## 2.1.1 Epipolar Geometry

In an image taken with a pinhole camera, each point of an object, the center of projection as well as the associated pixel lie on a straight line, called the epipolar line [18]. When searching for a corresponding pixel, the matching candidates therefore lie on the epipolar line of the other image, as illustrated in Figure 2.2. This constraint reduces the searchspace considerably, as corresponding pixels only have to be searched along the epipolar line. The nearer the objects are, the higher is the displacement of the object between the two images. Therefore, a high disparity means low distance. For canonical stereo systems the disparity search range starts at infinity with a disparity of 0 and ends at a defined minimum distance, which represents the maximum disparity.

Geometry between cameras has to be known in order to calculate the corresponding epipolar lines, which requires stereo calibration further described in [18].



**Figure 2.2:** The points  $X,O_l$  and  $O_r$  form the epipolar plane. The intersection with the image planes result in epipolar lines. All world points (gray) corresponding with a point  $X_L$  in the left image plane therefore lie on the epipolar line of the right image.

Source: http://en.wikipedia.org/wiki/File:Epipolar\_geometry.svg (accessed Dec 2012), originally created by Arne Nordmann, License: CC BY-SA 3.0

## 2.1.2 The Correspondence Problem

The task of a stereo matching algorithm is the calculation of the disparity value for image pixels by finding corresponding points or pixels in both images. The resulting 2D data-structure which contains the calculated disparity values is called disparity map.

However, there are several problems stereo matching algorithms are facing when determining correspondences. Transparent areas are not detected at all therefore resulting in bogus depth information. Texture-less or repetitive areas, which do not contain enough color information or structure to allow for choosing the correct pixel, are filtered out using confidence thresholding. Also, disparity for occluded or half-occluded areas can not be determined, such as areas are not visible in both images. Therefore valid disparity values cannot be determined for all pixels/points.