US 20070058037A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2007/0058037 A1

Bergeron et al. (43) Pub. Date: Mar. 15, 2007

(54) USER INTERFACE FOR USE IN SCREENING LUGGAGE, CONTAINERS, PARCELS OR PEOPLE AND APPARATUS FOR IMPLEMENTING SAME

(75) Inventors: **Eric Bergeron**, Quebec (CA); **Jean Lachapelle**, Quebec (CA); **Marc Gendron**, St-Jean-Chrysostome (CA); **Bertrand Couture**, St-Nicolas (CA); **Michel R. Bouchard**, Sainte-Foy (CA); **Luc Perron**, Charlesbourg (CA); **Martin Lacasse**, Levis (CA)

Correspondence Address:
FETHERSTONHAUGH - SMART & BIGGAR
1000 DE LA GAUCHETIERE WEST
SUITE 3300
MONTREAL, QC H3B 4W5 (CA)

(73) Assignee: **OPTOSECURITY INC.**

(21) Appl. No.: **11/407,217**

(22) Filed: **Apr. 20, 2006**

Related U.S. Application Data

(63) Continuation-in-part of application No. PCT/CA05/00716, filed on May 11, 2005.

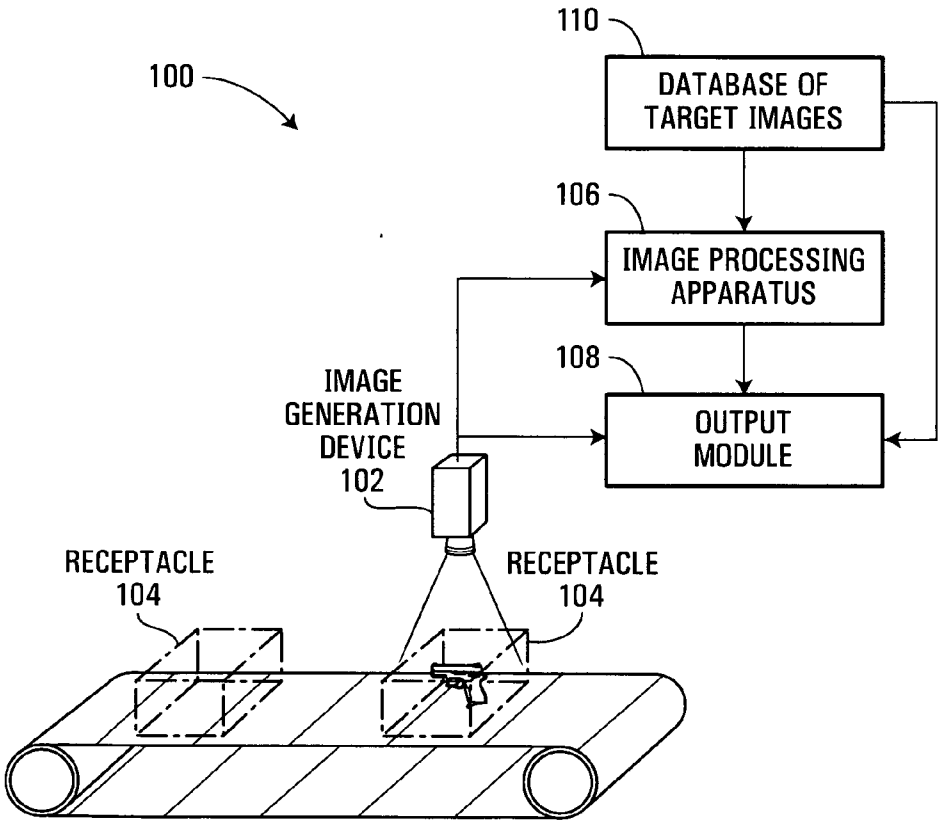
Publication Classification

(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.** **348/82**

(57) **ABSTRACT**

An apparatus and method for implementing a user interface module for use in screening a receptacle to detect therein the presence of one or more prohibited objects is provided. An image signal associated with the receptacle conveying information related to the receptacle's contents and a detection signal conveying a presence of at least one prohibited object in the receptacle are received. A user interface module is adapted for displaying first information conveying an image associated with the receptacle on the basis of the image signal. The user interface module is also adapted for displaying, simultaneously with the first information, second information conveying the presence of the prohibited object in the receptacle. The second information is derived at least in part on the basis of the detection signal. As a variant, the user interface module is adapted for providing a control allowing a user to cause third information to be displayed. The third information conveys at least one characteristic associated to the prohibited object. Alternative implementations of the user interface module may be made for use in screening a person to detect thereon the presence of one or more prohibited objects.



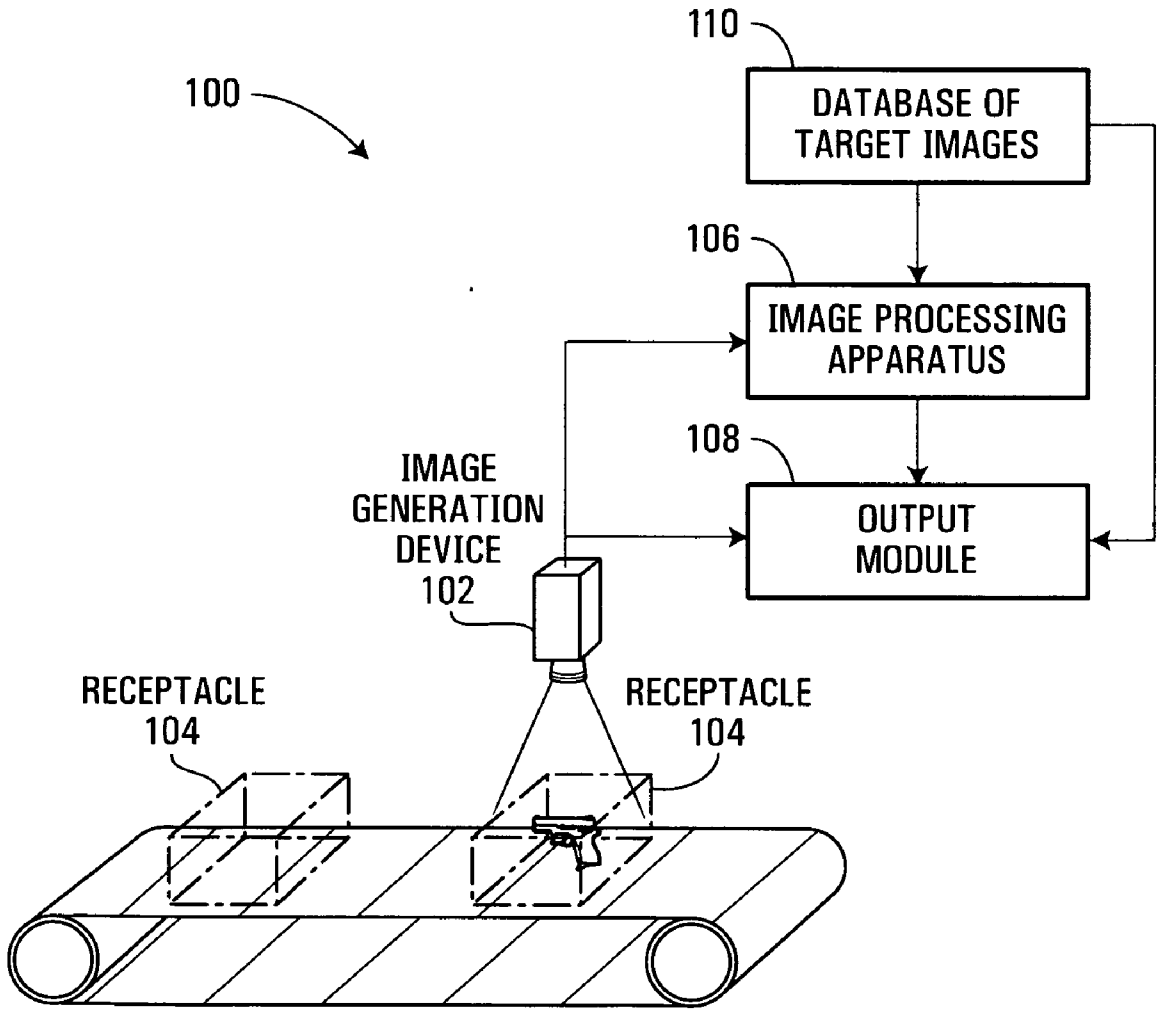

110
100
DATABASE OF TARGET IMAGES
106
IMAGE PROCESSING APPARATUS
108
IMAGE GENERATION DEVICE 102
OUTPUT MODULE
RECEPTACLE 104
RECEPTACLE 104

FIG. 1

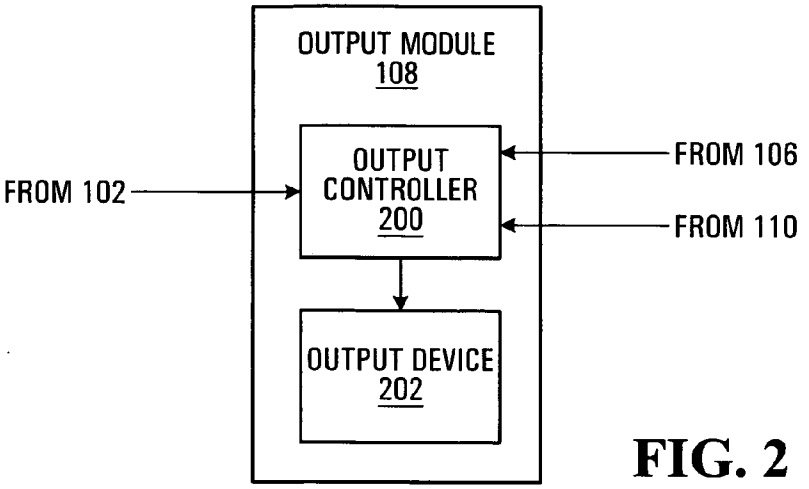

OUTPUT MODULE
108
OUTPUT
CONTROLLER
200
OUTPUT DEVICE
202
FROM 102
FROM 106
FROM 110

FIG. 2

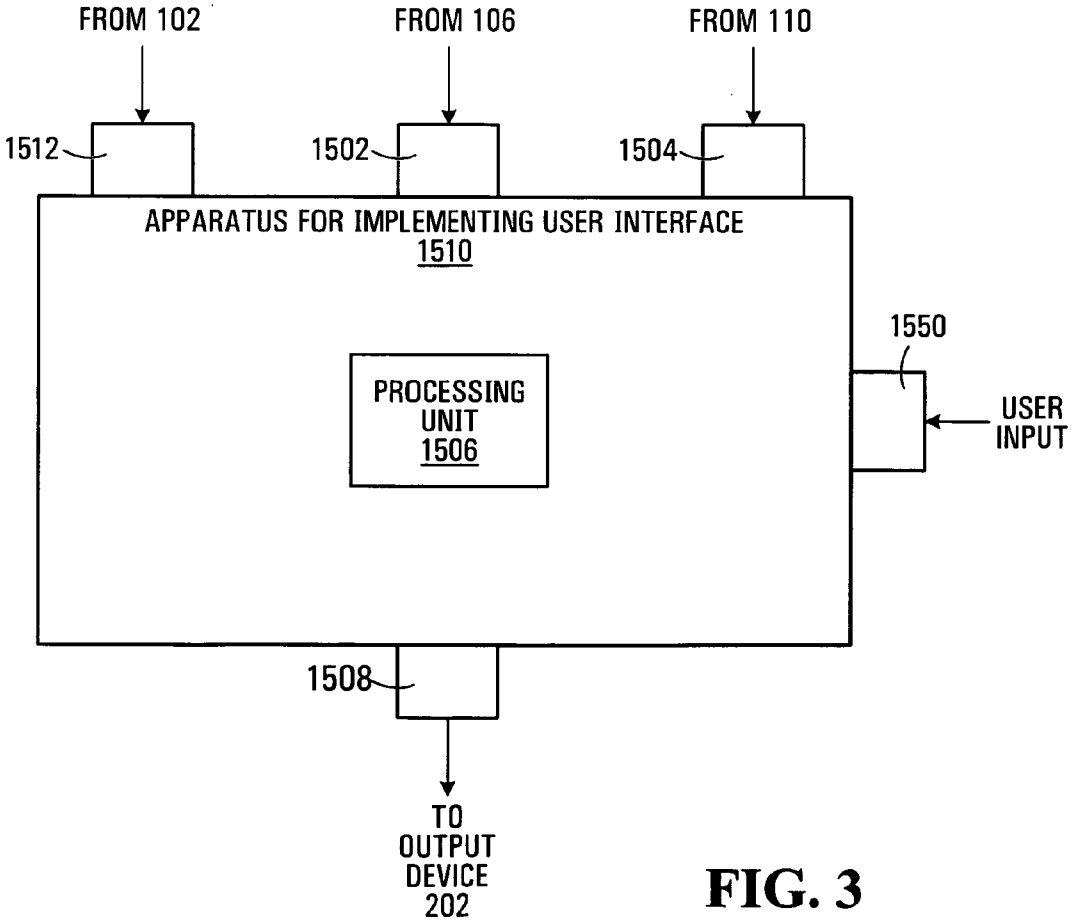

FROM 102
FROM 106
FROM 110
1512
1502
1504
APPARATUS FOR IMPLEMENTING USER INTERFACE
1510
1550
PROCESSING
UNIT
1506
USER
INPUT
1508
TO
OUTPUT
DEVICE
202

FIG. 3

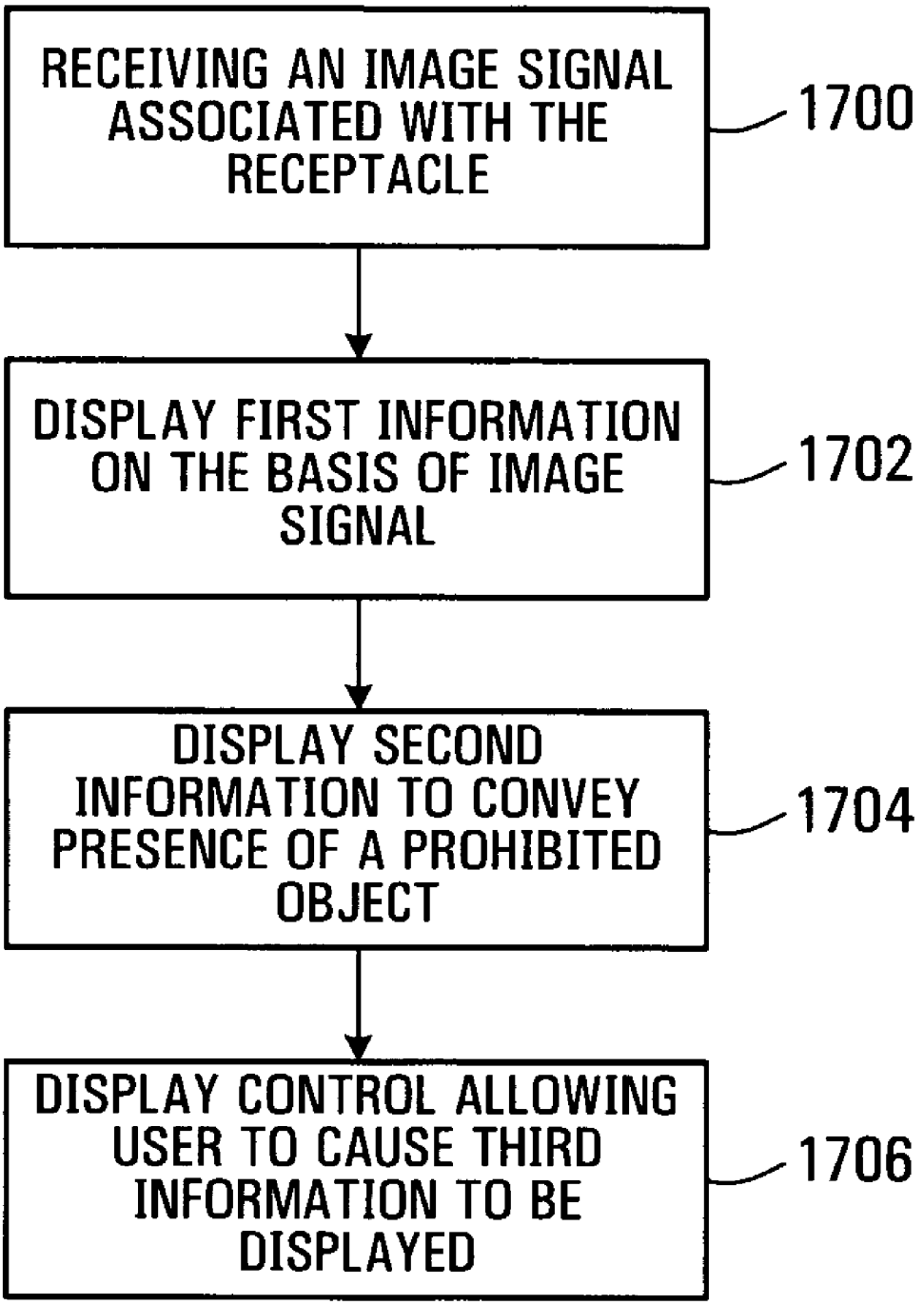

RECEIVING AN IMAGE SIGNAL ASSOCIATED WITH THE RECEPTACLE
1700
DISPLAY FIRST INFORMATION ON THE BASIS OF IMAGE SIGNAL
1702
DISPLAY SECOND INFORMATION TO CONVEY PRESENCE OF A PROHIBITED OBJECT
1704
DISPLAY CONTROL ALLOWING USER TO CAUSE THIRD INFORMATION TO BE DISPLAYED
1706

