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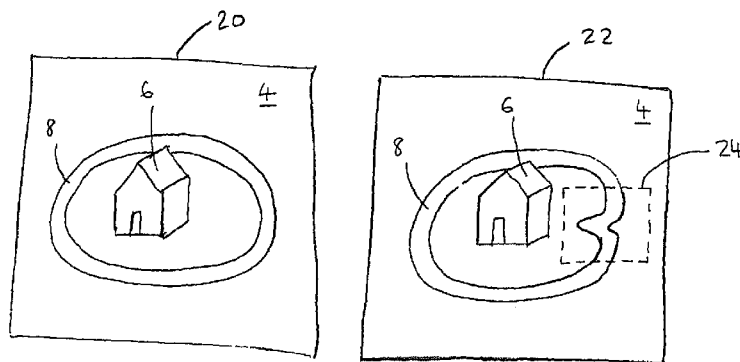


FIG. 4

(57) Abstract: Apparatus and method for performing surveillance of an area (4), comprising: placing an amount of material (8) within a portion of the area (4), the material (8) being a granular material having a grain size of less than 65 mm diameter, the material (8) being material that, to some extent, reflects or emits electromagnetic radiation, wherein reflected electromagnetic radiation has a wavelength that is not within the visible light wavelength range; thereafter, imaging, using a sensor (14) configured to detect the reflected or emitted electromagnetic radiation, the area (4), thereby providing one or more images of the area (4) and the material (8) placed therein, and analysing the images to detect a disturbance of the placed material (8).

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SURVEILLANCE PROCESS AND APPARATUS

FIELD OF THE INVENTION

The present invention relates to methods for performing surveillance.

5

BACKGROUND

Aircraft, e.g. Unmanned Air Vehicles (UAVs), are commonly used in surveillance operations.

Typically, surveillance operations comprise imaging an area under
10 surveillance. These images may then be analysed to detect e.g. people or vehicles within those images.

In a separate field to the field of surveillance, sand that reflects or emits (e.g. by absorbing and re-emitting) electromagnetic radiation (e.g. ultraviolet electromagnetic radiation) is commercially available. An example of such sand
15 is "UV Blue response sand" manufactured by Specialist Aggregates Ltd. This sand has conventionally been used for event decoration, tracer marking of products, plant and machinery, marine and stream sediment surveys, theatrical applications, and contamination simulation.

20 SUMMARY OF THE INVENTION

In a first aspect, the present invention provides a method of performing surveillance of an area, the method comprising: placing an amount of material within a portion of the area, the material being a granular material having a grain size of less than 65 mm diameter, the material being material that, to
25 some extent, reflects or emits electromagnetic radiation; thereafter, imaging, using a sensor configured to detect the reflected or emitted electromagnetic radiation, the area, thereby providing one or more images of the area and the material placed therein; and analysing the images to detect a disturbance of the placed material.

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Electromagnetic radiation reflected or emitted by the material may have a wavelength that is not within the visible light wavelength range.

The material may be material that absorbs electromagnetic radiation having a first wavelength that is incident on the material, and, in response to absorbing incident electromagnetic radiation having a first wavelength, emits electromagnetic radiation having a second wavelength. The first wavelength may be a different wavelength to the second wavelength.

The first wavelength may be within the ultraviolet range of the electromagnetic spectrum, and the second wavelength may be within the visible light range of the electromagnetic spectrum.

The method may further comprise, whilst imaging the area, illuminating the area with electromagnetic radiation, the electromagnetic radiation used to illuminate the area having a wavelength such that the material may reflect or absorb that electromagnetic radiation.

The step of imaging may comprise using a spectral filter to filter out electromagnetic radiation having a different wavelength to that reflected or emitted by the material.

The material may have a grain size selected from the group of grain sizes consisting of: between 1/16 mm and 1/8 mm diameter, between 1/8 mm and 1/4 mm diameter, between 1/4 mm and 1/2 mm diameter, between 1/2 mm and 1 mm diameter, and between 1 mm and 2 mm diameter.

The material may have a grain size of between 0.3 mm and 0.6 mm.

The material may be sand that has been coated with or treated with a substance that reflects or emits the electromagnetic radiation.

The sensor may be mounted on an aircraft, the aircraft flying proximate to the area such that the area can be imaged using the sensor. The aircraft may be an unmanned aircraft.

The method may further comprise transmitting, from the aircraft to a location remote from the aircraft, image data captured by the sensor. Analysing

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the images may be performed at the location remote from the aircraft or onboard the aircraft (e.g. prior to transmission of the image data to the location).

The method may further comprise identifying an entity causing the disturbance of the material by detecting, using a further sensor configured to
5 detect electromagnetic radiation reflected or emitted by the material, one or more grains of the material on the entity.

In a further aspect, the present invention provides apparatus for performing surveillance of an area, the apparatus comprising: an amount of material, the material having been placed within a portion of the area, the
10 material being a granular material having a grain size of less than 65 mm diameter, the material being material that, to some extent, reflects or emits electromagnetic radiation; a sensor configured to image the area with the material placed therein thereby providing one or more images of the area and the material placed therein, the sensor being configured to detect
15 electromagnetic radiation reflected or emitted by the material; and an image analysis module operatively coupled to the sensor and configured to analyse the images to detect a disturbance of the placed material.

