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- 1 -

TARGET ILLUMINATION DEVICE

FIELD OF THE INVENTION

The present invention relates to image readers. More particularly, the present invention relates to an target illumination device for use with an image reader.

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BACKGROUND OF THE INVENTION

To identify certain objects, such as electronic components, many industries, such as the automotive and electronics industries, often use indicia, such as bar codes or data matrix codes, etched onto the surface of the object. Typically, these indicia represent data used to identify the objects and, particularly in the case of electronic components, to
10 accurately position the components during assembly. Generally, the indicia, or targets, are read by an image reader, such as a camera, positioned over the object. To provide the camera with a clear image of the indicia to be read, proper illumination of the indicia is essential.

Often, the surfaces onto which the indicia are etched are shiny, or mirror-like, surfaces. Proper illumination of many different shiny and uneven surfaces is critical,
15 especially in an application where robotic assembly is required. However, shiny, uneven surfaces are difficult to illuminate for accurate imaging. The uneven reflections from these surfaces frequently produce erroneous images and signals within the camera, thereby resulting in erroneous identification or positioning of the object.

Identification of objects is rapidly becoming a critical issue in the manufacture
20 and sale of miniature components, particularly in the electronics industry. Identification is used to track faulty components during automated manufacturing processes. For example, it is costly to apply subsequent steps of the manufacturing process on a component that has been identified as faulty at an earlier step. By reading the identity of the component before each step is applied, an automated manufacturing process can determine whether the component
25 is faulty and, consequently, whether to apply the current step. Thus, if a component is

- 2 -

identified as faulty during one step of the manufacturing process, it can be ignored at all subsequent steps.

Similarly, object identification is also desirable in order to trace components once they have been shipped into the field. If a problem develops with a component in the field, the identification on the component provides a key to accessing historical information retained on the component at the factory. This historical information is invaluable in troubleshooting problems in the field.

One object identification technique that has been used with great success is the etching of bar codes onto the objects' surfaces. However, as components become smaller, it is necessary to fit more data into less surface area. In response, the etching of data matrix codes onto the objects' surfaces has begun to emerge as a preferred identification technique. Due to the large amount of data stored in such a small area, it is important that the image provided to the camera be as accurate as possible. Thus, to pick up the subtle contrasts in a data matrix code etched onto a highly reflective, uneven surface, proper target illumination has become even more critical.

Thus, there is a need in the art for a target illumination device that provides the necessary illumination of targets on highly reflective, uneven surfaces of miniature components such that an image reader can accurately process the image of the target.

SUMMARY OF THE INVENTION

The present invention satisfies these needs in the art by providing an imaging apparatus comprising an image reader comprising an image sensor, a radiation source, a radiation directing device, coupled to the image reader, comprising a radiation transmissive body having a lens at one end thereof and a deflector at another end thereof, disposed in spaced apart relationship; wherein said lens is adapted to receive radiation directly from the radiation source and to transmit at least a portion of the radiation through said radiation transmissive body in a first direction toward said deflector; and wherein said deflector is adapted to deflect at least a portion of the transmitted radiation into a viewing area of said image sensor at an angle such that a target in the viewing area is illuminated by the reflected radiation.

- 2a -

The radiation source comprises, for example, a plurality of light emitting diodes. The lens and the deflector are disposed in spaced apart relationship defining a transmission space therebetween and a reflection space proximate the transmission space. In a first embodiment, the reflection space and the transmission space are both symmetric around a central axis. In another embodiment, the reflection space is symmetric about a central plane, to which the transmission space is substantially parallel.

The lens is adapted to receive radiation directly from the radiation source and to transmit at least a portion of the incident radiation in a first direction through the transmission space in a manner such that the transmitted radiation is substantially uniform

- 3 -

through the transmission space and such that the reflection space is substantially devoid of transmitted radiation.

The deflector is adapted to be placed proximate a target and to deflect at least a portion of the transmitted radiation onto the target at an angle such that the target
5 reflects at least a portion of the deflected radiation in a second direction through the reflection space. The deflector may have an inner wall and an outer wall, the outer wall forming an angle with the inner wall. The outer wall is adapted to deflect the transmitted radiation toward the target a predetermined angle.

