object. User **604** may approach any object in view on the screen. The zoom factor may depend on the relative distance and desired realism in the VAR system. These features may create enhanced depth & motion experience.

[0125] In one embodiment, the IPD renders a scene by continuous real-time adjustments of the projected image by referencing the image as viewed through a position camera aligned with the viewer's perspective, as described above with respect to FIGS. **6**A and **6**B. In one embodiment, the position camera may be focused on a field of view within the screen, representing a focus area of the viewer/user. For example, if the screen has the image of a football match, and the position camera is focused on a subarea of the screen, where the ball is located, then that subarea is the field of view. In one embodiment, the position camera may be mounted on goggles such that the direction of the gaze of the viewer/user determines the field of view seen by the position camera, which is subsequently fed back to the IPD.

[0126] The position feedback and independence of quantization allows the IPD to render objects in great detail, relatively unconstrained by any fixed resolution. By concentrating the graphics subsystem computational resources, such as memory and processing power, on the rendering of graphics polygons describing the projected object, more detailed objects may be rendered. The system resources are more efficiently used because the field of view may be rendered with greater detail than a peripheral field, while still a sufficiently realistic peripheral vision experience is maintained. The peripheral field may be rendered in less detail, or with greater latency (for example, due to a lower processing priority), conserving computational resources such as memory and computing bandwidth.

[0127] As discussed above, the distance of the viewer/user to the projected surface may be determined by detecting the tracer beam and determining the flight time of the tracer beam pulses. A total viewer distance, D_T to an object is the sum of a real distance, D_R, and an imaginary distance, D_I: $D_T = D_R + D_I$. D_R is the distance from the viewer (for example, the viewer's eyes) to the position on the screen where the object is projected. D_I is the distance of the object away from and behind the plane represented by the projection surface (for example, screen), measured along the direction of view. For example, in a video game or VAR environment, a game engine may control D_I by the varying size, shading, and rendering of perceivable details appropriately. D_T, may also be referred to as a radial distance (total perceived distance), that is the distance from the object in view to the viewer's eye measured radially, that is, along the direction of view. In addition to this radial distance, a correct angular perspective may also be determined, as discussed above.

[0128] Objects that can be rendered and viewed in different directions and angular positions may be limited by the screen geometry and the position of the viewer. In case of a standard single rectangular projection surface (for example, normal front or rear projection system configurations) the limiting factors are screen height and width, and the viewing distance. If projection is done on walls surrounding the viewer, little or no geometric limitations may exist for the field of view of the user and interactions with objects projected onto the screen. Apart from screen limitations imposed by geometry or physical configuration, the viewer, equipped with the position camera, may move freely about the screen and approach any object in his field of view, which is usually a limited subset of, a "view cone," within the total possible field of view. When the viewer approaches the screen the objects in his view will tend to naturally increase in size because the viewer is getting closer to them. As the image on the screen gets bigger, the image also occupies a greater portion of the field of view of the viewer. Accordingly, the viewer expects to see more details about the object, just as in real world.

[0129] At this point certain problems may occur that are best illustrated with an example. In an illustrative example, the viewer is looking at a static outdoor scene including a mountain about 10 miles away, some trees, and some rocks. Without any image adjustments by IPD, as the viewer moves closer to the screen, the distance of the viewer to an object, for example, a tree, is reduced exactly proportionally to the real distance traversed by the viewer towards the screen. Thus as the viewer approaches a far away object, for example, the mountain 10 mile away in the view, the mountain will appear to come much closer than it should. For example, if the viewer travels three feet, half the distance of six feet from his original position to the screen, he will see the mountain twice as close even though he has not actually traveled five miles (half the perceived distance to the mountain). Even though this change in perceived distance is an expected artifact in a static image, it immediately tells the viewer's brain that the mountain is actually just a number of pixels projected on a flat surface six feet away, and not a real mountain 10 miles away. Thus, as the viewer comes closer to the screen, his natural depth perception is violated by every object in the scene, except possibly those objects that are perceived as close to the screen in the foreground.

[0130] Additionally, without image adjustment, all objects in the projected view may have unaltered geometric positions fixed to the projection surface, which is clearly not what would happen in reality. Furthermore, in the far background, the horizon does not recede, as it does in the real world, but comes 50% closer as the viewer moves three feet. In real world, as the user walks towards a mountain in the distance and approaches closer objects, the angular positions of objects with respect to the viewer's field of view generally increase for all objects in the view, more for closer objects, and less for farther objects.

[0131] Furthermore, without image adjustment, details that were hard to see at some distance, for example a tree that was 15 feet away, are still hard to see, when the viewer gets three feet closer. So, getting closer has less effect than expected. Also, as the viewer gets closer to the screen, serious projection and display limitations become visible due to an excessively coarse image rendering granularity and pixel pitch and other quantization artifacts that destroy the "suspension of disbelief".

[0132] The above visual faults may be more acute in a VAR environment. The visual faults that result from lack of proper adjustment to the projected image when the viewer moves with respect to the screen result in the loss of the carefully constructed illusion, which so critical to a full immersive experience.

[0133] The IPD provides the capability to properly adjust the projected images, static, dynamic, or interactive, like VAR and video game environments, with respect to the viewer's position and field of view, to provide a realistic visual experience. Continuing with the illustrative example above, the viewer standing six feet away from the screen, may see in the center of the field of view a far away object, for example, the mountain. As the viewer moves half the distance to the screen—three feet—the system detects the viewer's motion