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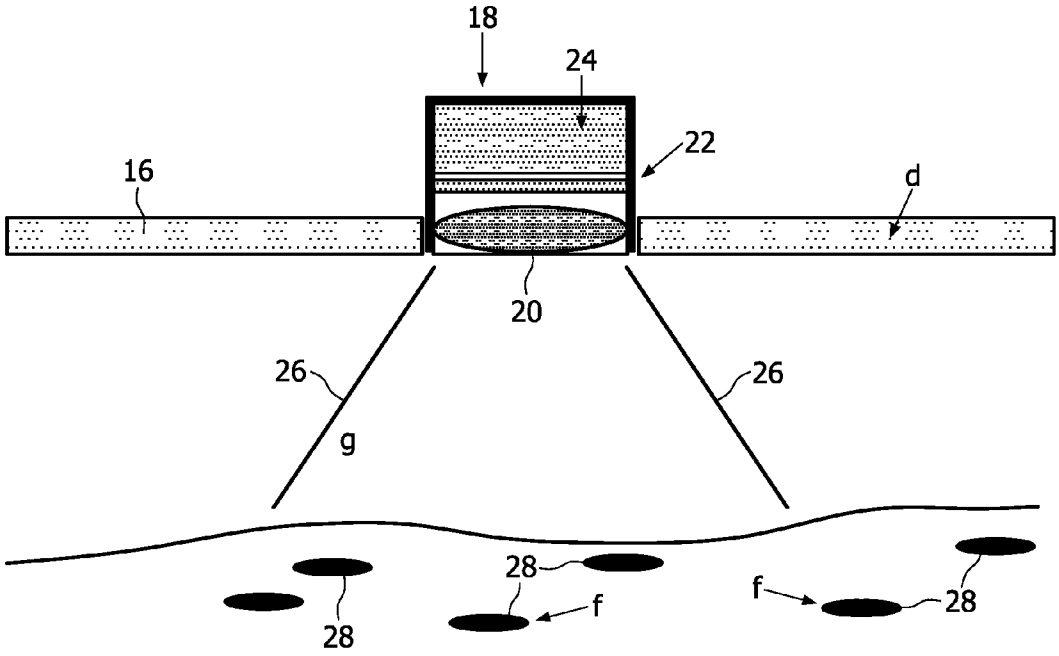
(54) Title: POSITIONING SYSTEM FOR PATIENT MONITORING SENSORS



(57) Abstract: This invention relates to a positioning system for monitoring sensors or treatment devices which are to be accurately located on the skin of a patient, especially where professional assistance is unavailable, for example in a domestic environment. It comprises a positioning system for a patient monitoring sensor or treatment device with imaging means for detecting a texture or pattern on the skin of a patient to identify a sensor location, an image processing unit which is adapted to learn the required location of a sensor by storing the local texture or pattern, and means for guiding a user to reposition the sensor in the desired location by reference to the stored pattern.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Positioning system for patient monitoring sensors

This invention relates to a positioning system for monitoring sensors or treatment devices which are to be accurately located on the skin of a patient, especially where professional assistance is unavailable, for example in a domestic environment.

The use of sophisticated sensing and actuating devices for medical purposes has increasingly spread into the unsupervised home environment, in addition to their application in well-supervised patient care facilities as hospitals. However, it is very difficult for a non-professional user or their carer to utilize such equipment effectively, because of the requirement for accurately reproducible results, when sensors are repeatedly removed and replaced.

Accordingly, the present invention provides a positioning system for a patient monitoring sensor or treatment device (hereinafter referred to as "a sensor") comprising imaging means for detecting a texture or pattern on the skin of a patient to identify a sensor location, an image processing unit which is adapted to learn the required location of a sensor by storing the local texture or pattern, and means for guiding a user to reposition the sensor in the desired location by reference to the stored pattern.

The texture or pattern may consist of a natural pattern such as a pattern of moles or varying skin color, or an artificial pattern, such as can be provided by UV active markers.

The detection means may operate using visible light and/or UV or IR which may reveal additional texture information. In operation of the system, each sensor is initially placed in the required position by a medical professional, and the system learns the exact location from the local skin pattern.

