DEPTH SENSING BY COMBINING COMPUTER VISION AND LIDAR POINT-CLOUD DATA

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ABSTRACT

One of the main challenges in modern self-driving cars is creating a system that can reliably identify obstacles and calculate their distances in real time. Such challenges are nontrivial because one must consider multiple conflicting sensory interferences. Ambient light from the Sun, reflective surfaces, darkness, fog, and other sensory obsurements pose significant challenges to guaranteeing an autonomous driving system's safety. Infrared depth-sensors such as devices used in the Microsoft Kinect promise high depth and object recognition accuracy but fail to work reliably in direct sunlight. Computer vision machine learning models are capable of object recognition and depth perception, but only to a degree of certainty. LIDAR (Light Imaging Detection and Ranging) sensors are capable of high-accuracy depth sensing, but are affected by fog and are only able to collect point cloud data in a single plane. This project seeks to be a proof of concept system that achieves reliable object detection and depth sensing by combining a computer vision model and live LIDAR point-cloud data.

Keywords Depth sensor · LIDAR · Computer Vision

1 Introduction

Depth Sensing with Computer Vision and LIDAR aims to create a reliable depth sensing system using computer vision and LIDAR. This project spanned 2018 Winter and Spring terms at Oregon State University. Special acknowledgement to Kevin McGrath, who supplied equipment and technical guidance.

This project's motivation came from an annual robotics competition at Oregon State University, my client noted that all the robots had been designed and tested indoors. This later proved to be an issue because when the robots were brought outside for a competition, their guidance systems failed to work as the IR cameras were inherently subject to interference from the Sun's ambient light. As the prevalence of automation in our daily lives increases, such as autonomous cars or robots, a cheap and scalable depth sensing system that is resistant to common interferences is necessary. The goal of this project is to create a reliable depth sensing system using computer vision and LIDAR. Such a system that combines these two technologies will be more reliable than infrared depth sensing because cameras and LIDAR devices are less prone to interference from ambient light or anomalies.

2 Design

The Logitech Brio webcam provides a high-resolution, two-dimensional image but lacks depth perception. The LIDAR provides accurate depth measurement in a horizontal dimension but lacks vertical perspective. This project proposes bridging the utility of both devices by securing them in stationary positions, then using software to combine their outputs. This involves using the M16 LIDAR to get depth sensing information and using computer vision to recognize objects. The result is a scalable and reliable depth sensor that will not be affected by natural light, and can be further improved by training a better computer vision model or adding more sensors. This project hopes to achieve a proof of concept design to be showcased in a live demo at Oregon State University's 2018 Undergraduate engineering expo. This live demo shall consist of the full system pointed at the project booth's audience.

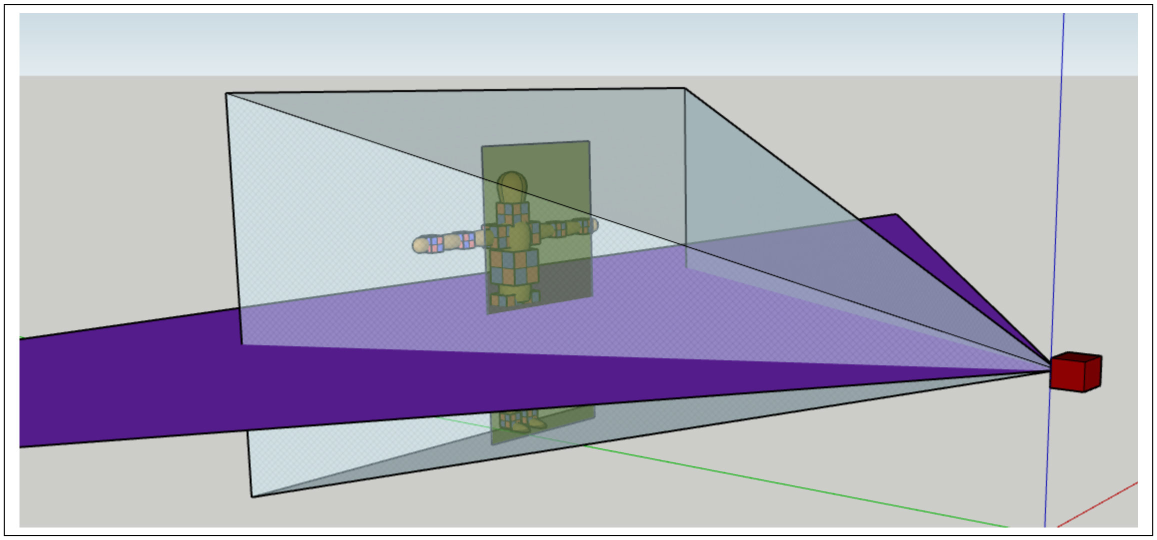

Figure 1: Visualizing different dimensions measured by the LIDAR and Brio Webcam.

Figure 1 illustrates different dimensions measured by the M16 LIDAR and Brio Webcam. The red cube represents the Logitech Brio webcam and M16 LIDAR secured in stationary positions. The flat purple triangle represents the M16 LIDAR's horizontal range detection. The transparent green rectangle in front of the person represents the computer vision model recognizing that there is a person in-front of the sensor. The transparent teal pyramid represents the Brio webcam's field-of-view.

2.1 Headings: second level

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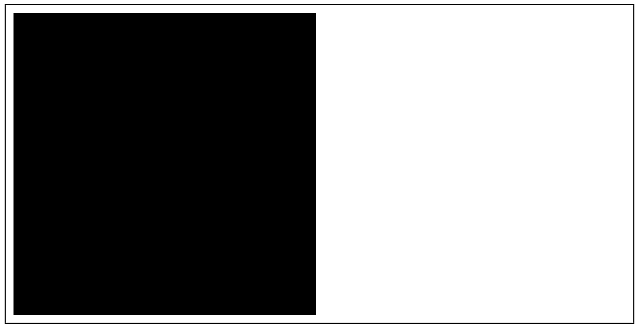

Figure 2: Sample figure caption.

3 Examples of citations, figures, tables, references

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Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

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3.1 Figures

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See awesome Table 1.

[1]Sample of the first footnote.

Table 1: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

3.3 Lists

- Lorem ipsum dolor sit amet
- consectetur adipiscing elit.
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References

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