BRIEF DESCRIPTION OF THE DRAWINGS

20 Figure 1 is a schematic illustration (not to scale) showing a configuration of entities during a step of an embodiment of a surveillance process;

Figure 2 is a schematic illustration (not to scale) of an aircraft;

Figure 3 is a process flow chart showing certain steps of the surveillance process; and

25 Figure 4 is a schematic illustration (not to scale) showing two surveillance images.

DETAILED DESCRIPTION

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Figure 1 is a schematic illustration (not to scale) showing a configuration of entities during a step of an embodiment of a surveillance process.

The surveillance process is described in more detail later below with reference to Figure 3.

5 During the surveillance process, an unmanned air vehicle (UAV) 2 flies over (or proximate to) an area of terrain 4.

 The area of terrain 4 comprises a building 6 and an amount of sand 8. The sand is located on the ground, i.e. on a portion of the area of terrain 4, such that the sand 8 surrounds the portion of the area of terrain 4 that is occupied by
10 the building 6. In other words, the sand 8 surrounds the building 6 to some extent. In other words, the sand 8 has been placed on the ground around the perimeter of the building 6. Thus, the sand 8, in effect, forms a "ring" around the building.

 In this embodiment, the sand 8 is configured or adapted to absorb
15 electromagnetic radiation having a first wavelength, and then emit electromagnetic radiation of a second, different wavelength (e.g. a wavelength that is longer than the first wavelength). In particular, in this embodiment the sand 8 is configured or adapted to absorb ultraviolet (UV) radiation (i.e. electromagnetic radiation in the UV range) and re-emit visible light (i.e. the sand
20 may "fluoresce" when UV radiation is incident upon it). The incident UV light is not visible light (i.e. is not visible to the naked human eye).

 An example of appropriate sand that may be used is "UV Blue response sand" from Specialist Aggregates Ltd. The grain size of the sand is typically 0.3-0.6mm. This sand tends to appear, to a naked human eye, like "ordinary" sand
25 when not exposed to UV light, but tends to "glow" when exposed to UV light. In other words, to the naked human eye, the sand 8 tends to be indistinguishable from ordinary sand when not exposed to UV light, i.e. sand that has not been coated with or treated with a substance that reflects, absorbs and/or emits (e.g. re-emits) UV radiation.

30 Although sunlight comprises UV light which may be absorbed by the sand 8, sunlight tends to be so bright that, to the naked eye, the visible (blue)

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light re-emitted by the sand 8 when the sand 8 is exposed to the UV light, tends to be “washed out”, or overwhelmed. Thus, in daylight, to the naked human eye, the sand 8 tends to be indistinguishable from ordinary (i.e. non-flourescent) sand (unless UV is specifically shone onto the sand 8). by the sulight of similar
5 colour and at other wavelengths.

In other embodiments, a different type of material may be used instead of or in addition to the above described sand 8. For example, a different type of sand that is configured or adapted to reflect electromagnetic radiation having a certain wavelength (e.g. in the UV range) or emit electromagnetic radiation
10 having a certain wavelength (e.g. in the UV range) may be used. Also, in other embodiments, a sand that is configured or adapted to absorb electromagnetic radiation having a wavelength other than UV, and/or re-emit electromagnetic radiation having a wavelength other than visible light, may be used.

The reflection, absorption and/or emission of electromagnetic radiation
15 by the sand 8 may, for example, be provided by each particle of the sand 8 being coated with or treated with a substance that reflects, absorbs and/or emits (e.g. re-emits) UV radiation. In other embodiments, the sand 8 may be made of a substance that reflects, absorbs and/or emits (e.g. re-emits) UV radiation.

As described in more detail later below, as UAV 2 flies over the area of
20 terrain 4, the UAV 2 performs surveillance of the area of terrain 4 (and the building 6 and the sand 8 therein). This surveillance comprises the UAV 2 capturing images of the area of terrain 4.

In this embodiment, the UAV 2 is connected to a ground station 10 by a wireless data-link 12. This connection is such that information may be sent
25 between the UAV 2 and the ground station 10. The UAV 2 may, for example, be controlled by an operator (e.g. a human operator) located at the ground station 10 and control signals for the UAV 2 may be sent from the ground station 10 via the data-link 12.

Figure 2 is a schematic illustration (not to scale) of the UAV 2.

30 The UAV 2 comprises an illuminator 13, a sensor 14, a processor 16, and a transceiver 18.

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The illuminator 13 is a device that is configured to “shine” UV electromagnetic radiation onto the area of terrain 4 as the area of terrain 4 is imaged by the UAV 2. The illuminator 13 may, for example, be a UV laser. When incident on the sand 8, UV radiation from the illuminator 13, tends to be absorbed by the sand 8 and the sand 8 re-emits visible light, i.e. UV radiation from the illuminator 13 that is incident on the sand 8 causes the sand 8 to fluoresce. The use of an illuminator 13 to cause the sand 8 to fluoresce advantageously avoids a reliance on ambient illumination to excite the sand’s fluorescence response. Furthermore, a signal to noise ratio advantageously tends to be increased.

In this embodiment, the sensor 14 is a visible light sensor, i.e. a sensor configured to detect electromagnetic radiation within the visible range. For example, the sensor 14 may be a visible light detecting camera. The sensor 14 may also comprise a spectral filter to block out unwanted “background” clutter. The spectral filter may only allow through light of the wavelength re-emitted by the fluorescent sand 8 when it is illuminated with UV light.

