United States Patent Application Publication 20250258566
Kind Code A1
Publication Date August 14, 2025
Inventor(s) Asakura; Tomo et al.

POSITION DETECTION APPARATUS CONFIGURED TO DETECT THE POSITIONS OF MULTIPLE POSITION INDICATORS, AND POSITION DETECTION METHOD

Abstract

A position detection apparatus includes a sensor, and a controller that detects a position of a first position indicator and a position of a second position indicator through the sensor. The controller continues detecting the position of the first position indicator and halts detecting the position of the second position indicator after a state in which the positions of the first position indicator and the second position indicator are not detected changes to a state in which the position of the first position indicator is detected, and continues both detecting the position of the second position indicator and detecting the position of the first position indicator after the state in which the positions of the first position indicator and the second position indicator are not detected changes to a state in which the position of the second position indicator is detected.

Inventors: **Asakura; Tomo (Saitama, JP), Ito; Masamitsu (Saitama, JP)**

Applicant: **Wacom Co., Ltd.** (Saitama, JP)

Family ID: **1000008572027**

Appl. No.: **19/172525**

Filed: **April 07, 2025**

Foreign Application Priority Data

JP	2019-000251	Jan. 04, 2019

Related U.S. Application Data

parent US continuation 18178432 20230303 parent-grant-document US 12293038 child US 19172525
parent US continuation 17343561 20210609 parent-grant-document US 11599220 child US

18178432
parent WO continuation PCT/JP2019/045177 20191119 PENDING child US 17343561

Publication Classification

Int. Cl.: **G06F3/041** (20060101); **G06F3/039** (20130101)

U.S. Cl.:

CPC **G06F3/041661** (20190501); **G06F3/0393** (20190501);

Background/Summary

BACKGROUND
Technical Field
[0001] The present disclosure relates a position detection apparatus and a position detection method, and particularly, to a position detection apparatus and a position detection method for appropriately detecting a position indicated by each of a plurality of position indicators.
Background Art
[0002] An electromagnetic-induction input apparatus is known as an input device of an electronic device, such as a tablet terminal and a smartphone. This type of input apparatus includes, for example, a position indicator formed in a pen shape and a position detection apparatus including a planar input surface. The user holds the position indicator by hand and performs an input operation by sliding the position indicator on the input surface as if the user writes words or pictures on paper.
[0003] The position indicator includes a resonant circuit including an inductor and a capacitor. The position detection apparatus includes a plurality of loop coils provided in the input surface. Position detection of the position indicator performed by the position detection apparatus will be simply described. The position detection apparatus first causes one of the loop coils to generate a magnetic field. Consequently, induced power is generated in the inductor of the position indicator, and the capacitor is charged. Subsequently, once the position detection apparatus causes the magnetic field to disappear, the power charged in the capacitor is used to transmit a reflected signal from the position indicator. The position detection apparatus determines the reception strength of the transmitted reflected signal at each loop coil to detect the position of the position indicator in the input surface.
[0004] A position indicator provided with resonant circuits at both ends is disclosed in Japanese Patent Laid-Open No. H8-69350. The phases of the reflected signals of the signal from the position detection apparatus vary in the resonant circuits at both ends, and therefore, the position detection apparatus can distinguish and detect the reflected signals. As a result, one end can be handled as a pen, and the other end can be handled as an eraser, for example. Therefore, the user can use the position indicator as if the user is using a pencil with eraser.
[0005] In typical stationery, not only erasers provided at back ends of pencils, but also erasers separated from pencils are often used. Therefore, in relation to the position indicator, the inventor of the present specification is also examining to provide a position indicator with eraser function and a position indicator with pen function as separate devices. In this case, an example of a position detection method for distinguishing and detecting the positions indicated by the position indicators includes the following method. Different resonant frequencies are allocated to the position indicators, and the resonant frequencies are first used to perform global scans (scans of the entire

sensors) in a time-division manner. When the position indicated by one of the position indicators is detected in the global scan, the global scan is shifted to a local scan of the position indicated by the position indicator (scan of a neighborhood area of the detected position in the sensor). Such a position detection method can be adopted.

[0006] However, when such a position detection method is adopted, the position indicated by another position indicator cannot be detected after the position indicated by a position indicator is detected. Therefore, there is a demand for allowing to detect the position indicated by another position indicator even when the position indicated by a position indicator is detected. For example, even in a case where the position indicated by the position indicator with eraser function is detected, there is a demand for allowing to detect the position indicated by the position indicator with pen function when the position indicator that is a pen approaches.