Subsequently, when the patient is required to re-position the sensor himself, he places it over the area of the desired location, and the system produces signals instructing him to move or rotate the sensor, based on its recognition of the skin pattern, until the required position over the target location is achieved, and the device can be placed in contact with the skin. Preferably, the system incorporates an inertia sensor in order to ensure that the final placement towards the target position is executed in a consistent way.

This ensures that a lay person can attach the sensor at exactly the same position as done previously by a medical professional, thereby significantly improving the quality of data which can be gathered. It also ensures that, when the device has to be utilized over a period of time, during which it is removed and repeatedly reattached, the consistency of positioning will still be maintained.

In addition, under some circumstances a patient may be required to re-attach the sensor in an area where he or she cannot see it directly, for example, on the patient's own back.

The system is applicable to the attachment of various kinds of sensors, and transducers such as capacious or inductive types, and also to treatment electrodes such as those used for AED (Automatic External Defibrillators) which require exact position of their stimulating pads, in order to operate effectively.

One embodiment of the invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figs. IA to IE illustrate the process of using skin pattern recognition to control navigation of a sensor type device;

Fig. 2 is a diagrammatic view of a signal interface presented to the user, in order to provide suitable positioning guidance; and

Fig. 3 is a diagrammatic view of one practical form of the system.

Fig. 4 is an overall schematic diagram of the modes of operation of the system; and

Fig. 5 is a detailed flowchart of operation in the patient guiding mode.

Referring firstly to Figure IA, the desired target position for location of a sensor or stimulating pad, for example, is indicated by reference 2, and this is located on an area of the patient's skin which, in the normal way, carries a distinctive pattern of various larger or smaller, lighter or darker areas such as moles. This position is initially determined by a medical professional.

Figure IB shows the individual, slightly darkened areas of skin which are identified by a pattern of crosses, 4, 6, 8, 10 etc whose coordinates relative to the target area 2

are memorized in the system, for each sensor, after it has been properly positioned. As shown in Figure 4, this is achieved using the "training mode" of the system.

In operation this is achieved as follows:

(a) The medical professional activates the training mode of the device and places the device above the desired location, e.g. 10 cm. The system's camera image is acquired and analyzed for skin texture, e.g. moles, as shown in Fig. 1, at step 40 in Figure 4.

(b) If there is not enough skin texture in the image area, the medical professional is instructed by the device to increase the distance to skin or to move the device in a circle around the desired area (more area covered).

(c) The system generates a reference pattern or map that is stored in the system's memory.

(d) The system may use different wavelength in addition to the visible light. UV or IR may reveal additional texture information. In this case, the device is fitted with appropriate light emitting units (LEDs).

(e) The device is lowered by the medical professional onto the patient's skin and the device tracks the skin texture until the camera opening is obscured by the skin.

(f) From the last distribution of the texture, the valid position will be calculated (42, 44 in Figure 4).

When the patient subsequently attempts to locate the sensor in the approximate area of the target 2, in the "guiding mode" of Figure 4, he will typically, at first, place it too far to one side as indicated in the diagram of Figure 1C in which it can be seen that only the left hand group of mole patterns, including areas 6 and 10 can be detected. Accordingly, the system will identify the current skin texture pattern and compare it with the stored reference image, and signal that the sensor should be moved to the right, as indicated by the arrow 12 in Figure 1C.

Similarly, if the patient initially positions the sensor too far below the required target position 2, as indicated in Figure ID, again, only part of the required mole pattern including areas 6 and 8 can be detected by the sensor, so the user will be directed to move it in an upward direction as indicated by the arrow 14 of Figure ID, until the proper position is acquired as indicated in Figure IE, with the target 2 centralized.

If the user positions the sensor in a region that is not recognized, he may also be instructed to move it further from his skin, or to move it in a circular pattern, to increase the area covered.

Figure 2 illustrates a possible type of user instruction interface (48 in Figure 4) which can be used to give the necessary directional information to the user in the "guiding mode". This will be capable of displaying downwardly or upwardly directed arrows A and B, as well as rightwardly and leftwardly directed arrows such as C and D to indicate required movement in the corresponding lateral directions.

