DESCRIPTION

TITLE: Device for acquiring images of an individual aboard a vehicle

TECHNICAL FIELD

The present disclosure relates to a device for acquiring images of an individual aboard a vehicle.

PRIOR ART

A device for acquiring images of the iris of an individual aboard a vehicle is known from the prior art. The device comprises a camera and an illumination source configured to illuminate the iris during acquisition of an image of the iris by the camera. The image of the iris can then be utilized in subsequent processing, for example to authenticate the individual.

However, the iris may not be clearly visible in the acquired image, which prevents subsequent processing from being carried out. For example, when the individual wears spectacles, a reflection from the spectacles can mask the iris.

SUMMARY OF THE INVENTION

An aim of the invention is to more reliably detect the iris of an individual aboard a vehicle.

This aim is achieved by a device for acquiring images of an individual aboard a vehicle, the device comprising: a first camera configured to acquire a first image showing the individual aboard the vehicle; a second camera configured to acquire a second image showing the individual aboard the vehicle; a processing unit for determining data indicative of a position of an iris of the individual from the first image and the second image; an infrared camera configured to be oriented towards the iris of the individual by means of the data, and then to acquire a third image and a fourth image while the infrared camera is oriented towards the iris; a first infrared illumination source configured to illuminate the iris during acquisition of the third image; and a second infrared illumination source configured to illuminate the iris during acquisition of the fourth image, the second infrared illumination source being separate from the first infrared illumination source 12.

The device, which is a first subject of the present disclosure, may also comprise the following optional features, taken alone or in any technically possible combination.

Preferably, the first camera, the second camera and the infrared camera have respective optical inputs, the first infrared illumination source has a first optical output, the second

infrared illumination source has a second optical output, the first optical output and the optical inputs together bound a first working area visible in a front view of the device, the first working area having, in the front view, a first dimension measured in a first direction, and a second dimension measured in a second direction perpendicular to the first direction. In addition, the second optical output and the optical inputs together bound a second working area visible in the front view, the second working area having, in the front view, a first dimension measured in the first direction, and a second dimension measured in the second direction. The first dimension of the second area is greater than the first dimension of the first area and/or the second dimension of the second area is smaller than the second dimension of the first area.

Preferably, the first dimension of the first area is between 200 and 250 millimetres.

Preferably, the second dimension of the first area is between 250 and 260 millimetres.

Preferably, the first dimension of the second area is between 250 and 320 millimetres.

Preferably, the second dimension of the second area is between 120 and 130 millimetres.

Preferably, the optical inputs are included in an acquisition area, the first optical output is included in a first infrared illumination area separated from the acquisition area by a first line parallel to the first direction, the first working area being the union of the acquisition area and the first infrared illumination area, and the second optical output is included in a second infrared illumination area separated from the acquisition area by a second line parallel to the second direction, the second working area being the union of the acquisition area and the second infrared illumination area.

Preferably, the second direction is vertical with respect to the ground.

Preferably, the first infrared illumination source has a first optical output spaced at least 13 centimetres from an optical input of the infrared camera.

Preferably, the second infrared illumination source has a second optical output spaced at least 13 centimetres from the optical input of the infrared camera.

Preferably, the first camera and the second camera have respective optical inputs that are separated by a distance of at least 20 centimetres.

Preferably, the first camera and the second camera have respective optical inputs having optical axes that are secant or that intersect.

Preferably, the device moreover comprises an illumination source in the visible range configured to illuminate the individual during acquisition of the first image or acquisition of the second image, wherein the first camera and the second camera are sensitive to wavelengths emitted by the illumination source in the visible range.

Preferably, the infrared camera is configured to acquire a succession of images comprising at least three images while the infrared camera is oriented towards the iris, and the first illumination source and the second illumination source are configured to alternately illuminate the iris during acquisition of the succession of images.

Preferably, the processing unit is configured to detect whether or not the iris is visible in the third image, and the infrared camera is configured to acquire the fourth image provided that the processing unit has detected that the iris is visible in the third image.

Preferably, the device comprises a frame suited to being fixed to the ground, and a support mounted so that it can move in vertical translation with respect to the frame and/or rotatably about a vertical axis with respect to the frame, the support comprising the first camera, the second camera, the infrared camera, the first infrared illumination source and the second infrared illumination source.

Preferably, the processing unit is moreover configured to: detect the vehicle in an image, determine a position of the support suitable for showing a face of an individual aboard the vehicle, move the support with respect to the frame towards the position.