The sensor 14 may be mounted on the UAV 2 via a gimbal (not shown in the Figures).

The sensor 14 and the illuminator 13 are connected to the processor 16 such that information may be sent from each of the sensor 14 and the illuminator 13 to the processor 16 and *vice versa*.

The processor 16 may be configured to provide, or “drive”, a control signal for the illuminator 13. Thus, the processor 16 may control the operation of the illuminator 13. Also, the processor 16 may be configured to provide, or “drive”, a control signal for the sensor 14. Thus, the processor 16 may control the operation of the sensor 14. For example, the processor 16 may control the facing of the sensor 14 relative to the UAV 2 and/or the rate at which the sensor 14 captures images of the area of terrain 4.

Also, In this embodiment, the processor 16 is configured to process image data generated by the sensor 14 and sent to the processor 16 from the sensor 14, as described in more detail later below with reference to Figure 3.

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In addition to being connected to the sensor 14, the processor 16 is connected to the transceiver 18. This is such that information may be sent from the processor 16 to the transceiver 18 and vice versa.

The transceiver 18 is connected to the ground station 8 via the data-link
5 10 such that information may be sent from the transceiver 18 to the transceiver ground station 10 (via the data-link 12) and vice versa.

Apparatus, including the processor 16, for implementing the above arrangement, and performing the method steps to be described later below with reference to Figure 3, may be provided by configuring or adapting any suitable
10 apparatus, for example one or more computers or other processing apparatus or processors, and/or providing additional modules. The apparatus may comprise a computer, a network of computers, or one or more processors, for implementing instructions and using data, including instructions and data in the form of a computer program or plurality of computer programs stored in or on a
15 machine readable storage medium such as computer memory, a computer disk, ROM, PROM etc., or any combination of these or other storage media. The apparatus may be wholly onboard the UAV 2, wholly off-board the UAV 2 (e.g. at the ground station 8), or partially on board and partially off-board the UAV 2.

Figure 3 is a process flow chart showing certain steps of the surveillance
20 process that may be performed by the UAV 2 in the above described scenario 1.

At step s2, sand is placed on the ground, i.e. on a portion of the area of terrain 4, such that the sand 8 surrounds the portion of the area of terrain 4 that is occupied by the building 6. In other words, the sand 8 is placed such that
25 surrounds the building 6. In other words, the sand 8 is placed on the ground around the perimeter of the building 6. Thus, the sand 8, in effect, forms a "ring" around the building. The depth of the sand on the ground may be any appropriate depth. Also, the thickness of the ring that the sand 8 forms on the ground may be any appropriate thickness. In this embodiment, the thickness of
30 the ring of sand is such that a human being would be unable to jump across the ring of the sand 8, i.e. such that, were a human being to cross the ring of sand

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8, that human would tend to disturb the sand 8 to some extent. Thus, advantageously it would tend to be difficult or impossible for a human intruder to enter or leave the portion of the area of terrain 4 that is surrounded by the ring of sand 8 without disturbing the sand 8.

5 At step s4, the UAV 2 is launched, e.g. from the ground station 10, and flies over or proximate to the area of terrain 4 such that images of the area of terrain 4 may be captured by the UAV 2 using the sensor 14.

 At step s5, as the UAV 2 flies proximate to the area of terrain 4, the illuminator 13 illuminates the area of terrain 4 using UV radiation, i.e. the
10 illuminator 13 shines UV light onto the area of terrain 4. UV electromagnetic radiation that is incident on the sand 8 is absorbed by the sand 8 and causes the sand 8 to fluoresce. Thus, the sand 8 upon which the UV light is incident re-emits visible (blue) light. This re-emitted visible light is detectable by the sensor 14.

15 At step s6, as the UAV 2 flies proximate to the area of terrain 4, the sensor 14 images the area of terrain 4, e.g. the sensor 14 captures a sequence of images (i.e. frames) of the area of terrain 4 and the building 6 and sand 8 therein. This may be performed such that each frame comprises an image of all of the area of terrain 4 (and building 6 and sand 8 therein). In other words, the
20 sensor 14 images the portion of the area of terrain 4 that has been illuminated at step s5. The sensor 14 is configured to detect visible light emitted by the sand 8 (when the sand 8 fluoresces), thus the sand 8 tends to clearly be shown in the captured images.

 At step s8, the image data captured by the sensor 14 is sent from the
25 sensor 14 to the processor 16. This may, for example, be performed continuously as the sensor 14 captures images of the area of terrain 4 over a period of time.

 At step s10, the processor 16 processes the received image data to produce images of the area of terrain 4 and the building 6 and sand 8 therein.
30 The processor may process the received image data to produce a sequence of images of the area of terrain 4 and the building 6 and the sand 8 therein.

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At step s12, the images are sent from the processor 16 to the transceiver 18.

At step s14, the images received by the transceiver 18 are sent from the UAV 2 to the ground station 10 via the data-link 12.

5 At step s16, the images received by the ground station 10 are displayed, on a display, to a human operator. The images may be displayed to the human operator as video footage of the area of terrain 4. In other embodiments, the images may not be displayed to a human operator and, for example, instead the image data may be analysed automatically by a processor.

