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(71) Applicant: **Alpine Electronics, Inc.**
Tokyo (JP)

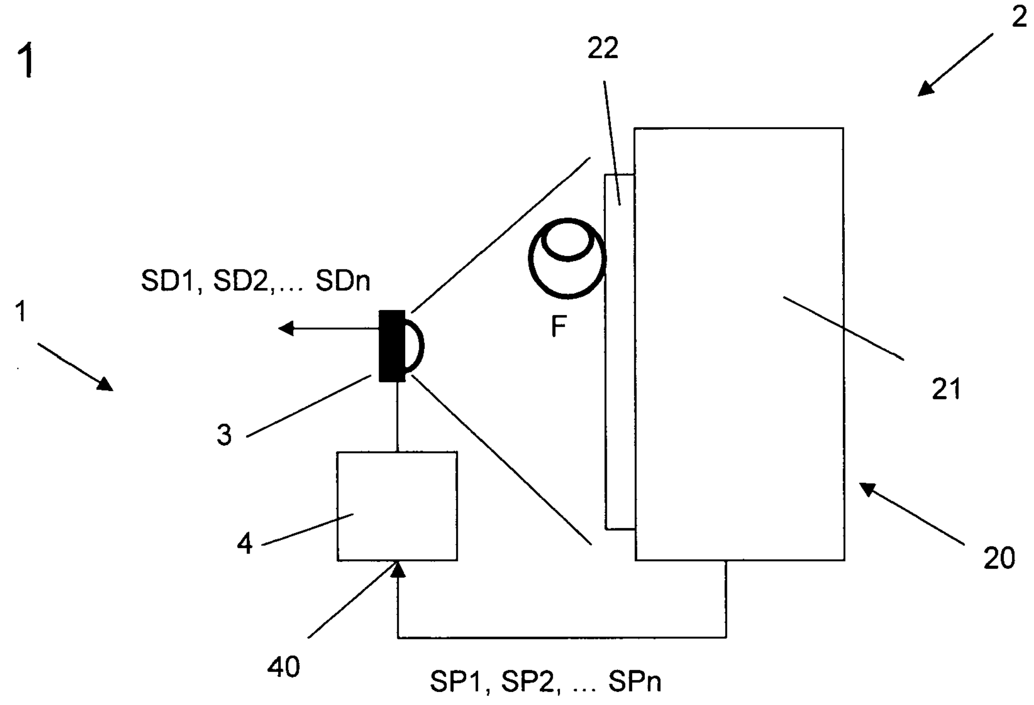
(72) Inventor: **Galos, Andreas**
70567 Stuttgart (DE)

(74) Representative: **Klunker . Schmitt-Nilson . Hirsch**
Patentanwälte
Destouchesstraße 68
80796 München (DE)

(54) Position detection system and method of calibrating a position detection system

(57) A position detection system (1) comprises a proximity sensor device (3) which is configured to detect at least one position of an object (F) approaching towards at least one input device (20), and a calibration device (4) which is configured to calibrate the proximity sensor device (3) with respect to a position detection and comprises a terminal (40) for coupling to the at least one input device (20). The calibration device (4) is configured to repeatedly receive from the at least one input device (20) position signals (SP1, SP2, SPn) over at least a period of time during normal operation of the input device (20), wherein each of the position signals (SP1, SP2, SPn) contains information regarding a respective position of an object (F) touching the at least one input device (20). The calibration device (4) then repeatedly calibrates the proximity sensor device (3) with respect to position detection upon receiving of a respective one of the position signals (SP1, SP2, SPn).

FIG. 1



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Description

[0001] The present invention relates to a position detection system, comprising a proximity sensor device which is configured to detect at least one position of an object approaching towards at least one input device, and a method of calibrating a position detection system comprising a proximity sensor device.

[0002] Object position detection systems known in the art, for example, comprise proximity sensors which detect an approaching of an object to be detected, for example an object of a human such as a human's finger or hand approaching a graphical user interface (GUI) of an automotive input device. For example, when a user's hand approaches the GUI of the input device, such as a human machine interface (HMI) of a head unit in an automobile, a particular function of the head unit may be controlled. For example, when the user's hand is approaching the head unit, a display screen of the head unit may be switched to a particular appearance, such as an enlargement of certain display areas approached by the hand. In this field, there is typically the requirement that the position of the user's finger or hand detected by the position detection system should be quite accurate, so that the user has an intuitive feeling in controlling the respective function.

[0003] Such position detection systems, like 3D finger tracking sensors, are becoming increasingly popular for proximity detection or gesture control. However, in typical implementations, such as in a vehicle, a finger tracking sensor is often an independent system component, which needs to be calibrated to real-world coordinates for correct coordinate output when used in the final system installation. Such a calibration could become necessary several times during lifetime, e.g. after mechanical impact like vehicle vibration which may cause some misalignment.

[0004] A typical calibration process of a finger tracking sensor is initialized and carried out manually. For example, the user needs to start a calibrating procedure which instructs the user to carry out certain movements for calibrating position detection. Potential problems involved with such calibrating procedures may be as follows:

> Some users do not understand the need for calibration. Therefore, they do not see a need to calibrate, and thus will not initiate such calibration procedure. As a consequence, the sensor output may be misaligned and not correct. Further, such calibration is often annoying and feeled like a waste of time, therefore users are not motivated to calibrate the sensor.