A second subject of the present disclosure is a system comprising two devices for acquiring images of an individual aboard a vehicle, each of the two devices conforming to the first subject of the disclosure, the two devices being situated on either side of a passage for the vehicle.

A third subject of the present disclosure is a method for acquiring images of an individual aboard a vehicle, the method comprising the following steps: acquiring a first image showing the individual aboard the vehicle, by means of a first camera; acquiring a second image showing the individual aboard the vehicle, by means of a second camera; determining data indicative of a position of an iris of the individual from the first image and the second image; orienting an infrared camera towards the iris of the individual by means of the data, and then acquiring a third image and a fourth image showing the iris, by means of the infrared camera oriented towards the iris; illuminating the iris during acquisition of the third image, by means of a first infrared illumination source; and illuminating the iris

during acquisition of the fourth image, by means of a second infrared illumination source separate from the first infrared illumination source.

DESCRIPTION OF THE FIGURES

Further features, aims and advantages of the invention will become apparent from the following description, which is purely illustrative and non-limiting, and which should be read with reference to the appended drawings, in which:

Figure 1 schematically illustrates a traffic control system according to one embodiment.

Figure 2 is a front view of an image acquisition device according to one embodiment.

Figure 3 is a front view of a support forming part of the image acquisition device of Figure 2.

Figure 4 is a schematic view, in cavalier perspective, of the support of Figure 3, and of a vehicle window.

Figure 5 is a schematic representation of components of an image acquisition device according to one embodiment.

In all of the figures, elements that are similar have been designated by identical references.

DETAILED DESCRIPTION OF THE INVENTION

Referring to **Figure 1**, a traffic control system comprises an image acquisition device 1.

The image acquisition device 1 comprises a frame 2, also called a kiosk, intended to be fixed to the ground, typically at the edge of a passage 3 for a vehicle, and a support 4 that can move in vertical translation with respect to the frame 2. Thus, the support 4 can be positioned at different altitudes with respect to the ground.

The device 1 also comprises a motorization for vertically moving the support 4 with respect to the frame 2.

Hereinafter, three characteristic directions will be referred to, parallel to three axes X, Y and Z together forming an orthonormal reference system (the X axis is visible in Figure 2).

The Z axis is a vertical axis (normal to the ground). It is parallel to the Z axis that the support 4 can move in translation with respect to the frame 2 by means of the motorization.

The support 4 may also be able to move rotatably about an axis parallel to the Z axis. Such a rotation allows the support to be visible from a vehicle that has gone forwards to a greater

or lesser extent in the passage 3. This rotation moreover increases the field of acquisition by the optical device, in particular in such a way as to show a central person in a rear row of the vehicle, who will thus no longer be hidden by the person closest to the kiosk, or in such a way as to allow a rearward-facing person to be shown, for example in the case of a row oriented in the opposite direction to the direction of movement of the vehicle.

The system comprises a second image acquisition device 1′. The second image acquisition device 1′ can have the same features as the image acquisition device 1.

The two devices 1, 1′ are situated on either side of a passage 3 for a vehicle. It will be seen hereinafter that these two devices 1, 1′ are each intended to image individuals aboard the vehicle when the vehicle is in the passage 3.

Referring to Figure 2, the support 4 has a front face. The front face has a height measured parallel to the Z axis and a width measured parallel to the X axis. The Y axis is normal to the front face.

The front face is, for example, rectangular or square.

The front face is oriented so as to be visible from the passage 3. For example, the front face is oriented parallel to an edge of the passage 3. As a variant, the face has a fixed angle (for example 20°) with respect to such an edge so that a user situated in the passage does not have to turn 90° to observe the front face. In this case, the kiosk can be arranged a little further forward, which is more comfortable for the users.

The support 4 comprises a first camera 6 having a field of view oriented towards the road. As will be seen hereinafter, the first camera 6 is intended to acquire an image of an individual aboard a vehicle that is on the passage 3.

The first camera 6 has a first optical input opening into the front face of the support 4. The first optical input has a first optical axis that does or does not extend parallel to the Y axis.

The first optical axis is fixed with respect to the support 4.

The first camera 6 has a viewing angle of at least 40 degrees in the plane (Y, Z) parallel to the ground, for example 53 degrees.

The support 4 also comprises a second camera 8 having a field of view oriented towards the road. As will be seen hereinafter, the second camera 8 is intended to acquire an image of an individual aboard a vehicle that is on the road.

