FERMILAB-POSTER-22-095-AD-STUDENT

3D Stereoscopic Inspection Camera

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Purpose of Camera

Intel RealSense Technology is a product range of depth and tracking technologies designed to give machines and devices depth perception capabilities. The Intel RealSense D435i stereoscopic camera has applications that enable a wide field of view that is essential for applications in robotics and 3D mapping. Along with a range of up to 10 meters, the technology equipped with this product senses depth, navigates environments, and recognizes obstacles.

Intel RealSense D435i model combines the depth sensing capabilities of the D435 with an inertial measurement unit (IMU).

Figure 4-6. Depth Camera X-Y Depth Origin Reference

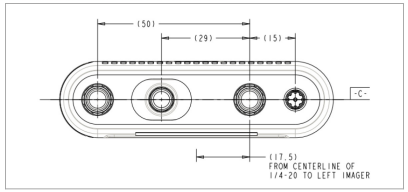
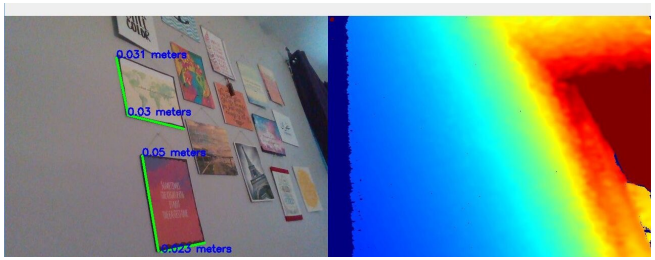


Table 4-12. Depth Camera X-Y Depth Origin Coordinates

Depth Camera	From Centerline of ¼-20[1] To Left Imager
D415	20mm
D435/D435i	17.5mm

Distance Detection



Realsense packages such as the SDK library and Python modules such as "numpy" allow depth configuration and image rendering.

Imaging and viewing can be streamed via code or the real-sense viewer.

The main task of this camera was to create a program that would compute the distance between two given points in an image. This distance would return the distance in real-world measurements, specifically in meters. In the future, this application would allow operators to implement this in the beamlines to compute the distances between pipes and other machinery.

Data/Results

Box Data	Left Angle	Center View	Right Angle
Average	0.227 m	0.242 m	0.159 m
Std. Dev	0.035	0.036	0.005
% Error	58.7	69.2	11.1

Multiple images of the length of a box were taken from different angles. The actual measured length measured with a ruler was 0.143 m. Images taken with an angle of objects shifted slightly to the right indicate the smallest percentage error.

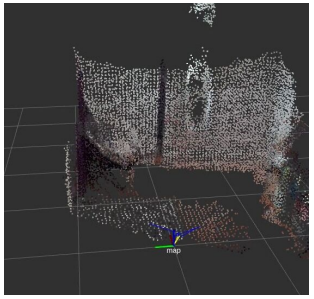
Phone Data	Left Angle	Center View	Right Angle
Average	0.190 m	0.169 m	0.168 m
Std. Dev	0.062	0.0157	0.008
% Error	40.7	25.2	24.4

Results from a measured iPhone also indicate that images taken from an angle shifted to the right return a smaller error. The actual measured length of the iPhone was 0.135 m.

Data was drawn through a series of tests by taking multiple images from the same three angles (center, shifted to the left and right) and calculating the average. Program allows user to click and drag on certain points for desired measurement. The data returns images taken with a shift to the left return a greater error.

3D Mapping / Navigation

A point cloud is a set of data points in space, containing an X, Y, Z coordinate. Point clouds are mainly used for 3D modeling and can be used for floor planning for autonomous navigation. Point clouds are more favored than 3D maps or mesh clouds due to higher resolutions and known vertices.



Simultaneous localization and mapping is the process of creating a map using a robot or unmanned vehicle that navigates the environment using the map generated. Programs such as RViz allow a smooth transition for robots to be navigated autonomously. The benefit of using a depth camera using RGB-D sensors with robots provides accurate results while in usage due to its higher resolution. In the future, obstacle detection will be further studied using RViz and other external programs.

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