[0005] If a calibration (e.g., made at a factory or at initial user setup) has an error, then this error typically remains until the next manual calibration. It may occur that such error is not detected, and then mismatching can continuously happen during normal operation when controlling functions of the input device. Further, the result of a one-time calibration can become invalid during a long period of time of operation by general drifting or some unexpected mechanical impact. This may result in wrong coordinates and needs manual recalibration, which is inappropriate effort for the general user.

[0006] US 8 504 944 A discloses an image processing apparatus which includes an image display control unit controlling an image display on a display screen, an image generating unit generating a question image including a question and option buttons configured by icons that can be arbitrarily selected for the question, a position detecting unit detecting a position of a pointer present on the display screen from imaging data acquired by imaging the display screen, a position information storing unit storing positions of the icons when the question image is displayed on the display screen, and a control unit specifying an icon out of the icons selected by the pointer based on the position of the pointer and calibrating the position of the pointer based on the position of the icon, which is stored in the position information storing unit, corresponding to the icon specified to have been selected.

[0007] It is an object of the present invention to provide a position detection system and a method of calibrating a position detection system which are capable to increase an accuracy of a proximity sensor device.

[0008] According to an aspect of the present invention, there is provided a position detection system, comprising a proximity sensor device which is configured to detect at least one position of an object approaching towards at least one input device, and a calibration device which is configured to calibrate the proximity sensor device with respect to a position detection and comprises a terminal for coupling to the at least one input device. The calibration device is configured to repeatedly receive from the at least one input device position signals over at least a period of time during normal operation of the input device, wherein each of the position signals contains information regarding a respective position of an object touching the at least one input device. The calibration device is configured to repeatedly calibrate the proximity sensor device with respect to position detection upon receiving of a respective one of the position signals.

[0009] For example, the proximity sensor device may be a 3D object tracking sensor. Such sensor is especially useful for pre-touch / proximity function on touch screens in a vehicle. Such sensor may be attached to a touch screen of the at least one input device. For instance, the 3D object tracking sensor coordinates may be continuously calibrated every time the user is touching the touch screen. It is not necessary to initialize and perform a manual calibration by the user.

[0010] In a potential implementation, during normal operation, the user is touching the input device typically many times at many locations, for example to activate some functions in the GUI displayed at the input device. Then, every time the user's finger is actually touching the input device, e.g. the touch display surface, the proximity sensor device may be calibrated by the calibration device in the background automatically. The user is not required to initiate a manual calibration procedure. Moreover, the calibration will become better and better over time during normal operation of the input device, thus increasing accuracy of the proximity sensor device. It is assumed that input devices, such as touch screens, are calibrated in the factory and therefore output correct position coordinates over lifetime.

[0011] According to an embodiment, the proximity sensor device is configured to detect at least one three-dimensional position of an object with respect to the at least one input device.

[0012] According to an embodiment, the proximity sensor device is configured to track a motion of an object approaching towards the at least one input device. Such proximity sensor device is also known as tracking sensor device. For example, the proximity sensor device may be a 3D tracking sensor device for tracking a three-dimensional position and motion of an object.

[0013] For example, the proximity sensor device comprises at least one camera based sensor.

[0014] According to an embodiment, the at least one input device comprises a touch screen, wherein each of the position signals contains information regarding a respective position of an object touching a touch display surface of the touch screen.

[0015] According to an embodiment, the position detection system is configured to be installed in a vehicle. Preferably, the proximity sensor device is configured to be coupled with a head unit of the vehicle comprising the at least one input device.

[0016] According to another aspect, the invention also relates to a vehicle comprising a position detection system as described herein.

[0017] According to a further aspect, there is disclosed herein a method of calibrating a position detection system comprising a proximity sensor device which is configured to detect at least one position of an object approaching towards at least one input device. Particularly, the method comprises the steps of detecting touching of the at least one input device by an object and generating a respective position signal by the at least one input device containing information regarding a position of the respective object touching the at least one input device, receiving from the at least one input device respective position signals repeatedly over at least a period of time during normal operation of the input device, and repeatedly calibrating the proximity sensor device with respect to detecting of at least one position of an object upon receiving of a respective one of the position signals.

[0018] According to an embodiment, the proximity sensor device is repeatedly calibrated each time when detecting touching of the at least one input device by an object.

[0019] According to a further embodiment, the at least one input device comprises a touch screen having a touch display surface, and the step of detecting touching comprises detecting touching of the touch display surface by an object and generating a respective position signal by the at least one input device containing information regarding a position of the respective object touching the touch display surface.

[0020] According to an embodiment, the calibration of the proximity sensor device comprises setting of an offset parameter of a detected position of the proximity sensor device using a corresponding one of the received position signals.

[0021] For example, each of the position signals may contain information indicative of first coordinates of where the respective object is touching the at least one input device, and the proximity sensor device may be configured to output at least one detection signal when detecting a position of an object, the at least one detection signal containing information indicative of second coordinates of the respective detected object. For calibration, the calibration device then sets the second coordinates to correspond to the first coordinates received with a corresponding position signal.

[0022] Further advantages and aspects of the invention will be described with reference to the following Figures, in which:

Fig. 1	shows a schematic arrangement of a position detection system according to an embodiment of the invention,
Fig. 2	shows a potential implementation of a position detection system according to an embodiment of the invention which is coupled to an input device comprising a touch screen,
Figs. 3A-3D	show the embodiment of a position detection system according to Fig. 2 in various states of normal operation in which the user is touching the touch screen at different locations,
Fig. 4	shows a flowchart of a method for calibrating a position detection system according to an embodiment of the invention.

