Real-Time Depth Sensing by Combining Computer Vision and LIDAR Point-Cloud Data

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Abstract

Modern self-driving car systems face a massive challenge: creating a holistic system capable of accurately identifying obstacles and quickly calculating 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 promise depth measurement 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 demonstrates real-time object detection and depth sensing is feasible by combining a computer vision model and live LIDAR point-cloud data using simple geometry.

***K*eywords** Depth sensor · LIDAR · Computer Vision

1 Introduction

1.1 Existing Depth Sensing Technologies

Current depth sensing technologies do not independently satisfy the definition of a holistic system capable of accurately identifying obstacles and quickly calculating their distances in real time. The following candidate technologies did not

1.1.1 Radar

1.1.2 Infrared Sensors

1.1.3 Lidar

1.1.4 Computer Vision

2 Design

The Logitech Brio webcam provides a high-resolution, two-dimensional image but lacks depth perception. The LIDAR provides accurate depth measurement but lacks multi-dimensional point cloud data to perform classifications. 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

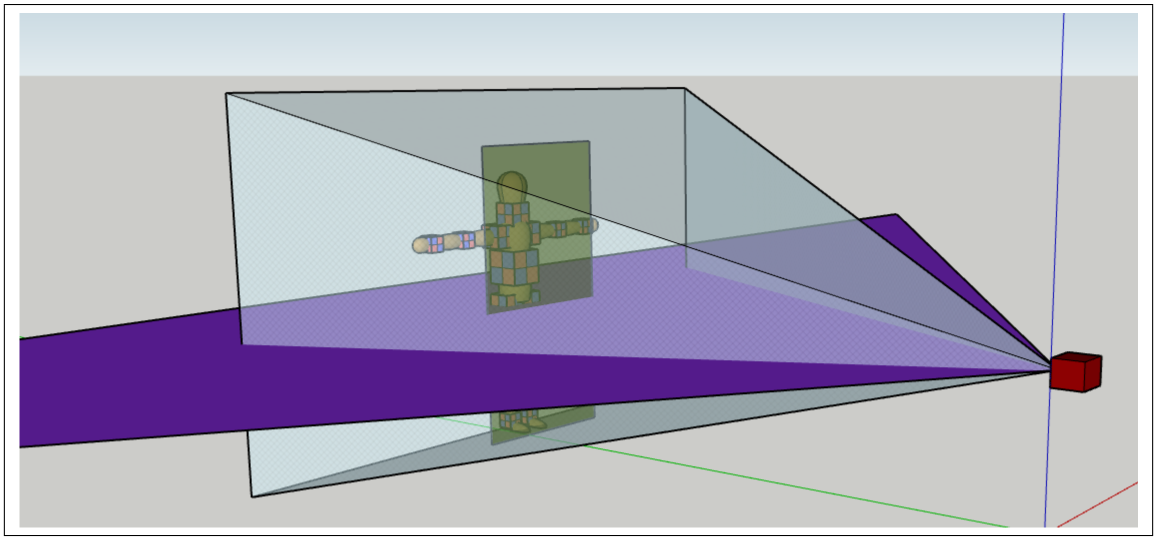

Figure 1: Visualizing different dimensions measured by the LIDAR and Brio Webcam.

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 **??** 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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$$\theta \geq 305 : X = \frac{videowidth}{2} * sin(360 - \theta) \tag{2}$$

2.1.1 Headings: third level

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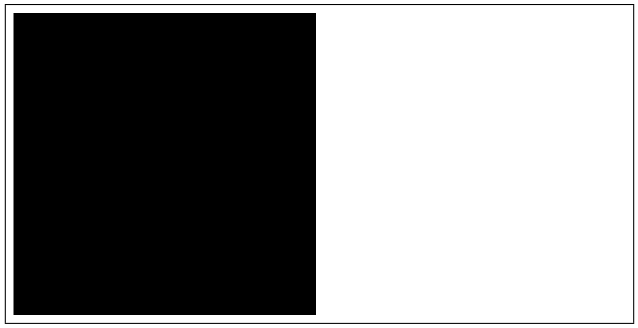

Figure 2: Sample figure caption.

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3 Examples of citations, figures, tables, references

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The documentation for `natbib` may be found at

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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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> Hasselmo, et al. (1995) investigated...

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3.1 Figures

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[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

3.2 Tables

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3.3 Lists

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