Of course it is also possible that the electrode may require to be moved in a specific rotational direction and for that purpose, clockwise and counter-clockwise arrow signs such as indicated at F and E respectively, may also be displayable.

Once the device is accurately positioned, a centrally located display element indicated by the letter L in Figure 2 will be activated so as to indicate that the device can be lowered into place.

Figure 3 illustrates a practical form of a sensor arrangement of the system in use, in which a skin attached device 16 includes an integrated imaging device 18 comprising an optical system 20, an image acquisition device 22, and an image processing unit 24. The optical system is arranged to cover a reasonably wide angle of view, as indicated by lines 26 in the Figure, so as to encompass a reasonable number of areas 28 of different coloration in the desired skin area. The imaging device may utilize UV or IR light as well as or instead of visible wavelength, in which case it will be fitted with appropriate light emitting devices such as LEDs.

The device also incorporates a contact sensor to confirm when it has reached a contact position with the skin, and an inertia sensor such as an etched-beam capacitive device, to accurately control the lowering of the device into its final placement in the target position. This ensures that it s not shifted sideways at the last moment before making contact with the skin, or immediately afterwards.

Figure 5 is a detailed flowchart of operation of the device in the "guiding mode". At the start (50) the image is acquired and the detected pattern is analyzed (52). If it cannot be identified (54) the patient is instructed to increase the sensor distance from the skin or move the sensor around (56) and the image acquisition step (52) is repeated. If the pattern is identified, the location and orientation are determined (58) and checked against the desired position and orientation (60). If this is incorrect the patient is instructed to shift or rotate the sensor (62) and the acquisition step (52) is repeated.

If the pattern is correctly centered and oriented, the patient is instructed to lower the sensor (64) and the signal from the inertia sensor is monitored (66) to determine

whether the patient's movement steady in the lowering direction; however if rapid movement is detected, the image acquisition is repeated (52).

If the inertia sensor signal does not detect rapid movement, the system checks for the occurrence of sensor contact with the skin (68), and when this occurs, the system determines that the process is complete (70) otherwise the image acquisition process is restarted (52).

CLAIMS:

1. A positioning system for a patient monitoring sensor or treatment device (hereinafter referred to as "a sensor") comprising imaging means for detecting a texture or pattern on the skin of a patient to identify a sensor location, an image processing unit which is adapted to learn the required location of a sensor by storing the local texture or pattern, and means for guiding a user to reposition the sensor in the desired location by reference to the stored pattern.

2. A positioning system according to claim 1 in which the texture or pattern comprises a naturally occurring pattern of moles or skin coloration.

3. A positioning system according to claim 1 in which the texture or pattern comprises artificial markers.

4. A positioning system according to any preceding claim in which the imaging means is adapted to use UV or IR wavelengths and includes corresponding light emitting devices.

5. An imaging system according to any preceding claim in which the device is adapted to provide visible signals to the user to guide the sensor to the desired position.

6. An imaging system according to any preceding claim in which the device is adapted to provide audible signals to the user to guide the sensor to the desired position.

7. An imaging system according to any preceding claim which comprises a separate signaling unit adapted to communicate wirelessly with the sensor device.

8. An imaging system according to any preceding claim in which the image processing unit is separated from the image sensor and is adapted to communicate wirelessly with the sensor device.