10 At step s18, the human operator analyses the displayed images. This may, for example, be performed by displaying the received imagery to a human operator located at the ground station, and that human operator manually (i.e. visually) analysing the displayed images. The human operator may manipulate the video footage, or any of the individual images, in any appropriate way (e.g.
15 by zooming, pausing, replaying, fast-forwarding, rewinding etc.). In other embodiments, analysis may not be performed by a human operator and instead may be performed automatically by a processor.

Analysis of the images may comprise performing a change detection algorithm on the received image data. The change detection algorithm may be
20 performed to identify significant changes between a frame and one or more subsequent frames e.g. between one image from the captured sequence of images and a subsequent image.

Any appropriate change detection algorithm may be used. For example, a change detection algorithm that detects changes based on changes in image
25 contrast or edge detection may be used.

In this embodiment, the analysis of the images is performed to detect disturbance of the sand 8. If such a disturbance is detected, the images may also be analysed to determine or infer a cause of that disturbance of the sand 8.

Figure 4 is a schematic illustration (not to scale) showing a first image 20
30 (i.e. a first frame) and a second image 22 (i.e. a second frame).

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The first image 20 is an image that contains the area of terrain 4, the building 6, and the sand 8. In this image, the sand 8 has not been disturbed and a human operator analysing this (at the ground station 10) would tend to detect no disturbance of the sand 8.

5 The second image 22 is a further image that contains the area of terrain 4, the building 6, and the sand 8. In this image, the sand 8 has been disturbed and a human operator analysing this (at the ground station 10) would tend to detect that the sand 8 has been disturbed. The disturbance of the sand 8 has occurred in the region of the second image 22 that is indicated in Figure 4 by a
10 dotted box and the reference numeral 24.

The second image may be further analysed, e.g. by the human operator, e.g. by zooming in on the region 24, to determine or infer what has caused the disturbance (for example, a human being, a vehicle, or an animal crossing the ring of sand 8, or a disturbance caused by the weather e.g. wind or rain).

15 Also, if it is determined that the disturbance of the sand 8 has been caused by e.g. a human being, a vehicle, or an animal crossing the ring of sand 8, it may also be determined in which direction that human, vehicle, or animal was travelling (e.g. from the direction that tracks made in the sand 8). Thus, it may be determined whether the human, vehicle, or animal was travelling away
20 from the building 6 or towards the building 6.

Thus, by analysing the images an intruder to the region surrounding the building 6 that is enclosed by the ring of sand 8 (e.g. a human or vehicle that has not been authorised to enter the portion of the area of terrain 4 that the ring of sand 8 surrounds) may be detected. Similarly, a direction of travel of the
25 intruder, or unauthorised party, may be determined or inferred.

At step s20, depending on the results of the analysis of the images performed at step s18, the human operator may perform an action. Any appropriate action may be performed. For example, if at step s18 the images are analysed, it is detected that the sand 8 has been disturbed, and it is
30 determined or inferred that the disturbance has been caused by a human or vehicle crossing the sand 8 in a direction towards the building 6, the human

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operator at the ground station 10 may raise an alarm, or dispatch security personnel to investigate the intrusion, etc. Similarly, if at step s18 the images are analysed, it is detected that the sand 8 has been disturbed, and it is determined or inferred that the disturbance has been caused by a human or vehicle crossing the sand 8 in a direction away from the building 6, the human operator at the ground station 10 may raise an alarm, or conduct a headcount of personnel within the building etc.

Thus, a surveillance process performed by the UAV 2 is provided.

The above described apparatus and methods advantageously tend to exploit the fluorescent (or UV-reflective, or UV-emitting) properties of the sand to facilitate or provide for the detection of intruders into, or out of, an area of terrain.

Intruders tend to be detectable by analysing image data taken of the area of terrain to detect disturbances in the pattern of the sand that has been placed on the ground.

In the above described methods, automatically detecting changes between frames in the captured sequence of images (e.g. using a change detection algorithm) advantageously tends to provide that events that are typically deemed to be important in surveillance operations (e.g. intruders moving to within the area surrounded by the sand 8 ring) are automatically detected and tracked.

Advantageously, the above described apparatus and methods tend to allow for the detection of intruders in real-time. Thus, it tends to be possible to detect when (i.e. at what time) an intrusion occurred. Also, images of the area of terrain may be stored and analysed at a later time. The images taken of the area of terrain may be time-stamped. This may allow when (i.e. at what time) an intrusion occurred to be determined.

Advantageously, the use of sand that fluoresces (or emits or reflects e.g. UV radiation) may be used to identify entities (e.g. humans or vehicles) that crossed the sand ring without authorisation (i.e. identify intruders). For example, in some embodiments, a process may be performed that comprises detecting

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the sand (e.g. using a further sensor that is configured to detect the electromagnetic radiation that is reflected or emitted by the sand) on a suspected intruder e.g. on the footwear of a human, or on the tyres or tracks of a land-based vehicle. From this detection of the sand on a suspected intruder it
5 may then be determined or inferred that that suspected intruder was indeed an intruder. Thus, the sand may be used to ascertain the identity of an intruder, or ascertain as to whether or not a suspected intruder is indeed an intruder instead of or in addition to detecting whether or not an intruder has entered or left a restricted area.

