DreamVu

Obstacle Detection & Obstacle Avoidance - PAL Mini

Evaluation Setup Manual

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The DreamVu PAL Mini camera uses a single sensor to capture stereoscopic 360° panoramic images of the scene. These images can be used for surround situational awareness and dense 360° 3D reconstruction of the scene.

The DreamVu PAL Mini camera has a broad dynamic range and can be operated in both day and night conditions. The Explorer application shipped with the camera includes a range of parameters that can be controlled for ideal operating conditions in different scenes, including an "Auto" mode that identifies the best camera properties for each scene.

This document provides a step by step guide for using the PAL Mini camera for obstacle detection and avoidance using a depth-scan (analogous to laserscan) generated from the camera.

To evaluate the PAL Mini camera, please follow the step-by-step recommendation on setting up the camera.

Step 1: Software Installation
Step 2: Mounting the PAL Mini Camera
Step 3: Setting ODOA Parameters
Step 4: Measuring the Depth of Obstacles

Step 1. v3.0 Software Installation

Please follow the instructions given below on the already available Jetson NX to install the latest v3.0 software.

- Download and Extract the software file from this link.
- Open a terminal with the extracted folder as the current working directory.
- Run the following commands

```
$ cd installations
$ chmod +x ./*.sh
$ ./install.sh
```

- Once complete, please reboot the Jetson board.

- Download and extract the camera data zip file and run these commands:

```
$ chmod +x setup.sh
$ ./setup.sh
```

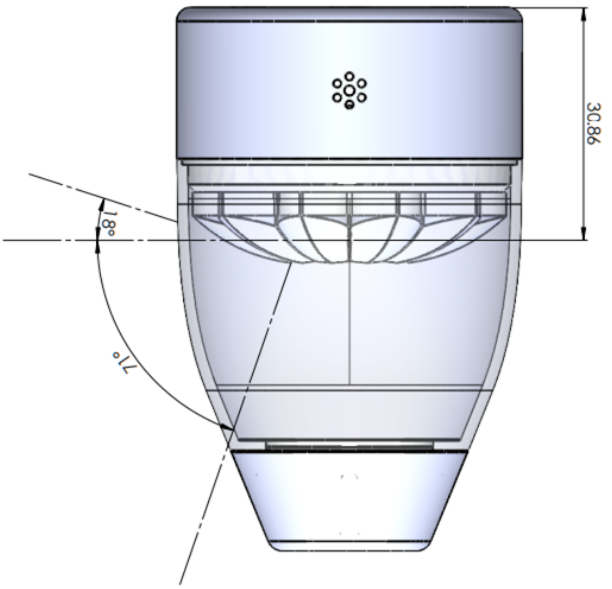
Step 2. Mounting the PAL Mini Camera

The DreamVu PAL Mini camera has a full 360° horizontal field-of-view and a large 80° degree vertical field-of-view. The ideal mounting for the PAL Mini camera is the inverted orientation. The vertical field-of-view of the PAL Mini Camera is asymmetric about the horizon (71° above the horizon and 18° below the horizon) and is shown in the figures below.

The height of the PAL Mini camera and other parameters related to the active field-of-view of the camera can be specified in the ODOA.yml file that is provided with the `dreamvu_pal_navigation` ROS package.