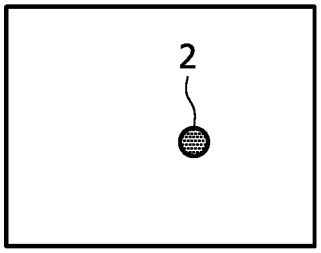

FIG. 1A

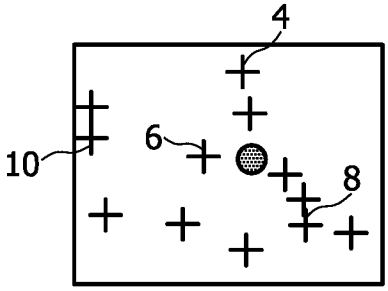

FIG. 1B

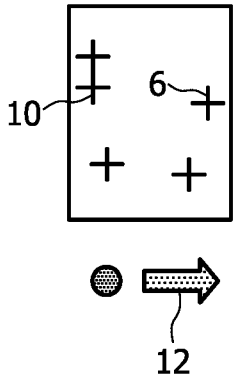

FIG. 1C

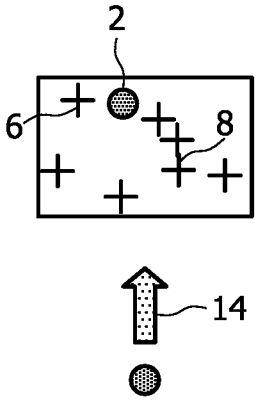

FIG. 1D

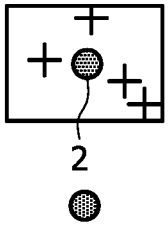

FIG. 1E

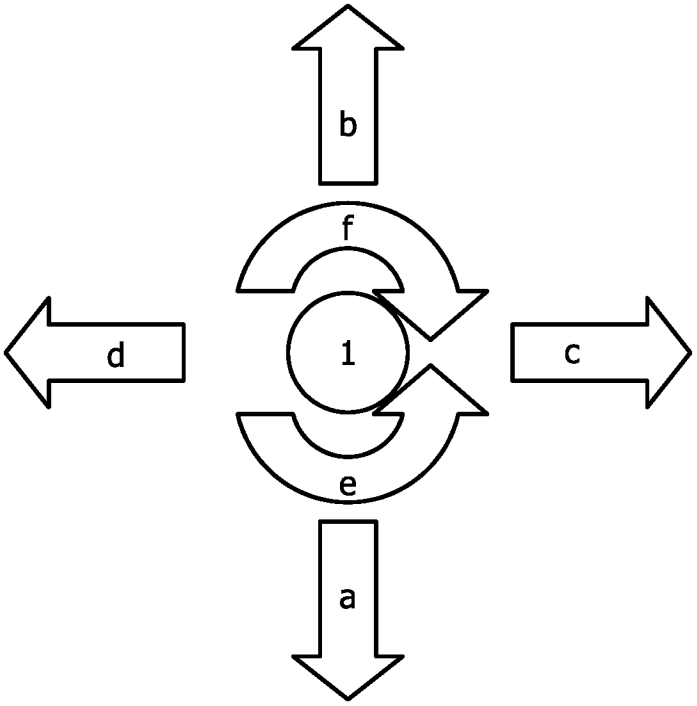