10 Conventionally, surveillance operations tend to comprise analysing captured images to detect e.g. people or vehicles within those images. In contrast, the above described methods and apparatus may be used to detect the presence of an intruder by analysing the captured images to detect disturbances to the terrain (i.e. the sand) caused by the intruder, i.e. the effect
15 an intruder has on the area under surveillance is detected as opposed to the intruder itself.

Advantageously, with the human eye, the sand tends to be indistinguishable from ordinary sand (i.e. sand that does not reflect or emit UV radiation or fluoresce when exposed to UV radiation). Thus, an intruder would
20 tend to be unaware that the ground surrounding the building had been covered in the sand. Thus, an intruder would tend not to try and avoid disturbing the sand.

It should be noted that certain of the process steps depicted in the flowchart of Figure 3 and described above may be omitted or such process
25 steps may be performed in differing order to that presented above and shown in Figure 3. Furthermore, although all the process steps have, for convenience and ease of understanding, been depicted as discrete temporally-sequential steps, nevertheless some of the process steps may in fact be performed simultaneously or at least overlapping to some extent temporally.

30 In the above embodiments, surveillance of a building and surrounding terrain is performed. However, in other embodiments, surveillance of a different

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type of entity or area of terrain is performed. For example, surveillance of an area surrounding a stretch of road, or a bridge, or an indoors area, may be performed.

In the above embodiments, the surveillance operation is performed to
5 detect whether or not an intruder (e.g. a human or vehicle) entered, or exited, an area of terrain (e.g. a restricted area). However, in other embodiments, a different type of surveillance operation may be performed. For example, in other embodiments, the above described apparatus and methods may be employed to detect or determine whether or not certain types of action have been
10 performed in an area of terrain (e.g. a restricted area). For example, the sand could be placed proximate to a road. The sand could then be monitored, and disturbances of the sand could be detected and identified as possible locations where improvised explosive devices (IEDs) have been set or buried. Thus, the above described methods and apparatus can be used to detect booby traps
15 (e.g. IEDs or mines) etc.

In the above embodiments, the surveillance process is implemented in the scenario described above with reference to Figure 1. However in other embodiments, the surveillance process may be implemented in a different scenario, e.g. a scenario comprising a plurality of ground stations, a plurality of
20 UAVs and a plurality of targets to be kept under surveillance.

In the above embodiments, the surveillance process was implemented using a UAV. However, in other embodiments, the surveillance process may be performed by one or more different entities, e.g. manned aircraft, land-based or water-based vehicles, surveillance systems on or in buildings, etc.

25 In the above embodiments, image data is transmitted from the UAV to the ground station (for analysis). However, in other embodiments, some or all of the image data may not be transmitted from the UAV. For example, some or all of the image data may be stored on board the UAV until the surveillance operation is finished. Also for example, only high rate image data (i.e. video
30 footage of the regions of interest) may be transmitted or stored by the UAV.

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In the above embodiments, the sand is placed on the ground as a ring (that surrounds the building). However, in other embodiments the sand may be placed on the ground in a different pattern, e.g. as a line.

In the above embodiments, sand that fluoresces when exposed to UV light is used to detect intruders. Also, a visible light sensor is used to capture images of the area of terrain under surveillance and detect the light emitted by the sand. However, in other embodiments the sand may be a different type of sand e.g. sand that absorbs and/or re-emits electromagnetic radiation having a wavelength different to those described in the above embodiments. Preferably, the sand is configured or adapted to re-emit electromagnetic radiation having non-visible wavelengths. Also, for example, the sand may be configured to reflect or emit electromagnetic radiation of a different frequency or wavelength of the electromagnetic spectrum instead of or in addition to part of the UV range of the electromagnetic spectrum. A different appropriate type of sensor may be used to detect the radiation emitted or reflected by the sand.

In the above embodiments, the sand has grain size of approximately 0.3-0.6mm. However, in other embodiments, the sand may be a different type of granular material. Also, in other embodiments, the granular material may have a different grain size. For example, the granular material may be "very fine" and have a grain size in the range 1/16 to 1/8 mm diameter. Alternatively, the granular material may be "fine" and have a grain size in the range 1/8 to 1/4 mm diameter. Alternatively, the granular material may be "medium" and have a grain size in the range 1/4 to 1/2 mm diameter. Alternatively, the granular material may be "coarse" and have a grain size in the range 1/2 to 1 mm diameter. Alternatively, the granular material may be "very coarse" and have a grain size in the range 1 to 2 mm diameter. Also, in other embodiments, the granular material may comprise powder or silt (e.g. having a grain size of less than 1/16 mm diameter, and preferably in the range 0.0625 mm to 0.004 mm diameter), or may be a granular material the grain size of which is comparable to pebbles or small rocks (e.g. having a grain size of less than 65 mm diameter, and preferably in the range 2 mm to 64 mm diameter). The granular material may be a combination of different granular materials having different grain sizes.

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Preferably, the material used has a particle size that is small and/or light enough to provide that an intruder would disturb and/or transport the material. Also, preferably the material used has a particle size that is large and/or heavy enough to provide that the pattern of material tends not to be disturbed by e.g. the weather (wind, rain, etc.).