In a preferred embodiment, the transmission space is contained within the
10 inner and outer walls of a wave guide. The wave guide is adapted to receive the transmitted radiation and to guide the transmitted radiation to the deflector. The deflector has a first end adapted to receive at least a portion of the transmitted radiation and a second end adapted to prevent at least a portion of the transmitted radiation from passing
15 therethrough. The lens and the deflector are integrally formed with the wave guide. Also, a trap may be disposed around a portion of the reflection space, on the inner walls of the wave guide and the deflector. The trap is adapted to prevent at least a portion of the transmitted radiation from entering the reflection space.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be better understood, and its numerous objects
20 and advantages will become apparent by reference to the following detailed description of the invention when taken in conjunction with the following drawings, in which:

FIG. 1 shows an embodiment of a target illumination device according to the present invention;

FIG. 2 shows a target illumination device according to the present invention
25 in use in an image reader;

FIG. 3 shows a target illumination device according to the present invention in use with a hand-held image reader; and

FIG. 4 shows an embodiment of a target illumination device according to the present invention which is particularly suitable for reading linear indicia.

30 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

- 4 -

An apparatus which meets the above-mentioned objects and provides other beneficial features in accordance with the presently preferred exemplary embodiments of the invention will be described below with reference to Figures 1-4. Those skilled in the art will readily appreciate that the description given herein with respect to those figures is for explanatory purposes only and is not intended in any way to limit the scope of the invention. Accordingly, all questions regarding the scope of the invention should be resolved by referring to the appended claims.

FIG. 1 shows a preferred embodiment of a target illumination device according to the present invention. As shown in FIG. 1, a target illumination device 100 comprises a radiation source 20 and a device 101 for directing incident radiation 10 from radiation source 20 to a target 50. Preferably, incident radiation 10 is light. Radiation source 20, comprises a plurality of radiation emitters 224, preferably LEDs. By way of example, target 50 may be any of several indicia, such a bar code or a data matrix code, etched onto the surface of an object, such as an electronic component. Radiation directing device 101 comprises a lens 140 and a deflector 120. Lens 140 and deflector 120 are disposed in spaced apart relationship defining a transmission space 106 therebetween and a reflection space 136 proximate transmission space 106.

Lens 140 is adapted to receive incident radiation 10 and to transmit at least a portion of incident radiation 10 in a first direction through transmission space 106 to deflector 120 in a manner such that transmitted radiation 12 is substantially uniform through transmission space 106 and such that reflection space 136 is substantially devoid of transmitted radiation 12. Deflector 120 is adapted to be placed proximate target 50 and to deflect at least a portion of transmitted radiation 12 onto target 50 at an angle 160 such that target 50 reflects at least a portion of deflected radiation 138 in a second direction through reflection space 136.

In a preferred embodiment, radiation source 20 and lens 140 are constructed such that the irradiance (i.e., power per unit area) striking deflector 120 is nearly constant throughout any differential cross-section of transmission space 106. This is achieved by using a plurality of LEDs spaced as closely together as possible and an anamorphic lens.

The LEDs used have no optical components embodied within the LED structure itself. Thus, they individually serve as near point sources of highly divergent radiation. The divergence angle of the radiation from the LED source differs in the

- 5 -

meridional or tangential plane versus the sagittal plane. This divergence angle plays a role in determining the collection efficiency of the lens as described below.

In a preferred embodiment, lens 140 is a half-toroid. It serves as an anamorphic optical element. An anamorphic optical element is one in which the optical power or "light bending capability" is different in the sagittal plane versus the tangential plane. In the tangential plane, lens 140 collects and nearly collimates incident radiation into transmission space 106. In the sagittal plane, which can be viewed as an infinitesimal arc segment of a circle which bisects the half-toroid, lens 140 has no power and incident radiation 10 continues to diverge in this plane. Some of this radiation remains in the transmission space overlapping radiation from the sagittal planes of contiguous LEDs and contributes to the irradiance uniformity in this direction in transmission space 106. (Note: it is contemplated that lens 140 may be designed such that a radius is constructed along the sagittal direction to control the divergence and overlap along this direction in transmission space 106. This would effectively break-up the half-toroid). The combinatorial effect of the lens is to efficiently collect the radiation and to provide a source of irradiance which is constant throughout any differential cross-section of transmission space 106.