BRIEF SUMMARY

[0007] Therefore, an object of the present disclosure is to provide a position detection apparatus and a position detection method that can appropriately detect a position indicated by each of a plurality of position indicators according to the situation.

[0008] The present disclosure provides a position detection apparatus including a sensor, and a controller which, in operation, detects a position indicated by a first position indicator and a position indicated by a second position indicator through the sensor, in which the controller continues a process of detecting the position indicated by the first position indicator and halts a process of detecting the position indicated by the second position indicator after a state in which the position indicated by the first position indicator and the position indicated by the second position indicator are not detected changes to a state in which the position indicated by the first position indicator is detected, and continues both the process of detecting the position indicated by the second position indicator and the detection of the first position after the state in which the position indicated by the first position indicator and the position indicated by the second position indicator are not detected changes a state in which the position indicated by the second position indicator is detected.

[0009] The present disclosure provides a position detection method that includes: performing a process of detecting a position indicated by a first position indicator through a sensor; performing a process of detecting a position indicated by a second position indicator through the sensor; continuing the process of detecting the position indicated by the first position indicator and halting the process of detecting the position indicated by second position indicator after a state in which the position indicated by the first position indicator and the position indicated by the second position indicator are not detected changes to a state in which the position indicated by the first position indicator is detected, and continuing both the process of detecting the position indicated by the second position indicator and the process of detecting the position indicated by the first position indicator after the state in which the position indicated by the first position indicator and the position indicated by the second position indicator are not detected changes to a state in which the position indicated by the second position indicator is detected.

[0010] According to the present disclosure, the position indicated by each of a plurality of position indicators can be appropriately detected according to the situation.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. **1** depicts an appearance of a position detection apparatus and position indicators according to a first embodiment of the present disclosure;

[0012] FIG. **2** depicts an internal configuration of a position indicator, a sensor, and a sensor controller;

[0013] FIGS. **3**A and **3**B depict an outline of a position detection process carried out by a controller according to the first embodiment of the present disclosure;
[0014] FIG. **4** is a process flow chart illustrating a position detection process according to the first embodiment of the present disclosure;
[0015] FIG. **5** is a process flow chart illustrating a position detection process according to the first embodiment of the present disclosure;
[0016] FIG. **6**A is a process flow chart illustrating details of a Y-axis global scan performed at S**2** of FIGS. **4**, **11**, and **13**; FIG. **6**B is a process flow chart illustrating details of a Y-axis global scan performed at S**7** of FIGS. **4**, **11**, and **13**;
[0017] FIG. **7**A is a process flow chart illustrating details of a local scan performed at S**11** of FIGS. **5**, **12**, and **13**; FIG. **7**B is a process flow chart illustrating details of a partial global scan performed at S**43** of FIG. **5** and S**64** of FIG. **12**;
[0018] FIG. **8** schematically depicts a resonant level detected at S**2** and S**7** of FIGS. **11** and **13**;
[0019] FIG. **9** depicts an appearance of the position detection apparatus and position indicators according to a second embodiment of the present disclosure;
[0020] FIGS. **10**A and **10**B depict an outline of a position detection process carried out by a controller according to the second embodiment of the present disclosure;
[0021] FIG. **11** is a process flow chart illustrating a position detection process according to the second embodiment of the present disclosure;
[0022] FIG. **12** is a process flow chart illustrating a position detection process according to the second embodiment of the present disclosure; and
[0023] FIG. **13** is a process flow chart illustrating a specific example of a position detection process of the present disclosure.

DETAILED DESCRIPTION

[0024] Embodiments of the present disclosure will now be described in detail with reference to the attached drawings.

[0025] FIG. **1** depicts an appearance of a position detection apparatus **1** and position indicators **2***a* and **2***b* according to a first embodiment of the present disclosure. The position detection apparatus **1** is a computer, such as a tablet terminal, including an input surface **10***a*, and as illustrated in FIG. **1**, the position detection apparatus **1** includes a sensor **10**, a sensor controller **20**, and a host processor **40**. Among these, the sensor **10** and the sensor controller **20** will be described in detail later. The host processor **40** is a central processing unit of the position detection apparatus **1** that is a computer. The host processor **40** executes instructions stored in a memory in order to perform a process of generating stroke data based on coordinates input from the sensor controller **20**, a process of storing the generated stroke data in a storage apparatus, a process of transmitting the generated stroke data to another computer, a process of rendering and displaying the generated stroke data on a display apparatus, etc.