FIG. 4

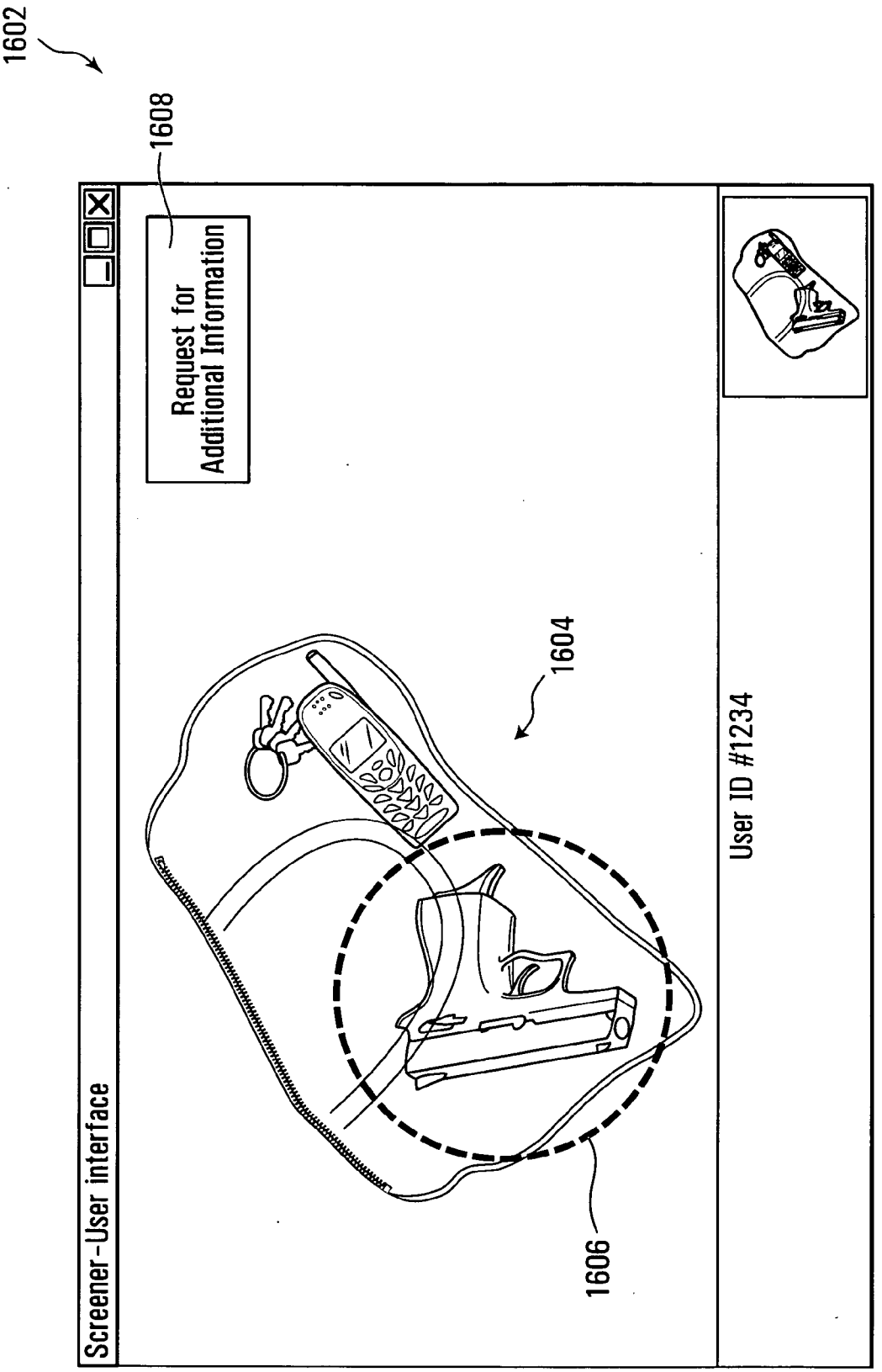

1602
1608
Request for Additional Information
Screener-User interface
1604
1606
User ID #1234

FIG. 5A

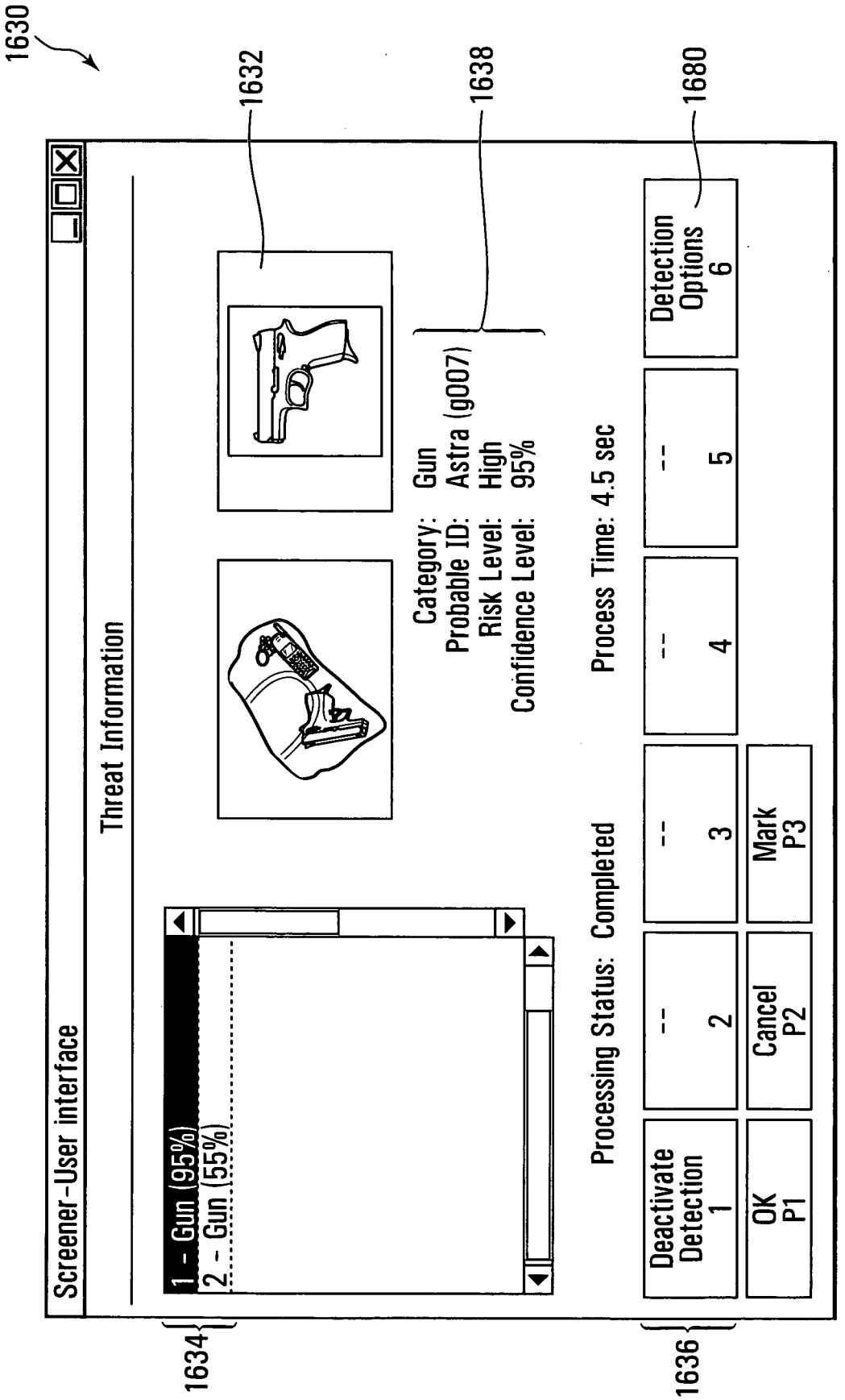

1630
1632
1638
1680
Screener-User interface
Threat Information
1 - Gun (95%)
2 - Gun (55%)
Category: Gun
Probable ID: Astra (g007)
Risk Level: High
Confidence Level: 95%
Process Time: 4.5 sec
Processing Status: Completed
Deactivate Detection 1
--
2
--
3
--
4
--
5
Detection Options 6
OK P1
Cancel P2
Mark P3
1634
1636

FIG. 5B

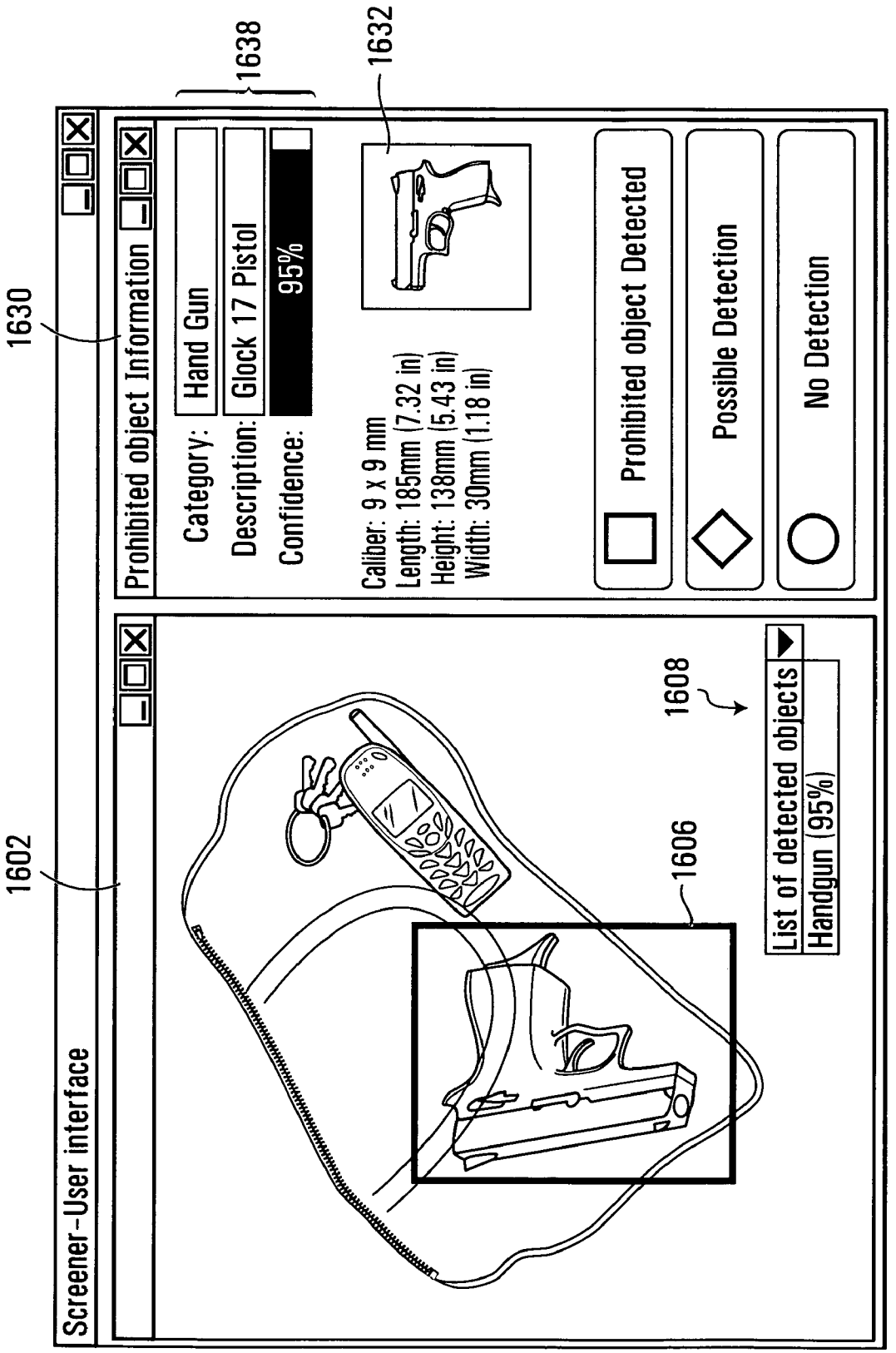

1602
1630
1638
1632
1608
1606
Screener-User interface
Prohibited object Information
Category: Hand Gun
Description: Glock 17 Pistol
Confidence: 95%
Caliber: 9 x 9 mm
Length: 185mm (7.32 in)
Height: 138mm (5.43 in)
Width: 30mm (1.18 in)
Prohibited object Detected
Possible Detection
No Detection
List of detected objects
Handgun (95%)

FIG. 5C

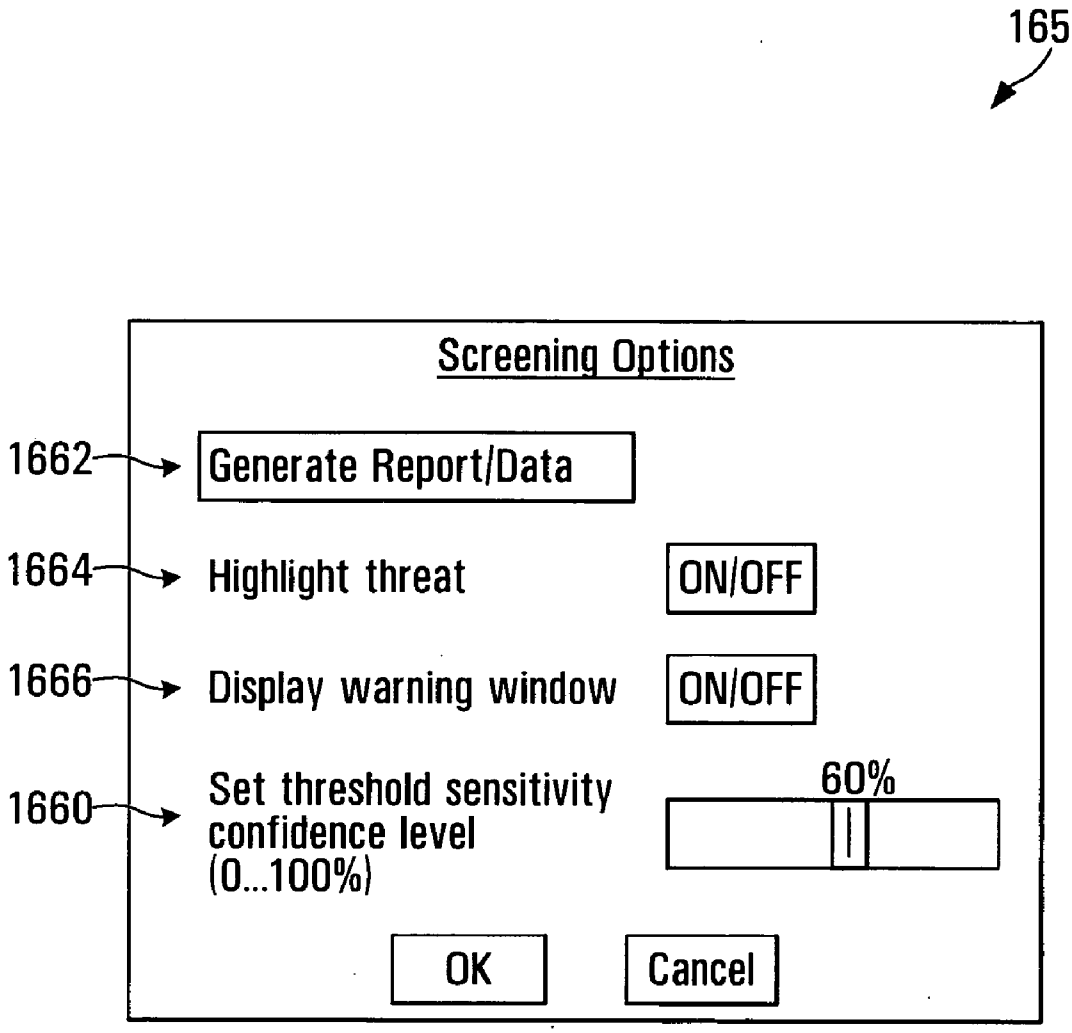

1650
Screening Options
1662
Generate Report/Data
1664
Highlight threat
ON/OFF
1666
Display warning window
ON/OFF
1660
Set threshold sensitivity
confidence level
(0...100%)
60%
OK
Cancel

FIG. 5D

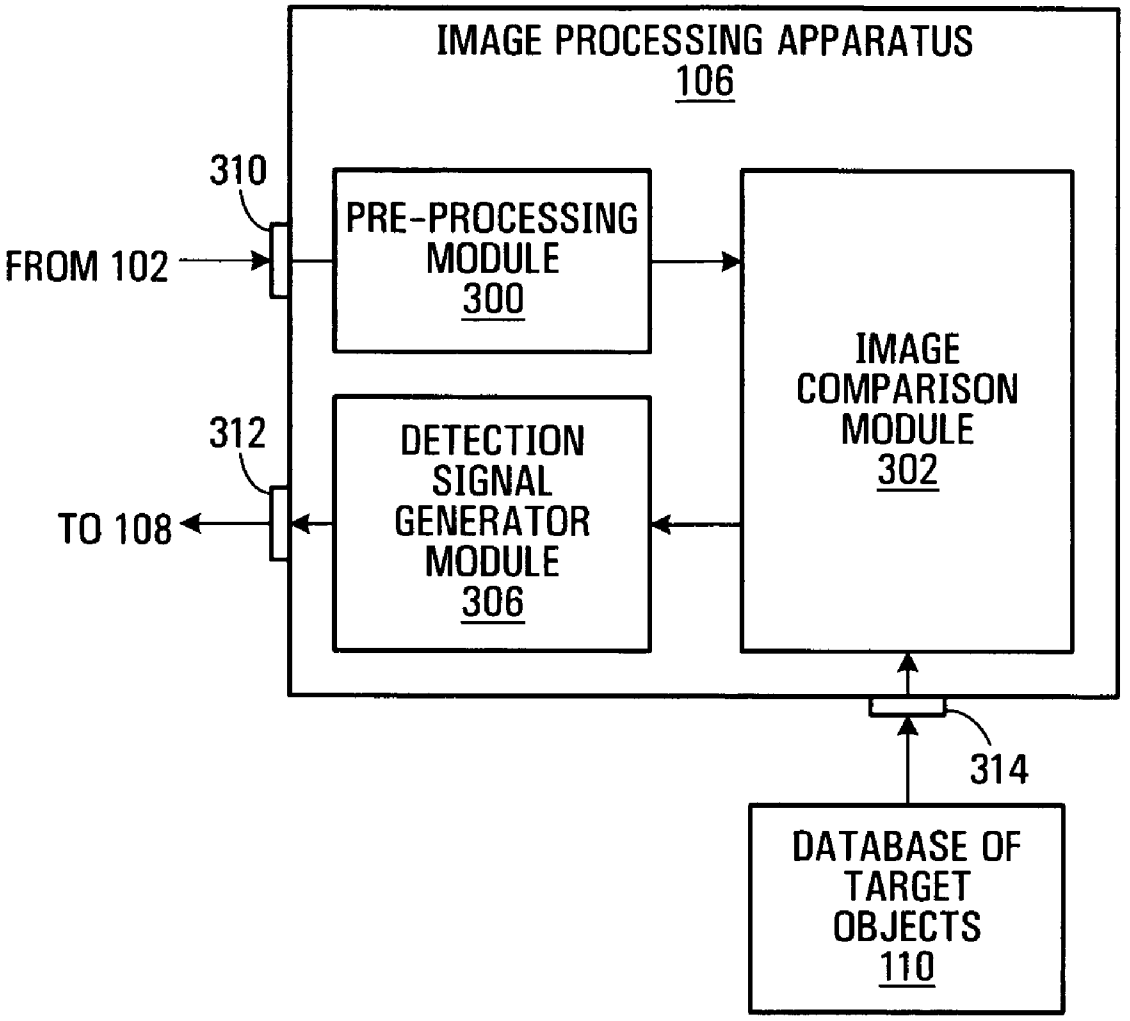


IMAGE PROCESSING APPARATUS
106
310
FROM 102
PRE-PROCESSING MODULE
300
IMAGE COMPARISON MODULE
302
312
TO 108
DETECTION SIGNAL GENERATOR MODULE
306
314
DATABASE OF TARGET OBJECTS
110