As a second purpose in collecting and redirecting the radiation, lens 140 also prevents radiation from the highly divergent source from entering reflection space 136. This effect is augmented by the addition of trap 142, described more fully below. Interference, or noise, would be defined as radiation reflections from target 50 whose initial source was from a direction other than that coming from deflector 120. In keeping reflection space 136 devoid of any transmitted radiation 12, this interference is minimized, thus increasing the signal-to-noise performance of the device 101.

As shown in FIG. 1, the device of the present invention further comprises a wave guide 110. Wave guide 110 is adapted to receive transmitted radiation 12 and to guide transmitted radiation 12 to deflector 120. Wave guide 110 has an inner wall 116 and an outer wall 119. Transmitted radiation 12 is directed through wave guide 110 between inner wall 116 and outer wall 119. Thus, in the embodiment shown in FIG. 1, transmission space 106 is essentially contained between inner wall 116 and outer wall 119 of wave guide 110 and inner wall 116 of wave guide 110 forms a boundary of reflection space 136. By directing transmitted radiation 12 between inner wall 116 and outer wall

- 6 -

119, lens 140 prevents at least a portion of transmitted radiation 12 from entering reflection space 136.

Similarly, deflector 120 has an inner wall 126 and an outer wall 129. Inner wall 126 of deflector 120 also forms a boundary of reflection space 136. Outer wall 129 of deflector 120 forms an angle 131 with inner wall 126 of deflector 120 and an angle 130 with outer wall of wave guide 110. Deflector 120 may be fixedly connected with wave guide 110, or deflector 120 may be integrally formed with wave guide 110. Outer wall of deflector 120 is adapted to deflect transmitted radiation 12 at an angle 132 toward target 50.

10 In a preferred embodiment shown in FIG. 1, reflection space 136 is symmetric around a central axis 200. Similarly, transmission space 106 is symmetric around central axis 200. The axial symmetry of deflected radiation 138 on target 50 provides several advantages. Because the incidence angle from the target surface normal to the radiation is controlled, the specularly reflected component of the radiation is known and directed away from the imaging device in all directions. Thus, the reflection from specular or highly reflective surfaces on which codes have been marked will not reach the imaging device. If the specular reflection did reach the imaging device, it could produce a signal exceeding the dynamic range of the imaging device. This would prevent the imaging device from producing the desired result of successfully detecting the marked code, whose diffuse component of reflection is usually at a much lower radiant intensity (watts per solid angle).

The axial symmetry of the radiation incident on the target also increases the consistency and uniformity of the diffuse reflected component of radiation from uneven surfaces. Uneven surfaces when illuminated from one particular direction at a predetermined angle will cause shadows and other reflection irregularities. Sometimes this may be desired to enhance the contrast of a surface irregularity as in the case of flaw detection.

In the case of code reading, the marked surface as well as the background surface may be irregular and/or uneven. The reflection irregularities caused by the combination of the surface irregularities and the construction of the target illumination will cause a noise component to be induced on the nominal contrast value of the background

- 7 -

and/or the marked portion of the code. This can reduce the overall performance of the imaging/reading system.

By using directional illumination which is symmetric about the surface normal to the target, the reflection irregularities caused by surface irregularities (unevenness) are minimized. Shadows caused by one direction of illumination are filled in by the other directions uniformly. This serves to reduce the contrast noise described above while at the same time eliminating specular reflection in the image, increasing the overall signal-to-noise performance of the system.

As shown in FIG. 1, wave guide 110 is essentially a hollow cylinder and deflector 120 is essentially a hollow frustum, each of which has an annular cross-section. Preferably, the inner diameter 127 of deflector 120 is equal to the inner diameter 117 of wave guide 110. Inner wall 116 of wave guide 110 and inner wall 126 of deflector 120 are each disposed symmetrically around central axis 200. Thus, inner wall 116 of wave guide 110 and inner wall 126 of deflector 120 form a boundary of reflection space 136.

Deflector 120 has a varying outer diameter 128 and, consequently, a varying thickness, w. Preferably, at end 124 of deflector 120 thickness, w, is nearly zero. Similarly, lens 140 is disposed symmetrically around central axis 200. Preferably, lens 140 is essentially a ring or half-toroid having an annular cross-section and radiation source 20, is a ring of radiation emitters, such as LEDs. It is contemplated that wave guide 110 and deflector 120 may each be hollow frustums symmetric around central axis 200 (i.e., radiation directing device 101 would be essentially conical in shape). In this embodiment, lens 140 may be a ring as described above, as would radiation source 20. Again, wave guide 110, deflector 120, and lens 140 each would have an annular cross-section.