In the above embodiments, processed image data is transmitted from the UAV to the ground station for analysis. However, in other embodiments, processed (or unprocessed) image data may be stored e.g. by the processor of the UAV, in a database. This database may be onboard the UAV. The image data stored on such a database may be retrieved (e.g. at a later time) from that database e.g. by the ground station after the UAV 2 has landed. Also, in other embodiments, the image data is not processed and raw or unprocessed image data is sent to the ground station to be processed at the ground station.

In the above embodiments, a change detection may be performed at the ground station. Also, the image analysis is performed at the ground station. However, in other embodiments, this functionality may be provided by a different entity e.g. the image analysis may be performed (automatically or manually) on-board the aircraft. For example, in some embodiments, image data may be processed automatically onboard the aircraft (e.g. to detect or highlight possible indicators of intrusion). These detection results may then be transmitted to a ground station for presentation to a human operator. This may be done instead of or in addition to sending the raw image data from the aircraft to the ground station. An advantage of processing the image data on board the aircraft and only transmitting the results of an intruder detection process is that less bandwidth tends to be needed to transmit the results compared to the raw image data e.g. images in which no intrusion is detected can avoid being transmitted to the ground station.

In some embodiments, different types of image processing algorithms may be performed on the captured images, e.g. a tracking algorithm may be performed to track or predict movements of an intruder.

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CLAIMS

1. A method of performing surveillance of an area (4), the method comprising:

5 placing an amount of material (8) within a portion of the area (4), the material (8) being a granular material having a grain size of less than 65 mm diameter, the material (8) being material that, to some extent, reflects or emits electromagnetic radiation, wherein the reflected electromagnetic radiation has a wavelength that is not within the visible light wavelength range;

10 thereafter, imaging, using a sensor (14) configured to detect the reflected or emitted electromagnetic radiation, the area (4), thereby providing one or more images of the area (4) and the material (8) placed therein; and

analysing the images to detect a disturbance of the placed material (8).

2. A method according to claim 1, wherein the emitted electromagnetic radiation has a wavelength that is not within the visible light wavelength range.

3. A method according to claims 1 or 2, wherein the material (8) is material that:

20 absorbs electromagnetic radiation having a first wavelength that is incident on the material (8); and

in response to absorbing incident electromagnetic radiation having a first wavelength, emits electromagnetic radiation having a second wavelength.

4. A method according to claim 3, wherein the first wavelength is a different wavelength to the second wavelength.

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5. A method according to claim 4, wherein the first wavelength is within the ultraviolet range of the electromagnetic spectrum, and the second wavelength is within the visible light range of the electromagnetic spectrum.

5 6. A method according to any of claims 1 to 5, wherein the method further comprises, whilst imaging the area (4), illuminating the area (4) with electromagnetic radiation, the electromagnetic radiation used to illuminate the area having a wavelength such that the material (8) may reflect or absorb that electromagnetic radiation.

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7. A method according to any of claims 1 to 6, wherein the step of imaging comprises using a spectral filter to filter out electromagnetic radiation having a different wavelength to that reflected or emitted by the material (8).

15 8. A method according to any of claims 1 to 7, wherein the material (8) has a grain size selected from the group of grain sizes consisting of: between 1/16 mm and 1/8 mm diameter, between 1/8 mm and 1/4 mm diameter, between 1/4 mm and 1/2 mm diameter, between 1/2 mm and 1 mm diameter, and between 1 mm and 2 mm diameter.

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9. A method according to any of claims 1 to 8, wherein the material (8) has a grain size of between 0.3 mm and 0.6 mm.

10. A method according to any of claims 1 to 9, wherein the material (8) is
25 sand that has been coated with or treated with a substance that reflects or emits the electromagnetic radiation.

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11. A method according to any of claims 1 to 10, wherein the sensor (14) is mounted on an aircraft (2), the aircraft (2) flying proximate to the area (4) such that the area (4) can be imaged using the sensor (14).
- 5 12. A method according to claim 11, wherein the aircraft (2) is an unmanned aircraft.
13. A method according to claim 11 or 12, wherein:
- the method further comprises transmitting, from the aircraft (2) to a
10 location (10) remote from the aircraft (2), image data captured by the sensor (14); and
- either:
- the step of analysing the images is performed at the location (10) remote from the aircraft (2): or
- 15 onboard the aircraft (2), prior to transmission of the image data to the location (10).
14. A method according to any of claims 1 to 13, the method further comprising identifying an entity causing the disturbance of the material (8) by
20 detecting, using a further sensor configured to detect electromagnetic radiation reflected or emitted by the material, one or more grains of the material (8) on the entity.
15. Apparatus for performing surveillance of an area (4), the apparatus
25 comprising:
- an amount of material (8), the material having been placed within a portion of the area (4), the material being a granular material having a grain size of less than 65 mm diameter, the material being material that, to some extent, reflects or emits electromagnetic radiation, wherein the reflected

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electromagnetic radiation has a wavelength that is not within the visible light wavelength range;

a sensor (14) configured to image the area (4) with the material placed therein thereby providing one or more images of the area (4) and the material
5 (8) placed therein, the sensor (14) being configured to detect electromagnetic radiation reflected or emitted by the material (8); and

an image analysis module operatively coupled to the sensor (14) and configured to analyse the images to detect a disturbance of the placed material (8).