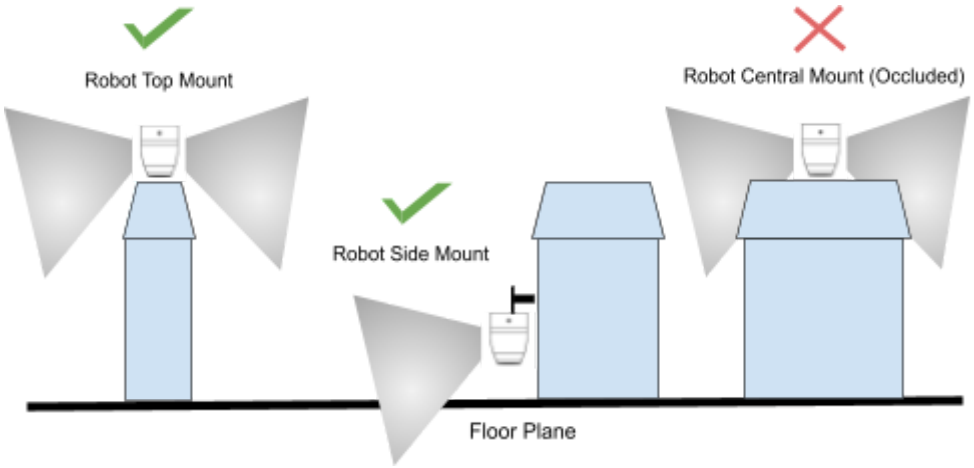
Inverted Orientation

Default Orientation for using the PAL Mini Camera

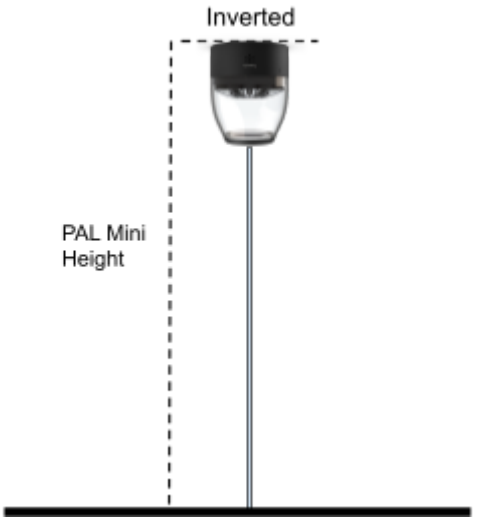


To use the PAL Mini camera for ODOA and Mapping, it is important to mount the camera appropriately on a robot as shown in the figure below. It is important to avoid any occlusions in the field of view caused by the parts of the robot. If a portion of the field-of-view is occluded by the robot, this portion can be removed

by choosing the active field-of-view in the ODOA.yml file. The Height of the PAL Mini Camera must also be measured and recorded in the ODOA.yml file as shown in the figure below.



The PAL Mini Camera must be mounted on an appropriate robot mount. It can be mounted on the top of the robot with an unobstructed field-of-view or at the side of the robot with appropriately specified start_hfov and end_hfov parameters. Do not mount the camera in the center of the robot or where the field of view is completely occluded.



Inverted Mounting for PAL mini cameras is recommended for ODOA and mapping.

The default setting in the software assumes that a Robot Side Mount is used and a field-of-view of 240° is selected as the active area (120° being occluded by the robot). It is also assumed that the PAL Mini camera is mounted at a height of 25cm from the floor on the side of the robot.

Step 3. Setting ODOA Parameters

For Mapping, ODOA and Navigation, the laser-scan from the PAL mini camera (published as the scan topic) can be used. This scan provides the 2D occupancy map of the 360° view around the camera, but utilizes a vertical 3D context to find the nearest obstacle. In principle, this scan is similar to a scan generated from laser-scanners, but the occupancy is measured from 360°stereoscopic panoramas and therefore includes a set of parameters that can be tuned for ideal operation and performance.

The `dreamvu_pal_navigation` package consists of a set of parameters contained within a metadata file named `odoa.yml`. These parameters control the laser-scan generated from the PAL mini camera. Based on the target application - mapping, obstacle detection or navigation - these parameters may be adaptively modified during deployment. The default parameters, along with descriptions of the parameters are provided below. We use the default parameters listed here for in the following sections of the document.

Parameters	Description	Default value
depth_context_threshold	Range = [0, 255] This parameter indicates the sensitivity of the scan towards obstacles in the scene. Higher values (150-180) represent higher sensitivity towards obstacle detection while lower values (120-150) are suitable for minimal false detections.	140
depth_context_sigma	Range = Odd integer values from [0,25] In the presence of highly textured floors, this parameter can	0

	be used to improve the obstacle detection quality. Values from (11-25) are suitable for highly textured floors, with lower values (0-10) for non-textured floors.	
stereo_threshold	Range = [0,25] This parameter defines the sensitivity of the scan to 'close obstacles'. A value of 20 implies the scan will be sensitive towards floating obstacles from 0cm to 20cm.	25
odoa_start_hfov	Range = [0,360] This parameter defines the start (in degrees) of the horizontal field of view of interest. It is recommended that the occluding parts of the robot body should be removed from the horizontal field of view.	0
odoa_end_hfov	Range = [odoa_start_hfov, 360] This parameter defines the end (in degrees) of the horizontal field of view of interest. It is recommended that the occluding parts of the robot body should be removed from the horizontal field of view. For the default parameters, it is assumed that 0-240 degrees is the active area, while the remaining 120 degrees is occluded by the presence of the robot.	240
odoa_start_vfov	Range = [0,100]	50