FIG. 6

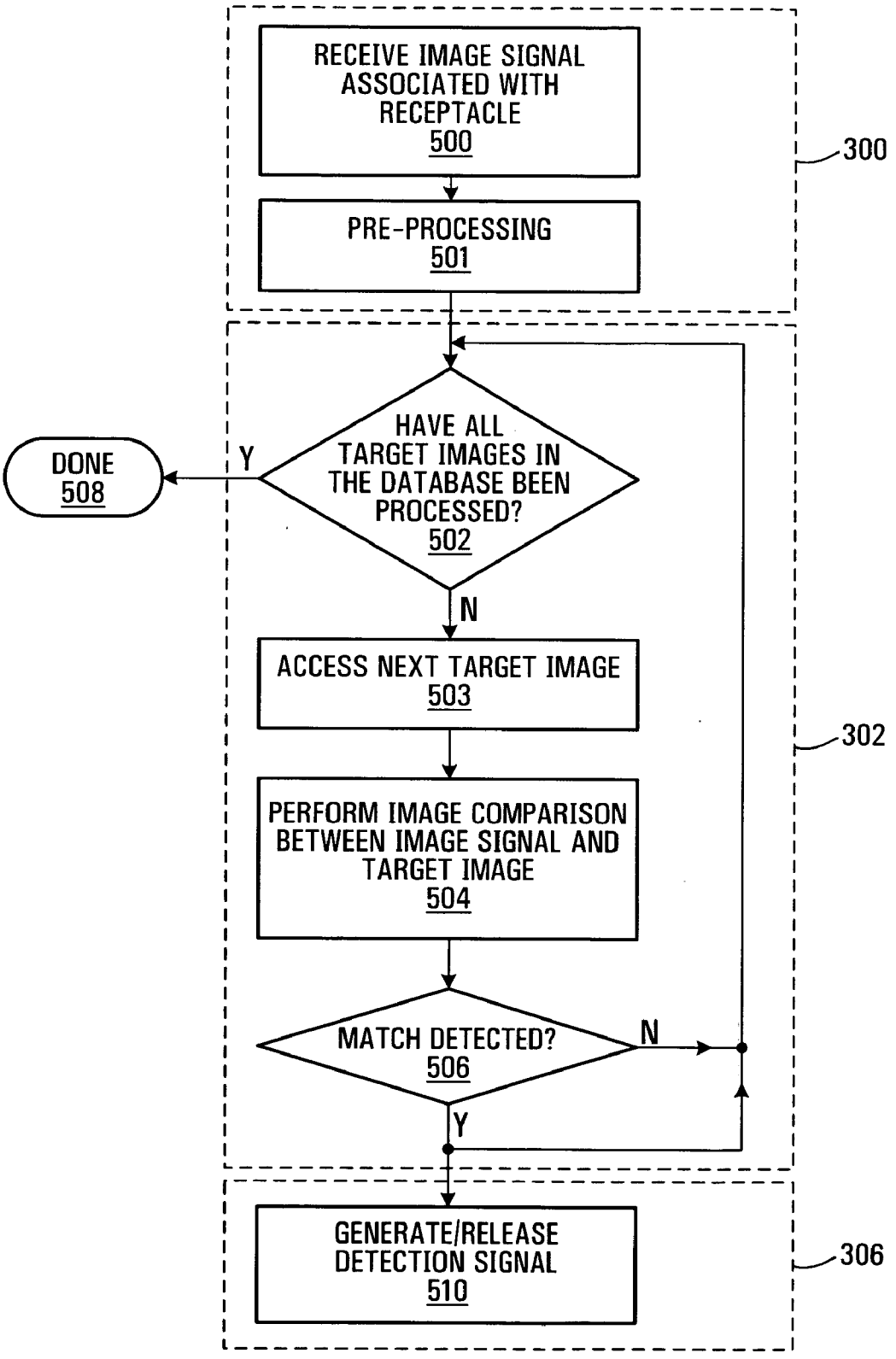

RECEIVE IMAGE SIGNAL ASSOCIATED WITH RECEPTACLE 500
PRE-PROCESSING 501
300
HAVE ALL TARGET IMAGES IN THE DATABASE BEEN PROCESSED? 502
Y
DONE 508
N
ACCESS NEXT TARGET IMAGE 503
PERFORM IMAGE COMPARISON BETWEEN IMAGE SIGNAL AND TARGET IMAGE 504
MATCH DETECTED? 506
N
Y
302
GENERATE/RELEASE DETECTION SIGNAL 510
306

FIG. 7

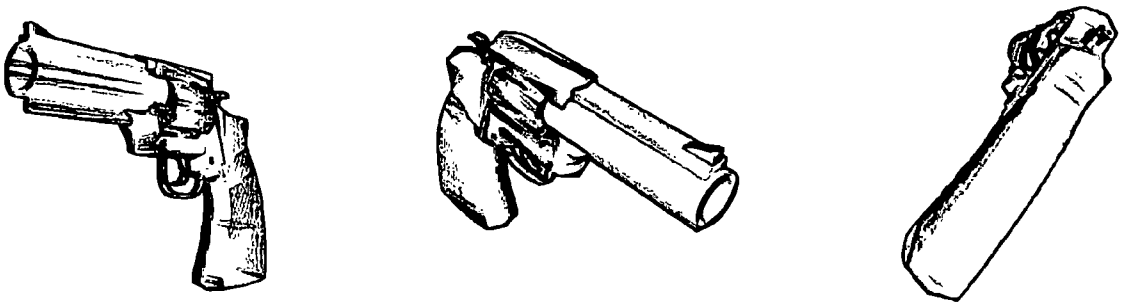


FIG. 8

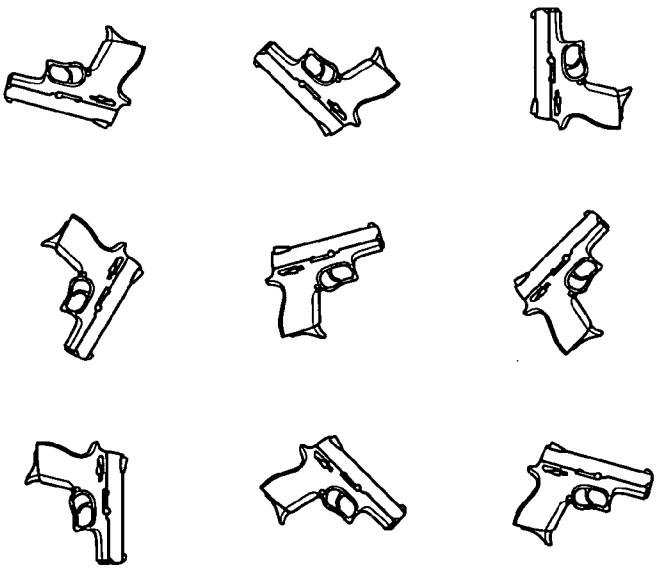


FIG. 9

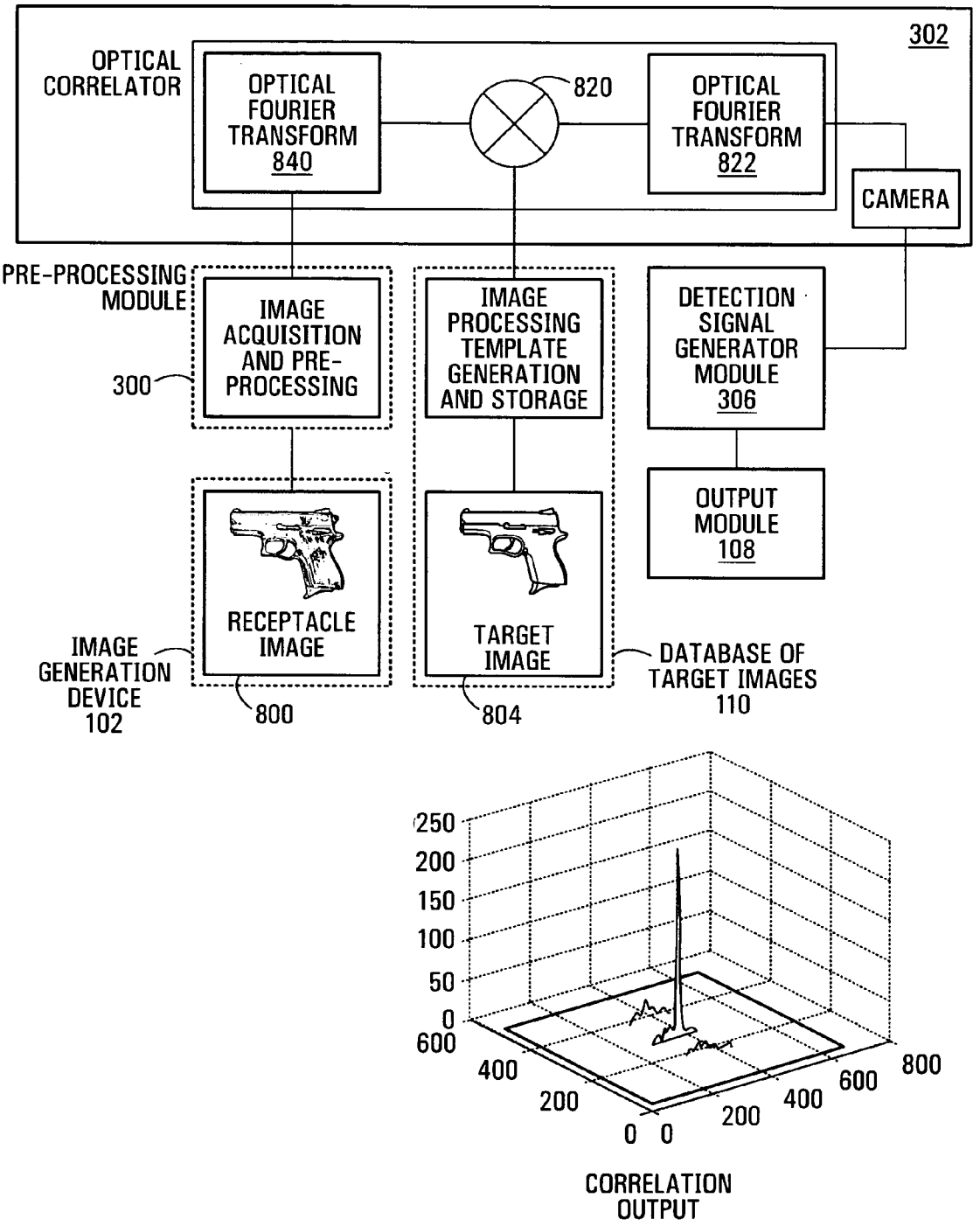

302
OPTICAL CORRELATOR
OPTICAL FOURIER TRANSFORM 840
820
OPTICAL FOURIER TRANSFORM 822
CAMERA
PRE-PROCESSING MODULE
300
IMAGE ACQUISITION AND PRE-PROCESSING
IMAGE PROCESSING TEMPLATE GENERATION AND STORAGE
DETECTION SIGNAL GENERATOR MODULE 306
OUTPUT MODULE 108
RECEPTACLE IMAGE
TARGET IMAGE
IMAGE GENERATION DEVICE 102
800
804
DATABASE OF TARGET IMAGES 110
250
200
150
100
50
0
600
400
200
0 0
200
400
600
800
CORRELATION OUTPUT