The second camera 8 has a second optical input also opening into the front face of the support 4. The second optical input has a second optical axis that does or does not extend parallel to the Y axis.

The second optical axis is fixed with respect to the support 4.

The second camera 8 has a viewing angle of at least 40 degrees in the plane (Y, Z) parallel to the ground, for example 53 degrees.

In an embodiment of Figure 2, the first optical axis and the second optical axis are parallel (to the Y axis). In another embodiment, the first optical axis and the second optical axis are secant. For example, the first optical axis and the second optical axis intersect at a point that is in the passage 3. In particular, there can be provision for one axis from the first optical axis and the second optical axis to be parallel to the Y axis (which is normal to the direction of the road), and for the other axis from the first optical axis and the second optical axis to be oriented slightly backwards when referring to a direction of traffic on the road.

The two cameras 6, 8 are intended to image the same individual aboard a vehicle, and possibly multiple individuals, in particular their faces.

The second camera 8 can be identical to the first camera 6 (aside from their respective positions).

The first camera 6 and the second camera 8 operate in the visible range in the sense that these cameras are sensitive to wavelengths in the visible range.

The device moreover comprises an infrared camera 10, which is separate from the first camera 6 and the second camera 8.

The infrared camera 10 comprises a third optical input also opening into the front face of the support 4.

The infrared camera has a narrower viewing angle than the cameras 6, 8.

The optical input of the infrared camera has a third optical axis that can move rotatably with respect to the support 4, preferably that can move rotatably about two orthogonal axes (for example parallel to the X and Z axes, respectively). In this way, the infrared camera 10 can perform a horizontal scan, for example over at least 40 degrees, for example 53 degrees, and a vertical scan, for example over at least 40 degrees, for example 53 degrees.

The infrared camera 10 comprises a motorization for changing the orientation of the third optical axis with respect to the support 4.

The infrared camera comprises a focusing system for varying the position of a sharpness plane within a range of positions, for example a range of 100 centimetres in length. For example, the distance between the position of the sharpness plane and the support 4 extends over a range from 50 centimetres to 150 centimetres.

In one embodiment, the infrared camera 10 comprises a reflecting mirror and two lenses. The mirror forms the third optical input of the infrared camera 10 in the sense that a light ray from outside the device is reflected from the mirror before reaching the lenses. The reflecting mirror can move rotatably with respect to the support 4. The two lenses of the infrared camera 10 are oriented so that their optical axes are vertical. This arrangement allows the depth of the support 4 (measured parallel to the Y axis) to be reduced.

The infrared camera 10 is sensitive to wavelengths in the infrared range. It is not sensitive to wavelengths in the visible range.

The device 1 also comprises a first infrared illumination source 12 configured to illuminate the iris during acquisition of an image by the infrared camera 10.

The first infrared illumination source 12 is configured to emit light having infrared wavelengths to which the infrared camera 10 is sensitive.

The first infrared illumination source 12 comprises a first optical output that opens into the front face of the support 4. In this way, the light emitted by the first infrared illumination source 12 illuminates the road, and possibly a vehicle that is in the passage 3.

In one embodiment, the first infrared illumination source 12 comprises a plurality of infrared light-emitting diodes (LEDs). The LEDs are, for example, arranged in horizontal rows and vertical columns so as to form a matrix of LEDs. A matrix of LEDs has the advantage of not generating excessively wide reflections from spectacle lenses.

The device 1 also comprises a second infrared illumination source 14 configured to illuminate the iris during acquisition of an image by the infrared camera 10. The second infrared illumination source 14 is separate from the first infrared illumination source 12.

The second infrared illumination source 14 is configured to emit light having infrared wavelengths to which the infrared camera 10 is sensitive.

The second infrared illumination source 14 comprises a second optical output that opens into the front face of the support 4. In this way, the light emitted by the first infrared illumination source 14 illuminates the road, and possibly a vehicle that is in the passage 3.

In one embodiment, the second infrared illumination source 14 comprises a plurality of infrared light-emitting diodes (LEDs). The LEDs are, for example, arranged in horizontal rows and vertical columns so as to form a matrix of LEDs.

The second infrared illumination source 14 can be identical to the first infrared illumination source 12, aside from their respective positions.