FIG. 2

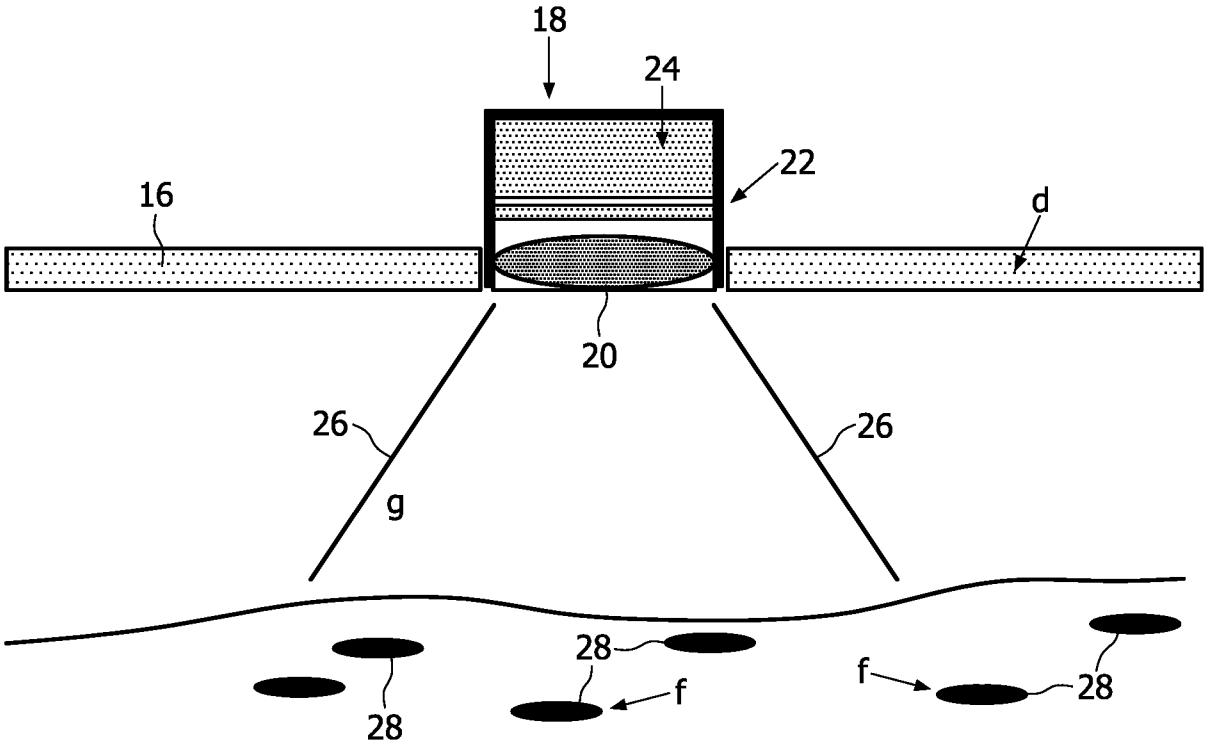

FIG. 3

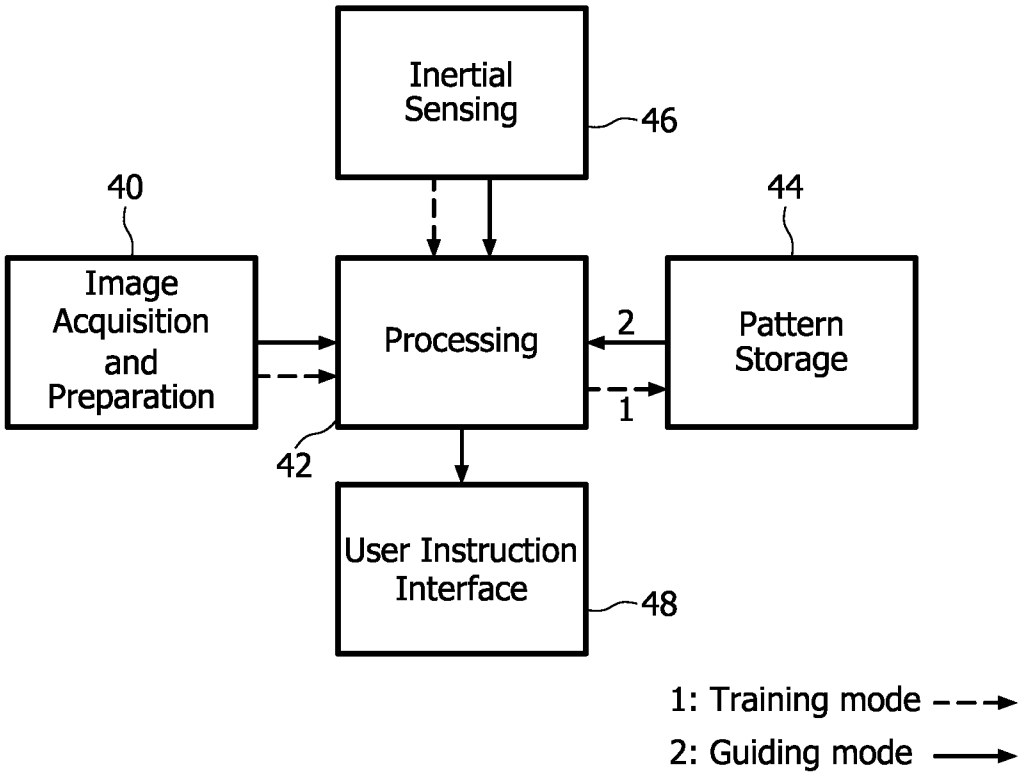
Inertial Sensing
46
40
44
Image Acquisition and Preparation
Processing
2
Pattern Storage
1
42
User Instruction Interface
48
1: Training mode
2: Guiding mode