[0023] Fig. 1 shows a schematic arrangement of a position detection system according to an embodiment of the invention. The position detection system 1 comprises a proximity sensor device 3 for detecting at least one position of an object (such as a human finger F, or any other object like a pen, etc.) approaching towards an input device 20. For example, the proximity sensor device 3 detects at least one three-dimensional position of an object with respect to the input device 20. It may be implemented as a 3D object tracking sensor device which tracks a three-dimensional position and motion of a user's finger approaching the input device 20. For example, the proximity sensor device 3 comprises at least one camera based sensor. Such camera based sensor has a field of view, as schematically shown in Fig. 1, for monitoring position and/or motion of an object (e.g., finger F) approaching towards the input device 20.

[0024] According to the embodiment as shown in Fig. 1, the input device 20 comprises a touch screen 21 having a touch display surface 22 for displaying a GUI for operation by the user. For example, the user's finger F may touch a particular area on the GUI displayed on the touch display surface 22 for operation of a particular control function. For instance, when the user's finger F is touching the touch display surface 22, the touch screen 21 is configured to generate respective positions signals SP1, SP2, SP3, ..., SPn for a respective touch (which is explained in more detail with respect to Figures 3A-3D). Each of the position signals SP1 to SPn contains information regarding a respective position of the finger F when touching the touch display surface 22 of the touch screen 21. For example, the respective position signal may contain coordinates x, y, z (e.g., z may be z=0) of the respective position with respect to a coordinate system of the input device.

[0025] In a particular implementation, the position detection system 1 is installed in a vehicle. The proximity sensor device 3 may be coupled with a head unit 2 of the vehicle which comprises the input device 20. On the touch display surface 22, a GUI related to certain functions to be controlled in the vehicle may be displayed.

[0026] Upon detection of an object, such as the finger F, the proximity sensor device 3 produces a respective detection signal SD1, SD2, SD3, ..., SDn, each indicating a respective finger position, for example with respect to a sensor coordinate system or an input device coordinate system. For example, the respective detection signal may contain coordinates x, y, z of the respective detected position with respect to a sensor coordinate system or an input device coordinate system. For example, the detection signals SD1 to SDn may be sent to the input device 20 which controls, for example, the appearance of particular elements of the GUI shown on the touch display surface accordingly. For example, certain elements of the GUI near the detected finger position may be enlarged. According to another embodiment, a gesture control function may be performed by the input device 20 if the proximity sensor device 3 is implemented as a tracking sensor device.

[0027] The position detection system 1 further comprises a calibration device 4 for calibrating the proximity sensor device 3 with respect to position detection thereof. The calibration device 4 comprises a terminal 40 for coupling to the input device 20 for receiving the position signals SP1 to SPn. In a particular implementation, the calibration device 4 may be a component, such as a microprocessor, which may be contained in the proximity sensor device 3. According to another embodiment, the calibration device 4 may be a separate component installed externally from the sensor device 3, or may be a component of the input device 20 and/or of the head unit 2. With calibration of the proximity sensor device 3, the calibration device 4 adjusts generation of a respective detection signal SD1 to SDn indicative of a detected position of an object to coincide or correspond with a corresponding position signal SP1 to SPn received from the input device 20 when the object is touching the input device, as explained in more detail below. More particularly, after the calibration, the position coordinates contained in a generated detection signal SD1 to SDn coincide or correspond with respective position coordinates of a corresponding position signal SP1 to SPn.

[0028] For example, the sensor device 3 needs to be calibrated to real-world coordinates, so that when the user is touching the touch display surface 22, the sensor coordinates and the touch screen coordinates are corresponding to each other or even identical.

[0029] Fig. 2 shows a potential implementation of a position detection system 1 according to an embodiment of the invention which is coupled to an input device comprising a touch screen.

[0030] Referring to Fig. 2, the proximity sensor device 3 is installed, for example, proximate the top edge of the touch display surface 22 of the input device 20. However, other installation locations are also possible. Once the user is touching with finger F the touch display surface 22 at any position, such as position P1 shown in Fig. 2, the input device 20 generates a position signal SP1 indicative of that position P1. It is presumed that the touch screen coordinates output with position signal SP1 are correct and the coordinates of the proximity sensor device 3 output with a corresponding detection signal SD1 can have some offset error (which is then eliminated by calibration). In an exemplary scenario, as shown in Fig. 2, when the input device 20 detects a position P1 when the finger F is touching the touch display surface 22, the proximity sensor device 3 detects a position D1 which does not correspond to position P1, but is offset by a particular offset value. Thus, the position signal SP1 output by the input device 20 and corresponding detection signal SD1 output by the proximity sensor device 3 do not correspond.

[0031] Fig. 3A-3D show the embodiment according to Fig. 2 in various states of normal operation in which the user is touching the touch display surface at different locations for controlling one or more functions, which is also used for automatically calibrating the proximity sensor device in the background.

[0032] According to Fig. 3A, the user's finger F is touching the touch display surface 22 at a position P2 at the top right corner for controlling a function, with the input device 20 generating a position signal SP2 indicative of that position P2. In the exemplary scenario as shown in Fig. 3A, when the input device 20 detects a position P2 when the finger F is touching the touch display surface 22, the proximity sensor device 3 detects a position D2 which is different from position P2. Thus, the position signal SP2 output by the input device 20 and corresponding detection signal SD2 output by the proximity sensor device 3 do not correspond. The position signal SP2 is provided to the terminal 40 and supplied to the calibration device 4 which calibrates the proximity sensor device 3 with respect to position detection. After the calibration, the position signal SP2 and corresponding detection signal SD2 output by the proximity sensor device 3 are corresponding to each other, i.e. are indicating the same position P2 of the detected object with respect to the input device 20. For example, the position coordinates of the finger F contained in both signals SP2 and SD2 are the same with respect to a common coordinate system. Such common coordinate system may be, for example, a coordinate system of the input device 20.