FIG. 10

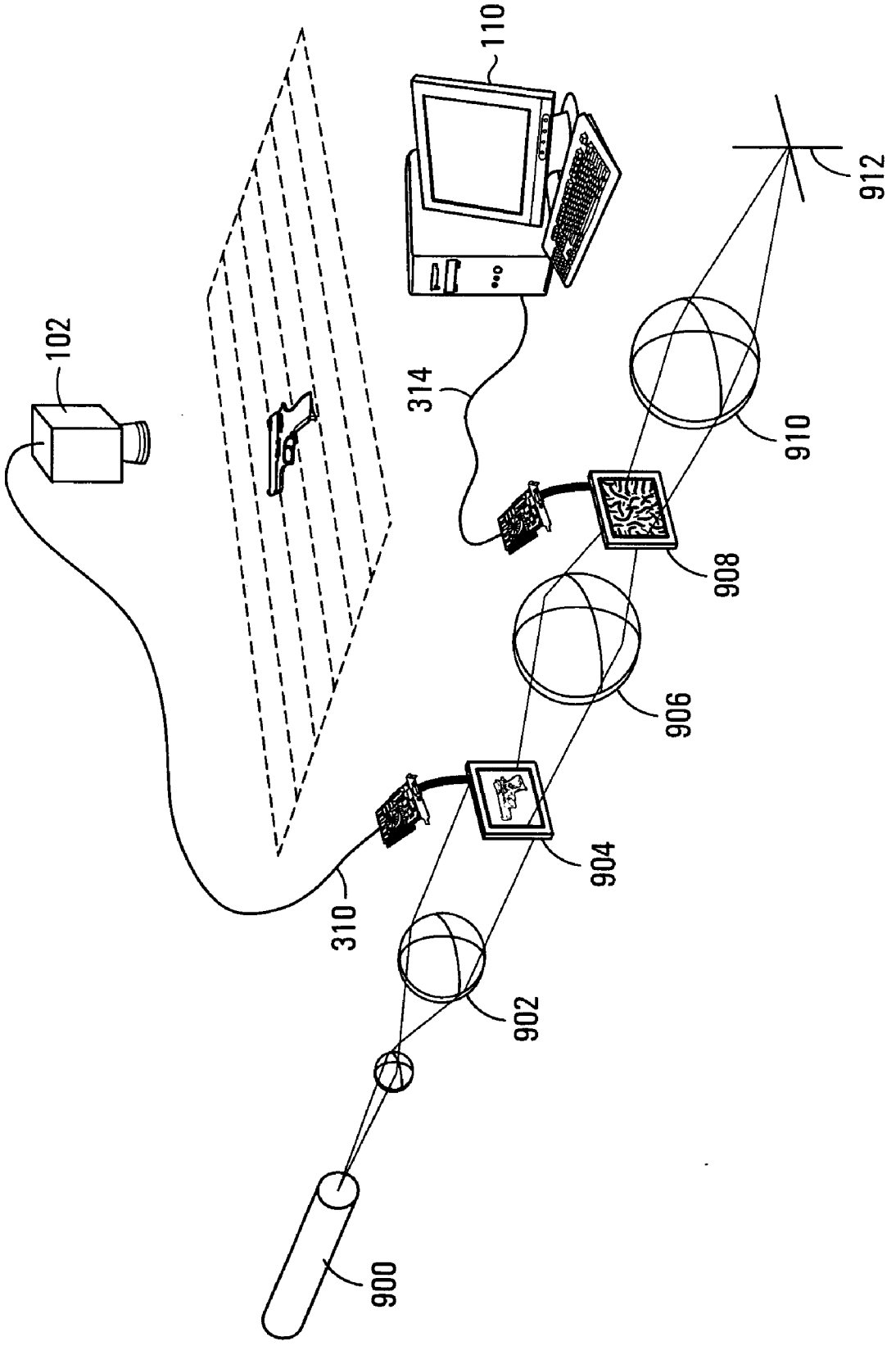


FIG. 11

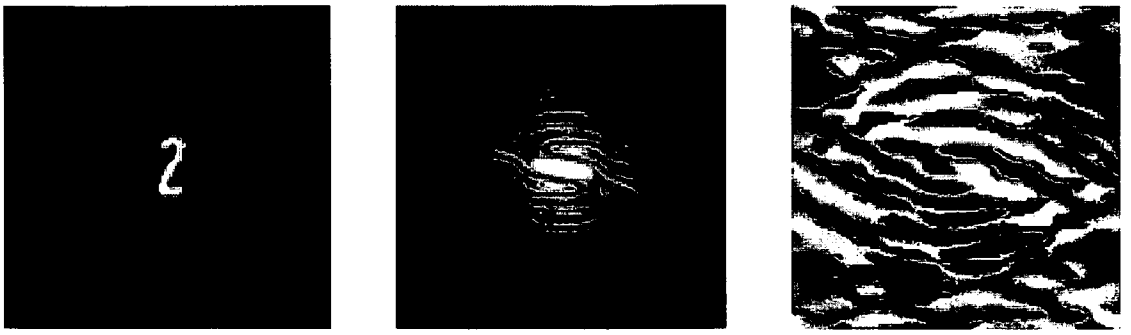


FIG. 12

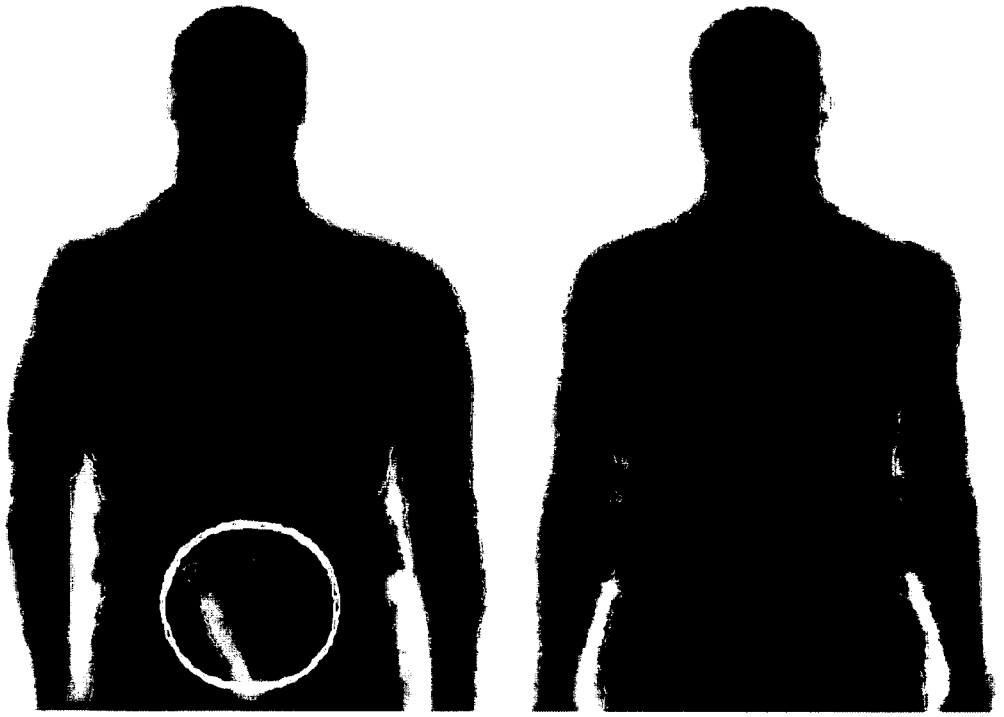


FIG. 13

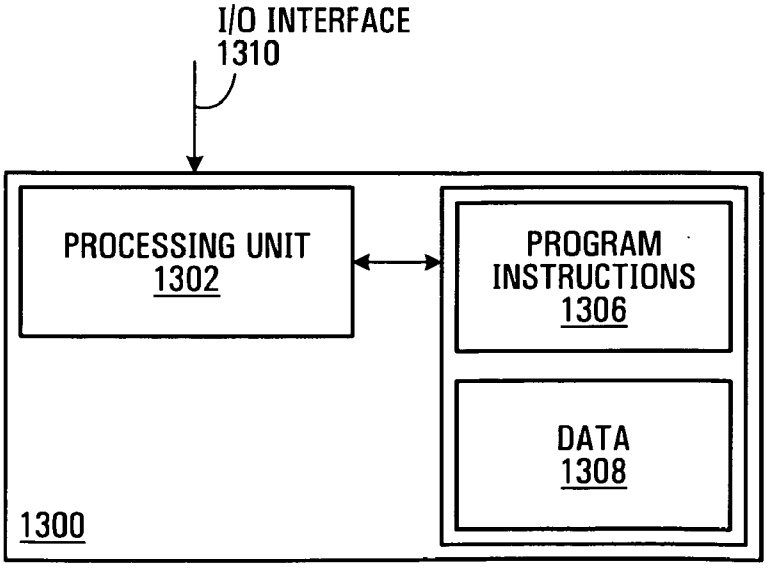

I/O INTERFACE
1310
PROCESSING UNIT
1302
PROGRAM
INSTRUCTIONS
1306
DATA
1308
1300

FIG. 14

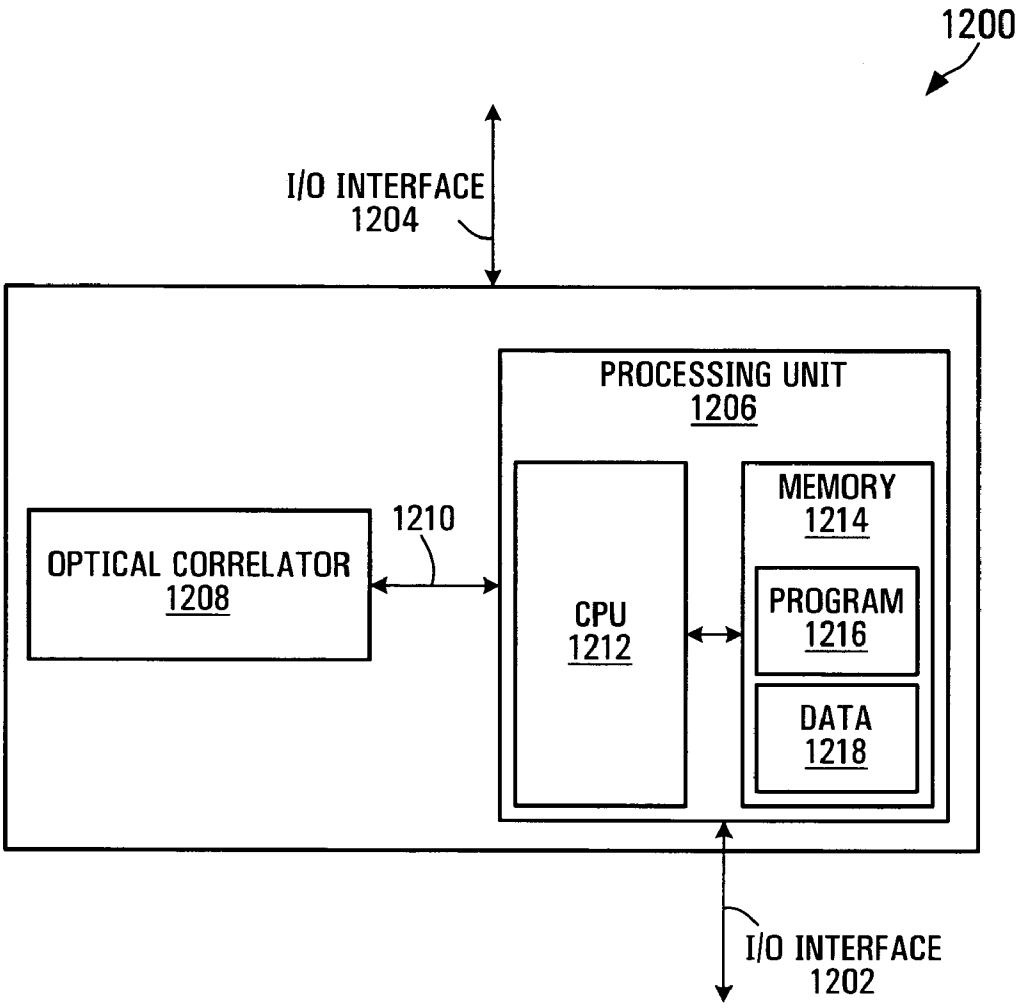

1200
I/O INTERFACE
1204
PROCESSING UNIT
1206
MEMORY
1214
1210
OPTICAL CORRELATOR
1208
CPU
1212
PROGRAM
1216
DATA
1218
I/O INTERFACE
1202

FIG. 15

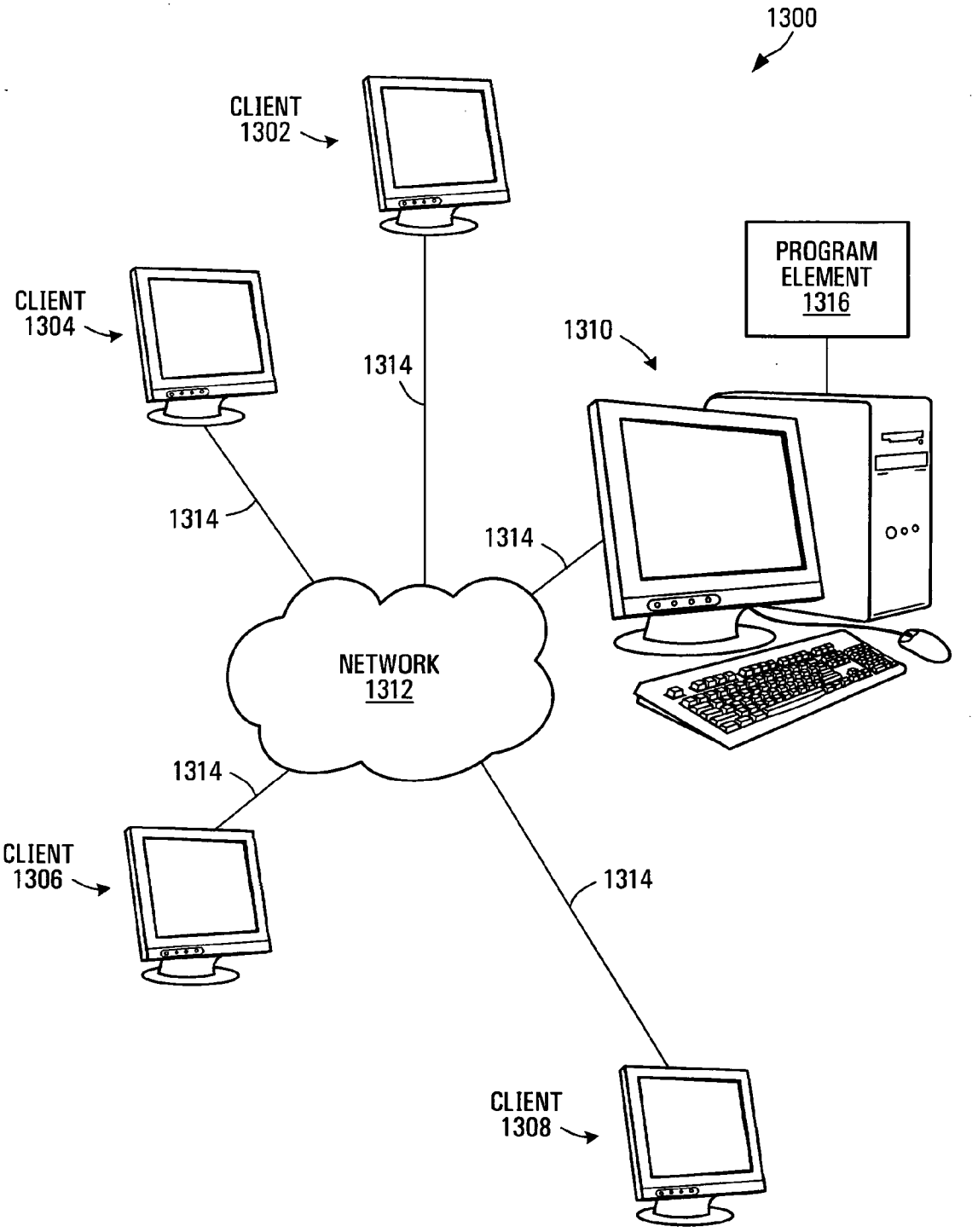

1300
CLIENT
1302
CLIENT
1304
1314
PROGRAM
ELEMENT
1316
1310
1314
1314
NETWORK
1312
1314
CLIENT
1306
1314
CLIENT
1308

FIG. 16

USER INTERFACE FOR USE IN SCREENING LUGGAGE, CONTAINERS, PARCELS OR PEOPLE AND APPARATUS FOR IMPLEMENTING SAME

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part application of international PCT patent application serial number PCT/CA2005/000716 filed May 11, 2005 designating the United States.

[0002] The contents of the above referenced applications are incorporated herein by reference.

Field of the Invention

[0003] The present invention relates generally to security systems and, more particularly, to a user interface for use in screening luggage, mail parcels or cargo containers to identify certain objects located therein or for screening persons to identify certain objects located thereon and to a method and system for implementing such a user interface.

BACKGROUND

[0004] Security in airports, train stations, ports, mail sorting facilities, office buildings and other public or private venues is becoming increasingly important in particular in light of recent violent events.

[0005] Typically, security-screening systems at airports make use of devices generating penetrating radiation, such as x-ray devices, to scan individual pieces of luggage to generate an image conveying the contents of the luggage. The image is displayed on a screen and is examined by a human operator whose task it is to identify, on the basis of the image, potentially threatening objects located in the luggage.

[0006] A deficiency with current systems is that they are entirely reliant on the human operator to identify potentially threatening objects. However, the performance of the human operator greatly varies according to such factors as poor training and fatigue. As such, the process of detection and identification of threatening objects is highly susceptible to human error.

[0007] Another deficiency with current systems is that the labour costs associated with such systems are significant since human operators must view the images.

[0008] Yet another deficiency is that the images displayed on the x-ray machines provide little, if any, guidance as to what is being observed. It will be appreciated that failure to identify a threatening object, such as a weapon for example, may have serious consequences, such as property damage, injuries and human deaths.

[0009] Consequently, there is a need in the industry for providing a method and system for use in screening luggage items, mail parcels, cargo containers or persons to identify certain objects that alleviate at least in part the deficiencies of the prior art.

SUMMARY OF THE INVENTION

[0010] In accordance with a broad aspect, the invention provides a method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in a receptacle during security screening. The method comprises receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle. The method also includes displaying first information conveying an image associated with the receptacle on the basis of the image signal. The method also includes displaying second information conveying a presence of at least one prohibited object in the receptacle, the second information being displayed simultaneously with the first information. The method also includes providing a control allowing a user to cause third information to be displayed, the third information conveying at least one characteristic associated to the at least one prohibited object.

[0011] In accordance with a specific implementation, the first information and second information are displayed in a first viewing window and the third information is displayed in a second viewing window. Optionally, the control is adapted for causing the second viewing window to be displayed to a user.

[0012] In accordance with a specific implementation, the control allows the user to cause the third information to be displayed by using any suitable input device such as, for example, a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen. In addition, the control may be embodied in any suitable form including, for example, a selection box.

[0013] In accordance with a specific implementation, the graphical user interface module displays a prohibited object list, the prohibited object list including a plurality of entries, each entry being associated to a corresponding prohibited object whose presence in the receptacle was detected. Optionally, at least one entry in the prohibited object list conveys a level of confidence associated to detection of the corresponding prohibited object in the receptacle. The graphical user interface module is adapted for enabling a user to select an entry from the plurality of entries in the prohibited object list and to display information associated with the entry selected by the user. The type of information displayed associated with the entry selected can vary from one implementation to the other depending on the specific application. Examples of the type of information that can be displayed include an image of the selected prohibited object detected and a risk levels associated to the prohibited object detected.

[0014] In accordance with a specific implementation, the second information conveys the presence of at least one prohibited object in the receptacle in either textual format or graphical format. Optionally, the second information conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

[0015] In accordance with a specific implementation, the method comprises receiving a detection signal conveying the presence of at least one prohibited object in the receptacle and processing the detection signal to derive the second information. The detection signal may convey a plurality of information items. For example, the detection signal may provide information allowing to identify the type of prohibited object detected, the level of confidence associated to the detection process and the position of the prohibited object in the receptacle amongst others. In the specific example where the detection signal provides information associated level of

confidence associated to the detection process, the graphical user interface module may be operative for processing the data element indicative of the level of confidence in combination with a detection sensitivity level. When the level of confidence associated to the presence a prohibited object in the receptacle is below the detection sensitivity level, the second information may be omitted from the user interface module. Optionally, the user interface provides a control allowing a user to modify the detection sensitivity level.

[0016] For the purpose of this specification, the expression "receptacle" is used to broadly describe an entity adapted for receiving objects therein such as, for example, a luggage item, a cargo container or a mail parcel.

[0017] For the purpose of this specification, the expression "luggage item" is used to broadly describe luggage, suitcases, handbags, backpacks, briefcases, boxes, parcels or any other similar type of item suitable for containing objects therein.

[0018] In accordance with another broad aspect, the invention provides and apparatus suitable for implementing a user interface for use in screening a receptacle to detect the presence of one or more prohibited objects in accordance with the above described method.

[0019] In accordance with another broad aspect, the invention provides a computer readable storage medium including a program element suitable for execution by a CPU for implementing a graphical user interface module for displaying information associated to the content of a receptacle in accordance with the above described method.

[0020] In accordance with another broad aspect, the invention provides an apparatus for implementing a user interface module for use in screening receptacles to detect the presence of one or more prohibited objects. The apparatus comprises means for receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle. The apparatus also comprises means for receiving a detection signal conveying a presence of at least one prohibited object in the receptacle. The apparatus also comprises means for implementing the user interface module. The user interface module is adapted for displaying first information conveying an image associated with the receptacle on the basis of the image signal. The user interface module is also adapted for displaying second information conveying a presence of at least one prohibited object in the receptacle, the second information being displayed simultaneously with the first information and being derived at least in part on the basis of the detection signal. The user interface module is also adapted for providing a control allowing a user to cause third information to be displayed, the third information conveying at least one characteristic associated to the at least one prohibited object. The apparatus also comprises means for releasing a signal adapted to cause a display module to display the user interface module.

[0021] In accordance with yet another broad aspect, the invention provides a system for detecting the presence of one or more prohibited objects in a receptacle. The system includes an input, an optical correlator and an apparatus for implementing a user interface module. The input is for receiving data conveying graphic information regarding the contents of the receptacle. The optical correlator is in communication with the input and is operative for processing the graphic information to detect a depiction of the one or more prohibited objects in the receptacle. The apparatus implementing the user interface module is in communication with the input and with the optical correlator. The user interface module implemented by the apparatus is operative for displaying first information conveying an image associated with the receptacle on the basis of the data conveying graphic information regarding the contents of the receptacle. The user interface module is also adapted for displaying second information conveying a presence of one or more prohibited objects in the receptacle, the second information being displayed simultaneously with the first information. The user interface module is also operative for releasing a signal adapted to cause a display module to display the user interface module.

[0022] In accordance with another broad aspect, the invention provides a method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in the receptacle during security screening. The method comprises receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle and displaying first information conveying an image associated with the receptacle on the basis of the image signal. The method also comprises receiving a detection signal conveying a presence of at least one prohibited object in the receptacle and displaying second information conveying a presence of at least one prohibited object in the receptacle. The second information is displayed simultaneously with the first information and is derived at least in part on the basis of the detection signal.

[0023] In accordance with another broad aspect, the invention provides an apparatus suitable for implementing a user interface for use in screening a receptacle to detect the presence of one or more prohibited objects in accordance with the above described method.

