Depth reconstruction from stereo images

Student

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Introduction: The client is in need of a camera system, that is able to identify and count the number of plastic crates in view. An important step in identification is to accurately calculate the depth of every crate in relation to the camera. While they already have a sparse mapping of depth data, a dense depth image is paramount for reliable results. Depth estimation is realized by simulating human vision with a stereo or even multi-view camera system. Humans perceive depth by the slight difference of objects between the left and right eye. This difference is called disparity. The core principle in calculating the disparity is to find matching pixels between our image frames.

Approach: Template matching is used as groundwork for finding correspondences, pixels that match between image frames. Extreme points in template matching correspond to best matches. All calculated matching values are introduced to the Disparity Space Image, creating an intuitive relationship between both images of our stereo system. By finding the lowest cumulative cost path through a Disparity Space Image, accurate disparity values for every pixel on a horizontal line can be calculated. Repeating this method for every image row creates a dense disparity map. Finding reliable points in the DSI allows us to influence or even force our path through matches with high certainty. The Disparity Space Image even allows us to locate and fill Occlusions, pixels visible in only one image. With a few camera parameters, usually obtained through calibration, disparity values can be converted to actual depth.

Result: The Disparity Space Image is an intuitive and accurate way to calculate dense disparity maps. Like many other stereo matching algorithms, the presence of smooth surfaces and repetitive patterns can cause a significant number of false matches. Artificially adding random patterns to smooth surfaces leads to accurate results. Real time capability is somewhat impaired by the huge amount of matching values that need to be calculated through template matching.
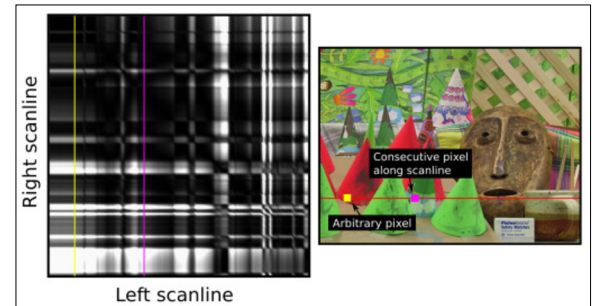
A pixel with its surrounding support window is matched in a horizontal image line.

https://vision.middlebury.edu/stereo/data/
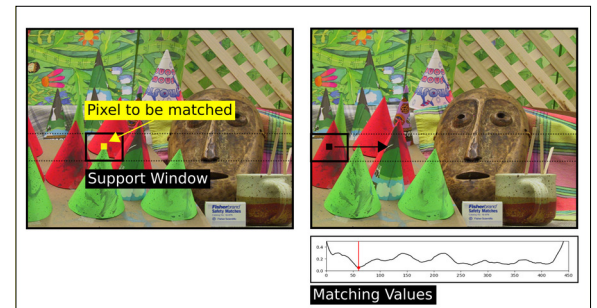
Disparity Space Image of a single horizontal image line.
https://vision.middlebury.edu/stereo/data/

Original image and dense disparity map with two plastic crates.
Own presentment

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Subject Area
Image Processing and Computer Vision

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