In the embodiment shown in FIG. 1, the directions of travel for transmitted radiation 12 and reflected radiation 150 are substantially opposite one another. Similarly, the directions are substantially parallel. However, this is primarily a result of the cylindrical overall shape of radiation directing device 101. The benefit is to minimize the overall size of device 101 in directions radially perpendicular to central axis 200. In an embodiment wherein radiation directing device 101 is, for example, conical (as described above), the directions of travel for transmitted radiation 12 and reflected radiation 150 would not be parallel.

- 8 -

As shown in FIG. 1, deflector 120 and lens 140 are integrally formed with wave guide 110. Outer diameter 128 of deflector 120 varies such that outer wall 129 of deflector 120 forms angle 130 with outer wall 119 of wave guide 110. Thus, in the embodiment shown in FIG. 1, deflector 120 is essentially a tapered, or beveled, end of radiation directing device 101. Thus, it is an advantage of the present invention that the embodiment shown in FIG. 1 can be formed from a tube having a suitable outer diameter 118, inner diameter 117, and thickness, t . Preferably, the tube is made of clear acrylic and is lathed on one end to form deflector 120, and ground on the other end to form lens 140. The length of inner wall 126 of deflector 120 is optimized for each application (i.e., set to ensure that transmitted radiation 12 is deflected uniformly toward target 50).

The optical characteristics of the transmission medium should be suited to the characteristics of the radiation. In the case of an acrylic tube, the material provides a near lossless transmission medium for the wavelength of the radiation used (for example, 660 nm nominally).

In the embodiment shown in FIG. 1, the radius of the lens is related to the waveguide thickness. The radius of the lens, which determines its focal length and therefore optical power, dictates the placement of the radiation source relative to the device so as to provide the desired collection and redirection of the incident radiation.

The collection efficiency of the lens is related to the divergence angle of the radiation previously mentioned. For maximum efficiency, the F number of the lens, which is related to the ratio of the lens' focal length to its diameter, should be low enough to collect as much of the radiation as possible while providing the desired redirection characteristics. Since the lens radius, which determines focal length, is related to waveguide thickness in this embodiment, the desired waveguide thickness is driven by this relationship.

The length of the waveguide is arbitrary. It may depend, however, on the optical characteristics of the imaging lens. The illumination device should be of suitable length such that it illuminates the target at the proper angle and distance where the target is in focus on the imaging device.

A trap 142 is disposed around at least a portion of reflection space 136. Trap 142 is adapted to prevent at least a portion of transmitted radiation 12 from entering reflection space 136. For example, trap 142 may be opaque or reflective. Preferably, trap

- 9 -

142 is disposed around the entire inner wall 116 of wave guide 110 and extends beyond the top of radiation directing device 101 as shown in FIG. 1.

It has been observed that, especially when a clear, acrylic tube is used to form radiation directing device 101, a portion of incident radiation 10 is not deflected, but passes through outer wall 129 of deflector 120. Thus, to decrease the amount of incident radiation 10 that passes through outer wall 129, and to increase the efficiency of radiation directing device 101, an opaque or reflective surface may be disposed around outer wall 129 of deflector 120. Similarly, in an embodiment in which deflector end 124 has a nonzero width, it has been observed that a portion of transmitted radiation 12 passes through deflector end 124. Deflector end 124 acts as a lens, focusing any transmitted radiation 12 that passes therethrough onto points on target 50, rather than uniformly distributing the radiation. These points are commonly known as "hot-spots" and cause interference with the image of the target as seen by an image reader, for example. Thus, end 124 of deflector 120 is adapted to prevent at least a portion of transmitted radiation 12 from passing therethrough. For example, to decrease the amount of transmitted radiation 12 that passes through deflector end 124, deflector end 124 may be made opaque or reflective.