[0026] Each of the position indicators **2***a* and **2***b* is an apparatus that functions as an input apparatus for the position detection apparatus **1**. As illustrated in FIG. **1**, the position indicator **2***a* with pen function is formed in a pen shape, and the position indicator **2***b* with eraser function is formed in an eraser shape. Although described in detail later, the position detection apparatus **1** can distinguish and detect the position indicators **2***a* and **2***b* based on the difference in resonant frequency. In generating the stroke data, the position detection apparatus **1** handles the position indicator **2***a* as a pen and handles the position indicator **2***b* as an eraser. In the following description, the position indicators **2***a* and **2***b* (and a position indicator **2***c* described in a second embodiment) will be collectively called a position indicator **2** in some cases.

[0027] FIG. **2** depicts an internal configuration of the position indicator **2**, the sensor **10**, and the sensor controller **20**. The position indicator **2** will be described first. The position indicator **2** includes an LC resonant circuit including an inductor **3** and a capacitor **4**. The inductance of the inductor **3** and the capacitance of the capacitor **4** are set so that the resonant frequency of the LC resonant circuit varies in each type of position indicator **2**. The inductor **3** plays a role of generating an induced voltage according to a magnetic field supplied from the sensor **10** to charge the capacitor **4**. The inductor **3** after the stop of the supply of magnetic field from the sensor **10** also plays a role of using the charge accumulated in the capacitor **4** to transmit a reflected signal to the position detection apparatus **1**.

[0028] The sensor **10** includes a plurality of loop coils LC arranged in a rectangular planar area as illustrated in FIG. **2**. One end of each loop coil LC is grounded, and the other end is connected to the sensor controller **20**. FIG. **2** illustrates an example of the plurality of loop coils LC including m X-axis loop coils X.sub.1 to X.sub.m extending in an illustrated y-direction and n Y-axis loop coils Y.sub.1 to Y.sub.n extending in an x-direction orthogonal to the y-direction. Each of m and n is, for example, **40**.

[0029] The sensor controller **20** detects a position (first position) on the input surface **10***a* indicated by the position indicator **2***a* and a position (second position) on the input surface **10***a* indicated by the position indicator **2***b* through the sensor **10**. The sensor controller **20** includes a selection circuit **21**, a switch circuit **22**, an amplifier **23**, a detection circuit **24**, a low-pass filter (LPF) **25**, a sample and hold circuit (S/H) **26**, an analog-to-digital conversion circuit (A/D) **27**, a controller **28**, an oscillator **29**, and a current driver **30** as illustrated in FIG. **2**.

[0030] The other end of each loop coil LC is connected to the selection circuit **21**. The selection circuit **21** plays a role of selecting one or a plurality of loop coils LC according to the control from the controller **28** and connecting the selected loop coils LC to the switch circuit **22**.

[0031] The switch circuit **22** is a switch including one common terminal and two selection terminals, and the switch circuit **22** can switch the selection terminal to be connected to the common terminal according to the control from the controller **28**. The selection circuit **21** is connected to the common terminal of the switch circuit **22**. An input end of the amplifier **23** is connected to one of the selection terminals, and an output end of the current driver **30** is connected to the other selection terminal.

[0032] The amplifier **23** is a circuit that amplifies a voltage signal supplied from the selection circuit **21** through the switch circuit **22** and that outputs the voltage signal to the detection circuit **24**. The detection circuit **24** is a circuit that detects envelopes of a voltage signal output from the amplifier **23** to generate an envelope signal and that outputs the envelope signal to the low-pass filter **25**. The low-pass filter **25** plays a role of removing high frequency components from the envelope signal generated by the detection circuit **24**. The sample and hold circuit **26** is configured to perform, at a predetermined time interval, a sampling operation and a holding operation of the envelope signal from which the high frequency components are removed by the low-pass filter **25**. The analog-to-digital conversion circuit **27** applies analog-to-digital conversion to the signal held by the sample and hold circuit **26** to thereby generate a digital signal and outputs the digital signal to the controller **28**.

[0033] The controller **28** is a processor that operates according to a program stored in a storage apparatus, and the controller **28** is connected to the host processor **40** illustrated in FIG. **1**. The controller **28** controls the selection circuit **21**, the switch circuit **22**, the sample and hold circuit **26**, the analog-to-digital conversion circuit **27**, and the oscillator **29**. The controller **28** is also configured to perform, for example, a process of detecting the position of the position indicator **2** based on the digital signal supplied from the analog-to-digital conversion circuit **27** and outputting coordinates representing the detected position to the host processor **40** in association with the type of position indicator **2**.