[0033] According to Fig. 3B, the user's finger F is touching the touch display surface 22 at a position P3 at the bottom left corner for controlling a different function as in Fig. 3A, with the input device 20 generating a position signal SP3 indicative of that position P3. In the exemplary scenario of Fig. 3B, when the input device 20 detects the position P3 upon touching the touch display surface 22, the proximity sensor device 3 detects a position D3 which is different from position P3. Thus, the position signal SP3 output by the input device 20 and corresponding detection signal SD3 output by the proximity sensor device 3 do not correspond. The position signal SP3 is supplied to the calibration device 4 which again calibrates the proximity sensor device 3 with respect to position detection. After the calibration, the position signal SP3 and corresponding detection signal SD3 output by the proximity sensor device 3 are corresponding to each other, i.e. are indicating the same position P3 of the detected object with respect to the input device 20. For example, the position coordinates of the finger F contained in both signals SP3 and SD3 are the same with respect to a common coordinate system.

[0034] According to Fig. 3C, the user's finger F is touching the touch display surface 22 at a position P4 in some area of the display surface for controlling a different function, with the input device 20 generating a position signal SP4 indicative of that position P4. In the exemplary scenario as shown in Fig. 3C, when the input device 20 detects position P4 when the finger F is touching the touch display surface 22, the proximity sensor device 3 detects a position D4 which is different from position P4. Thus, the position signal SP4 output by the input device 20 and corresponding detection signal SD4 output by the proximity sensor device 3 are different. The position signal SP4 is supplied to the calibration device 4 which again calibrates the proximity sensor device 3 with respect to position detection. After the calibration, the position signal SP4 and corresponding detection signal SD4 output by the proximity sensor device 3 are corresponding with each other, i.e. are indicating the same position P4 of the detected object with respect to the input device 20. For example, the position coordinates of the finger F contained in both signals SP4 and SD4 are the same with respect to a common coordinate system.

[0035] According to Fig. 3D, the user's finger F is touching the touch display surface 22 at a position P5 at some area of the display surface for controlling a different function, with the input device 20 generating a position signal SP5 indicative of that position P5. In the scenario of Fig. 3D, when the input device 20 detects the position P5 upon touching the touch display surface 22, the proximity sensor device 3 detects a position D5 which is still different from position P5. Thus, the signal SP5 output by the input device 20 and corresponding detection signal SD5 output by the proximity sensor device 3 are different. The position signal SP5 is supplied to the calibration device 4 which again calibrates the proximity sensor device 3 with respect to position detection. After the calibration, the position signal SP5 and corresponding detection signal SD5 output by the proximity sensor device 3 are corresponding with each other, i.e. are indicating the same position P5 of the detected object F with respect to the input device 20. For example, the position coordinates of the finger F contained in both signals SP5 and SD5 are the same with respect to a common coordinate system.

[0036] In this way, the proximity sensor device 3 is repeatedly calibrated over at least a period of time during normal operation of the input device. By touching different locations at the input device, the proximity sensor device 3 is advantageously calibrated with respect to different locations with respect to the input device 20. Particularly, the calibration device repeatedly receives from the input device 20 position signals SP1 to SPn over a period of time during normal operation of the input device 20. Each of the position signals SP1 to SPn contains information regarding a respective position of finger F touching the touch display surface 22. The calibration device 4 then each time upon receiving of a respective one of the position signals SP1 to SPn repeatedly calibrates the proximity sensor device 3 with respect to position detection. For example, the proximity sensor device 3 is repeatedly calibrated each time when detecting touching of the touch display surface 22 by an object.

[0037] The calibration may be performed continuously over a period of time, which means that calibration is performed continuously upon touching the input device during normal operation over a period of time. Such period of time may be set in advance, and can be modified if required. According to another embodiment, calibration may be performed at intervals, e.g. at certain time intervals, or when receiving particular ones of multiple position signals from the input device, for example at every second received position signal, or at intervals over respective periods of time (such as every day for at least 15 minutes). Such intervals may be set in advance, and can be modified if required. The intervals may also be set depending on environmental influences, such as detected vibrations of a head unit in a vehicle, travelled distance of the vehicle, and/or impacts like accidents. Various implementations are possible in this regard.

[0038] Preferably, the user is not required to conduct a manually initiated calibration procedure. Rather, the user is touching the input device (e.g., the touch display surface) in normal operation of the input device, which operation is also used for calibration in the background. In normal operation, the input device is configured to receive instructions from the user, e.g. for controlling one or more functions of a controlled device, such as one or more functions of a media player, not related to calibration. Particularly, the received instructions are not related to calibration instructions. For example, the user is touching elements of a GUI provided on the input device in normal operation thereof to activate one or more functions of the GUI. The functions are not related to a calibration procedure. No separate calibration operation is necessary, in which a special calibration procedure different from a GUI in normal operation is displayed on the input device. During normal operation, the user is typically touching the input device (e.g., touch screen) many times at many points to activate various functions according to the GUI which are related to normal operation (i.e. not related to calibration). For example, each time the user's finger is actually touching the touch display surface to activate some function in normal operation, e.g. related to controlling a media player, the proximity sensor device is calibrated in the background automatically. Further, the calibration will become better and better over time. The calibration is not related to a particular arrangement or design of the GUI. That is, no matter where the user is touching the input device and independent from a particular GUI, a correct calibration is made. For example, proximity sensor coordinates are continuously calibrated every time the user is touching the touch screen. It is not necessary to initialize and perform a manual calibration by the user.