FIG. 2 shows a target illumination device 100 according to the present invention in use in an image reader, an application for which the invention is particularly suited. In the application shown, a plurality of objects 210, such as electronic components, are located on a moving surface 202, such as a conveyor belt. A target 50, such as a data matrix code, is disposed, such as by etching, on each object 210. An image reader 220, such as a data matrix code reader, is situated over moving surface 202. Image reader 220 comprises a camera lens 226 and an image sensor 228. Image sensor 228 may be, for example, a charge coupled device (CCD). A target illumination device 100 is coupled to image reader 220. Radiation source 20, shown as a ring of LEDs 224, is disposed between image reader 220 and radiation directing device 101. As shown in FIG. 2, radiation directing device 101 is positioned such that central axis 200 is substantially vertical, with deflector end 124 nearest to moving surface 202. In operation, as moving surface 202 moves objects 210 past image reader 220, radiation source 20 emits incident radiation 10. Lens 140 receives incident radiation 10 and transmits at least a portion of incident radiation 10 through wave guide 110. Deflector 120 deflects at least a portion of

- 10 -

transmitted radiation 12 toward target 50. Deflected radiation 138 is reflected off of target 50 through reflection space 136. Reflected radiation 150 is redirected by camera lens 226 to image sensor 228. Image reader 220 interprets information contained in reflected radiation 150 by processes known in the art.

5 FIG. 3 shows a target illumination device according to the present invention in use with a hand-held image reader. In the application shown, a target 50, such as a data matrix code, is disposed, such as by etching, on an object 210. Hand-held image reader 420 comprises a camera lens 226 and an image sensor 228. Hand-held image reader 420 may be, for example, a data matrix code reader. Image sensor 228 may be, for
10 example, a charge coupled device (CCD). As shown, a target illumination device 100 is coupled to image reader 420. Radiation source 20, shown as a ring of LEDs 224, is disposed between image reader 420 and radiation directing device 101. Radiation directing device 101 is positioned such that central axis 200 is substantially perpendicular to image reader 420, with deflector end 124 farthest from image reader 420. In operation,
15 a user places image reader 420 over target 50 in a manner such that target 50 is surrounded, at least in part, by deflector 120. Deflector end 124 is particularly suited to aid the user in positioning the target within the viewing area. The user simply adjusts the attitude of hand-held image reader 420 until deflector end 124 is flush against the surface on which target 50 is located and moves hand-held image reader 420 until target 50 is
20 located beneath reflection space 136. In so doing, radiation directing device is substantially vertical, insuring that deflected radiation 138 will uniformly and symmetrically illuminate target 50.

 To read the information represented by indicia 50, radiation source 20 emits incident radiation 10. Lens 140 receives incident radiation 10 and transmits at least a
25 portion of incident radiation 10 through wave guide 110. Deflector 120 deflects at least a portion of transmitted radiation 12 toward target 50. Deflected radiation 138 is reflected off of target 50 through reflection space 136. Reflected radiation 150 is redirected by camera lens 226 to image sensor 228. Image reader 420 interprets information contained in reflected radiation 150 by processes known in the art.

30 FIG. 4 shows an embodiment of a target illumination device according to the present invention which is particularly suitable for reading linear indicia, such as bar codes. As shown in FIG. 4, target illumination device 102 comprises a radiation source 20

- 11 -

and a pair of plates 300. Radiation source 20, comprises a plurality of radiation emitters 224, preferably LEDs. Plates 300 are substantially parallel to each other and separated by a distance, d . Plates 300 may be coupled to one another and kept parallel to one another by the use of spacers, for example.

5 Each plate 300 comprises a deflector 320, a wave guide 310, and a lens 340. Each deflector 320 has an inner wall 326. Inner walls 326 of deflectors 320 form boundaries of a reflection space 336. Reflection space 336 is symmetric about a central plane 360. Inner walls 326 of deflectors 320 are substantially parallel to central plane 360. Similarly, each wave guide 310 has an inner wall 316. Inner walls 316 of wave guides 310
10 are also substantially parallel to central plane 360. Preferably, inner wall 316 of wave guide 310 is coplanar with inner wall 326 of deflector 320. Lenses 340 are disposed substantially parallel to central plane 360. Each lens 340 is adapted to receive incident radiation 10 from radiation source 20 and to transmit at least a portion of incident radiation 10 to deflector 320 in a manner such that transmitted radiation 12 is substantially uniform
15 and such that reflection space 336 is substantially devoid of transmitted radiation. Wave guide 310 is adapted to receive transmitted radiation 12 and to guide transmitted radiation 12 through wave guide 310 to deflector 320. Each deflector 320 is adapted to be placed proximate target 50 to deflect at least a portion of transmitted radiation 12 toward target 50 in a manner such that at least a portion of deflected radiation 138 is reflected off of target
20 50 into reflection space 336.