[0024] In accordance with another broad aspect, the invention provides a computer readable storage medium including a program element suitable for execution by a CPU for implementing a graphical user interface module for displaying information associated to the content of a receptacle in accordance with the above described method.

[0025] In accordance with yet another broad aspect, the invention provides an apparatus for implementing a user interface module for use in screening a person to detect the presence of one or more prohibited objects. The apparatus comprising a first input for receiving an image signal associated with the person and a second input for receiving a detection signal conveying a presence of at least one prohibited object on the person. The apparatus also includes a processing unit operative for implementing the user interface module. The user interface module is adapted for displaying first information conveying an image associated with the person on the basis of the image signal and displaying second information conveying a presence of at least one prohibited object on the person. The second information is displayed simultaneously with the first information and is derived at least in part on the basis of the detection signal. The apparatus also includes an output for releasing a signal adapted to cause a display module to display said user interface module.

[0026] Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying Figures.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] A detailed description of the embodiments of the present invention is provided herein below, by way of example only, with reference to the accompanying drawings, in which:

[0028] FIG. **1** is a high-level block diagram of a system for screening a receptacle to detect therein the presence of one or more prohibited objects in accordance with a specific example of implementation of the present invention;

[0029] FIG. **2** is a block diagram of an output module suitable for use in connection with the system depicted in FIG. **1** in accordance with a specific example of implementation of the present invention;

[0030] FIG. **3** is a block diagram of an apparatus suitable for implementing a user interface for use in screening a receptacle in accordance with a specific example of implementation of the present invention;

[0031] FIG. **4** shows a flow diagram depicting a process for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in a receptacle during security screening;

[0032] FIG. **5***a* and **5***b* depict viewing windows of a user interface module displayed by the output module of FIG. **2** in accordance with a specific example of implementation of the present invention;

[0033] FIG. **5***c* depicts a viewing window of a user interface module displayed by the output module of FIG. **2** in accordance with an alternative specific example of implementation of the present invention;

[0034] FIG. **5***d* depicts a control window of a user interface module displayed by the apparatus of FIG. **3** allowing a user to select screening options in accordance with a specific example of implementation of the present invention;

[0035] FIG. **6** is a block diagram of an apparatus for processing images suitable for use in connection with the system depicted in FIG. **1** in accordance with a specific example of implementation of the present invention;

[0036] FIG. **7** is a flow diagram depicting a process for detecting a presence of at least one target object in the receptacle in accordance with specific examples of implementation of the present invention;

[0037] FIG. **8** shows three images associated to a target object suitable for use in connection with the system depicted in FIG. **1**, each image depicting the target object in a different orientation, in accordance with a specific example of implementation of the present invention;

[0038] FIG. **9** shows a mosaic image including a plurality of sub-images associated with a target object suitable for use in connection with the system depicted in FIG. **1**, each sub-image depicting the target object in a different orientation and scale, in accordance with a specific example of implementation of the present invention;

[0039] FIG. **10** is a functional block diagram a luggage screening system including an optical correlator in accordance with a specific example of implementation of the present invention;

[0040] FIG. **11** is a block diagram depicting the functioning of an optical correlator in accordance with a specific example of implementation of the present invention;

[0041] FIG. **12** depicts a Fourier transform, amplitude and phase, of the spatial domain image for number **2**;

[0042] FIG. **13** shows two images associated to a person suitable for use in a system for screening a person to detect the presence of one or more prohibited objects in accordance with a specific example of implementation of the present invention;

[0043] FIG. **14** is a block diagram of an apparatus suitable for implementing a user interface for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in a receptacle during security screening in accordance with a specific example of implementation of the present invention;

[0044] FIG. **15** is a block diagram of an alternative implementation of an apparatus suitable for for use in detecting the presence of one or more prohibited objects in a receptacle during security screening in accordance with a specific example of implementation of the present invention;

[0045] FIG. **16** shows a functional block diagram of a client-server system suitable for use in screening a receptacle to detect therein the presence of one or more prohibited objects in accordance with an alternative specific example of implementation of the present invention.

[0046] In the drawings, the embodiments of the invention are illustrated by way of examples. It is to be expressly understood that the description and drawings are only for the purpose of illustration and are an aid for understanding. They are not intended to be a definition of the limits of the invention.

DETAILED DESCRIPTION

[0047] Shown in FIG. **1** is a system **100** for screening a receptacle in accordance with a specific example of implementation of the present invention. It is to be understood that the expression "receptacle", as used for the purposes of the present description, is used to broadly describe an entity adapted for receiving objects therein such as, for example, a luggage item, a cargo container or a mail parcel. In addition, the expression "luggage item" is used to broadly describe luggage, suitcases, handbags, backpacks, briefcases, boxes, parcels or any other similar type of item suitable for containing objects therein.

[0048] As depicted, the system **100** includes an image generation device **102**; an apparatus **106** in communication with the image generation device **102** and an output module **108**.

[0049] The image generation device **102** generates an image signal associated with a receptacle **104**. The image signal conveys information related to the contents of the receptacle **104**. The apparatus **106** receives the image signal associated with the receptacle **104** and processes that image signal in combination with a plurality of target images

associated with target objects to detect a presence of at least one target object in the receptacle **104**. In a specific implementation, the plurality of target images is stored in a database of target images **110**. In response to detection of the presence of at least one target object in the receptacle **104**, the apparatus **106** generates a detection signal conveying the presence of the target object in the receptacle **104**. Examples of the manner in which the detection signal can be derived are described later on in the specification. The output module **108** conveys to a user information derived at least in part on the basis of the detection signal to a user of the system.

[**0050**] Advantageously, the system **100** provides assistance to the human security personnel using the system in detecting certain target objects, including prohibited objects, and decreases the susceptibility of the screening process to human error.

Image Generation Device **102**

[**0051**] In a specific example of implementation, the image generation device **102** uses penetrating radiation or emitted radiation to generate the image associated with the receptacle **104**. Specific examples of such devices include, without being limited to, x-ray, gamma ray, computed tomography (CT scans), thermal imaging, TeraHertz and millimeter wave devices. Such devices are known in the art and as such will not be described further here. In a non-limiting example of implementation, the image generation device **102** is a conventional x-ray machine adapted for generating an x-ray image of the receptacle **104**.

[**0052**] The image signal generated by the image generation device **102** and associated with the receptacle **104** may be conveyed as a two-dimensional (2-D) image or as a three-dimensional (3-D) image and may be in any suitable format. Possible formats include, without being limited to, JPEG, GIF, TIFF and bitmap amongst others. Preferably, the image signal is in a format that can be displayed on a display screen.

Database of Target Images **110**

[**0053**] In a specific example of implementation, the database of target images **110** includes a plurality of entries associated to respective target objects that the system **100** is designed to detect.

[**0054**] In a non-limiting implementation, for each entry associated to a target object at least one image (hereinafter referred to as a "target image") is provided in the database of target images **110**. The format of the target images will depend upon the image processing algorithm implemented by the apparatus **106**. More specifically, the format of the target images is such that a comparison operation can be performed by the apparatus **106** between the target images and data derived from the image signal associated with the receptacle **104**.

[**0055**] Optionally, for each entry associated to a target object, a set of images is provided in the database of target images **110**. For example, images depicting the target object in various orientations may be provided. FIG. **6** of the drawings depicts an example of arbitrary 3D orientations of a target object.

[**0056**] Optionally still, for each entry associated to a target object, characteristics of the target object are provided. Such characteristics may include, without being limited to, the name of the target object, its associated threat level, the recommended handling procedure when such a target object is detected and any other suitable information. In a specific implementation, the threat level information associated to the target object convey the relative threat level of a prohibited object compared to other prohibited objects in the database of target images **110**. For example, a gun would be given a relatively high threat level while a metallic nail file would be given a relatively low level threat level and a pocket knife would be given a threat level between that of the nail file and the gun. Optionally still, each entry in the database of target images **110** is also associated to a respective target object identifier data element. In a non-limiting example of implementation, the database of target images **110** includes at least one entry associated to a prohibited object, such as a weapon. In the case of luggage screening (in an airport facility for example) the prohibited object typically constitutes a potential threat to the safety of the passenger or aircraft.

[**0057**] In the case of mail parcel screening, the prohibited object is typically an object that is normally not permitted to be sent through the mail, such as guns (in Canada) for example, due to registration requirements/permits and so on.

[**0058**] In a non-limiting example of implementation, the database of target images **110** includes one or more entries associated to objects which are not prohibited but which may represent potential threats. For example, the presence of a metal plate or a metal canister in a piece of luggage going through luggage security screening is not prohibited in itself. However such objects may conceal one or more dangerous objects. As such, it is desirable to be able to detect the presence of such objects in receptacle such as to bring them to the attention of the security screeners.

[**0059**] The specific design and content of the database of target images **110** may vary from one implementation to the next without detracting from the spirit of the invention. The design of the database is not critical to the present invention and as such will not be described further here.

[**0060**] Although the database of target images **110** has been shown in FIG. **1** to be a component separate from the apparatus **106**, it will be appreciated that in certain embodiments the database of target images **110** may be part of apparatus **106** and that such implementations do not detract from the spirit of the invention. In addition, it will also be appreciated that in certain implementations, the database of target images **110** is shared between multiple apparatuses **106**.

Output Module **108**

[**0061**] In a specific example of implementation, the output module **108** conveys to a user of the system information derived at least in part on the basis of the detection signal.

[**0062**] A specific example of implementation of the output module **108** is shown in FIG. **2** of the drawings. As depicted, the output module includes an output device **202** and an output controller unit **200**.

[**0063**] The output device **202** may be any device suitable for conveying information to a user of the system **100** regarding the presence of a prohibited object in the receptacle **104**. The information may be conveyed in visual

format, audio format or as a combination of visual and audio formats. In a first specific example of implementation, the output device **202** is in communication with the output module **200** and includes a display unit adapted for displaying in visual format information related to the presence of a prohibited object in the receptacle **104** on the basis of a signal received from the output module **200**. In a second specific example of implementation, the output device **202** includes a printer adapted for displaying in printed format information related to the presence of a prohibited object in the receptacle **104**. In a third specific example of implementation, the output device **202** includes an audio output unit adapted for releasing an audio signal conveying information related to the presence of a prohibited object in the receptacle **104**. In a fourth specific example of implementation, the output device **202** includes a set of visual elements, such as lights or other suitable visual elements, adapted for conveying in visual format information related to the presence of a prohibited object in the receptacle **104**. The person skilled in the art will readily appreciate, in light of the present specification, that other suitable types of output devices may be used here without detracting from the spirit of the invention.

[**0064**] The output controller unit **200** receives the detection signal conveying the presence of the at least one prohibited object in the receptacle **104** from apparatus **106** (shown in FIG. **1**). In a specific implementation, the detection signal conveys position information related to a certain prohibited object detected in the receptacle **104** and information allowing for the identification of the prohibited object. Optionally, the detection signal also conveys a prohibited object identifier data element. The prohibited object identifier data element is associated to an entry in the database of target images **110**.

[**0065**] In a first specific example of implementation, the output controller unit **200** includes an apparatus **1510** of the type depicted in FIG. **3** implementing a user interface module. In such an implementation, the output controller unit **200** is adapted for communicating with an output device **202** including a display screen for causing the latter to display the user interface module generated by the apparatus **1510**.

[**0066**] The apparatus **1510** implements a method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in the receptacle during security screening. A specific example of a method implemented by the apparatus **1510** will now be described with reference to FIG. **4**. At step **1700**, an image signal associated with a receptacle is received, the image signal conveying information related to the contents of the receptacle. At step **1702**, first information conveying an image associated with the receptacle on the basis of the image signal is caused to be displayed. At step **1704**, second information is displayed, the second information conveying a presence of at least one prohibited object in the receptacle. The second information is displayed simultaneously with the first information. The second information is derived from a detection received from the image processing apparatus **106** and conveying the presence of at least one prohibited object in the receptacle. Optionally, at step **1706**, a control is provided for allowing a user to cause third information to be displayed, the third information conveying at least one characteristic associated to the prohibited object whose presence in the receptacle was detected.

[**0067**] The apparatus **1510** includes a first input **1512**, a second input **1502**, a third input **1504**, a user input **1550**, a processing unit **1506** and an output **1508**.

[**0068**] The first input **1512** is for receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle. In a specific implementation, the image signal is derived from a signal generated by the image generation device **102** (shown in FIG. **1**).

[**0069**] The second input **1502** is for receiving a detection signal conveying a presence of at least one prohibited object in the receptacle. In a specific implementation, the detection signal is provided by the image processing apparatus **106**. The type of information received at the second input **1502** depends on the specific implementation of the image processing apparatus **106** and may vary from one implementation to the next without detracting from the spirit of the invention. Examples of the type of information that may be received include information on the position of the prohibited object detected, information about the level of confidence of the detection and data allowing identifying the prohibited object detected.

[**0070**] The third input **1504** is for receiving information associated to the one or more prohibited objects detected in the receptacle from the database of target images **110**. The type of information received at the third input **1504** depends on the content of the database of target images **110** and may vary from one implementation to the next. Examples of the type of information that may be received include images depicting the target object and characteristics of the target object. Such characteristics may include, without being limited to, the name of the target object, dimensions of the target object, its associated threat level, the recommended handling procedure when such a target object is detected and any other suitable information.

[**0071**] The user input **1550** is for receiving signals from a user input device, the signals conveying commands for controlling the information displayed by the user interface module or for annotating the information displayed. Any suitable user input device for providing user commands may be used such as, for example, a mouse, keyboard, pointing device, speech recognition unit or touch sensitive screen.

[**0072**] The processing unit **1506** is in communication with the first input **1512**, the second input **1502**, the third input **1504** and the user input **1550** and implements a user interface module for displaying information for use in screening receptacles to detect the presence of one or more prohibited objects.

[**0073**] The output **1508** is for releasing a signal for causing the output device **202** (shown in FIG. **2**) to display the graphical user interface module implemented by processing unit **1506**. A graphical user interface module implemented by apparatus **1510** in accordance with a specific example of implementation is described in greater detail herein below with reference to figures **5***a*, **5***b*, **5***c* and **5***d*.

[**0074**] With reference to FIG. **5***a*, there is shown a display generated by a graphical user interface module in accordance with a non-limiting implementation on the invention.

[0075] As depicted, the user interface module displays first information **1604** conveying an image associated with a receptacle on the basis of the image signal received at input **1512** (shown in FIG. **3**). The image associated with the receptacle may be in any suitable format and will depend on the format of the image signal received at input **1512**. For example, the image may be of type x-ray, gamma-ray, computed tomography (CT scans), TeraHertz, millimeter wave or emitted radiation amongst others.

[0076] The user interface module also displays second information **1606** conveying a presence of one or more prohibited objects in the receptacle on the basis of the detection signal received at input **1502** (shown in FIG. **3**). The second information **1606** is derived at least in part on the basis of the detection signal received at second input **1502**. Preferably, the second information **1606** is displayed simultaneously with the first information **1604**. In a specific example, the second information **1606** conveys position information related to one or more prohibited objects whose presence in the receptacle was detected. The second information may convey the presence of one or more prohibited object in the receptacle in textual format in graphical format or as a combination of graphical information and textual information. In textual format, the second information may appear in a dialog box with a message of the form "A ### prohibited object name ### has been detected." In the specific implementation depicted in FIG. **5***a*, the second information **1606** includes visual graphic indicators in the form of circles positioned such as to identify the location of the one or more prohibited objects in the image associated with the receptacle. The location of the circles is derived on the basis of the content of the detection signal received at input **1502** (shown in FIG. **3**). It will be readily apparent that visual indicators of any suitable shape (e.g. square, arrows, etc . . .) may be used to identify the location of the one or more prohibited objects in the image associated with the receptacle and that the examples depicted in the figures have been presented for the purpose of illustration only. Moreover, functionality may be provided to the user to allow the latter to modify the appearance, such as size, shape and/or color, of the visual indicators used to identify the location of the one or more prohibited objects in the image associated with the receptacle. The manner in which such a functionality would be provided is not critical to the present invention and as such will not be described further here.

[0077] The user interface module also provides a control **1608** allowing a user to cause third information to be displayed, the third information conveying at least one characteristic associated to the one or more prohibited objects. In a specific implementation, the control **1608** allows the user to cause the third information to be displayed by using an input device such as, for example, a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen. In the example depicted, the control **1608** is in the form of a selection box including an actuation button that can be selectively actuated by a user. In an alternative embodiment, the control **1608** is provided as a physical button (or key) on a keyboard or other input device that can be selectively actuated by a user. In such an implementation, the physical button (or key) is in communication with the apparatus **1510** (shown in FIG. **3**) through user input **1550**.

[0078] In a specific example of implementation, the first information **1604** and the second information **1606** are displayed in a first viewing window **1602** and the third information is displayed in a second viewing window **1630** of the type depicted in figure **5***b*. The first and second viewing windows **1602** and **1630** may be displayed concurrently on same display screen, concurrently on separate display screens or separately such that when the second viewing window **1630** is displayed the first viewing window **1602** is partially or fully concealed. In a specific implementation, the control **1608** allows a user to cause the second viewing window displaying third information to be displayed. FIG. **5***c* of the drawings depicts an alternative embodiment of a user interface module where the first and second viewing windows **1602** and **1630** are displayed concurrently.

[0079] With reference to FIG. **5***b*, there is shown a second viewing window **1630** for displaying third information conveying at least one characteristic associated to the one or more prohibited objects detected in the receptacle. The type of data conveyed by the third information will vary from one implementation to another.

[0080] In the specific example depicted in FIG. **5***b*, the third information conveys an image **1632** and object characteristics **1638** including a description, a risk level and a level of confidence for the detection, each of the above being associated with one of the prohibited objects that was detected. Other types of information that may be conveyed include, without being limited to: handling procedure when such a prohibited object is detected, dimensions of the prohibited object or any other characteristics of the prohibited object that could assist the user in validating the information provided, confirm its presence, or facilitate its handling. The third information may be conveyed in textual formal or graphical format. For example, the third information may include information related to the level of confidence for the detection using a color schema. A non-limiting example of a color scheme that may be used in the following:

[0081] Red: threat positively detected.

[0082] Yellow: possible threat detected.

[0083] Green: No threat detected.