[0034] FIGS. **3**A and **3**B depict an outline of a position detection process carried out by the controller **28** according to the present embodiment. FIG. **3**A illustrates a global scan mode of performing a global scan for scanning the entire sensor **10** to detect the position indicated by each position indicator **2**, and FIG. **3**B illustrates a local scan mode of performing a local scan for scanning a neighborhood area of a detected position in the sensor **10**. Although described in detail later, FIG. **3**B illustrates a local scan mode for the detection of the position indicated by the position indicator **2***b* with eraser function. Between the global scan mode and the local scan mode, there is an intermediate mode for confirming the position detected in the global scan mode.

[0035] After entering into the global scan mode, the controller **28** is configured to perform the global scan of each position indicator **2** in a time-division manner at a frequency of once per time period TG. “PGS” illustrated in FIGS. **3**A and **3**B represents a global scan (GlobalScan) of the position indicator **2***a* with pen (Pen) function, and “EGS” represents a global scan (GlobalScan) of the position indicator **2***b* with eraser (Eraser) function.

[0036] The time period TG is set to, for example, 0.125 seconds (8 Hz). The controller **28** is configured to divide the global scan of the individual position indicators **2** into a Y-axis global scan that is a scan of the Y-axis loop coils LC and an X-axis global scan that is a scan of the X-axis loop coils LC. In the global scan mode, the controller **28** is configured to repeatedly perform the Y-axis global scans of the position indicators **2** in a time-division manner. Note that in FIGS. **3**A and **3**B, reference sign “y” added to the end of each of “PGS” and “EGS” represents a Y-axis global scan. When a position indicator **2** is detected in one of the Y-axis global scans, the controller **28** shifts to the intermediate mode for the position indicator **2**.

[0037] The order of position indicators that perform the Y-axis global scan is determined in advance in the global scan mode of the present embodiment, and when the controller **28** enters into the global scan mode from another mode, the Y-axis global scan of each position indicator is started according to the predetermined order. In the following description, the position indicator for which the Y-axis global scan is performed earlier in the global scan mode will be referred to as a “priority position indicator,” and the position indicator for which the Y-axis global scan is performed later will be referred to as a “non-priority position indicator.” As illustrated in FIG. **3**A, the Y-axis global scan is performed in the order of the position indicator **2***a* and the position indicator **2***b*. Therefore, the position indicator **2***a* with pen function is the priority position indicator, and the position indicator **2***b* with eraser function is the non-priority position indicator in the present embodiment.

[0038] The intermediate mode will be described. Once the controller **28** enters into the intermediate mode, the controller **28** performs the X-axis global scan for the position indicator **2** detected in the global scan mode and performs a determination process for confirming the detection. The determination process is a process of determining whether the detection results of the Y-axis global scan and the X-axis global scan satisfy a predetermined detection condition. Although the details will be described in detail later, an example of the predetermined detection condition includes that the reception strength distribution of the reflected signals detected in the Y-axis global scan and the X-axis global scan has a predetermined shape. When the controller **28** confirms the detection of the position as a result of the determination process, the controller **28** shifts to the local scan mode for the position indicator **2** for which the detection of the position is confirmed. On the other hand, when the controller **28** does not confirm the detection of the position, the controller **28** returns to the global scan mode.

[0039] After entering into the local scan mode, the controller **28** performs the local scan for the target position indicator at a frequency of once per time period TL as illustrated in FIG. **3**B. TL is, for example, approximately 0.0075 seconds (133 Hz) and is set to a value smaller than the time period TG. This is for generating the stroke data at a high accuracy. Note that “ELS” illustrated in FIG. **3**B represents a local scan (LocalScan) of the position indicator **2***b* with eraser (Eraser) function. Reference signs “x” and “y” added to the ends of “ELS” represent a scan of the X-axis loop coils LC and a scan of the Y-axis loop coils LC, respectively. As illustrated in FIG. **3**B, the controller **28** is configured to sequentially carry out the scan of the X-axis loop coils LC and the scan of the Y-axis loop coils LC in one local scan.

