

the target orientation toward the cameras as the dance turns, this method extends the range of motion allowed by the dancer or other users.

[0646] It should be noted that many of the embodiments of the invention described do not depend on TV cameras, Stereo imaging, special targets, or the like, but rather can be used with any sort of non contact means by which to determine position of a point, multiple points, or complete position and orientation of the object, or portion of a human used in the embodiment. While optical, and particularly TV camera based systems are preferred for their low cost and wide functionality, ultra sonic and microwaves can also be used as transduction means in many instances.

[0647] Note that an object may be physically thrown, kicked, slung, shot, or otherwise directed at the image represented on screen (say at an enemies or some object, or in the case of a baseball game, at a batters strike zone for example), and the thrown object tracked in space by the stereo camera of the invention and/or determined in its trajectory or other function by information relating to the impact on the screen (the latter described in a referenced co-pending application). Damage to the screen is minimized by using front projection onto a wall.

[0648] FIG. 22

[0649] FIG. 22 illustrates the use of a PSD (position sensitive photodiode)based image sensor as an alternative to, or in conjunction with, a solid state TV camera. Two versions are shown, A single point device, with retro-reflective illumination, or with a battery powered LED source is described, and a multi-point device with LED sources, can also be used A combination of this sensor and a TV camera is also described., as is an alternative using fiber optic sources. In addition a device using such an imaging device and a retroreflective background is presented as an alternative to specialized high reflectance datums on the human for example.

[0650] To achieve high signal to noise, the PSD detector can utilize modulated sources, and demodulated PSD outputs as is well known. Detectors of this type are made for example by Sitek in Sweden and Hamamatsu in Japan. Where individual LED targets on the object are used, they may also be individually modulated at different frequencies in order to be distinguished one from the other, and from the background, and/or they may be rippled in sequence. Similarly fiber optically remoted sources may do this as well.

[0651] The camera 2210 is composed of a lens 2215 and a PSD detector 2220, which provides two voltage outputs proportional to the location of an image on its face. When a single bright point such as retroreflective target 2230 is illuminated with a co-axial, or near coaxial light source 2235, a spot 2240 is formed on the PSD face, whose xy location voltage signal 2244 is digitized and entered into the control computer 2250 by known excitation and A-D converter means. Alternatively an LED or other active source can be used in place of the retro and its light source. In either case the background light reaching the PSD is much less than that from the target and effectively ignored. (if it isnt, errors can result, as the PSD is dumb, and cant sort out what is a target from background—except via filtering at the special wavelength of the LED using filter 2247 in front of the detector, or by modulating the led, or LED of the retro

light source using modulated power supply 2236—a novel approach which recognizes that the light from this source does not contribute so much to background as to retro-reflected return. When a modulated source is used, the led output signal 2244 is demodulated at the same frequency by filter 2245

[0652] Such PSD systems are fast, and can run at speeds such as 10,000 readings per second, far beyond a tv cameras ability to see a point. This is very desirable where high speed is needed, or where high background noise rejection is required, such as in bright light (eg in a car on a sunny day). A TV camera and a PSD camera as above can be used in concert, where desired..

[0653] A combination of this sensor and a TV camera is now described. As shown a PSD chip such as 2260 can be built into a TV camera, 2265 having a lens 2270 and a CCD array chip 2271, using a beam splitter 2275 which allows in this case, both to view the same field of view. This allows one, for example, to use the retroreflector illumination such as 2235 for the psd detected target, and the TV camera to obtain normal scene images, or to determine other target presence and location—for example those near the more rapidly and easily detected PSD sensed target (but knowing where it is, via its output signal related to the output scan of the TV camera).

[0654] An IR (infra-red) led or IR reflecting reflector to be used even with bright room lighting suitable for TV Camera use. The LED or other retroreflection specific light source can light up the whole object, but other effects such as saturation don't concern the TV image as they can if strong retro signals result with tv cameras.

[0655] As noted a feature of such a combination allows the PSD sensor system for example to find one target, and use the tv to find the rest made easier once the first one is identified, since the others can be specified apriori to be within a given search area or path from the first target.

[0656] It is further noted that an inverse type system can be made, where the background surface (eg on a desk top) appears bright, and the target is black. This can be done with retroreflector material or even white paper on a desk top for example. In this case the target object could be ones finger which would cover up the retro and the psd give a rough output as to its x and y position. By using a strip of one axis PSDs, one can find its position more accurately. For example, 8 parallel PSD detectors 2280 giving x outputs to an 8 channel common PC computer A-D data acquisition card 2282 can provide finger 2285 location in x and y (the latter only to a level of 1 part in 8), and pointing angle of the finger (roll in the xy plane). This is much faster than a TV camera for this purpose. That is the finger extended to detector 3, and the top end was at VLEFT while the bottom one on detector 2 was a VRIGHT.

[0657] Previous copending applications illustrate a fiber optic alternative in which light enters the fibers at one point, and is dispersed to a single fiber or a group traveling to the fiber end, which acts then as a target, and can be provided on an object (even during molding or casting thereof. This can be less obtrusive than individual LED's for example.

[0658] These applications have also identified a co-target, which is a target put on an object for the purpose of telling a computer based camera obtaining its image, where to look