 In the embodiment shown in FIG. 4, wave guide 310 has an outer wall 319. Transmitted radiation 12 is directed through wave guide 310 between inner wall 316 and outer wall 319. Thus, a transmission space 306 is contained between outer wall 319 and inner wall 316 of wave guide 310. Similarly, deflector 320 has an outer wall 329. Outer
25 wall 329 of deflector 320 forms an angle 330 with outer wall 319 of wave guide 310. Wave guide 310 has a thickness, t , and deflector 320 has a varying thickness, w . Preferably, end 324 of deflector 320 has a nonzero thickness. Thus, deflector 320 is essentially a tapered, or beveled, end of plate 300. The length of inner wall 326 of deflector 320 is optimized for each application (i.e., set to ensure that transmitted radiation
30 12 is deflected uniformly toward target 50.

 In a preferred embodiment, a trap 342 is disposed on at least a portion of inner wall 316 of wave guide 310. Trap 342 is adapted to prevent at least a portion of

- 12 -

transmitted radiation 12 from entering reflection space 336. Thus, it is preferred that trap 342 be disposed on the entire inner wall 316 of wave guide 310. Trap 342 may be an opaque or reflective surface, for example.

As shown in FIG. 4, deflector 320 and lens 340 are integrally formed with
5 wave guide 310. Thus, it is an advantage of the present invention that plate 300 can be formed from a sheet having a thickness suitable for wave guide 310. The sheet, which, preferably, is made of clear acrylic, is lathed on one end to form deflector 320, and ground on the other end to form lens 340.

It has been observed that, especially when a clear, acrylic sheet is used to
10 form plate 300, a portion of transmitted radiation 12 is not deflected off of deflector 320, but passes through outer wall 329 of deflector 320. Thus, a reflective surface, such as a mirror, may be disposed on outer wall 329 of deflector 320 to prevent at least a portion of transmitted radiation 12 from passing through outer wall 329. Similarly, it has been observed that, if deflector end 324 has a nonzero width, a portion of deflected radiation
15 138 passes through deflector end 324. Thus, deflector end 324 may be made opaque or reflective to decrease the amount of deflected radiation 138 that passes through deflector end 324.

While the invention has been described and illustrated with reference to specific embodiments, those skilled in the art will recognize that modification and
20 variations may be made without departing from the principles of the invention as described hereinabove and set forth in the following claims.

CLAIMS:

1. Image processing apparatus comprising:
an image reader comprising an image sensor;
a radiation source; and
a radiation directing device, coupled to the image reader, comprising a radiation transmissive body having a lens at one end thereof and a deflector at another end thereof, disposed in spaced apart relationship;
wherein said lens is adapted to receive radiation directly from the radiation source and to transmit at least a portion of the radiation through said radiation transmissive body in a first direction toward said deflector; and
wherein said deflector is adapted to deflect at least a portion of the transmitted radiation into a viewing area of said image sensor at an angle such that a target in the viewing area is illuminated by the deflected radiation.
2. The apparatus of claim 1, wherein the radiation source is of a configuration corresponding to the configuration of the radiation directing device and is disposed in proximity the radiation directing device.
3. The apparatus of claim 1 or 2, wherein the deflector is adapted to deflect the portion of the transmitted radiation into the viewing area of said image sensor at an angle such that the target reflects at least a portion of the deflected radiation in a second direction toward the image sensor, thereby providing an image of the target to the image sensor.
4. The apparatus of claim any one of the preceding claims, wherein the image reader operable to process the image of the target by interpreting information contained in the reflected radiation.
5. The apparatus of any one of the preceding claims, wherein the image reader is a bar code reader.
6. The apparatus of any one of claims 1 to 4, wherein the image reader is a data matrix code reader.

