

[0751] It's also an alternative to have the lights not surrounding the lens axis but off to one side but as close as possible for best retro-reflective performance.

[0752] The LED's are energized in the particular embodiment here and the LED's are near infrared operating at a wavelength 0.85 micron. They provide the illumination needed without being distracting to the user. Visible LED's are usable too if they don't distract the user. A filter on the front of the camera removes largely the effect of light outside of the wavelength of the illumination.

[0753] It is also possible to detection datums on the object without the additional use of auxiliary illumination and the optional wavelength based filtering process described above. This is further possible to do this with white light illumination that can be used to illuminate the object as well as the datums in cases of low light and so on. In this case, it is the desire to have the datums distinguished as possible and particularly useful inventors have found color and shape for this purpose, typically a combination of the two. For example a triangular shaped target can be used whose solution is somewhat different from that above. In this case it's not multiple points as in targets that are used to solve an equation but rather the lines of the edges of the target.

[0754] A question to answer, is it required for the camera system to be used for both image production of the object and for viewing certain types of special targets, or can it be just devoted to the special target purpose? In the latter case, the lighting is easier because there is only one issue to contend with; seeing the light reflected from the special target, which typically has high brightness, and /or high contrast or color contrast to its surroundings. This can be done at specialized wave lengths, particularly of interest in the very near infrared (eg 0.75 to 0.9 microns wavelength) where strong LED's sources exist, which is visible to the cameras in general use, but which is not bothersome or unobtrusive to the user.

[0755] If the camera is also to be used for general imaging, but not simultaneous with special target detection, a special band pass filter transmissive to the LED, laser or other sufficiently monochromatic light source wavelength can be used to cover the camera lens. The filter is conveniently provided with a chain, or preferably a sliding function, to slide in front of the lens when this function is needed. This function can be automated with, for example, a solenoid at added cost, to provide quick switching. Electronically switchable filters can also be used where faster switching is required.

[0756] Where the function is needed concurrently with imaging, more difficulty remains, as the tv camera image contains both target and scene information. Bright retro-reflector indications will show bright in the tv scene image as well. One solution is to take two TV images, the first with retro illumination on, and the second with it off. If the frame rate is double the usual display frame rate, no change in response is detected. The integration times of the two frames is likely to be different, being adjusted once for the retro return case, and next for the scene illumination at that instant. To do this quickly in one frame may require special exposure control or retro LED illumination control procedures.

[0757] This is also the case when stereo cameras are utilized. The exposure for one, may not be the same as for the other, given different tilt angles of the object.

[0758] For two camera stereo imaging, one camera too can be a master, used for conventional images, with the other a slave used only for determining object location. It is noted that if the stereo pair are spaced roughly like the eyes (eg 6-8 inches apart) and pointing straight ahead or nearly so, that the image created can be used to drive a stereo display—this could be of considerable interest at the other end of an internet connection for example, where the other person could view the person being imaged in 3D using "Crystal eyes" or other brands of LCD glasses and appropriate Video displays.

[0759] The invention can use special datum's such as round or point source LED's, retro-reflective, or other contrasting material comprising spots or beading defining lines or edges, or it can use natural object features, such as fingertips hands, head, feet, or eyes. Often a judicious combination of natural and object features can be chosen to minimize special features and their application, but to make use of their ease of discovery at high speed in a large field of view. For example, if one finds a high contrast, perhaps specially colored artificial feature, one can reduce the search window in the field of view often to that immediate area around the feature for example, where other related natural (or artificial) features are likely to lie.

[0760] Note that in a time sense, one often may be dealing with limited data due to momentary obscuration of some datum's, or the whole object. In this case an anticipated further movement of the object to some future position may be calculated so as to create a small as possible search window for the missing datum's in the future.

[0761] Note by combining LEDs of different colors, one can create light which allow illumination of several colors of individual targets, or even create effective white light illumination. Note that in this case the tv camera could employ a bandpass filter passing each of 3 led wavelengths thru, but that's all. This would discriminate against other white light sources, but still allow colored targets to be seen.

[0762] Note that other solid state sources than LEDs are also desirable, such as Diode lasers (including diode pumped lasers), superluminous devices and others.

[0763] Note that when flat targets become warped, for example when attached to skin or to clothing, their size as viewed changes, so in many cases size by itself is not a good indicator. The same holds true because of different views and their effect on apparent size. Shape of targets too can change, for example a circular target viewed at an angle is an ellipse. All of these issues need to be accounted for in determining target location and identification.

[0764] When two stereo pair images are used, the angle between them, and the object, means that each camera may see a somewhat different target shape as well. And its brightness can be different, as pointed out above. It is desirable to optimally detect each target datum in each separate stereo image first, before attempting to match images to determine where the datums coincide, which gives the z axis range.

[0765] When many datums are present a match sometimes is difficult. A human can aid the match by identifying target in both camera images during some set up stage.