The device 1 also comprises a first illumination source in the visible range 16. The first illumination source in the visible range 16 comprises an optical output opening into the front face of the support 4. The optical output of the first illumination source in the visible range 16 has, for example, the shape of a horizontally elongated strip (parallel to the X axis).

The device also comprises a second illumination source in the visible range 18. The second illumination source in the visible range 18 comprises an optical output opening into the front face of the support 4. The optical output of the second illumination source in the visible range 18 has, for example, the shape of a horizontally elongated strip (parallel to the X axis).

The device 1 also comprises a display screen 20. This display screen 20 opens into the front face of the support 4 so as to be able to be seen from the passage 3, in particular by an individual aboard a vehicle that is in the passage 3. The display screen is, for example, touch-sensitive.

The support 4 can also have a front window to camouflage all or some of the optical components listed above.

In one embodiment, the window is transparent to the infrared wavelengths discussed above and opaque to wavelengths in the visible range. The infrared optical components are masked by the window. Thus, the following are arranged behind the window: the optical outputs of the illumination sources 12 and 14, and the optical input of the infrared camera 10. On the other hand, the window has openings for the optical components operating in the visible range: the respective optical inputs of the first camera 6 and of the second camera 8, and also the display screen 20.

Relative positioning of the sources and cameras in a front view of the device

There now follows a discussion of the relative positioning of the optical inputs of the various cameras 6, 8, 10 and the optical outputs of the various illumination sources 12, 14, 16, 18 in a front view of the support 4, this front view being illustrated in Figure 2 and in Figure 3. The front view is perpendicular to the Y axis and parallel to the plane (X, Z).

The first optical input (of the first camera 6), the second optical input (of the second camera 8) and the third optical input (of the infrared camera 10) are located between the optical outputs of the illumination sources in the visible range 14, 16.

The first optical input (of the first camera 8), the second optical input (of the second camera 10), the third optical input (of the infrared camera 10) and the optical output of the first infrared illumination source 12 together bound a first working area.

The first working area is rectangular.

The first working area is divided into two areas A and B by a first line X1 parallel to a first direction. In the embodiment illustrated in Figure 3, the first direction is parallel to the X axis, and therefore perpendicular to the direction of translation of the support 4 with respect to the frame 2.

Area A includes the first optical input (of the first camera 8), the second optical input (of the second camera 10) and the third optical input (of the infrared camera 10). By convention, area A can be called the "acquisition area", since rays must pass through this area in order to reach one or other of the cameras 6, 8, 10. Area A is rectangular.

Area B includes the optical output of the first infrared illumination source 12. The rectangular area B can therefore be called the "first infrared illumination area", since infrared rays emanating from the first illumination source 12 pass into this area. Area B is rectangular.

In addition, the first optical input (of the first camera 8), the second optical input (of the second camera 10), the third optical input (of the infrared camera 10) and the optical output of the second infrared illumination source 14 together bound a second working area different from the first working area.

The second working area is divided into two areas A and C by a first line Z1 parallel to a second direction perpendicular to the first direction. In the embodiment illustrated in Figure 3, the second direction is parallel to the Z axis, and therefore corresponds to the direction of translation of the support 4 with respect to the frame 2.

Area C includes the optical output of the second infrared illumination source 14. Area C can therefore be called the "second infrared illumination area", since infrared rays emanating from the first illumination source 12 pass into this area C. Area C is rectangular.

With the above arrangement, the three areas A, B, C together form an L (area A forming the "corner" of the L). Such an arrangement offers an advantageous compromise between reducing the bulk of the support 4 in the plane (X, Z) and the performance of the device 1. Indeed, this arrangement satisfies multiple constraints at the same time:

- It allows the support 4 to have a relatively small height and width.
- The second infrared illumination source 14 remains relatively distant from the first illumination source 12 in order to reduce the risks of non-detection of irises (for example owing to a reflection from a pair of spectacles).
- Each of the illumination sources 12 and 14 remains relatively distant from the infrared camera 10.

The first working area, which by convention is denoted "A+B" to signify that it constitutes the union of areas A and B, is bounded by two other lines parallel to the first direction, denoted X2 and X3.

Area A is bounded along the Z axis by the line X1 and by the line X2. In other words, the first optical input (of the first camera 8), the second optical input (of the second camera 10) and the third optical input (of the infrared camera 10) are between the lines X1, X2.

Area B is bounded along the Z axis by the line X1 and by the line X3. In other words, the optical output of the first infrared illumination source 12 is between the lines X1, X3.