7. The apparatus of any one of the preceding claims, wherein the image sensor is a charged coupled device.
8. The apparatus of any one of the preceding claims, wherein the deflector is a tapered end of the radiation directing device.
9. The apparatus of any one of the preceding claims, wherein the radiation directing device further comprises a waveguide disposed between the lens and the deflector.
10. The apparatus of claim 9, wherein the waveguide has a generally annular cross-section.
11. The apparatus of claim 9, wherein the waveguide has a generally rectangular cross-section.
12. Image processing apparatus comprising:
 - a handheld image reader comprising an image sensor;
 - a radiation source; and
 - a radiation directing device, coupled to the image reader, comprising a radiation transmissive body having a lens at one end thereof and a deflector disposed at another end thereof, in spaced apart relationship;
 - wherein said lens is adapted to receive radiation directly from said radiation source and to transmit at least a portion of said radiation in a first direction toward said deflector; and
 - wherein said deflector is adapted to deflect at least a portion of said transmitted radiation into a viewing area of said image sensor at an angle such that a target in the viewing area is illuminated by said deflected radiation.
13. Image processing apparatus comprising:
 - an image reader comprising an image sensor;
 - a radiation source; and
 - a radiation directing device, detachably coupled to the image reader, comprising a radiation transmissive body having a lens at one end thereof and a deflector disposed at another end thereof in spaced apart relationship;

wherein said lens is adapted to receive radiation directly from said radiation source and to transmit at least a portion of said radiation in a first direction toward said deflector; and

wherein said deflector is adapted to deflect at least a portion of said transmitted radiation into a viewing area of said image sensor at an angle such that a target in the viewing area is illuminated by said deflected radiation.

14. The apparatus of claim 12 or 13, wherein the radiation source is of a configuration corresponding to the configuration of the radiation directing device and is disposed in proximity the radiation directing device.

15. The apparatus of any one of claims 12 to 14, wherein the deflector is adapted to deflect the portion of the transmitted radiation into the viewing area of said image sensor at an angle such that the target reflects at least a portion of the deflected radiation in a second direction toward the image sensor, thereby providing an image of the target to the image sensor.

16. The apparatus of any one of claims 12 to 15, wherein the image reader operable to process the image of the target by interpreting information contained in the reflected radiation.

17. The apparatus of any one of claims 12 to 16, wherein the image reader is coupled to the radiation directing device such that a user of the apparatus can adjust an altitude of the hand-held image reader until an end of the deflector is flush against a surface on which the target is disposed, and move the hand-held image reader until the target is located in the viewing area of the image sensor.

18. The apparatus of any one of claims 12 to 17, wherein the image reader is coupled to the radiation directing device such that a user of the apparatus can use the radiation directing device as a guide to position the apparatus such that the target is in the viewing area of the image sensor.

19. The apparatus of any one of claims 12 to 18, wherein the image reader is coupled to the radiation directing device such that a user of the apparatus can use the

deflected radiation as a guide to position the apparatus such that the target is in the viewing area of the image sensor.

20. The apparatus of any one of claims 12 to 18, wherein the radiation directing device further comprises a waveguide disposed between the lens and the deflector.

21. The apparatus of any one of claims 12 to 20, wherein the waveguide has a generally annular cross-section.

22. The apparatus of any one of claims 12 to 20, wherein the waveguide has a generally rectangular cross-section.

23. The apparatus of any one of claims 12 to 22, wherein said lens is integrally formed with said waveguide.

24. The apparatus of any one of claims 12 to 23, wherein said deflector is integrally formed with said wave guide.

25. An apparatus for directing radiation from a radiation source to a target, said apparatus comprising:

at least two deflectors, each said deflector having an inner wall, the inner wall of each deflector forming a boundary of a reflection space, said reflection space having a central plane, the inner wall of each said deflector substantially parallel to said central plane, each said deflector is placed proximate said target, each said deflector adapted to deflect at least a portion of said transmitted radiation toward said target in a manner such that the at least a portion of said deflected radiation is reflected off of said target through said reflection space; and

a lens disposed substantially parallel to said central plane, said lens adapted to receive said radiation and to transmit at least a portion of said radiation to said deflectors in a manner such that said transmitted radiation is substantially uniform.

26. The apparatus of claim 25, wherein said lens is further adapted to transmit at least a portion of said radiation to said deflectors in a manner such that said reflection space is substantially devoid of said transmitted radiation.