[0040] The controller **28** performs the local scan for the target position indicator at a frequency of once per time period TL. On the other hand, the controller **28** performs the global scan for the other position indicator **2**. In an example of the present embodiment, the global scan performed for the

other position indicator **2** is divided and performed. That is, the controller **28** is configured to perform a global scan of part of the other position indicator **2** (hereinafter, referred to as a partial global scan). The partial global scan is part of the corresponding global scan, and for example, the scan is performed for two or three loop coils LC. Note that one or both of the Y-axis loop coils LC and the X-axis loop coils LC may be included in the loop coils LC to be scanned in the partial global scan. The specific number of loop coils LC that can be scanned in the partial global scan is determined by, for example, taking into account the time length of the partial global scan. In the present embodiment, the controller **28** preferentially handles the position indicator **2***a* with pen function. Therefore, when the controller **28** is in the local scan mode for the position indicator **2***b* with eraser function, the controller **28** alternately performs the local scan of the position indicator **2***b* and the partial global scan of the position indicator **2***a*. Note that “PGSp” illustrated in FIG. **3**B represents the partial global scan of the position indicator **2***a* with pen function. In this way, after the controller **28** detects the position of the position indicator **2***b* in a state in which the position of the position indicator **2***a* and the position of the position indicator **2***b* are not detected, the controller **28** continues to detect both of the position of the position indicator **2***a* and the position of the position indicator **2***b*.
[0041] In the present embodiment, the controller **28** does not carry out the partial global scan of the position indicator **2***b* with eraser function when the controller **28** is in the local scan mode for the position indicator **2***a* with pen function. That is, after the state in which the position of the position indicator **2***a* and the position of the position indicator **2***b* are not detected is shifted to a state in which the position of the position indicator **2***a* is detected, the controller **28** continues the detection of the position of the position indicator **2***a* and halts the detection of the position of the position indicator **2***b*. This is a configuration based on an example of the actual situation of the user, in which the user does not input the position by using the position indicator **2***b* with eraser function while inputting the position by using the position indicator **2***a* with pen function. Depending on the actual situation of the user, it is obvious that the partial global scan of the position indicator **2***b* may be performed when the controller **28** is in the local scan mode for the position indicator **2***a*.
[0042] When the position indicator **2***a* is detected in the partial global scan, the controller **28** returns to the global scan mode. The position indicator **2***a* is detected in the global scan, and therefore, the controller **28** shifts to the local scan mode for the position indicator **2***a* after the end of the global scan and continues the position detection of the position indicator **2***a*.
[0043] FIG. **2** will be further described. The oscillator **29** is a circuit that can generate an AC (alternating current) signal at an arbitrary frequency (hereinafter, referred to as a “detection signal”). The frequency of the detection signal (hereinafter, referred to as a “detection frequency”) generated by the oscillator **29** is controlled by the controller **28**. The current driver **30** converts the detection signal output from the oscillator **29** into a current signal and supplies the current signal to the switch circuit **22**.
[0044] A specific method performed by the controller **28** to detect the position indicated by the position indicator **2** will now be described in more detail with reference to a process flow performed by the controller **28**.
[0045] FIG. **13** is a process flow chart illustrating a specific example of the position detection process performed by the controller **28**.
[0046] As illustrated in FIG. **13**, the controller **28** first enters into the global scan mode (S**1**). The controller **28** initializes the detection frequency at the entry into the global scan mode. The detection frequency initialized in this way is the resonant frequency of the position indicator **2***a* in the present embodiment (see FIG. **3**A).
[0047] After entering into the global scan mode, the controller **28** performs the Y-axis global scan (S**2**).
[0048] FIG. **6**A is a process flow chart illustrating details of the Y-axis global scan performed at S**2**. The controller **28** is configured to select the Y-axis loop coils LC one by one (specifically, use the