The second working area, which by convention is denoted "A+C" to signify that it constitutes the union of areas A and C, is bounded by two other lines parallel to the first direction, denoted Z2 and Z3.

Subarea A is bounded along the X axis by the line Z1 and by the line Z2. In other words, the first optical input (of the first camera 8), the second optical input (of the second camera 10) and the third optical input (of the infrared camera 10) are between the lines Z1, Z2.

Area B is bounded along the X axis by the line Z1 and by the line Z3. In other words, the optical output of the second infrared illumination source 14 is between the lines Z1, Z3.

The first area A+B has a first dimension DX1, measured in the first direction, constituting a distance between the lines Z1 and Z2.

The first area A+B has a second dimension DZ1, measured in the second direction, constituting a distance between the lines X2 and X3.

The second area A+C has a first dimension DX2, measured in the first direction, constituting a distance between the lines Z2 and Z3.

The second area A+C has a second dimension DZ2, measured in the second direction, constituting a distance between the lines X1 and X2.

It holds that DX2 > DX1. When the first direction is horizontal, as is the case with the embodiment shown in Figure 3, this implies that the second area A+C is wider than the first area A+B.

It also holds that DZ2 < DZ1. When the second direction is vertical, as is the case with the embodiment shown in Figure 3, this implies that the second area A+C is not as high (narrower in height) as the first area A+B.

Preferably, DX1 is between 200 and 250 millimetres, for example equal to 245 millimetres.

Preferably, DZ1 is between 250 and 260 millimetres, for example equal to 255 millimetres.

Preferably, DX2 is between 250 and 320 millimetres, for example equal to 317 millimetres.

Preferably, DZ2 is between 120 and 130 millimetres, for example equal to 121 millimetres.

Each of the above features contributes in its own way to being able to image an individual who is behind a window of a vehicle that is in passage 3. Figure 4 schematically shows that the second area A+C projects into a vehicle window of medium dimensions (the contour of which is represented by a dotted line closed on itself).

In particular, the fact that the first area and the second area have different dimensions allows the device to adjust to windows of different vehicles, thus allowing the device 1 to be used for vehicles of different dimensions.

In addition, the first infrared illumination source 12 has an optical output spaced at least 13 centimetres from an optical input of the infrared camera 10, and/or the second infrared illumination source 14 has an optical output spaced at least 13 centimetres, or even 20 centimetres, from the optical input of the infrared camera 10. The inventors have been able to find that this minimum distance of 13 centimetres makes it possible to avoid a "red eye" effect in an image acquired by the infrared camera 10. Indeed, with such a distance, the angle between a line from the illumination source 12 or 14 to an iris of an individual aboard a vehicle in the passage 3 and a line from the iris to the optical input of the infrared camera

is greater than 5 degrees when the iris is within 1.5 metres. Now, the inventors have been able to find that, in practice, a vehicle driver will tend to position their vehicle at a distance such that the irises of any individual inside the vehicle are at a distance less than or equal to 1.5 metres from a piece of equipment at the side.

Moreover, the first camera 6 and the second camera 8 are preferably at least 20 centimetres apart. This improves the ability of the device 1 to detect fraud by means of images acquired by the two cameras 6, 8.

Referring to Figure 5, the device 1 also comprises a processing unit 22 capable of interacting with the components 6, 8, 10, 12, 14, 16, 18, 20 described above.

The processing unit 22 is in particular capable of requesting the acquisition of images by the cameras 6, 8, 10, and of obtaining these images.

The processing unit 22 is also capable of controlling the illumination sources 14, 16, 18 so that these illumination sources do or do not emit light, specifically independently.

The processing unit 22 is moreover capable of requesting the display, by the display screen 20, of information intended for an individual aboard a vehicle in the passage 3.

The processing unit comprises a localization module having the function of applying localization processing taking images supplied by the first camera 6 and the second camera 8, respectively, as input. The operation of this module will be described later.

The processing unit 22 can have any structure. The processing unit can in particular comprise a memory storing a processing program comprising code instructions, and at least one processor for executing these code instructions, in order to cause one or other of the aforementioned processing operations, and which will be described in greater detail below.

The device 1′ can comprise all the features of the device 1 as described above.

There now follows a description of a method carried out by the system, in particular by the device 1.

In a detection step, the processing unit 22 detects entry of a vehicle into the passage 3. This detection can be performed, for example, by means of a vehicle detection camera, which can be either of the cameras 6 or 8, or another camera with a wider field than the cameras 6, 8.