[0039] Fig. 4 shows a flowchart of a method for calibrating a position detection system according to an embodiment of the invention.

[0040] Basically, according to the following embodiment, each of the position signals SP1 to SPn contains information indicative of first coordinates x_t, y_t, z_t indicating the location where the respective object F is touching the input device 20, i.e. its touch display surface 22. The proximity sensor device 3 outputs the detection signals SD1 to SDn when detecting a position of an object which each contain information indicative of second coordinates of the respective object x_p, y_p, z_p indicating the location where the respective object F is detected by the proximity sensor device 3. The first and second coordinates may be in a same or different coordinate systems. If different coordinate systems are used, then a spatial relationship between the coordinate systems should be known which could be used in the calibration.

[0041] In step S1, the proximity sensor device 3 initially is tracking an object (here: a user's finger) position according to position coordinates in raw/original values, which are for example x_p0, y_p0, z_p0. In step S2, the proximity sensor device 3 outputs detected object position coordinates with corrected/calibrated values as a result of a preceding calibration procedure:

$$x\_p = x\_p0 + x\_offset$$

$$y\_p = y\_p0 + y\_offset$$

$$z\_p = z\_p0 + z\_offset$$

[0042] These position coordinates x_p, y_p, z_p are contained in the calibrated output signal of the proximity sensor device 3, such as SD1 to SDn. Initially, i.e. before calibration, the offset values x_offset, y_offset, z_offset used for correction of the detection signal are set to be zero.

[0043] In step S3, it is detected whether the touch display surface is touched by an object. If not, then the process returns to step S1. If yes, then in step S4 a respective position signal SP1 to SPn is generated by the input device 20 containing information regarding a respective position of the detected object touching the touch display surface. For example, each of the position signals SP1 to SPn is containing the position coordinates x_t, y_t and z_t, wherein z_t may be set as z_t = 0 in a coordinate system of the input device as the detected z-position is the position of the touch display surface. For step S4, it is assumed that the output of the input device (e.g., touch screen output) with respect to position of a detected touch is already calibrated and correct.

[0044] In step S5, the proximity sensor device 3 is calibrated with respect to detecting the position of the finger F upon receiving of a respective one of the position signals SP1 to SPn, for example each time the calibration device 4 receives one of the position signals SP1 to SPn. (Re-)Calibration of the proximity sensor device may be made, for example, as follows:

$$\text{set } x\_offset = x\_t - x\_p0$$

$$\text{set } y\_offset = y\_t - y\_p0$$

$$\text{set } z\_offset = - z\_p0$$

[0045] wherein x_offset, y_offset and z_offset are offset parameters of a detected position of the proximity sensor device 3. With determining the respective offset parameters, the calibration device 4 sets the coordinates x_p, y_p, z_p of a proximity sensor detection signal SD1 to SDn to correspond to the coordinates x_t, y_t, z_t received with a corresponding position signal SP1 to SPn. If the coordinates are determined in a common coordinate system, e.g. related to the input device 20, then the coordinates x_p, y_p, z_p may be set to be equal to the coordinates x_t, y_t, z_t. Otherwise, a spatial relationship between different coordinate systems should be taken into account as well. With calibration of the proximity sensor device 3 a respective one of the offset parameters x_offset, y_offset, z_offset is set by calculating a difference between the coordinates x_t, y_t, z_t received with a corresponding position signal SP1 to SPn and respective coordinates x_p, y_p, z_p of the corresponding detection signal.

[0046] For step S5, it is assumed that in the moment of touching the touch display surface, z_t = 0 (i.e. finger distance to the touch display surface is zero), therefore z_offset = z_t - z_p0 is the same as z_offset = -z_p0.

[0047] The process then returns to step S1 for repeatedly iterating the steps S1 to S5. The determined offset parameters are then used for output of a new proximity sensor detection signal SD1 to SDn with coordinates x_p, y_p, z_p in step S2. In this way, the proximity sensor device 3 is repeatedly (re-)calibrated with respect to position detection of an object upon receiving of a respective position signal SP1, SP2, SPn from input device 20 according to step S4.

Claims

1. A position detection system (1), comprising:

   - a proximity sensor device (3) which is configured to detect at least one position of an object (F) approaching towards at least one input device (20),
   - a calibration device (4) which is configured to calibrate the proximity sensor device (3) with respect to a position detection and comprises a terminal (40) for coupling to the at least one input device (20),
   - wherein the calibration device (4) is configured to repeatedly receive from the at least one input device (20) position signals (SP1, SP2, SPn) over at least a period of time during normal operation of the input device (20),
   - wherein each of the position signals (SP1, SP2, SPn) contains information regarding a respective position of an object (F) touching the at least one input device (20),
   - wherein the calibration device (4) is configured to repeatedly calibrate the proximity sensor device (3) with respect to position detection upon receiving of a respective one of the position signals (SP1, SP2, SPn).