	This parameter defines the start (in percentage rows) of the vertical field of view of interest. This parameter is applicable for close obstacle detection enabled by *stereo_threshold*	
odoa_end_vfov	Range = [odoa_start_vfov,100] This parameter defines the end (in percentage rows) of the vertical field of view of interest. This parameter is applicable for close obstacle detection enabled by *stereo_threshold*	90
depth_context refinement	This parameter controls the sensitivity to small obstacles. Higher values (3-4) are used for high sensitivity to small obstacles at the cost of some noise in the scan. Lower values (1-2) are recommended for reduced noise and when only large obstacles are present. This mode requires additional computation and can be turned off by setting a value of 0.	4
camera_height	This parameter denotes the height (in centimeters) at which the camera is mounted from the surface of the floor. The height can be measured as shown in the preceding section.	25

Table 2.2: List of parameters for the Laserscan from the PAL Mini Camera

Step 3.1 Varying Illumination Conditions

The following table describes a set of ideal parameters for operating the PAL Mini camera in different illumination conditions.

Property Name	High Illumination	Low-Illumination

depth_context_threshold	<150	>200
depth_context refinement	2	4

Table: Ideal Properties in different illumination conditions. Higher values of depth_context_threshold are required in dark scenes for accurate detection of obstacles around the camera.

Step 3.2 Setting the Height of the PAL Mini Camera

The height of the PAL mini camera has an impact on the range of obstacle detection and mapping. The following table describes the relationship between the ideal range for mapping using the PAL Mini camera at different heights.

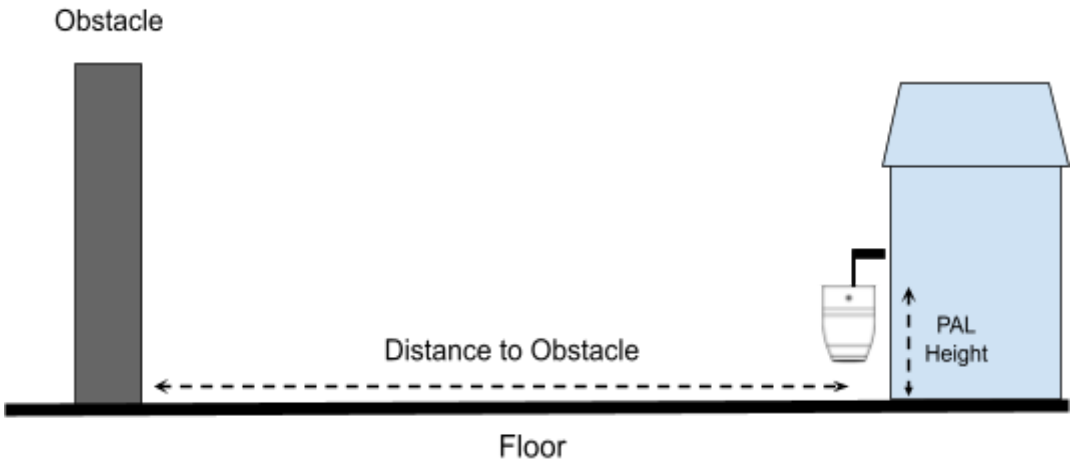
Mounting Type	Mounting Height	Mapping / ODOA Range
Low Mounting	Less than 20cm	1.5m - 2m
Moderate Mounting	20cm - 60cm	2m - 3m

Step 4. Measuring the Depth of Obstacles

To measure the depth to a known obstacle or to verify the depth accuracy provided by the PAL Mini Camera, the following steps may be used

The PAL camera uses stereo panoramas to compute the depth/distance to the objects in the scene and the distance is measured along the horizontal direction as shown in the figure below.

To make depth measurements using the PAL Mini Camera, please mount the camera as shown in the figure. It is important to ensure that the PAL camera is flat-mounted (no tilting) and there is no occlusion between the camera and the floor region caused by parts of the robot or the mounting support.



PAL Mini Mounting for Measuring the distance to Obstacles

Once the scene is set up, launch the ROS package from the catkin workspace:

```
$ cd <path_to_catkin_ws>
$ roslaunch dreamvu_pal_navigation scan_rviz.launch
```

Using the measure tool in the Rviz taskbar, the distance from the center of the grid to the obstacle can be measured as shown in the image below: