed at different points along a shared axis. Stereo vision cameras are specialized instruments designed to produce depth from at least two images. These cameras are specialized and expensive with state-of-the-art commercial cameras costing $500 and requiring a mount. In this proposal, we aim to produce a more affordable stereo vision camera designed for versatile applications.



A conceptual illustration of the proposed stereo vision camera. The camera is similar in style to most handheld digital cameras

Milestones:

- Milestone A - Develop simple stereo camera model and achieve functionality on breadboard
- Milestone B - Calibrate stereo-vision cameras
- Milestone C - Implement stereo vision processing, camera software mechanics, and PCB functionality



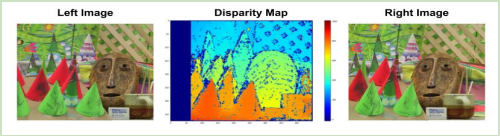
References:

[1] A. Vij, “Stereo vision: How do 'terminators' see the world?,” *Medium*, 23-Mar-2021. [Online].

[2] B.K.P. Horn,, “Robot Vision”, Cambridge, MA: MIT Press, 1986, ch. 13.

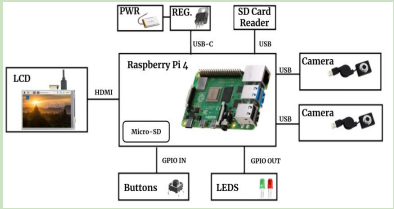
[3] D. Scharstein, R. Szeliski and R. Zabih, "A taxonomy and evaluation of dense two-frame stereo correspondence algorithms," Proceedings IEEE Workshop on Stereo and Multi-Baseline Vision (SMBV 2001), 2001, pp. 131-140, doi: 10.1109/SMBV.2001.988771.

Software Deliverable:



Example of depth estimation on stereo vision image set.

Hardware Deliverable:



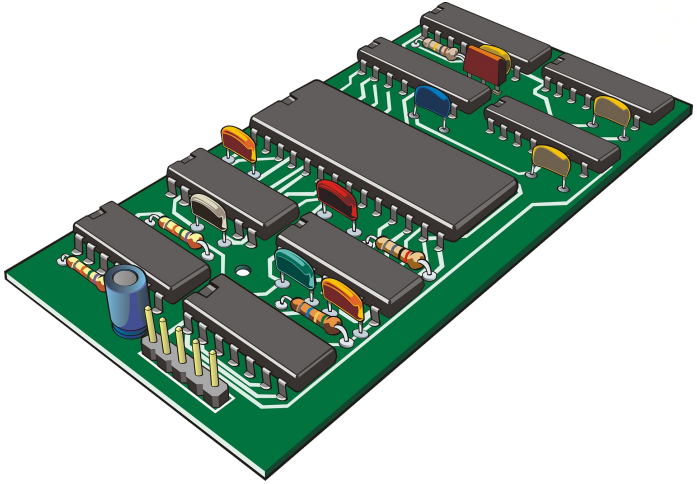
High level wiring schematic of the proposed stereo vision camera system

General Deliverables:

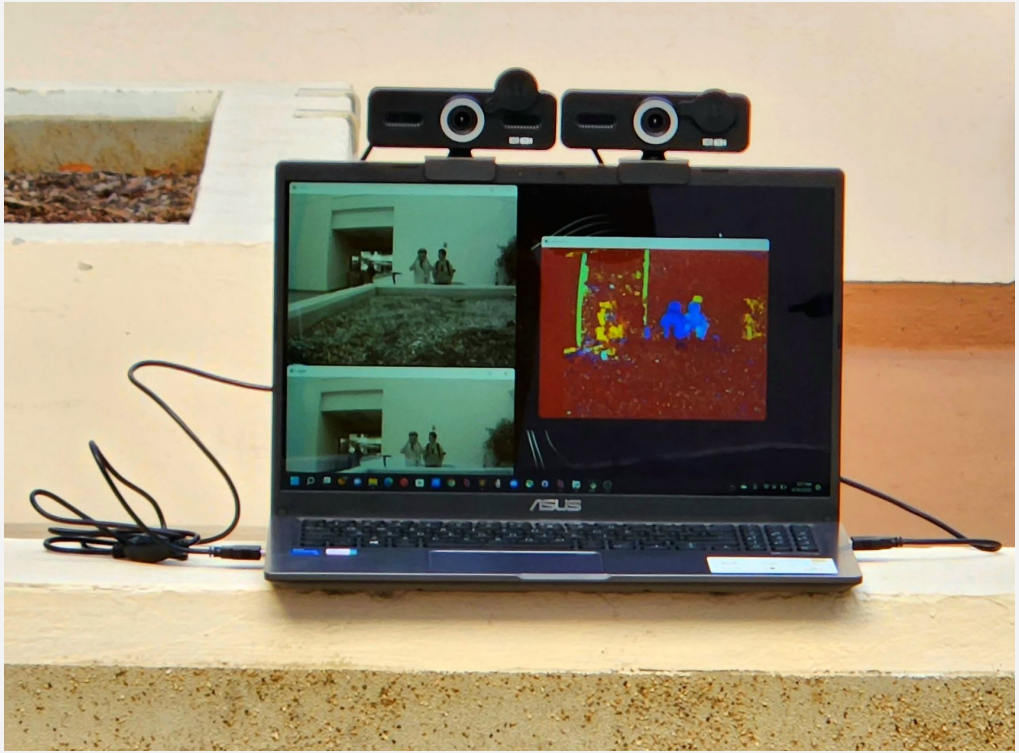
- Functional camera – 3D-printed chassis and manufactured PCB
- Auto-calibration
- Image & video Processing
- UI + touch screen + instruction manual
- ***Object tracking***

Estimated Expenses

$185



Stereo-Vision Demonstration



https://youtu.be/KSEhb_ojmms