FIG. 4

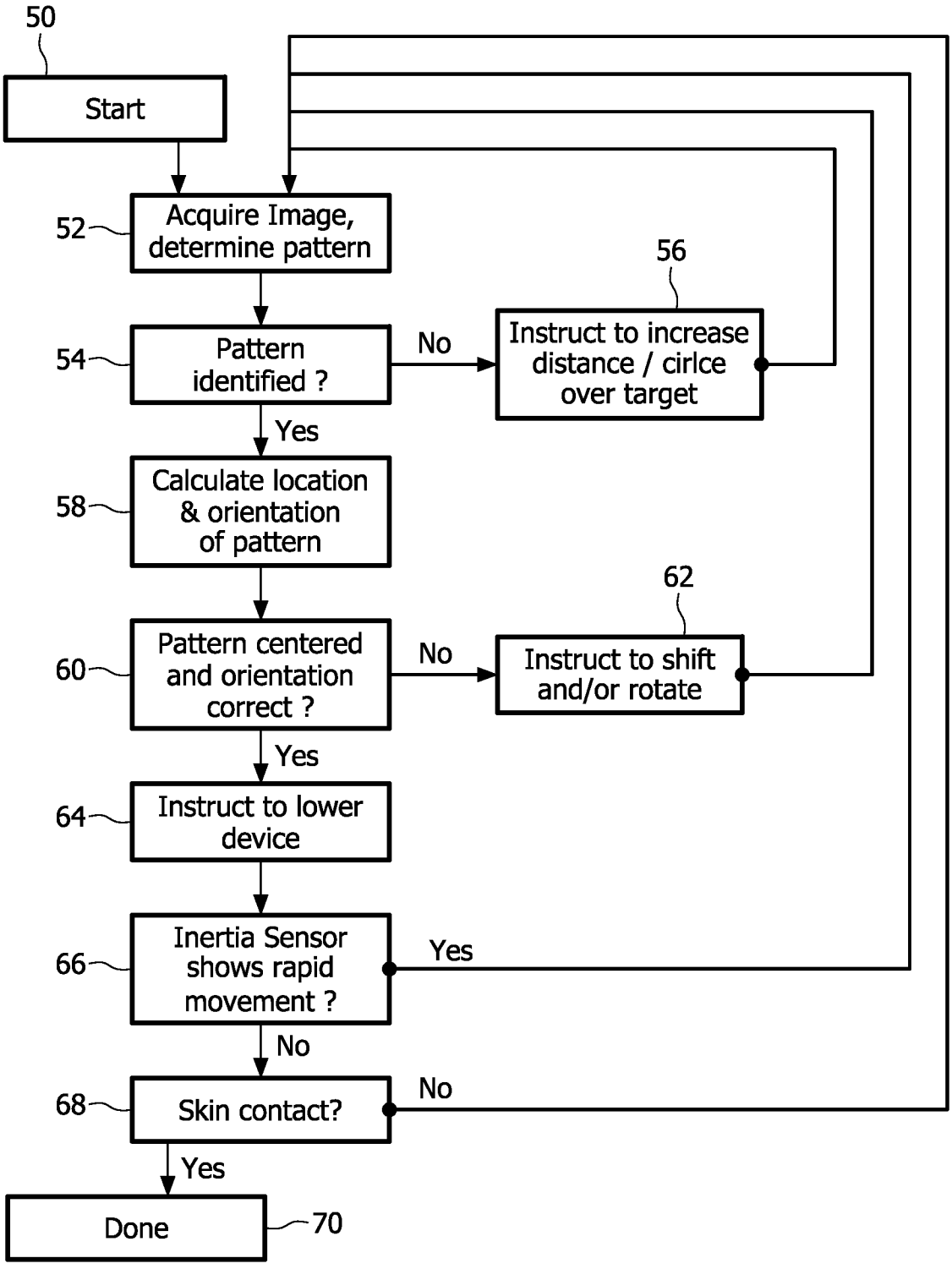
50
Start
52
Acquire Image, determine pattern
54
Pattern identified ?
No
56
Instruct to increase distance / cirlce over target
Yes
58
Calculate location & orientation of pattern
60
Pattern centered and orientation correct ?
No
62
Instruct to shift and/or rotate
Yes
64
Instruct to lower device
66
Inertia Sensor shows rapid movement ?
Yes
No
68
Skin contact?
No
Yes
Done
70

FIG. 5