Detection can be carried out when the vehicle is stationary, or when the vehicle is approaching.

The processing unit 22 determines a position for the support 4 that is suitable for showing a face of an individual aboard the vehicle.

In one embodiment, the processing unit 22 analyses the image produced by the vehicle detection camera to detect therein a class of vehicles to which the vehicle belongs (motorcycle, car, truck or bicycle). Class detection may call for artificial intelligence trained for this purpose. When the class relates to windowed vehicles (truck, car), the processing unit detects in the image a contour of a window of the vehicle. On the basis of this contour, the processing unit determines the altitude of a centre of the window. The position that the support 4 needs to reach is deduced from the position of the centre of the window.

In a vertical adjustment step, the processing unit 22 requests a translational movement parallel to the Z axis of the support towards the determined position. When such mobility is possible, the processing unit 22 can also request a rotation of the support 4 with respect to the frame 2 about an axis of rotation that is also parallel to the X axis.

The processing unit 22 then activates the illumination sources in the visible range 16, 18 (or only one of the two). The vehicle and its occupants are then illuminated by light in the visible range.

During this illumination, the first camera 6 acquires a first image showing an individual aboard the vehicle, and the second camera 8 acquires a second image showing the individual aboard the vehicle.

The processing unit 22 takes the first image and the second image as a basis for using stereoscopy to determine data indicative of the position of an iris of the individual, by means of a known method. During this step, the processing unit 22 can begin by detecting faces in the images and matching them. The data indicative of positions are, for example, Cartesian coordinates, or comprise angles.

The processing unit 22 then requests an orientation of the optical input of the infrared camera 10 towards the determined iris position so that this infrared camera points at the iris of the individual.

The processing unit can also tell the infrared camera 10 to use its focusing system to focus on the position in question in order to sharply image this iris (i.e. adjust the focal length of the infrared camera 10 to a distance between the camera 10 and the position of the iris).

The processing unit 22 activates the first infrared illumination source 12. Infrared radiation is thus emitted towards the vehicle, and in particular towards the determined iris position. During this illumination, the infrared camera acquires a third image. The processing unit 22 then deactivates the first infrared illumination source 12.

The processing unit 22 then activates the second infrared illumination source 14. Infrared radiation is thus emitted towards the vehicle, and in particular towards the determined iris position, but at a different angle from before. During this illumination, the infrared camera acquires a fourth image. The processing unit 22 then deactivates the second illumination source 14.

Thus, the processing unit 22 obtains two different images, which in a normal situation show the iris, since the infrared camera was pointed at the position of the iris when they were acquired. However, the iris can be masked by an obstacle in the third image or in the fourth image, for example by a reflection from a spectacle lens.

Indeed, when spectacles are worn, there may be a direct reflection of our own illumination from the spectacles (from one or 2 dioptres) that, seen from the camera, is superimposed on the iris. About 15% of acquisitions suffer from this problem. The position of the second illumination makes it possible to obtain a significantly different geometry and to ensure that, for the same position of spectacles, the reflection is "moved" with respect to the reflection obtained with the first illumination.

Thus, the presence in the device 1 of the two infrared illumination sources 12 and 14 increases the chances of correctly imaging the iris of a passenger with spectacles. The probability of a reflection hitting the iris with the two available illuminations is much lower than the probability of having a reflection from the iris with only one illumination.

In one embodiment, the two images are acquired successively in an unconditional manner, and their content is checked by the processing unit 22 in a second step.

In another embodiment, the processing unit acquires the third image (under the illumination of the first infrared illumination source 12), and checks the content of the third image. If the processing unit 22 finds that the iris is not visible in the third image, the processing unit 22 requests acquisition of the fourth image (under the illumination of the second infrared illumination source 14). If the iris is visible in the third image, the second infrared illumination source 14 is not called for.

Of course, the infrared camera may not be limited to acquiring only two images of the iris, but more generally a succession of images whose number of images is greater than or equal to three. The processing unit 22 uses the sources 12 and 14 alternately so that every other image is acquired under the illumination of the first infrared illumination source 12, and every other image is acquired under the illumination of the second illumination source 14.

Moreover, the processing unit 22 can select only one of the two sources 12 and 14, for example the source 14, when it has been determined that the height of a window of the vehicle is below a certain threshold H2 (for example 255 millimetres).