2. The position detection system according to claim 1, wherein the proximity sensor device (3) is configured to detect at least one three-dimensional position of an object (F) with respect to the at least one input device (20).

3. The position detection system according to claim 1 or 2, wherein the proximity sensor device (3) is configured to track a motion of an object (F) approaching towards the at least one input device (20).

4. The position detection system according to any of claims 1 to 3, wherein the proximity sensor device (3) comprises at least one camera based sensor.

5. The position detection system according to any of claims 1 to 4, wherein the terminal (40) is for coupling to the at least one input device (20) which comprises a touch screen (21), wherein each of the position signals (SP1, SP2, SPn) contains information regarding a respective position of an object (F) touching a touch display surface (22) of the touch screen (21).

6. The position detection system according to any of claims 1 to 6,

   - wherein each of the position signals (SP1, SP2, SPn) contains information indicative of first coordinates (x_t, y_t, z_t) of where the respective object (F) is touching the at least one input device (20),
   - wherein the proximity sensor device (3) is configured to output at least one detection signal (SD1, SD2, SDn) when detecting a position of an object (F), the at least one detection signal (SD1, SD2, SDn) containing information indicative of second coordinates of the respective object (x_p, y_p, z_p),
   - wherein the calibration device (4) is configured to set the second coordinates (x_p, y_p, z_p) to correspond to the first coordinates (x_t, y_t, z_t) received with a corresponding position signal (SP1, SP2, SPn).

7. The position detection system according to any of claims 1 to 6, wherein the position detection system (1) is configured to be installed in a vehicle.

8. The position detection system according to claim 7, wherein the proximity sensor device (3) is configured to be coupled with a head unit (2) of the vehicle comprising the at least one input device (20).

9. A vehicle comprising a position detection system (1) according to any of the preceding claims.

10. A method of calibrating a position detection system (1) comprising a proximity sensor device (3) which is configured to detect at least one position of an

object (F) approaching towards at least one input device (20), the method comprising:

- detecting touching of the at least one input device (20) by an object (F) and generating a respective position signal (SP1, SP2, SPn) by the at least one input device (20) containing information regarding a position of the respective object (F) touching the at least one input device (20),
- receiving from the at least one input device (20) respective position signals (SP1, SP2, SPn) repeatedly over at least a period of time during normal operation of the input device (20),
- repeatedly calibrating the proximity sensor device (3) with respect to detecting of at least one position of an object (F) upon receiving of a respective one of the position signals (SP1, SP2, SPn).

11. The method according to claim 10, wherein the proximity sensor device (3) is repeatedly calibrated each time when detecting touching of the at least one input device (20) by an object (F).

12. The method according to one of claims 10 or 11, wherein the at least one input device (20) comprises a touch screen (21) having a touch display surface (22), and the step of detecting touching comprises detecting touching of the touch display surface (22) by an object (F) and generating a respective position signal (SP1, SP2, SPn) by the at least one input device (20) containing information regarding a position of the respective object (F) touching the touch display surface (22).

13. The method according to one of claims 10 to 12, wherein the calibration of the proximity sensor device (3) comprises setting of an offset parameter (x_offset, y_offset, z_offset) of a detected position detected by the proximity sensor device (3) using a corresponding one of the received position signals (SP1, SP2, SPn).

14. The method according to one of claims 10 to 13,

- wherein each of the position signals (SP1, SP2, SPn) contains information indicative of first coordinates (x_t, y_t, z_t) of where the respective object (F) is touching the at least one input device (20),
- wherein the proximity sensor device (3) is configured to output at least one detection signal (SD1, SD2, SDn) when detecting a position of an object (F), the at least one detection signal (SD1, SD2, SDn) containing information indicative of second coordinates of the respective object (x_p, y_p, z_p),
- wherein the calibration of the proximity sensor device (3) comprises setting of an offset parameter (x_offset, y_offset, z_offset) of a detected position detected by the proximity sensor device (3) by calculating a difference between the first coordinates (x_t, y_t, z_t) received with a corresponding position signal (SP1, SP2, SPn) and respective second coordinates (x_p, y_p, z_p) of the at least one detection signal (SD1, SD2, SDn).