[0084] In yet another example, the third information may include information related to the level of confidence for the detection using a shape schema. The use of a shape based scheme to show information related to the level of threat is particularly useful for individuals who are color blind or for use with monochromatic display screens. A non-limiting example of a shape scheme that may be used in the following:

[0085] Diamond: threat positively detected.

[0086] Triangle: possible threat detected.

[0087] Square: No threat detected.

[0088] In a specific example of implementation, the processing unit **1506** is adapted to transmit a query signal to the database of prohibited objects **110** (shown in FIG. **1**), on the basis of information received through input **1502** in the detection signal, in order to obtain certain information elements associated to a detected prohibited object, for

example an image, a description, a risk level and a handling procedure amongst others. In response to the query signal, the database of prohibited objects **110** (shown in FIG. **1**) transmits the requested information with the processing unit **1506** through input **1504**. Alternatively, a signal conveying information associated with one of the prohibited objects that was detected can automatically provided to the apparatus **1510** without requiring a query.

[**0089**] In the specific example of implementation depicted in figure **5***b*, the graphical user interface module displays a prohibited object list **1634** including a plurality of entries, each entry being associated to a corresponding prohibited object whose presence in the receptacle was detected. In the example depicted, the prohibited object list **1634** is displayed in the second viewing window **1630** however it will be readily apparent that such a list may alternatively be displayed in the first viewing window **1602** or in yet another viewing window distinct from the first viewing window **1602** and the second viewing window **1630** without detracting from the spirit of the invention. Alternatively still, the prohibited object list **1634** may be displayed in the first viewing window **1602** and may perform the functionality of the control **1608**. More specifically, in this alternative implementation, the control **1608** (shown in FIG. **5***a*) is embodied in the form of a list of prohibited objects including entries associated to prohibited objects detected in the receptacle. The user is enabled to select one or more entries from the list of detected prohibited objects. In response to the user's selection, third information conveying at least one characteristic associated to the one or more selected prohibited objects is caused to be displayed by the user interface.

[**0090**] Optionally, each entry in the list of entries **1634** includes information conveying a level of confidence associated to the presence of the corresponding prohibited object in the receptacle. The information conveying a level of confidence is extracted from the detection signal received at input **1502**. In a specific example of implementation, the graphical user interface module is operative for processing a data element indicative of the level of confidence received in the detection signal in combination with a detection sensitivity level. When the level of confidence associated to the presence of a prohibited object in the receptacle conveyed by the data element in the detection signal is below the detection sensitivity level, the second information associated with the prohibited object is omitted from the user interface module. In addition, the prohibited object is not listed in the list of entries **1634**. As such, only information associated to prohibited objects for which detection levels of confidence exceeds the detection sensitivity level is provided by the user interface.

[**0091**] Optionally, each entry in the list of entries **1634** includes information conveying a threat level (not shown in the figures) associated to the corresponding prohibited object in the receptacle. The information conveying a threat level is extracted from the signal received from the database of target images **110** received at third input **1504**. The threat level information associated to the prohibited object may convey the relative threat level of a prohibited object compared to other prohibited objects in the database of target images **110**. For example, a gun would be given a relatively high threat level while a metallic nail file would be given a relatively low threat level and perhaps a pocket knife would be given a threat level between that of the nail file and the gun.

[**0092**] Optionally still, functionality is provided to the user for allowing the latter to sort the entries in the list of entries **1634** on the basis of one or more selection criteria. Such criteria may include, without being limited to, the detection levels of confidence and/or the threat level. In a specific example, such functionality may be enabled by displaying a control (not shown on the figures) on the user interface in the form of a pull-down menu providing a user with a set of sorting criteria and allowing the user to select the criteria via a user input device. In response to the user selection, the entries in the list of entries **1634** are sorting on the basis of the criteria selected by the user. Other manners for providing such functionality will become readily apparent to the person skilled in the art in light of the present description and as such will not be described further here.

[**0093**] Optionally still, functionality is provided to the user for allowing the latter to add and/or remove one or more entries in the list of entries **1634**. Removing an entry may be desirable for example when the screening personnel observes the detection results and decides that the detection was erroneous or, alternatively, that the object detected is not particularly problematic. Adding an entry may be desirable for example when the screening personnel observes the presence of a prohibited object on the image displayed which was not detected. As a variant, when an entry from the list of entries **1634** is removed/added, the user is prompted to enter information conveying a reason why the entry was removed/added from/to the list of entries. The information may be entered using any suitable user input device such as, for example, a mouse, keyboard, pointing device, speech recognition unit or touch sensitive screen.

[**0094**] The graphical user interface module enables a user to select one or more entries from the plurality of entries in the prohibited object list **1634** for which third information is to be displayed in the second viewing window **1630**. In a specific implementation, the user can select one or more entries entry from the prohibited object list **1634** by using an input device such as, for example, a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen. The user selection is received at user input **1550**. In response to receiving a signal conveying the user selection at user input **1550**, information associated with the one or more entries selected in the prohibited object list **1634** is displayed in the second viewing window **1630**.

[**0095**] Optionally, in addition to the control **1608**, the user interface module is adapted for displaying a second control (not shown in the figures) for allowing a user to cause the second information to be removed from the user interface module.

[**0096**] Optionally still, in addition to the control **1608**, the user interface module is adapted for displaying additional controls **1636** for allowing a user to modify the configuration of the user interface. In accordance with a specific implementation, the user interface module displays a control window of the type depicted in FIG. **5***d*, in response to actuation of control button **1680**, allowing a user to select screening options. In the specific example depicted, the user is enabled to select between the following screening options:

[**0097**] Generate a report data **1652**: this option allows a report to be generated detailing information associated

to the screening of the receptacle. In the example depicted, this is done by providing a control in the form of a button that can be toggled between an "ON" state and an "OFF" state. It will be readily apparent that other suitable forms of controls may also be used without detracting from the spirit of the invention. The information generated in the report may include, without being limited to, time of the screening, identification of the security personnel operating the screening system, identification of the receptacle and/or receptacle owner (e.g. passport number in the case of a customs screening), locations information, identification of the prohibited object detected and description of the handling that took place and the results of the handling amongst others. Advantageously, this report allows a tracking of the screening operation.

[0098] Highlight prohibited object **1664**: this option allows a user to cause the second information to be removed from or displayed on the user interface module. In the example depicted, this is done by provided a control in the form of a button that can be toggled between an "ON" state and an "OFF" state. It will be readily apparent that other suitable forms of controls may also be used without detracting from the spirit of the invention.

[0099] Display warning window **1666**: this option allows a user to cause a visual indicator in the form of a warning window to be removed from or displayed on the user interface module when a prohibited object is detected in a receptacle.

[0100] Set threshold sensitivity/confidence level **1660**: this option allows a user to modify the detection sensitivity level of the screening system. In specific implementations, this may be done by providing a control in the form of a text box, sliding ruler (as shown in the figure), selection menu or other suitable type of control allowing the user to select between a range of detection sensitivity levels. It will be readily apparent that other suitable forms of controls may also be used without detracting from the spirit of the invention.

[0101] It will be readily appreciated by the person skilled in the art in light of the present description that other options may be provided to the user and that certain options may be omitted from certain implementations without detracting from the spirit of the invention. As a variant, certain options may be selectively provided to certain users or, alternatively, may require a password to be modified. For example, the setting threshold sensitivity/confidence level **1660** may only be made available to user having certain privileges (examples screening supervisors or security directors). As such, the user interface module may include some type of user identification functionality, such as a login process, to identify the user of the screening system. Alternatively, the user interface module, upon selection by the user of the setting threshold sensitivity/confidence level **1660** option, may prompt the user to enter a password for allowing the user to modify the detection sensitivity level of the screening system.

[0102] Optionally still, the user interface module is adapted to allow the user to add complementary information to the information being displayed on the user interface. In a specific example of implementation, the user is enabled to insert markings in the form of text and/or visual indicators in the image displayed on the user interface. The markings may be used, for example, to emphasize certain portions of the receptacle. The marked-up image may then be transmitted to a third party location, such as a checking station, so that the checking station is alerted to verify the marked portion of the receptacle to locate a prohibited object. In such an implementation, the user input **1550** receives signals from a user input device, the signals conveying commands for marking the image displayed in the user interface. Any suitable user input device for providing user commands may be used such as, for example, a mouse, keyboard, pointing device, speech recognition unit or touch sensitive screen. The specific manner in which the functionality for marking the image is provided is not critical to the present invention and as such will not be described further here.

[0103] Optionally still, the user interface module is adapted to store a history of the image signals received at first input **1512** conveying information related to the contents of previously screened receptacles. The image signals may be stored in association with the corresponding detection signals received at input **1502** and any corresponding user input received at input **1550**. The history of prior images may be accessed through a suitable control (not shown in the figures) provided on the user interface. The control may be actuated to cause a list for prior images to be displayed to the user. The user may then be enabled to select one or more entries in the list of prior images. In specific examples of implementation, the selection may be effected on the basis of the images themselves or by allowing the user to specify either a time or time period associated to the images in the history of prior images. In response to a user selection, the one or more images from the history of prior images may then be displayed to the user along with information regarding the prohibited objects detected in those images. When multiple images are selected, the selected images may be displayed concurrently with another or may be displayed separately.

[0104] Optionally still, the user interface module is adapted to assign a classification to the receptacle depending upon the detection signal received at second input **1502** and optionally on the basis of information associated with the prohibited objects conveyed by the detection signal. The classification criteria may vary from one implementation to the other and may be further conditioned on the basis of external factors such as national security levels. The classification may be a two level classification, such as an "ACCEPTED/REJECTED" type of classification or alternatively may be a multi-level classification. An example of a multi-level classification is a three level classification where the receptacles are classified as "LOW/MEDIUM/HIGH RISK". The classifications may then be associated to respective handling procedures. For example, receptacles classified as "REJECT" may be automatically assigned to be manually inspected while receptacles classified as "ACCEPTED" may proceed without such an inspection. In a specific example of implementation, each class is associated to a set of criteria. Examples of criteria may include, without being limited to: a threshold confidence level associated to the detection process, the level of risk associated with the prohibited object detection and whether a prohibited object was detected. It will be readily apparent to the

person skilled in the art in light of the specification that other criteria may be used without detracting from the spirit of the invention.

[0105] The apparatus **200** for implementing a user interface then releases a signal for causing the output device **202**, in the form of a display, to convey the user interface to a user of the system.

[0106] In a second specific example of implementation, the output controller unit **200** is adapted to cause an audio unit to convey information related to the certain target object in the receptacle **104**. In a specific non-limiting example of implementation, the output controller unit **200** generates audio data conveying the presence of the certain target object in the receptacle **104**, the location of the certain target object in the receptacle **104** and the characteristics of the target object.

Apparatus **106**

[0107] The apparatus **106** will now be described in greater detail with reference to FIG. **6**. As depicted, the apparatus **106** includes a first input **310**, a second input **314**, an output **312** and a processing unit, generally comprising a pre-processing module **300**, an image comparison module **302** and a detection signal generator module **306**.

[0108] The first input **310** is for receiving an image signal associated with a receptacle from the image generation device **102** (shown in FIG. **1**).

[0109] The second input **314** is for receiving target images from the database of target images **110**. It will be appreciated that in embodiments where the database of target images **110** is part of apparatus **106**, the second input **314** may be omitted.

[0110] The output **312** is for releasing a detection signal conveying the presence of a target object in the receptacle **104** for transmittal to output module **108**.

[0111] The processing unit of the apparatus **106** receives the image signal associated with the receptacle **104** from the first input **310** and processes that image signal in combination with a plurality of target images associated with target objects received at input **314** to detect a presence of a target object in the receptacle **104**. In response to detection of the presence of at least one target object in the receptacle **104**, the processing unit of the apparatus **106** generates and releases at output **312** a detection signal conveying the presence of the target object in the receptacle **104**.

[0112] The process implemented by the various functional elements of the processing unit of the apparatus **106** is depicted in FIG. **7** of the drawings. At step **500**, the pre-processing module **300** receives an image signal associated with the receptacle **104** is received via the first input **310**. At step **501**, the pre-processing module **300** processes the image signal in order to enhance the image, remove extraneous information therefrom and remove noise artefacts in order to obtain more accurate comparison results. The complexity of the requisite level of pre-processing and the related tradeoffs between speed and accuracy depend on the application. Examples of pre-processing may include, without being limited to, brightness and contrast manipulation, histogram modification, noise removal and filtering amongst others. It will be appreciated that all or part of the functionality of the pre-processing module **300** may actually be external to the apparatus **106**, e.g., it may be integrated as part of the image generation device **102** or as an external component. It will also be appreciated that the pre-processing module **300** (and hence step **501**) may be omitted in certain embodiments of the present invention without detracting from the spirit of the invention. As part of step **501**, the pre-processing module **300** releases a modified image signal for processing by the image comparison module **302**.

[0113] At step **502**, the image comparison module **302** verifies whether there remain any unprocessed target images in the database of target images **110**. In the affirmative, the image comparison module **302** proceeds to step **503** where the next target image is accessed and the image comparison module **302** then proceeds to step **504**. If at step **502** all target images in the database of target images **110** have been processed, the image comparison module **302** proceeds to step **508** and the process is completed.

[0114] At step **504**, the image comparison module **302** compares the image signal associated with the receptacle **104** against the target image accessed at step **503** to determine whether a match exists. The comparison may be effected using any image processing algorithm suitable for comparing two images. Examples of algorithms that can be used to perform image processing and comparison include without being limited to:

[0115] A—Image Enhancement

- [0116] Brightness and contrast manipulation
- [0117] Histogram modification
- [0118] Noise removal
- [0119] Filtering

[0120] B—Image Segmentation

- [0121] Thresholding
  - [0122] Binary or multilevel
  - [0123] Hysteresis based
  - [0124] Statistics/histogram analysis
- [0125] Clustering
- [0126] Region growing
- [0127] Splitting and merging
- [0128] Texture analysis
- [0129] Watershed
- [0130] Blob labeling

[0131] C—General Detection

- [0132] Template matching
- [0133] Matched filtering
- [0134] Image registration
- [0135] Image correlation
- [0136] Hough transform

[0137] D—Edge Detection

- [0138] Gradient
- [0139] Laplacian

[0140] E—Morphological Image Processing

[0141] Binary

[0142] Grayscale

[0143] F—Frequency Analysis

[0144] Fourier Transform

[0145] Wavelets

[0146] G—Shape Analysis and Representations

[0147] Geometric attributes (e.g. perimeter, area, euler number, compactness)

[0148] Spatial moments (invariance)

[0149] Fourier descriptors

[0150] B-splines

[0151] Chain codes

[0152] Polygons

[0153] Quad tree decomposition

[0154] H—Feature Representation and Classification

[0155] Bayesian classifier

[0156] Principal component analysis

[0157] Binary tree

[0158] Graphs

[0159] Neural networks

[0160] Genetic algorithms

[0161] Markov random fields

[0162] The above algorithms are well known in the field of image processing and as such will not be described further here.

[0163] In a specific example of implementation, the image comparison module **302** includes an edge detector to perform part of the comparison at step **504**. In another specific example of implementation, the comparison performed at step **504** includes effecting a correlation operation between data derived from the image signal and the target images in the database **110**. In a specific example of implementation, the correlation operation is performed by an optical correlator. A specific example of implementation of an optical correlator suitable for use in comparing two images will be described later on in the specification. In an alternative example of implementation, the correlation operation is performed by a digital correlator.

[0164] The image comparison module **302** then proceeds to step **506** where the result of the comparison effected at step **504** is processed to determine whether a match exists between the image signal associated with the receptacle **104** and the target image. In the absence of a match, the image comparison module **302** returns to step **502**. In response to detection of a match, the image comparison module **302** triggers the detection signal generation module **306** to execute step **510**. Then, the image comparison module **302** returns to step **502** to continue processing with respect to the next target image.

[0165] At step **510**, the detection signal generation module **306** generates a detection signal conveying the presence of the target object in the receptacle **104**, and the detection signal is released at output **312**. The detection signal may simply convey the fact that a target object has been detected as present in the receptacle **104**, without necessarily specifying the identity of the target object. Alternatively, the detection signal may convey the actual identity of the detected target object detected as being present in the receptacle **104**. As previously indicated, the detection signal may include information related to the positioning of the target object within the receptacle **104** and optionally a target object identifier data element associated to the target object determined to be a potential match.

Specific Example of Image Comparison Module **302** Including an Optical Correlator

[0166] As mentioned above, in a specific implementation of the image comparison module **302**, step **504**, which involves a comparison between the image signal associated with the receptacle **104** and the target images from the database of target images **110**, is performed using a correlation operation. The correlation operation multiplies together the Fourier transform of the image signal associated with the receptacle **104** with the Fourier transform complex conjugate of a target image. The result of the correlation operation provides a measure of the degree of similarity between the two images.

[0167] In a specific implementation, the image comparison module **302** includes an optical correlator unit for computing the correlation between the image signal associated with the receptacle **104** and a target image from the database of target images **110**. Specific examples of implementation of the optical correlator include a joint transform correlator (JTC) and a focal plane correlator (FPC).

[0168] The optical correlator multiplies together the Fourier transform of the image signal associated with the receptacle **104** with the Fourier transform complex conjugate of a target image and records the result with a camera. An energy peak measured with that camera indicates a match between the image signal associated with the receptacle **104** and the target image.

[0169] Advantageously, an optical correlator performs the correlation operation physically through light-based computation, rather than by using software running on a silicon-based computer, which allows computations to be performed at a higher speed than is possible with a software implementation and thus provides for improved real-time performance.

[0170] It will be appreciated that the correlation computation may also be implemented using a digital correlator. The correlation operation is computationally intensive and, in certain implementations requiring real-time performance, the use of a digital correlator may not provide a suitable performance. In such implementations, an optical correlator will be preferred.

[0171] As described above, the correlation computation is performed between an images associated with the receptacle **104** and the target images from the database of target images **110**, which includes a plurality of target images associated to objects, which the system **100** is designed to detect. It will be appreciated that the content and format of the database of target images **110** may vary from one implementation to the next. The next paragraphs describe manners in which the

database **110** can be generated when a correlation computation is used to effect a comparison between an image associated with the receptacle **104** and the target images from the database of target images **110**. The skilled person in the art will readily appreciate in fight of the present description that other manners for generating the database **110** may be used without detracting from the spirit of the invention.