selection circuit **21** illustrated in FIG. **2** to connect the Y-axis loop coils LC one by one to the common terminal of the switch circuit **22**) and repeat the process of S**21** and S**22** (S**20**).
[0049] S**21** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the oscillator **29** side to use a current detection frequency to transmit a predetermined detection signal from a current loop coil LC (Y-axis loop coil LC) for a predetermined time period. If a position indicator **2** in which the current detection frequency is the resonant frequency exists near the current loop coil LC, the capacitor **4** illustrated in FIG. **2** is charged during S**21**.
[0050] S**22** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the detection circuit **24** side after the completion of the transmission of the detection signal to thereby perform a scan of the current loop coil LC (Y-axis loop coil LC). The scan here is a process of detecting the reception strength (resonant level) of the reflected signal transmitted by the position indicator **2**. The controller **28** temporarily stores the detected resonant level of each Y-axis loop coil LC.
[0051] FIG. **13** will be further described. Once the Y-axis global scan is finished, the controller **28** determines whether there is a resonant level equal to or greater than a threshold among the plurality of temporarily stored resonant levels (S**3**). As a result of the determination, if the controller **28** determines "no," the controller **28** switches the detection frequency to the next one (the resonant frequency for the position indicator **2***b* if the current detection frequency is the resonant frequency for the position indicator **2***a*, the resonant frequency for the position indicator **2***a* if the current detection frequency is the resonant frequency for the position indicator **2***b*) (S**4**) and returns the process to S**2**. S**4** is provided to alternately repeat the detection of the position of the position indicator **2***a* through the Y-axis global scan and the detection of the position of the position indicator **2***b* through the Y-axis global scan in the global scan mode.
[0052] On the other hand, if the controller **28** determines "yes" at S**3**, the controller **28** enters into the intermediate mode (S**5**) and determines the Y-axis loop coil LC (hereinafter, referred to as a "closest Y-axis loop coil LC") closest from the position indicator **2** based on the plurality of resonant levels temporarily stored at S**2** (S**6**). The controller **28** then performs the X-axis global scan of the position indicator **2** (S**7**).
[0053] FIG. **6**B is a process flow chart illustrating details of the X-axis global scan performed at S**7**. The controller **28** is configured to select the X-axis loop coils LC one by one (specifically, use the selection circuit **21** illustrated in FIG. **2** to connect the X-axis loop coils LC one by one to the common terminal of the switch circuit **22**) and repeat the process of S**26** and S**27** (S**25**).
[0054] S**26** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the oscillator **29** side to use the current detection frequency to transmit a predetermined detection signal from the closest Y-axis loop coil LC for a predetermined time period. At this point, it is highly probable that the position indicator **2** in which the current detection frequency is the resonant frequency exists near the closest Y-axis loop coil LC. Therefore, the capacitor **4** of the position indicator **2** is charged during S**26**.
[0055] S**27** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the detection circuit **24** side after the completion of the transmission of the detection signal to thereby perform a scan of the current loop coil LC (X-axis loop coil LC). The scan here is also a process of detecting the reception strength (resonant level) of the reflected signal transmitted by the position indicator **2**. The controller **28** temporarily stores the detected resonant level of each X-axis loop coil LC.
[0056] FIG. **13** will be further described. Once the X-axis global scan is finished, the controller **28** performs a determination process for confirming the detection of the position in response to processing results of S**2** and S**7** (S**8**). The determination process includes a process of determining whether there is a resonant level equal to or greater than a threshold among the plurality of temporarily stored resonant levels in relation to the X-axis loop coils LC as at S**3** and also includes a process of determining whether the distribution of the resonant levels has a predetermined shape (for example, an arched shape as illustrated in FIG. **8** described later), a process of checking that the phase difference in electromagnetic resonance does not indicate sidelobes, a process of

determining whether the ratio of the resonant level of the sidelobes to the resonant level of the main peak indicates a normal value, etc. The local scan may be attempted once, and whether the position indicator **2** is detected as a result of the local scan may also be determined.
[0057] FIG. **8** schematically depicts the resonant levels detected at S**2** and S**7**. The horizontal axis in FIG. **8** represents the x-axis or the y-axis, and the vertical axis represents the resonant levels. As illustrated in FIG. **8**, the resonant levels detected at S**2** and S**7** include a relatively large peak (main peak) appearing at an illustrated position Pm and relatively small peaks (sidelobes) appearing at both sides (illustrated positions Ps) of the large peak. The sidelobes are generated because the electromagnetic force generated from the sensor **10** is ring-shaped, and the position indicator **2** does not exist at the positions of the sidelobes.
[0058] FIG. **13** will be further described. The process of S**8** is, in short, a process of checking whether the waveform as illustrated in FIG. **8** is correctly obtained and whether the position to be detected is the position Pm. The position Pm is also determined as the position of the position indicator **2** at S**8**.
[0059] If the detection of the position indicator **2** is not confirmed as a result of the performance of the determination process at S**8**, the controller **28** returns the process to S**1** and enters into the global scan mode again. On the other hand, if the detection of the position indicator **2** is confirmed, the controller **28** enters into the local scan mode (S**10**) and starts the local scan of the position indicator **2** (S**11**). The resonant frequency (assigned frequency) used for the local scan in this case is the current detection frequency.
[0060] FIG. **7**A is a process flow chart illustrating details of the local scan performed at S**11**. The controller **28** is configured to select a predetermined number (for example, three or four) of Y-axis loop coils LC one by one (specifically, use the selection circuit **21** illustrated in FIG. **2** to connect the Y-axis loop coils LC one by one to the common terminal of the switch circuit **22**) in ascending order of distance from the position of the target position indicator **2** (determined at S**8** just after the shift from the intermediate mode and determined by the most recent local scan in the second and subsequent local scans) and repeat the process of S**31** and S**32** (S**30**).
[0061] S**31** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the oscillator **29** side to thereby use the assigned frequency to transmit a predetermined detection signal from the current loop coil LC (Y-axis loop coil LC) for a predetermined time period. S**32** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the detection circuit **24** side after the completion of the transmission of the detection signal to thereby perform the scan of the current loop coil LC. The controller **28** temporarily stores the detected resonant level of each of the selected loop coils LC.
[0062] Next, the controller **28** is configured to select a predetermined number (for example, three or four) of X-axis loop coils LC one by one (specifically, use the selection circuit **21** illustrated in FIG. **2** to connect the X-axis loop coils LC one by one to the common terminal of the switch circuit **22**) in ascending order of distance from the position of the target position indicator **2** and repeat the process of S**34** and S**35** (S**33**).
[0063] S**34** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the oscillator **29** side to thereby use the assigned frequency to transmit a predetermined detection signal from the current loop coil LC (X-axis loop coil LC) for a predetermined time period. S**35** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the detection circuit **24** side after the completion of the transmission of the detection signal to thereby perform the scan of the current loop coil LC. The controller **28** temporarily stores the detected resonant level of each of the selected loop coils LC.
[0064] Although the predetermined detection signal is transmitted from the current loop coil LC at S**34**, the closest Y-axis loop coil LC closest from the position indicator **2** may be determined based on the result of S**30** to transmit the detection signal from the closest Y-axis loop coil LC as in the case of the global scan. Although FIG. **7**A illustrates an example of performing S**33** to S**35** after

