Aim: To study the Depth Estimation

Objective: To Capturing Frames form a depth camera creating a mask from a disparity map Masking a copy operation Depth estimation with normal camera

Theory:

1. Depth map

A depth map is a two-dimensional representation of a scene that conveys the depth information of objects within it. It associates each pixel in an image with a corresponding depth value, indicating how far away the object represented by that pixel is from the camera or observer. Depth maps are essential for perceiving the three-dimensional structure of a scene, enabling applications such as 3D reconstruction, augmented reality, and object tracking.

2. Point cloud map

A point cloud map is a collection of three-dimensional points in a virtual space, where each point is defined by its spatial coordinates (x, y, z) and potentially additional attributes like color or intensity. These points collectively represent the shape and structure of objects in a scene. Point cloud maps are commonly generated from depth data obtained by depth cameras or other 3D sensing technologies and find applications in fields such as computer graphics, robotics, and geographical mapping..

3. disparity map

A disparity map is a visual representation that indicates the pixel-wise horizontal shift or disparity between corresponding points in a pair of stereo images taken from slightly different viewpoints. It is computed by analyzing the differences in pixel positions between the left and right images. Disparity maps provide information about the relative depth of objects in a scene and are particularly useful for tasks like stereo vision, depth estimation, and generating three-dimensional reconstructions.

Creating a Mask from a disparity map

The disparity map can be thresholded to create a valid depth mask. Pixels with a certain disparity value range are considered valid and used for depth estimation.This process results in a binary image where pixels belonging to objects of interest are highlighted while others are suppressed.

Masking a Copy Operation

By applying the valid depth mask to an image, you can copy or paste objects from one scene to another while maintaining depth consistency. This can be useful for augmented reality applications.Masking a copy operation is frequently employed in computer vision to focus on specific portions of an image, such as applying effects or filters only to regions indicated by the mask.

Depth estimation with a normal camera

Depth estimation using a normal camera involves inferring depth information from a single 2D image captured by a regular camera .While a depth camera directly provides depth information, estimating depth from a single normal camera requires additional techniques. This can involve using stereo vision, structure-from-motion, or deep learning-based methods.

Code:

```
import cv2
import numpy as np


#  disparity map and RGB image
disparity_map = cv2.imread("img33.jpg", cv2.IMREAD_GRAYSCALE)
rgb_image = cv2.imread("img222.jpg")


if disparity_map is None or rgb_image is None:
    print("Image loading failed.")
else:
    # Create a valid depth mask from the disparity map
    valid_mask = disparity_map > 0  # You might need to adjust this
threshold


    # Apply depth mask to the RGB image
    depth_estimated_image = np.zeros_like(rgb_image)
    depth_estimated_image[valid_mask] = rgb_image[valid_mask]


    # Display the original disparity map, RGB image, and depth-estimated
image
    down_width = 600
    down_height = 500
    down_points = (down_width, down_height)
```

```
    resized_down = cv2.resize(disparity_map, down_points, interpolation=
cv2.INTER_LINEAR)

    resized_down2 = cv2.resize(rgb_image, down_points, interpolation=
cv2.INTER_LINEAR)

    resized_down3 = cv2.resize(depth_estimated_image, down_points,
interpolation= cv2.INTER_LINEAR)

    cv2.imshow("Disparity Map", resized_down)

    cv2.imshow("RGB Image", resized_down2)

    cv2.imshow("Depth-Estimated Image", resized_down3)


    # Wait for a key press and close windows

    cv2.waitKey(0)

    cv2.destroyAllWindows()
```

Output:

Input Image:

Disparity Map:

Depth-Estimated Image:

Conclusion:

In this study, . We aimed to capture a comprehensive understanding of depth information within a scene and how it can be harnessed to enhance image manipulation and perception.we explored the concept of depth estimation using disparity maps and depth masks in the context of computer vision. We also looked at depth estimation with a conventional camera, highlighting its shortcomings in compared to specialist depth sensing systems. Even while depth maps, point cloud maps, and disparity maps provided important information, issues highlighted the need for specialist depth sensing for exact depth perception. This experiment highlighted the use of depth estimation approaches in a range of applications, as well as the role of advanced depth sensor technologies.