[**0172**] In a specific example of implementation, the database of target images **110** includes data indicative of the Fourier transform of the target image. This data will herein be referred to as a template or filter. In non-limiting examples of implementation, the Fourier transform of the target image is digitally pre-computed such as to improve the speed of the correlation operation when the system is in use. Image processing and enhancement can be performed on an original image of a target object to obtain better matching performance depending on the environment and application.

[**0173**] In a non-limiting example of implementation, the generation of the reference template or filter is performed in a few steps. First, the background is removed from the target image.

[**0174**] In other words the target image is extracted from the background and the background is replaced by a black background. The resulting image is then processed through a Fourier transform function. The result of this transform is a complex image. A phase only filter (POF) for example will only contain the complex conjugate of the phase information (between zero and 2 pi) which is mapped to a 0 to 255 range values. These 256 values correspond in fact to the 256 levels of gray of an image. The person skilled in the art, in light of the present specification, will readily appreciate that various types of templates or filters can be generated. Many methods for generating Fourier filters are known in the art and a few such methods will be described later on in the specification. The reader is invited to refer to the following document for additional information regarding phase only filters (POF): "*Phase-Only Matched Filtering*", Joseph L. Horner and Peter D. Gianino, Appl. Opt. Vol. 23 no. 6, 15 Mar. 1994, pp. 812-816. The contents of this document are incorporated herein by reference.

[**0175**] As a variant, in order to reduce the amount of data needed to represent the whole range of 3D orientations that a single target object can take, a MACE (Minimum Average Correlation Energy) filter is used to generate a template or filter for a given target object. Typically, the MACE filter combines several different 2D projections of a given object and encodes them in a single MACE filter instead of having one 2D projection per filter. One of the benefits of using MACE filters is that the resulting database of target images **110** would take less space since it would include fewer items. Also, since the number of correlation operations needed to identify a single target object would be reduced, the total processing time to determine whether a given object is present would also be reduced. The reader is invited to refer to the following document for additional information regarding MACE filters: Mahalanobis, A., B. V. K. Vijaya Kumar, and D. Casasent (1987); Minimum average correlation energy filters, Appl. Opt. 26 no. 17, 3633-3640. The contents of this document are incorporated herein by reference.

[**0176**] Another way of reducing the processing time of the correlation computation is to take advantage of the linear properties of the Fourier transform. By dividing the target image into several sub-images, a composite image can be formed, herein referred to as a mosaic. When a mosaic is displayed at the input of the correlator, the correlation is computed simultaneously on all the sub-images without incurring any substantial time penalty. A mosaic may contain several different target objects or several different orientations of the same target object or a combination of both. FIG. **9** of the drawings depicts a mosaic including a target object in various orientations and scales. The parallel processing **5** capabilities of a mosaic effectively increase the throughput of an optical correlator. The reader is invited to refer to the following document for additional information regarding the use of a mosaic in an optical correlator: Method and apparatus for evaluating a scale factor and a rotation angle in image processing, Alain Bergeron et al., U.S. Pat. No. 6,549,683, Apr. 15, 2003. The contents of this document are incorporated herein by reference.

[**0177**] FIG. **10** depicts a high level functional block diagram of a receptacle screening system using an optical correlator as part of the image comparison module **302**. As shown, an image **800** associated with a receptacle is generated by the image generation device **102** and provided as input to the pre-processing module **300**. The pre-processing module **300** performs image acquisition and pre-processing operations and forwards the pre-processed signal to the optical correlator, which is part of the image comparison module **302**. At the optical correlator, the pre-processed image undergoes an optical Fourier transformation **840**. The result of the transformation is multiplied **820** by the (previously computed) Fourier transform complex conjugate of a target image **804** obtained from the database of target images **110**. The optical correlator then processes the result of the multiplication of the two Fourier transforms by applying another optical Fourier transform **822**. The resulting signal is captured by a camera at what is referred to as the correlation plane, which yields the correlation output. The correlation output is released for transmission to the detection signal generator **306** where it is analyzed. A peak in the correlation output indicates a match between the image **800** associated with the receptacle **104** and the target image **804**. The result of the processing is then conveyed to the user by output module **108**.

[**0178**] In a non-limiting example of implementation of an optical correlator, the Fourier transform of the image **800** associated with the receptacle **104** is performed as follows: The image is displayed internally on a small Liquid Crystal Display (LCD). A collimated coherent light beam projects the image through a lens that performs the equivalent of a Fourier transform on the image. The multiplication **820** of the Fourier transform of the image **800** by the (previously computed) Fourier transform complex conjugate of a target image **804** is performed by projecting the Fourier transform of the image **800** on a second LCD screen on which is displayed the template or filter associated to the target image **804**. The two multiplied Fourier transforms are then processed through a second Fourier lens, which forces the light beam image to a CCD (camera) at the correlation plane. The CCD output is then sent to the detection signal generator module **306**. In a specific implementation, the detection signal generator module **306** includes a frame grabber

implemented by a digital computer. The digital computer is programmed to detect correlation peaks captured by the CCD.

[0179] The inner workings of the aforementioned non-limiting example optical correlator are illustrated in FIG. **11**. On the left hand side appears a laser source **900** that generates a coherent light beam used to project images across the correlator. The light beam is directed first through a small set of lenses **902** used to expand its diameter in order to illuminate, in parallel, the whole surface of a first LCD screen **904**. The image **800** associated with the receptacle **104** is displayed on the first LCD screen **904** either through a direct camera interface or provided as a VGA image by a computing device. The first LCD screen **904** is illuminated by the light beam and the image is propagated through the correlator. In the illustrated example, the image **800** captured by the camera is that of a gun on a conveyor belt.

[0180] The light beam modulated by the first image on the first LCD screen **904** is then propagated through a second set of lenses **906**, referred to as a Fourier lens since it performs the equivalent of the Fourier transform mathematical operation. The inherent properties of light are used to physically perform the appropriate calculations. Specifically, the propagation of light is a function which corresponds to the kernel of the Fourier transform operation, thus the propagation of light along the axis of a Fourier lens represents a sufficiently strong approximation of this natural phenomenon to assert that the light beam undergoes a Fourier transform. Otherwise stated, a lens has the inherent property of performing a Fourier transform on images observed at its front focal plane, provided that this image is displayed at its back focal plane. The Fourier transform, which can normally be rather computation-intensive when calculated by a digital computer, is performed in the optical correlator simply by the propagation of the light. The mathematics behind this optical realization is equivalent to the exact Fourier transform function and can be modeled with standard fast Fourier algorithms. For more information regarding Fourier transforms, the reader is invited to consider B. V. K. Vijaya Kumar, Marios Savvides, Krithika Venkataramani,and Chunyan Xie , "Spatial frequency domain image processing for biometric recognition", Biometrics ICIP Conference 2002 or alternatively J. W. Goodman, Introduction to Fourier Optics, 2nd Edition, McGraw-Hill, 1996. The contents of these documents are incorporated herein by reference.

[0181] After going through the Fourier lens **906**, the signal is projected on a second LCD screen **908** on which is displayed the target template, i.e., Fourier transform of the target image. When the Fourier transform of the image associated with the receptacle goes through the second LCD screen **908** on which the target template is displayed, the light beam crosses a second Fourier lens **910** which, again, optically computes the equivalent of a Fourier transform multiplication. This operation corresponds to a correlation in the spatial domain. The target image displayed on the second LCD screen **908** in fact induces a phase variation on the incoming light beam. Each pixel can potentially induce a phase change whose magnitude is equivalent to its grey level. As such the Fourier transform displayed on the first LCD screen **904** is multiplied with the Fourier transform of the target image, which is equivalent to performing a correlation.

[0182] The second Fourier lens **910** finally concentrates the light beam on a small area camera or CCD **912** where the result of the correlation is measured, so to speak. The CCD (camera) **912** in fact measures energy peaks on the correlation plane. The position of a correlation peak corresponds in fact to the location of the target object center in the image **800** associated with the receptacle.

[0183] Referring back to FIG. **10**, the CCD (or camera) communicates the signal from the optical correlator to the detection signal generator module **306**. In this specific implementation, the detection signal generator module **306** is a computing unit including a frame grabber and software. The software is adapted to processing the signal received from the correlator to detect energy peaks as gray level video signals varying between **0** and **255**. A strong intensity peak on the correlation plane indicates a match between the image **800** associated with the receptacle and the target image **804**. The location of the energy peak also indicates the location of the center of the target image in the image **800** associated with the receptacle.

[0184] The detection signal generator module **306** generates a detection signal. The detection signal may provide, for example, information about the level of the peak(s) and, optionally, the position of the peak(s). The detection signal may also include data allowing identifying the target object for which the level of the peak(s) and, optionally, the position of the peak(s) is being provided.

Fourier Transform and Spatial Frequencies

[0185] The Fourier transform as applied to images will now be described in general terms. The Fourier transform is a mathematical tool used to convert the information present within an object's image into its frequency representation. In short, an image can be seen as a superposition of various spatial frequencies and the Fourier transform is a mathematical operation used to compute the intensity of each of these frequencies within the original image. The spatial frequencies represent the rate of variation of image intensity in space. Consequently, a smooth or uniform pattern mainly contains low frequencies. Sharply contoured patterns, by contrast, exhibit a higher frequency content.

[0186] The Fourier transform of an image f(x,y) is given by:

$$F(u,v)=\int\int f(x,y)e^{-j2\pi(ux+vy)}dxdy \quad (1)$$

where u, v are the coordinates in the frequency domain. Thus, the Fourier transform is a global operator: changing a single frequency of the Fourier transform affects the whole object in the spatial domain.

[0187] A correlation operation can be mathematically described by:

$$C(\varepsilon,\xi)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}f(x,y)h^{*}(x-\varepsilon,y-\xi)dxdy \quad (2)$$

where ϵ and ξ represent the pixel coordinates in the correlation plane, $C(\epsilon,\xi)$ stands for the correlation, x and y identify the pixel coordinates of the input image, f(x, y) is the original input image and $h^{*}(\epsilon,\xi)$ is the complex conjugate of the correlation filter.

[0188] In the frequency domain the same expression takes a slightly different form:

$$C(\epsilon, \xi)=\Im^{-1}(F(u,v)H^*(u,v)) \quad (3)$$

where $\Im$ is the Fourier transform operator, u and v are the pixel coordinates in the Fourier plane, F(u,v) is the Fourier transform complex conjugate of the image acquired with the camera f(x,y) and H*(u,v) is the Fourier transform of the filter of the reference template. Thus, the correlation between an input image and a target template is equivalent, in mathematical terms, to the multiplication of their respective Fourier transform, provided that the complex conjugate of the filter is used. Consequently, the correlation can be defined in the spatial domain as the search for a given pattern (template), or in the frequency domain, as filtering operation with a specially designed matched filter.

[0189] Advantageously, the use of optics for computing a correlation operation allows the computation to be performed in a shorter time than by using a digital implementation of the correlation. It turns out that an optical lens properly positioned (i.e. input and output images are located on the lens's focal planes) automatically computes the Fourier transform of the input image. In order to speed up the computation of the correlation, the Fourier transform of a target image can be computed beforehand and submitted to the correlator as a mask or template. The target template (or filter in short) is generated by computing the Fourier transform of the reference template. This type of filter is called a matched filter.

[0190] FIG. **10** depicts the Fourier transform of the spatial domain image of a '**2**'. It can be seen that most of the energy (bright areas) is contained in the central portion of the Fourier transform image which correspond to low spatial frequencies (the images are centred on the origin of the Fourier plane). The energy is somewhat more dispersed in the medium frequencies and is concentrated in orientations representative of the shape of the input image. Finally, little energy is contained in the upper frequencies. The right-hand-side image shows the phase content of the Fourier transform. The phase is coded from black (0°) to white (360°).

Generation of Filters from Target Images

[0191] Matched filters, as their name implies, are specifically adapted to respond to one image in particular: they are optimized to respond to an object with respect to its energy content. Generally, the contour of an object corresponds to its high frequency content. This can be easily understood as the contour represent areas where the intensity varies rapidly (hence a high frequency).

[0192] In order to emphasize the contour of an object, the matched filter can be divided by its module (the image is normalized), over the whole Fourier transform image. The resulting filter is called a Phase-Only Filter (POF) and is defined by:

$$POF(u, v) = \frac{H^*(u, v)}{|H^*(u, v)|} \quad (4)$$

[0193] The reader is invited to refer to the following document for additional information regarding phase only filters (POF): "*Phase-Only Matched Filtering*", Joseph L. Homer and Peter D. Gianino, Appl. Opt. Vol. 23 no. 6, 15 Mar. 1994, pp. 812-816. The contents of this document are incorporated herein by reference.

[0194] Because these filters are defined in the frequency domain, normalizing over the whole spectrum of frequencies implies that each of the frequency components is considered with the same weight. In the spatial domain (e.g. usual real-world domain), this means that the emphasis is given to the contours (or edges) of the object. As such, the POF filter provides a higher degree of discrimination, sharper correlation peaks and higher energy efficiency.

[0195] The discrimination provided by the POF filter, however, has some disadvantages. It turns out that, although the optical correlator is somewhat insensitive to the size of the objects to be recognized, the images are expected to be properly sized, otherwise the features might not be registered properly. To understand this requirement, imagine a filter defined out of a given instance of a '2'. If that filter is applied to a second instance of a '2' whose contour is slightly different, the correlation peak will be significantly reduced as a result of the great sensitivity of the filter to the original shape. A different type of filter, termed a composite filter, was introduced to overcome these limitations. The reader is invited to refer to the following document for additional information regarding this different type of composite filter: H. J. Caufield and W. T. Maloney, Improved discrimination in optical character recognition, Appl. Opt., 8, 2354, 1969. The contents of this document are incorporated herein by reference.

[0196] In accordance with specific implementations, filters can be designed by:

[0197] Appropriately choosing one specific instance (because it represents characteristics which are, on average, common to all symbols of a given class) of a symbol and calculating from that image the filter against which all instances of that class of symbols will be compared; or

[0198] Averaging many instances of a given to create a generic or 'template' image from which the filter is calculated. The computed filter is then called a composite filter since it incorporates the properties of many images (note that it is irrelevant whether the images are averaged before or after the Fourier transform operator is applied, provided that in the latter case, the additions are performed taking the Fourier domain phase into account).

[0199] The latter procedure forms the basis for the generation of composite filters. Thus composite filters are composed of the response of individual POF filters to the same symbol. Mathematically, this can be expressed by:

$$h_{comp}(x,y)=\alpha_a h_a(x,y)+\alpha_b h_b(x,y)+K+\alpha_x h_x(x,y) \quad (5)$$

[0200] A filter generated in this fashion is likely to be more robust to minor signature variations as the irrelevant high frequency features will be averaged out. In short, the net effect is an equalization of the response of the filter to the different instances of a given symbol.

[0201] Composite filters can also be used to reduce the response of the filter to the other classes of symbols. In equation (5) above, if the coefficient b, for example, is set to

a negative value, then the filter response to a symbol of class b will be significantly reduced. In other words, the correlation peak will be high if $h_a(x,y)$ is at the input image, and low if $h_b(x,y)$ is present at the input. A typical implementation of composite filters is described in: Optical character recognition (OCR) in uncontrolled environments using optical correlators, Andre Morin, Alain Bergeron, Donald Prevost, and Ernst A. Radloff Proc. SPIE Int. Soc. Opt. Eng. 3715, 346 (1999). The contents of this document are incorporated herein by reference.

Second Embodiment—Screening of Persons

[0202] Although the above-described screening system was described in connection with screening of receptacles, the concepts described above can also be applied to the screening of people.

[0203] For example, in an alternative embodiment, a system for screening people is provided. The system includes components similar to those described in connection with the system depicted in FIG. **1**. In a specific example of implementation, the image generation device **102** is configured to scan a person and possibly to scan the person along various axes and/or views to generate multiple images associated to the person. The image or images associated with the person convey information related to the objects carried by the person. FIG. **13** depicts two images associated with a person suitable for use in connection with a specific implementation of the system. Each image is then processed in accordance with the method described in the present specification to detect the presence of prohibited objects on the person.

[0204] Optionally, in the case of a system for screening people, the database of target objects **110** may further include entries associated to non-prohibited objects and/or objects that do not represent a potential threat. Such entries may be used to detect objects commonly carried by people such as cell-phones, watches and rings, for example, which are not prohibited and not threatening. Advantageously, by identifying such objects and indicating to the screeners that such objects are not prohibited and/or do not represent a potential and as such can be ignored, unnecessary manual verifications can be avoided.

Specific Physical Implementation

[0205] Certain portions of the apparatus **1510** for implementing a user interface (shown in FIG. **3**) can be implemented on a general purpose digital computer **1300**, of the type depicted in FIG. **14**, including a processing unit **1302** and a memory **1304** connected by a communication bus. The memory includes data **1308** and program instructions **1306**. The processing unit **1302** is adapted to process the data **1308** and the program instructions **1306** in order to implement the functional blocks described in the specification and depicted in the drawings. The digital computer **1300** may also comprise an I/O interface **1310** for receiving or sending data elements to external devices.

[0206] Similarly, certain portions of the image processing apparatus **106** can also be implemented on a general purpose digital computer having a similar structure as that described in connection with FIG. **14**. Certain portions of the image processing apparatus **106** and of the apparatus **1510** for implementing a user interface may be implemented on a same general purpose digital computer without detracting from the spirit of the invention.

[0207] Alternatively, the above-described image processing apparatus **106** can be implemented on a dedicated hardware platform where electrical/optical components implement the functional blocks described in the specification and depicted in the drawings. Specific implementations may be realized using ICs, ASICs, DSPs, FPGA, an optical correlator, digital correlator or other suitable hardware platform.

[0208] Other alternative implementations of the image processing apparatus **106** and the apparatus **1510** for implementing a user interface can be implemented as a combination of dedicated hardware and software such as apparatus **1200** of the type depicted in FIG. **15**. As shown, such an implementation comprises an optical correlator **1208** or other dedicated image processing hardware and a general purpose computing unit **1206** including a CPU **1212** and a memory **1214** connected by a communication bus. The memory includes data **1218** and program instructions **1216**. The CPU **1212** is adapted to process the data **1218** and the program instructions **1216** in order to implement the functional blocks described in the specification and depicted in the drawings. The CPU **1212** is also adapted to exchange data with the optical correlator **1208** over communication link **1210** to make use of the optical correlator's image processing capabilities. The apparatus **1202** may also comprise I/O interfaces **12021204** for receiving or sending data elements to external devices.