FIG. 1

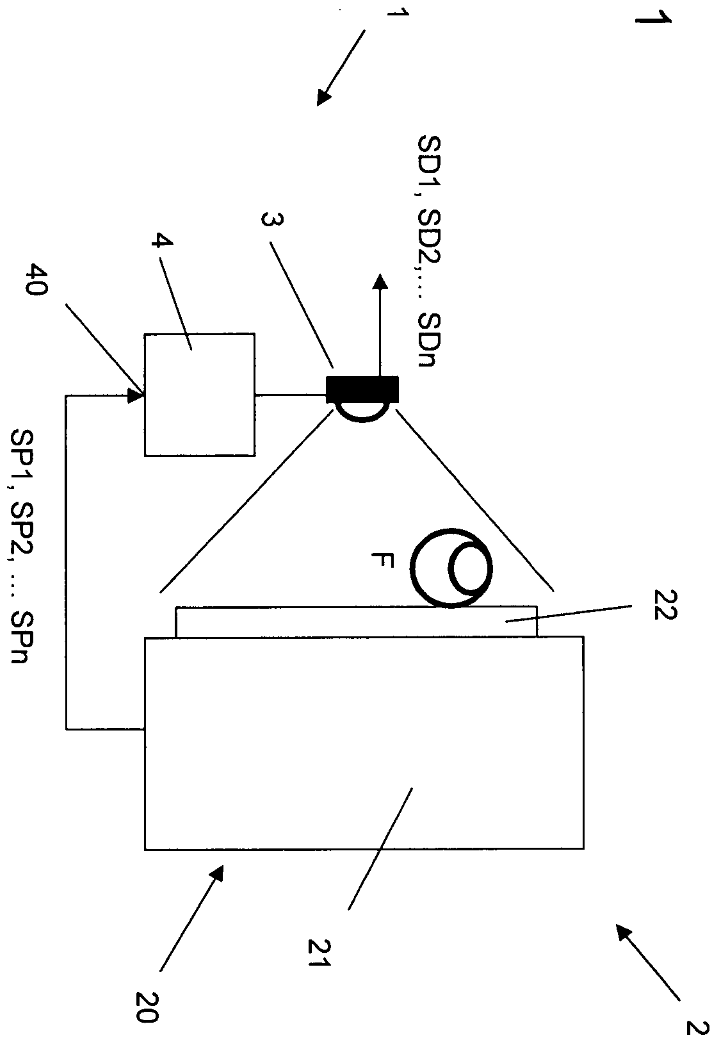
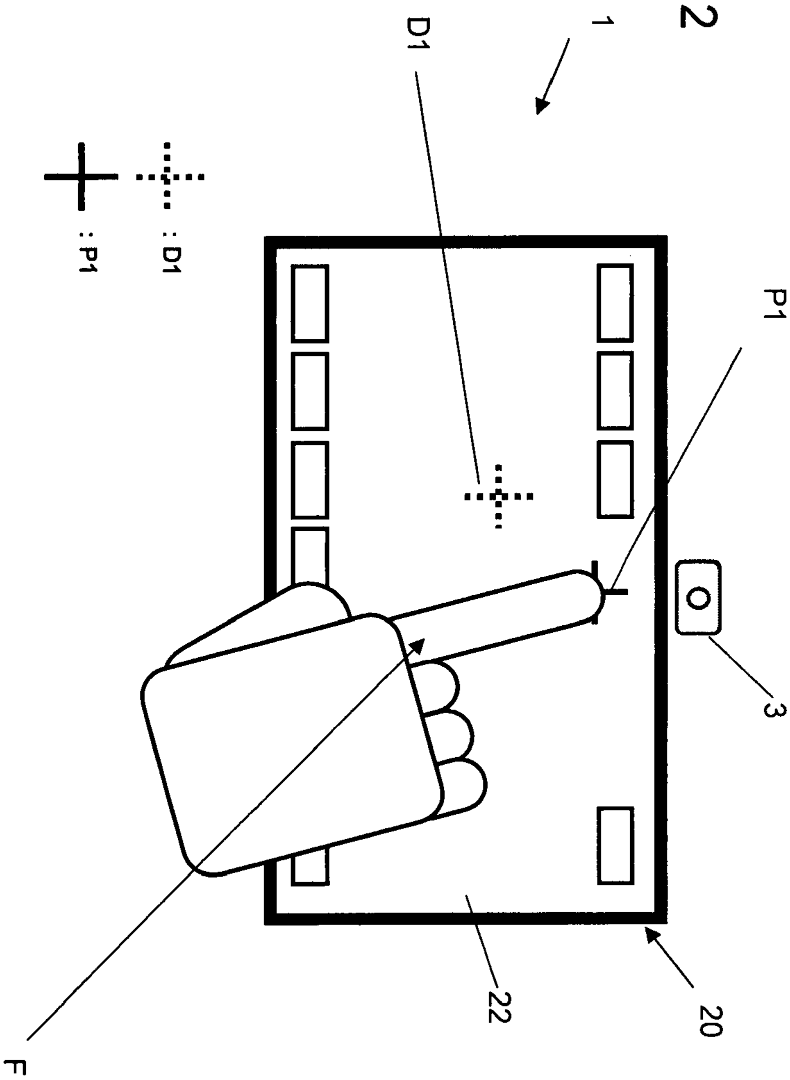