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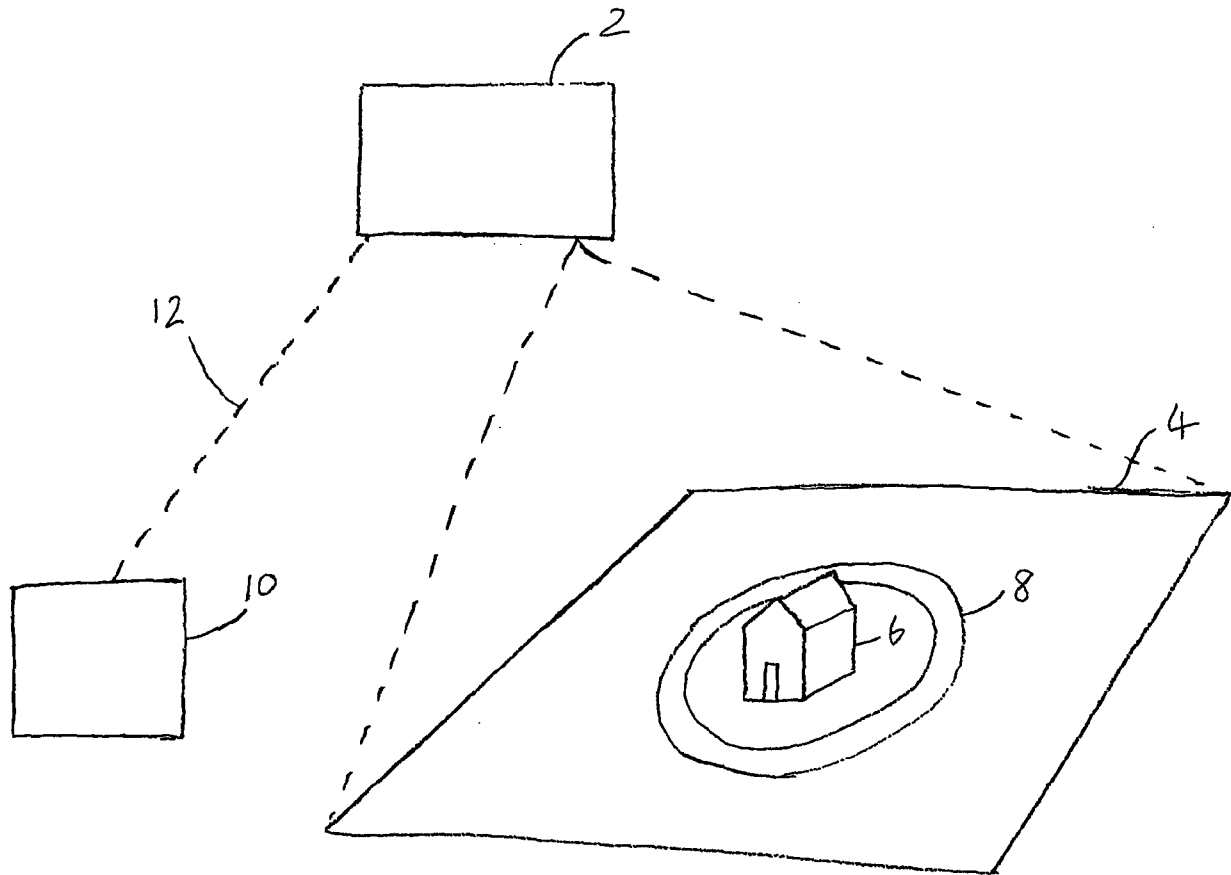