27. The apparatus of claim 25 or 26, further comprising:

a wave guide having an inner wall, the inner wall of said wave guide substantially parallel to said central plane, said wave guide adapted to receive said transmitted radiation and to guide said transmitted radiation to at least one said deflector.

28. A method for processing an image of a target disposed on a surface, comprising:

providing an image reader comprising an image sensor, a radiation source and a radiation directing device comprising a radiation transmissive body having a lens at one end thereof and a radiation deflector at another end thereof coupled to the said image reader to receive radiation from said radiation source and deflect at least a portion of said radiation into a viewing area of the image sensor;

using the deflected radiation and/or the radiation directing device as a guide to position said image reader such that the target is in the viewing area of said image sensor; and

processing an image of the target from information contained in reflected radiation reflected off of the target and received by said image sensor.

29. The method of claim 28, wherein the radiation source is configured to correspond to the configuration of the radiation directing device and is disposed in proximity the radiation directing device.

30. The method of claim 28 or 29, further comprising:

adjusting an altitude of the image reader until a distal end of the radiation directing device is flush against the surface on which the target is disposed; and

moving the image reader until the target is located in the viewing area of the image sensor.

31. A target illumination apparatus for use with a symbology imager having an illumination source of predetermined configuration and disposition, comprising:

(a) an illumination transmitting body of predetermined cross section configuration, corresponding to the predetermined configuration of the illumination source, and length having an outer wall, an inner wall, an illumination receiving lens surface and a central axis extending therethrough;

(b) said illumination body further having an illumination deflecting portion wherein said outer wall of said deflecting portion is tapered inwardly towards said central axis for a predetermined extent and terminates at an illuminating end surface;

(c) an open space of predetermined configuration disposed about said central axis and within said illumination body;

(d) said illumination body being disposed with respect to said imager illumination source so that illumination from said illumination source impinges directly upon said illumination receiving lens surface of said illumination body and is transmitted therethrough to said illumination deflecting portion and therefrom upon a target when disposed adjacent said illuminating end surface.

32. The target illumination apparatus of claim 31, wherein the illumination source and said illumination transmitting body are each of annular cross section configuration.

33. The target illumination apparatus of claim 31 or 32, wherein said illumination transmitting body is of a predetermined length so as to position the imager such that a target to be imaged will be in focus to the imager.

34. The target illumination apparatus of any one of claims 31 to 33, further including a trap disposed within said illumination body proximate an inner surface thereof and being non-transmissive to prevent illumination through said illumination body from entering said open space.

35. The target illumination apparatus of any one of claims 31 to 34, wherein said configuration of said illumination body permits coupling thereof with the imager.

36. A symbology imaging apparatus having an illumination source of predetermined configuration and disposition, comprising:

(a) an illumination transmitting body of predetermined cross section configuration, corresponding to the predetermined configuration of the illumination source, and length having an outer wall, an inner wall and an illumination receiving lens surface and wherein respective points on said cross section, outer and inner walls and lens surface are all equidistant from a central axis extending therethrough;

(b) said illumination body further having an illumination deflecting portion wherein said outer wall of said deflecting portion is tapered inwardly towards said

central axis for a predetermined extent and terminates at an illuminating end surface;

(c) an open space of predetermined configuration disposed about said central axis and within said illumination body;

(d) said illumination body being disposed with respect to said imager illumination source so that illumination from said illumination source impinges directly upon said illumination receiving end surface of said illumination body and is transmitted therethrough to said illumination deflecting portion and therefrom upon a target when disposed adjacent said illuminating end surface.

37. The symbology imaging apparatus of claim 36, wherein the illumination source and said illumination transmitting body are each of annular cross section configuration.

38. The symbology imaging apparatus of claim 36 or 37, wherein said illumination transmitting body is of a predetermined length so as to position the imager such that a target to be imaged is in focus to the imager.

39. The symbology imaging apparatus of claims 36, 37 or 38, further including a trap disposed within said illumination body proximate an inner surface thereof and being non-transmissive to prevent illumination through said illumination body from entering said open space.

40. The symbology imaging apparatus of any one of claims 36 to 39, wherein said configuration of said illumination body is such as to facilitate coupling thereof with the imager.

41. The apparatus or method of any one of the preceding claims, wherein said radiation source comprises a plurality of light emitting diodes.