S**30** to S**32**, the order may be the opposite.

[0065] FIG. **13** will be further described. After the end of the process of S**11**, the controller **28** determines whether the reflected signal is lost (S**12**). The state in which the reflected signal is lost denotes a case in which a sufficient resonant level is not detected as a result of scanning the loop coils. For example, the state corresponds to a case in which the target position indicator **2** gets away from the input surface **10***a*. In this case, the controller **28** returns the process to S**1** and enters into the global scan mode again. On the other hand, if the controller **28** determines that the reflected signal is not lost at S**12**, the controller **28** determines the position of the position indicator **2** based on the plurality of resonant levels temporarily stored at S**11** and supplies coordinates indicating the determined position to the host processor **40** illustrated in FIG. **1** (S**13**). The controller **28** then returns the process to S**11** and performs the local scan again.

[0066] In the position detection process, there may be two states described below. Each state will now be described.

[0067] The first state is that the position indicator **2***a* with pen function cannot be detected after the shift to the local scan mode for the position indicator **2***b* with eraser function. For example, there may be a state in which the user leaves the position indicator **2***b* with eraser function on the input surface **10***a* and uses the position indicator **2***a* with pen function to perform an input. Therefore, in this state, it is necessary to be able to detect the position indicator **2***a* with pen function even after the shift to the local scan for the position indicator **2***b* with eraser function.

[0068] The second state is that there is a case in which although the process advances to S**9** for the position indicator **2***a* as a priority position indicator, a negative determination is made at S**9**, so that the process cannot advance to the local scan. When this state continues, the position indicator **2***a* enters into the global scan mode again, and then the position indicator **2***a* as a priority position indicator is detected. Therefore, the Y-axis global scan of the non-priority position indicator is not performed, and as a result, the position indicator **2***b* as a non-priority position indicator cannot be detected. This state occurs because the detection frequency is initialized at S**1** every time S**9** is denied. The state may occur when, for example, the position indicator **2***a* with pen function is laid down and left on the input surface **10***a*, and a correct waveform cannot be obtained in the determination process of S**8**. Therefore, while realizing a quick global scan by adopting the global scan mode and the intermediate mode, the situation where the position indicator **2***b* as a non-priority position indicator cannot be detected needs to be prevented.

[0069] FIGS. **4** and **5** depict a process flow chart illustrating a position detection process performed by the controller **28** to prevent the state described above. The method of position detection performed by the controller **28** according to the present embodiment will now be described in detail with reference to the drawings.

[0070] The method illustrated in FIGS. **4** and **5** is different from the method illustrated in FIG. **13** in that S**1** is divided into S**1***a* and S**1***b*, the process moves to S**40** instead of S**1** when the determination result of S**9** is negative, and S**41** to S**44** are performed after S**13**. The differences will be mainly described.