All the above steps have been described for an individual aboard the vehicle.

During the method, the processing unit 22 can request the display of messages intended for an individual aboard the vehicle, for example the driver, on the display screen 20. These messages can, for example, prompt the driver to lower the window of their vehicle or give them other instructions for positioning their face in view of the device 1.

These steps can be performed for multiple individuals aboard the same vehicle. Indeed, multiple faces of people can be detected by the processing unit 22 in images acquired by the cameras 6, 8.

In addition, the above steps can be carried out not only by the device 1 but also by the device 1′ situated on the other side of the passage 3 that the vehicle is in. The device 1′ can thus make it possible to image the iris of an individual that the device 1 cannot see, for example because the individual has their face turned to the side, towards the device 1′, or because there is an obstacle between the individual and the device 1 (such as another individual positioned alongside).

In a particular application, the device 1 (or more generally the system comprising the devices 1 and 1′) checks that the number of individuals aboard the vehicle in the passage 3 conforms to a predefined number. The processing unit 22 can count the individuals whose faces are visible in the images acquired by the cameras 6, 8 and produce a list of detected individuals.

Acquisition of iris images can then be carried out individual by individual, according to an order predefined by the processing unit 22. In particular, the processing unit 22 can use the following as a criterion for organizing the detected individuals:

- an estimated distance between the individual and the device 1,

- a pixel difference, in one of the acquired images, between the face of the individual and a centre of the image.

The above device can be applied to any vehicle, not only those equipped with windows.

A system having two acquisition devices 1 and 1′ has been presented above. However, the number of acquisition devices is different in other embodiments. In one embodiment, the system comprises only the acquisition device 1. In another embodiment having four acquisition devices, the devices 1 and 1′ are arranged opposite one another so as to be able to simultaneously image passages of a front row of the vehicle (thus including the driver of the vehicle), and the system also comprises two additional oppositely arranged acquisition devices so as to be able to simultaneously image a rear row of the vehicle.

It has been assumed above that the first camera 6 and the second camera 8 operate in the visible range. However, this is not mandatory: one or the other of the cameras 6, 8 could alternatively be an infrared camera (or both of them), in which case one and/or the other of the illumination sources 14, 16 is also infrared.

It has also been assumed that the infrared camera 10 acquires two images sequentially using the infrared illumination sources 12 and 14 one after the other. This is simple to achieve. However, in another embodiment, the camera 10 can acquire these two images with the illumination sources 12 and 14 active simultaneously. For this purpose, there can be provision for the wavelengths emitted by the sources 12 and 14 to be different, and for the device 1 to comprise filters at corresponding wavelengths. Alternatively or in a complementary manner, the camera 10 may be capable of distinguishing between different polarizations of light, for example by means of a monochrome camera or by means of one or more appropriate polarizers.

CLAIMS

1. Device (1) for acquiring images of an individual aboard a vehicle, the device (1) comprising:

- a first camera (6) configured to acquire a first image showing the individual aboard the vehicle,
- a second camera (8) configured to acquire a second image showing the individual aboard the vehicle,
- a processing unit (22) configured to determine data indicative of a position of an iris of the individual from the first image and the second image,
- an infrared camera (10) configured to be oriented towards the iris of the individual by means of the data, and then to acquire a third image and a fourth image while the infrared camera (10) is oriented towards the iris,
- a first infrared illumination source (12) configured to illuminate the iris during acquisition of the third image,
- a second infrared illumination source (14) configured to illuminate the iris during acquisition of the fourth image, the second infrared illumination source (14) being separate from the first infrared illumination source (12).

2. Device (1) according to the preceding claim, wherein:

- the first camera (6), the second camera (8) and the infrared camera (10) have respective optical inputs,
- the first infrared illumination source (12) has a first optical output,
- the second infrared illumination source (14) has a second optical output,
- the first optical output and the optical inputs together bound a first working area (A+B) visible in a front view of the device (1), the first working area (A+B) having, in the front view:
  - a first dimension (DX1) measured in a first direction (X), and
  - a second dimension (DZ1) measured in a second direction (Z) perpendicular to the first direction (X),
- the second optical output and the optical inputs together bound a second working area (A+C) visible in the front view, the second working area (A+C) having, in the front view:
  - a first dimension (DX2) measured in the first direction (X), and
  - a second dimension (DZ2) measured in the second direction (Z),

- wherein the first dimension (DX2) of the second area (A+C) is greater than the first dimension (DX1) of the first area (A+B) and/or the second dimension (DZ2) of the second area (A+C) is smaller than the second dimension (DZ1) of the first area (A+B).