[0209] In a variant, a single optical correlator **1208** can be shared by multiple general purpose computing units **1206**. In such a variant, conventional parallel processing techniques can be used for sharing a common hardware resource.

[0210] In a specific example of implementation, the optical correlator suitable for use in the system described includes two video inputs. The video inputs are suitable for receiving a signal derived from an image generation device and a signal derived from a database of target images. In a specific implementation, the video inputs are suitable for receiving a signal in an NTSC compatible format or a VGA compatible format. It will be appreciated that either one of the video inputs may be adapted for receiving signals of lower or higher resolution than the VGA compatible format signal. Similarly, it will also be appreciated that the video input suitable for receiving a signal in an NTSC compatible format may be adapted for receiving signals in suitable formats such as, but not limited to, PAL and SECAM. In a non-limiting implementation, the optical correlator is adapted to process an image received at the video input having an area of **640×480** pixels. However, it will be readily apparent that, by providing suitable interfaces, larger or smaller images can be handled since the optical correlator's processing capability is independent of the size of the image, as opposed to digital systems that require more processing time and power as images get larger.

[0211] It will be appreciated that the system for screening a receptacle **100** (depicted in FIG. **1**) may also be of a distributed nature where the image signals associated with the receptacles are obtained at one location or more locations and transmitted over a network to a server unit implementing the method described above. The server unit may then transmit a signal for causing an output unit to display

information to the user. The output unit may be located in the same location where the image signal associated with the receptacle was obtained or in the same location as the server unit or in yet another location. In a non-limiting implementation, the output unit is part of a centralized receptacle screening facility. FIG. **16** illustrates a network-based client-server system **1300** for system for screening receptacles. The client-server system **1300** includes a plurality of client systems **1302**, **1304**, **1306** and **1308** connected to a server system **1310** through network **1312**. The communication links **1314** between the client systems **1302**, **1304**, **1306** and **1308** and the server system **1310** can be metallic conductors, optical fibres or wireless, without departing from the spirit of the invention. The network **1312** may be any suitable network including but not limited to a global public network such as the Internet, a private network and a wireless network. The server **1310** may be adapted to process and issue signals concurrently using suitable methods known in the computer related arts.

[**0212**] The server system **1310** includes a program element **1316** for execution by a CPU. Program element **1316** includes functionality to implement the methods described above, including a method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects during security screening of a receptacle, and includes the necessary networking functionality to allow the server system **1310** to communicate with the client systems **1302**, **1304**, **1306** and **1308** over network **1312**. In a specific implementation, the client systems **1302**, **1304**, **1306** and **1308** include display units responsive to signals received from the server system **1310** for displaying user interface module implementation by the server system **1310**. Optionally, server system **1310** also includes an optical correlator unit.

[**0213**] Although the present invention has been described in considerable detail with reference to certain preferred embodiments thereof, variations and refinements are possible without departing from the spirit of the invention. Therefore, the scope of the invention should be limited only by the appended claims and their equivalents.

1. A computer readable storage medium storing a program element suitable for execution by a CPU, said program element implementing a graphical user interface module for use in detecting the presence of one or more prohibited objects in a receptacle, said graphical user interface module being adapted for:

a) displaying first information conveying an image associated with the receptacle, said image conveying information related to the contents of the receptacle;

b) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information;

c) providing a control allowing a user to cause third information to be displayed, said third information conveying at least one characteristic associated to the at least one prohibited object.

2. A computer readable storage medium as defined in claim 1, wherein said third information conveys an image of the at least one prohibited object, the image being extracted from a database of prohibited objects.

3. A computer readable storage medium as defined in claim 1, wherein said third information conveys a risk level associated to the at least one prohibited object.

4. A computer readable storage medium as defined in claim 1, wherein said third information conveys a level of confidence associated to the presence of the at least one prohibited object in the receptacle.

5. A computer readable storage medium as defined in claim 1, wherein said first information and second information are displayed in a first viewing window and said third information is displayed in a second viewing window.

6. A computer readable storage medium as defined in claim 5, wherein said graphical user interface module being adapted for:

a) displaying a prohibited object list, the prohibited object list including a plurality of entries, each entry being associated to a corresponding prohibited object whose presence in the receptacle was detected;

b) enabling a user to select an entry from said plurality of entries in said prohibited object list;

c) displaying information associated with the entry selected in b).

7. A computer readable storage medium as defined in claim 6, wherein at least one entry in said prohibited object list conveys a level of confidence associated to detection of the corresponding prohibited object in the receptacle.

8. A computer readable storage medium as defined in claim 6, wherein said information associated to the selected entry includes an information item selected from the set consisting of an image of a prohibited object and a risk level associated to the prohibited object.

9. A computer readable storage medium as defined in claim 1, wherein said control is a first control, said graphical user interface module being adapted for providing a second control allowing a user to cause said second information to be removed from the user interface module.

10. A computer readable storage medium as defined in claim 1, wherein the image associated with the receptacle conveyed by said first information is selected from the set consisting of x-ray, gamma-ray, computed tomography (CT scans), TeraHertz and millimeter wave images.

11. A computer readable storage medium as defined in claim 1, wherein the image associated with the receptacle conveyed by said first information includes an image generated on the basis of emitted radiation.

12. A computer readable storage medium as defined in claim 1, wherein said control allows the user to cause said third information to be displayed by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

13. A computer readable storage medium as defined in claim 12, wherein said control includes a selection box.

14. A computer readable storage medium as defined in claim 1, wherein the second information conveys the presence of at least one prohibited object in the receptacle in textual format.

15. A computer readable storage medium as defined in claim 1, wherein the second information conveys the presence of at least one prohibited object in the receptacle in graphical format.

16. A computer readable storage medium as defined in claim 15, wherein the second information conveys position

information related to the at least one prohibited object whose presence in the receptacle was detected.

17. A computer readable storage medium as defined in claim 1, wherein said graphical user interface module is adapted for:

a) receiving a detection signal conveying presence of at least one prohibited object in the receptacle;

b) processing the detection signal to derive said second information.

18. A computer readable storage medium as defined in claim 17, wherein said detection signal includes a data element conveying a level of confidence associated to the presence of at least one prohibited object in the receptacle.

19. A computer readable storage medium as defined in claim 18, wherein said graphical user interface module is operative for:

a) processing the data element indicative of the level of confidence in combination with a detection sensitivity level;

b) when the level of confidence associated to the presence of at least one prohibited object in the receptacle conveyed by the data element in the detection signal is below the detection sensitivity level, causing said second information to be omitted from the user interface module.

20. A computer readable storage medium as defined in claim 19, wherein said control is a first control, said user interface is adapted for displaying a second control allowing a user to modify the detection sensitivity level.

21. A computer readable storage medium as defined in claim 17, wherein the detection signal conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

22. A computer readable storage medium as defined in claim 17, wherein the detection signal enables identification of the at least one prohibited object whose presence in the receptacle was detected.

23. A computer readable storage medium as defined in claim 1, wherein the receptacle is a luggage item.

24. A computer readable storage medium as defined in claim 1, wherein the receptacle is a cargo container.

25. A computer readable storage medium as defined in claim 1, wherein the receptacle is a mail parcel.

26. An apparatus for implementing a user interface module for use in screening receptacles to detect the presence of one or more prohibited objects, said apparatus comprising:

a) a first input for receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle;

b) a second input for receiving a detection signal conveying a presence of at least one prohibited object in the receptacle;

c) a processing unit in communication with said first input and second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:

i) displaying first information conveying an image associated with the receptacle on the basis of said image signal;

ii) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal;

iii) providing a control allowing a user to cause third information to be displayed, said third information conveying at least one characteristic associated to the at least one prohibited object;

d) an output for releasing a signal adapted to cause a display module to display said user interface module.

27. An apparatus as defined in claim 26, wherein said third information conveys an image of the at least one prohibited object, the image being extracted from a database of prohibited objects.

28. An apparatus as defined in claim 26, wherein said third information conveys a risk level associated to the at least one prohibited object.

29. An apparatus as defined in claim 26, wherein said third information conveys a level of confidence associated to the presence of the at least one prohibited object in the receptacle.

30. An apparatus as defined in claim 26, wherein said first information and second information are displayed in a first viewing window and said third information is displayed in a second viewing window.

31. An apparatus as defined in claim 30, wherein said graphical user interface module being adapted for:

a) displaying a prohibited object list, the prohibited object list including a plurality of entries, each entry being associated to a corresponding prohibited object whose presence in the receptacle was detected;

b) enabling a user to select an entry from said plurality of entries in said prohibited object list;

c) displaying information associated with the entry selected in b).

32. An apparatus as defined in claim 31, wherein at least one entry in said prohibited object list conveys a level of confidence associated to detection of the corresponding prohibited object in the receptacle.

33. An apparatus as defined in claim 31, wherein said information associated to the selected entry includes an information item selected from the set consisting of an image of a prohibited object and a risk level associated to the prohibited object.

34. An apparatus as defined in claim 26, wherein said control is a first control, said graphical user interface module being adapted for displaying a second control allowing a user to cause said second information to be removed from the user interface module.

35. An apparatus as defined in claim 26, wherein the image associated with the receptacle conveyed by said first information is selected from the set consisting of x-ray, gamma-ray, computed tomography (CT scans), TeraHertz and millimeter wave images.

36. An apparatus as defined in claim 26, wherein the image associated with the receptacle conveyed by said first information includes an image generated on the basis of emitted radiation.

37. An apparatus as defined in claim 26, wherein said control allows the user to cause said third information to be

displayed by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

38. An apparatus as defined in claim 37, wherein said control includes a selection box.

39. An apparatus as defined in claim 26, wherein the second information conveys the presence of at least one prohibited object in the receptacle in textual format.

40. An apparatus as defined in claim 26, wherein the second information conveys the presence of at least one prohibited object in the receptacle in graphical format.

41. An apparatus as defined in claim 40, wherein the second information conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

42. An apparatus as defined in claim 26, wherein said detection signal includes a data element conveying a level of confidence associated to the presence of at least one prohibited object in the receptacle.

43. An apparatus as defined in claim 42, wherein said graphical user interface module is operative for:

a) processing the data element indicative of the level of confidence in combination with a detection sensitivity level;

b) when the level of confidence associated to the presence of at least one prohibited object in the receptacle conveyed by the data element in the detection signal is below the detection sensitivity level, causing said second information to be omitted from the user interface module.

44. An apparatus as defined in claim 43, wherein said control is a first control, said user interface is adapted for displaying a second control allowing a user to modify the detection sensitivity level.

45. An apparatus as defined in claim 41, wherein the detection signal conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

46. An apparatus as defined in claim 41, wherein the detection signal enables identification of the at least one prohibited object whose presence in the receptacle was detected.

47. An apparatus as defined in claim 26, wherein the receptacle is a luggage item.

48. An apparatus as defined in claim 26, wherein the receptacle is a cargo container.

49. An apparatus as defined in claim 26, wherein the receptacle is a mail parcel.

50. A method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in the receptacle during security screening, said method comprising:

a) receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle;

b) displaying first information conveying an image associated with the receptacle on the basis of said image signal;

c) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information;

d) providing a control allowing a user to cause third information to be displayed, said third information conveying at least one characteristic associated to the at least one prohibited object.

51. A method as defined in claim 50, wherein said third information conveys an image of the at least one prohibited object, the image being extracted from a database of prohibited objects.

52. A method as defined in claim 50, wherein said third information conveys a risk level associated to the at least one prohibited object.

53. A method as defined in claim 50, wherein said third information conveys a level of confidence associated to the presence of the at least one prohibited object in the receptacle.

54. A method as defined in claim 50, wherein said first information and second information are displayed in a first viewing window and said third information is displayed in a second viewing window.

55. A method as defined in claim 54, wherein said graphical user interface module being adapted for:

a) displaying a prohibited object list, the prohibited object list including a plurality of entries, each entry being associated to a corresponding prohibited object whose presence in the receptacle was detected;

b) enabling a user to select an entry from said plurality of entries in said prohibited object list;

c) displaying information associated with the entry selected in b).

56. A method as defined in claim 55, wherein at least one entry in said prohibited object list conveys a level of confidence associated to detection of the corresponding prohibited object in the receptacle.

57. A method as defined in claim 55, wherein said information associated to the selected entry includes an information item selected from the set consisting of an image of a prohibited object and a risk level associated to the prohibited object.

58. A method as defined in claim 50, wherein said control is a first control, said graphical user interface module being adapted for displaying a second control allowing a user to cause said second information to be removed from the user interface module.

59. A method as defined in claim 50, wherein the image associated with the receptacle conveyed by said first information is selected from the set consisting of x-ray, gamma-ray, computed tomography (CT scans), TeraHertz and millimeter wave images.

60. A method as defined in claim 50, wherein the image associated with the receptacle conveyed by said first information includes an image generated on the basis of emitted radiation.

61. A method as defined in claim 50, wherein said control allows the user to cause said third information to be displayed by using an input device selected from the set consisting of a mouse, keyboard, pointing device, speech recognition unit and touch sensitive screen.

62. A method as defined in claim 61, wherein said control includes a selection box.

63. A method as defined in claim 50, wherein the second information conveys the presence of at least one prohibited object in the receptacle in textual format.

64. A method as defined in claim 50, wherein the second information conveys the presence of at least one prohibited object in the receptacle in graphical format.

65. A method as defined in claim 64, wherein the second information conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

66. A method as defined in claim 50, wherein said method comprises:

a) receiving a detection signal conveying presence of at least one prohibited object in the receptacle;

b) processing the detection signal to derive said second information.

67. A method as defined in claim 66, wherein said detection signal includes a data element conveying a level of confidence associated to the presence of at least one prohibited object in the receptacle.

68. A method as defined in claim 67, wherein said graphical user interface module is operative for:

a) processing the data element indicative of the level of confidence in combination with a detection sensitivity level;

b) when the level of confidence associated to the presence of at least one prohibited object in the receptacle conveyed by the data element in the detection signal is below the detection sensitivity level, causing said second information to be omitted from the user interface module.

69. A method as defined in claim 68, wherein said control is a first control, said user interface is adapted for displaying a second control allowing a user to modify the detection sensitivity level.

70. A method as defined in claim 66, wherein the detection signal conveys position information related to the at least one prohibited object whose presence in the receptacle was detected.

71. A method as defined in claim 66, wherein the detection signal enables identification of the at least one prohibited object whose presence in the receptacle was detected.

72. A method as defined in claim 50, wherein the receptacle is a luggage item.

73. A method as defined in claim 50, wherein the receptacle is a cargo container.

74. A method as defined in claim 50, wherein the receptacle is a mail parcel.

75. An apparatus for implementing a user interface module for use in detecting the presence of one or more prohibited objects in a receptacle, said apparatus comprising:

a) means for receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle;

b) means for receiving a detection signal conveying a presence of at least one prohibited object in the receptacle;

c) means for implementing the user interface module, said user interface module being adapted for:

i) displaying first information conveying an image associated with the receptacle on the basis of said image signal;

ii) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal;

iii) providing a control allowing a user to cause third information to be displayed, said third information conveying at least one characteristic associated to the at least one prohibited object;

d) means for releasing a signal adapted to cause a display module to display said user interface module.

76. A system for detecting the presence of one or more prohibited objects in a receptacle, comprising:

a) an input for receiving data conveying graphic information regarding the contents of the receptacle;

b) an optical correlator in communication with said input, said optical correlator being operative for processing the graphic information to detect a depiction of the one or more prohibited objects in the receptacle;

c) an apparatus for implementing a user interface module, said apparatus being in communication with said input and with said optical correlator, said apparatus being operative for implementing a user interface module adapted for:

i) displaying first information conveying an image associated with the receptacle on the basis of the data conveying graphic information regarding the contents of the receptacle;

ii) displaying second information conveying a presence of one or more prohibited objects in the receptacle, said second information being displayed simultaneously with said first information;

iii) releasing a signal adapted to cause a display module to display said user interface module.

77. A computer readable storage medium storing a program element suitable for execution by a CPU, said program element implementing a graphical user interface module for use in detecting the presence of one or more prohibited objects in a receptacle, said graphical user interface module being adapted for:

a) displaying first information conveying an image associated with the receptacle, said image conveying information related to the contents of the receptacle;

b) receiving a detection signal conveying a presence of at least one prohibited object in the receptacle;

c) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal.

78. A method for displaying information associated to a receptacle for use in detecting the presence of one or more prohibited objects in the receptacle during security screening, said method comprising:

a) receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle;

b) displaying first information conveying an image associated with the receptacle on the basis of said image signal;

c) receiving a detection signal conveying a presence of at least one prohibited object in the receptacle;

d) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal.

79. An apparatus for implementing a user interface module for use in screening receptacles to detect a presence of one or more prohibited objects, said apparatus comprising:

a) a first input for receiving an image signal associated with a receptacle, the image signal conveying information related to the contents of the receptacle;

b) a second input for receiving a detection signal conveying a presence of at least one prohibited object in the receptacle;

c) a processing unit in communication with said first input and second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:

i) displaying first information conveying an image associated with the receptacle on the basis of said image signal;

ii) displaying second information conveying a presence of at least one prohibited object in the receptacle, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal;

d) an output for releasing a signal adapted to cause a display module to display said user interface module.

80. An apparatus for implementing a user interface module for use in screening a person to detect the presence of one or more prohibited objects, said apparatus comprising:

a) a first input for receiving an image signal associated with the person;

b) a second input for receiving a detection signal conveying a presence of at least one prohibited object on the person;

c) a processing unit in communication with said first input and second input, said processing unit being operative for implementing the user interface module, said user interface module being adapted for:

i) displaying first information conveying an image associated with the person on the basis of said image signal;

ii) displaying second information conveying a presence of at least one prohibited object on the person, said second information being displayed simultaneously with said first information, said second information being derived at least in part on the basis of said detection signal;

d) an output for releasing a signal adapted to cause a display module to display said user interface module.

* * * * *