FIG. 2



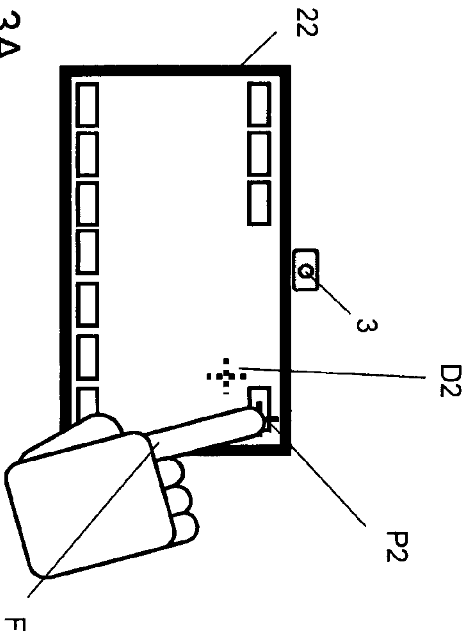


FIG. 3A

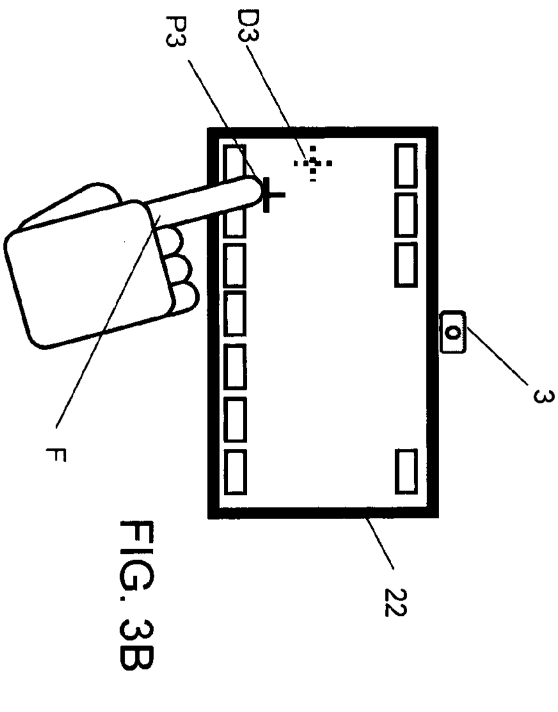


FIG. 3B

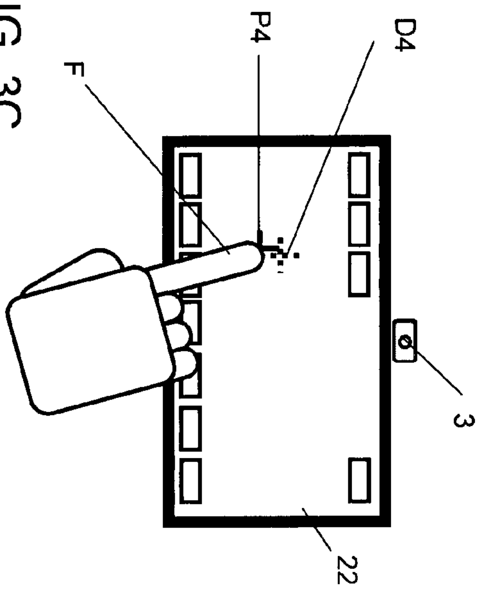


FIG. 3C

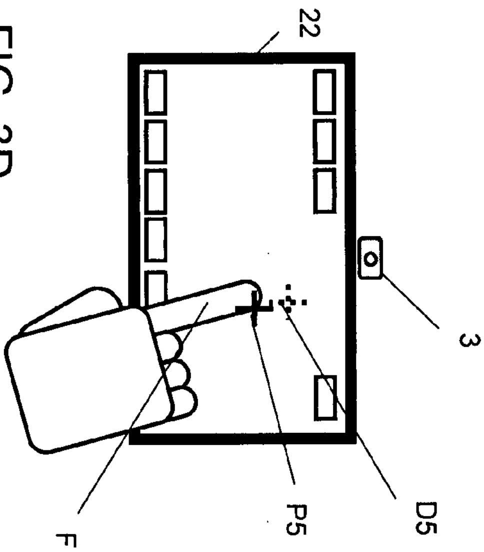
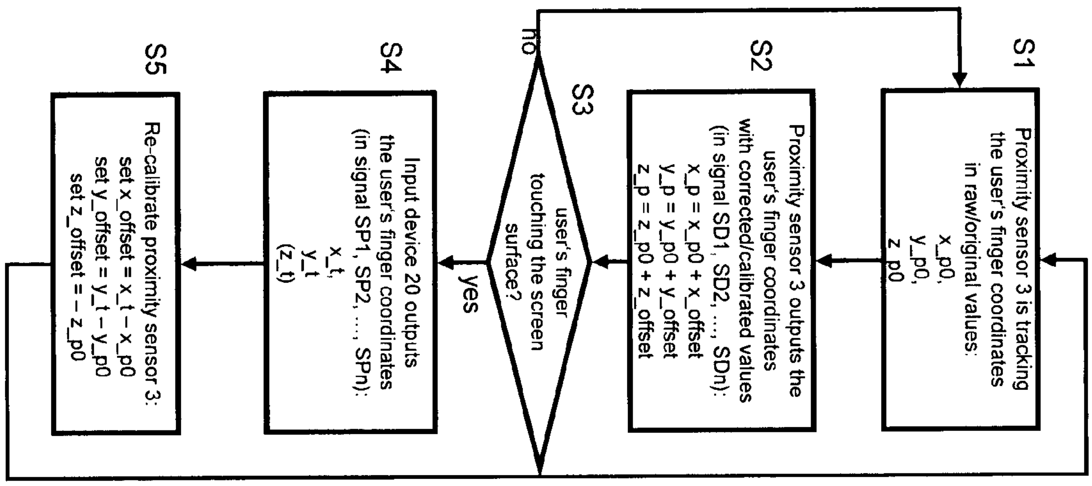


FIG. 3D

FIG. 4


S1
Proximity sensor 3 is tracking the user's finger coordinates in raw/original values:
x_p0,
y_p0,
z_p0
S2
Proximity sensor 3 outputs the user's finger coordinates with corrected/calibrated values (in signal SD1, SD2, ..., SDn):
x_p = x_p0 + x_offset
y_p = y_p0 + y_offset
z_p = z_p0 + z_offset
S3
user's finger touching the screen surface?
no
yes
S4
Input device 20 outputs the user's finger coordinates (in signal SP1, SP2, ..., SPn):
x_t,
y_t
(z_t)
S5
Re-calibrate proximity sensor 3:
set x_offset = x_t – x_p0
set y_offset = y_t – y_p0
set z_offset = – z_p0

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EUROPEAN SEARCH REPORT

Application Number
EP 14 00 2804

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G06F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	27 January 2015	Anticoli, Claud

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