FIG. 1

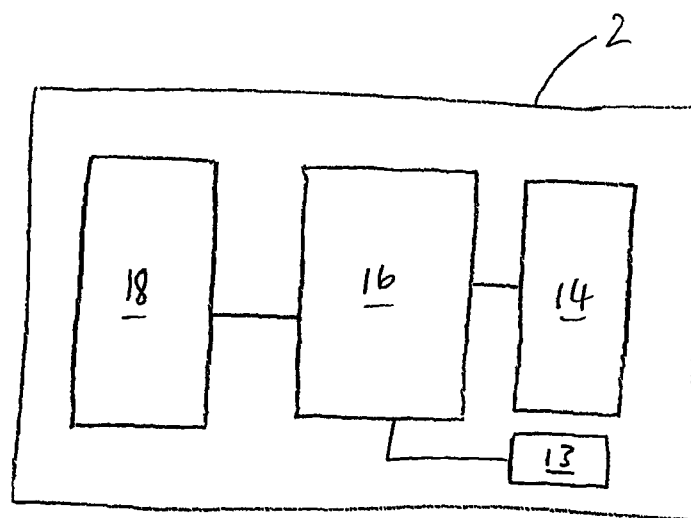


FIG. 2

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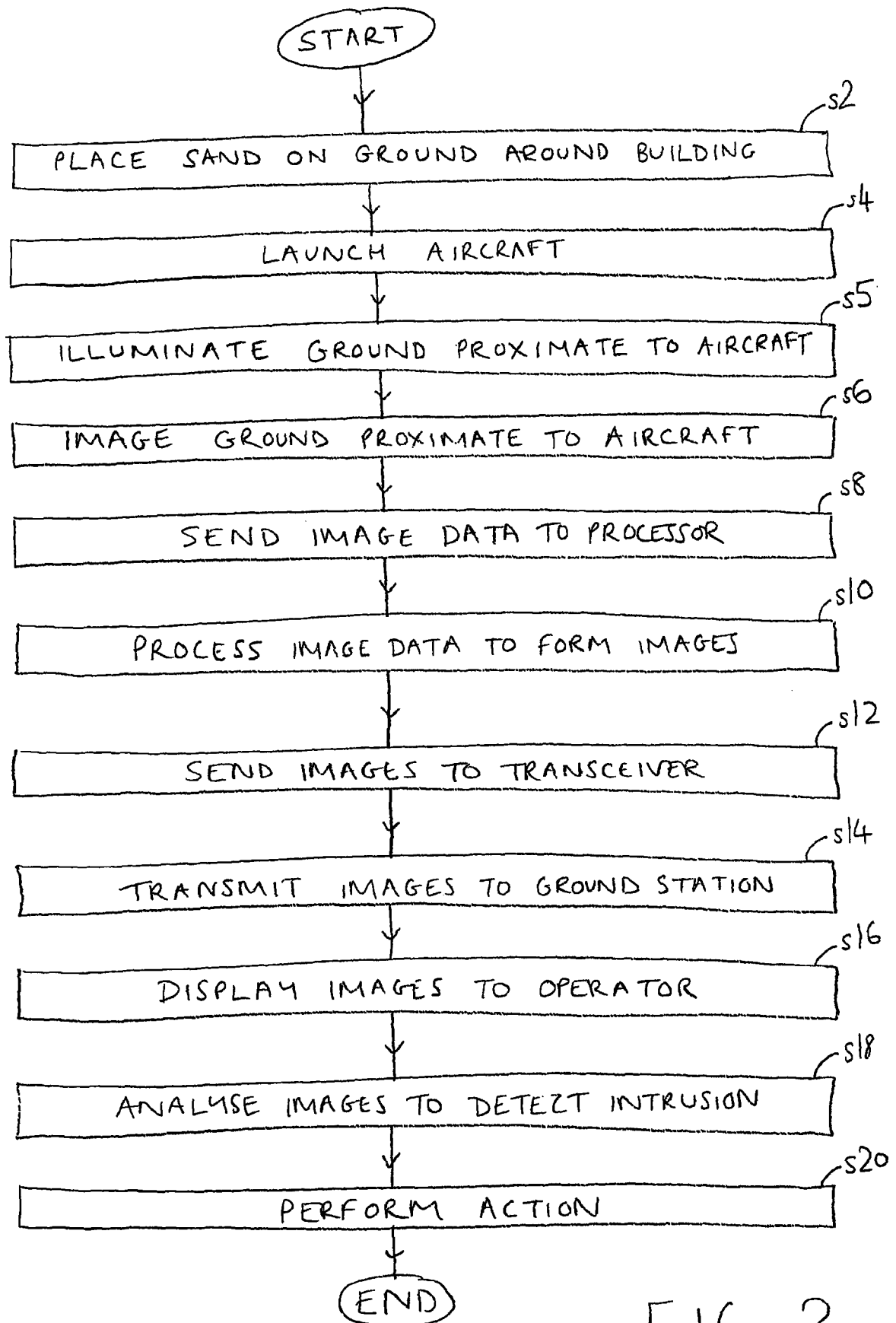


FIG 3

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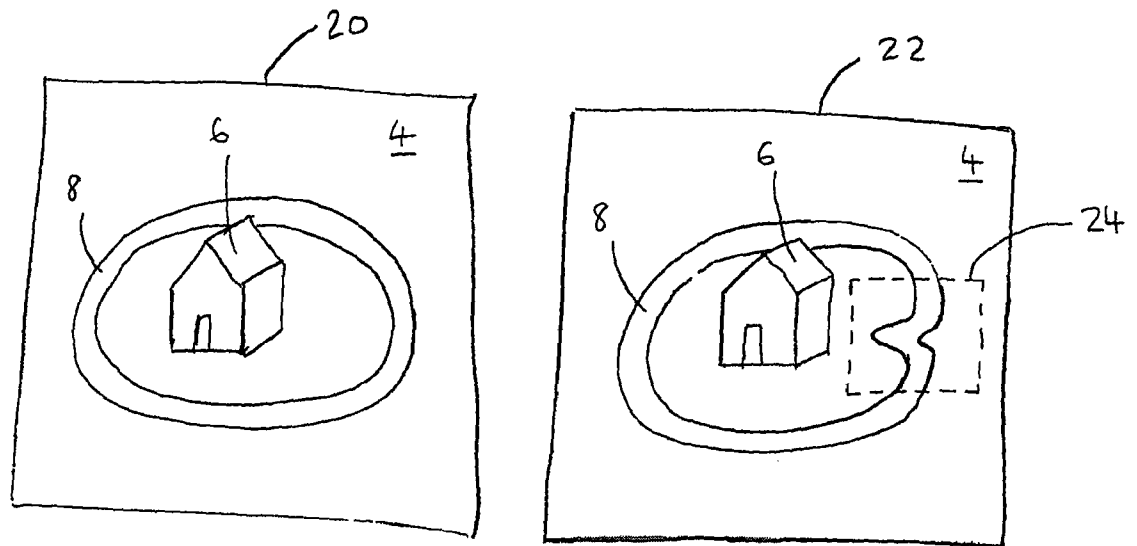


FIG. 4