3. Device (1) according to the preceding claim, wherein:

- the first dimension (DX1) of the first area (A+B) is between 200 and 250 millimetres, and/or
- the second dimension (DZ1) of the first area (A+B) is between 250 and 260 millimetres, and/or
- the first dimension (DX2) of the second area (A+C) is between 250 and 320 millimetres, and/or
- the second dimension (DZ2) of the second area (A+C) is between 120 and 130 millimetres.

4. Device (1) according to either one of Claims 2 and 3, wherein:

- the optical inputs are included in an acquisition area (A),
- the first optical output is included in a first infrared illumination area (B) separated from the acquisition area (A) by a first line (X1) parallel to the first direction (X), the first working area (A+B) being the union of the acquisition area (A) and the first infrared illumination area (B),
- the second optical output is included in a second infrared illumination area (C) separated from the acquisition area (A) by a second line (Z1) parallel to the second direction (Z), the second working area (A+C) being the union of the acquisition area (A) and the second infrared illumination area (C).

5. Device (1) according to any one of Claims 2 to 4, wherein the second direction is vertical with respect to the ground.

6. Device (1) according to any one of the preceding claims, wherein:

- the first infrared illumination source (12) has a first optical output spaced at least 13 centimetres from an optical input of the infrared camera (10), and/or
- the second infrared illumination source (14) has a second optical output spaced at least 13 centimetres from the optical input of the infrared camera (10).

7. Device (1) according to any one of the preceding claims, wherein the first camera (6) and the second camera (8) have respective optical inputs that are separated by a distance of at least 20 centimetres.

8. Device (1) according to any one of the preceding claims, wherein the first camera (6) and the second camera (8) have respective optical inputs having optical axes that are secant or that intersect.

9. Device (1) according to any one of the preceding claims, further comprising:

- an illumination source in the visible range (14, 16) configured to illuminate the individual during acquisition of the first image or acquisition of the second image,
- wherein the first camera (6) and the second camera (8) are sensitive to wavelengths emitted by the illumination source in the visible range (14, 16).

10. Device (1) according to any one of the preceding claims, wherein the infrared camera (10) is configured to acquire a succession of images comprising at least three images while the infrared camera (10) is oriented towards the iris, and the first illumination source (12) and the second illumination source (14) are configured to alternately illuminate the iris during acquisition of the succession of images.

11. Device (1) according to any one of Claims 1 to 9, wherein:

- the processing unit (22) is configured to detect whether or not the iris is visible in the third image,
- the infrared camera (8) is configured to acquire the fourth image provided that the processing unit (22) has detected that the iris is visible in the third image.

12. Device (1) according to any one of the preceding claims, comprising:

- a frame (2) suited to being fixed to the ground,
- a support (4) mounted so that it can move in vertical translation with respect to the frame (2) and/or rotatably about a vertical axis with respect to the frame (2), the support (4) comprising the first camera (6), the second camera (8), the infrared camera (10), the first infrared illumination source (12) and the second infrared illumination source (14).

13. Device (1) according to the preceding claim, wherein the processing unit (22) is moreover configured to:

- detect the vehicle in an image,
- determine a position of the support (4) suitable for showing a face of an individual aboard the vehicle,
- move the support (4) with respect to the frame (2) towards the position.

14. System comprising two devices (1, 1′) for acquiring images of an individual aboard a vehicle, each of the two devices (1, 1′) being according to any one of the preceding claims, the two devices (1, 1′) being situated on either side of a passage (3) for the vehicle.

15. Method for acquiring images of an individual aboard a vehicle, the method comprising the following steps:

- acquiring a first image showing the individual aboard the vehicle, by means of a first camera (6),
- acquiring a second image showing the individual aboard the vehicle, by means of a second camera (8),
- determining data indicative of a position of an iris of the individual from the first image and the second image,
- orienting an infrared camera (10) towards the iris of the individual by means of the data, and then acquiring a third image and a fourth image showing the iris, by means of the infrared camera (10) oriented towards the iris,
- illuminating the iris during acquisition of the third image, by means of a first infrared illumination source (12),
- illuminating the iris during acquisition of the fourth image, by means of a second infrared illumination source (14) separate from the first infrared illumination source (12).