[0071] The controller **28** divides S**1** into S**1***a* and S**1***b* and performs S**1***a* and S**1***b* as illustrated in FIG. **4**. S**1***a* is a process of initializing the detection frequency, and S**1***b* is a process of entering into the global scan mode.

[0072] Also, the controller **28** moves to S**40** instead of S**1** when the determination result of S**9** is negative as illustrated in FIG. **4**. S**40** is a process of switching the detection frequency to the next one as at S**4**. After executing S**40**, the controller **28** performs S**1***b*. In this way, the controller **28** enters into the global scan mode again without initializing the detection frequency. Therefore, when the position of the position indicator **2***a* is not confirmed at S**9** so that the controller **28** shifts to the global scan mode, the controller **28** performs the Y-axis global scan of the position indicator **2***b* first. This can prevent the situation where the position indicator **2***b* as a non-priority position indicator cannot be detected, while realizing the quick global scan by adopting the global scan

mode and the intermediate mode.
[0073] The controller **28** further performs S**41** to S**44** after S**13** as illustrated in FIG. **5**. More specifically, the controller **28** first determines whether the current detection frequency is the resonant frequency of the position indicator **2***b* with eraser function (S**41**). As a result, if the controller **28** determines that the current detection frequency is not the resonant frequency of the position indicator **2***b* with eraser function, the controller **28** returns the process to S**11** and continues the local scan of the position indicator **2***a*. On the other hand, if the controller **28** determines that the current detection frequency is the resonant frequency of the position indicator **2***b* with eraser function, the controller **28** selects the loop coils LC (partial global scan coils) to be used in the partial global scan (S**42**) and then performs the partial global scan of the position indicator **2***a* (S**43**). At S**42**, the controller **28** may, for example, sequentially select a plurality of loop coils LC including one or both of Y-axis loop coils LC and X-axis loop coils LC or may select a plurality of loop coils LC in another order. The resonant frequency (assigned frequency) used in the partial global scan of S**43** is the resonant frequency (pen frequency) of the position indicator **2***a*.
[0074] FIG. **7**B is a process flow chart illustrating details of the partial global scan performed by the controller **28** at S**43**. As illustrated in FIG. **7**B, the controller **28** is configured to select the loop coils LC for partial global scan (loop coils LC selected at S**42** of FIG. **5**) one by one (specifically, use the selection circuit **21** illustrated in FIG. **2** to connect the loop coils LC one by one to the common terminal of the switch circuit **22**) and repeat the process of S**51** and S**52** (S**50**).
[0075] S**51** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the oscillator **29** side to thereby use the assigned frequency to transmit a predetermined detection signal from the current loop coil LC for a predetermined time period. S**52** is a process of connecting the switch circuit **22** illustrated in FIG. **2** to the detection circuit **24** side after the completion of the transmission of the detection signal to thereby scan the current loop coil LC. The controller **28** temporarily stores the detected resonant level of each of the selected loop coils LC.
[0076] FIG. **5** will be further described. After executing the partial global scan, the controller **28** determines whether the position indicator **2***a* is detected based on whether the reflected signal from the position indicator **2***a* is detected (S**44**). If the controller **28** determines that the position indicator **2***a* is "detected", the controller **28** returns the process to Sla to halt the local scan of the position indicator **2***b* and enter into the global scan mode again. As a result, although the process is started over from the Y-axis global scan, the reflected signal from the position indicator **2***a* is detected. Therefore, the controller **28** shifts to the local mode for the position indicator **2***a*, and the user can use the position indicator **2***a* with pen function to perform an input. On the other hand, if the controller **28** determines that the position indicator **2***a* is "not detected" at S**44**, the controller **28** returns the process to S**11**. As a result, the local scan mode of the position indicator **2***b* continues, and the user can continue to use the position indicator **2***b* with eraser function to perform an input.
[0077] As described above, according to the position detection apparatus **1** and the position detection process of the present embodiment, the detection of the position indicated by the position indicator **2***a* continues even after the detection of the position indicated by the position indicator **2***b*. Therefore, the position indicated by the position indicator **2***b* can be detected, and the position indicated by the position indicator **2***a* can be detected. This allows the user to use the position indicator **2***a* with pen function to perform an input without moving the position indicator **2***b* with eraser function from the input surface **10***a*.
[0078] Although the partial global scan of the position indicator **2***a* is performed in the local scan mode for the position indicator **2***b* in the case described in the present embodiment, it is obvious that the partial global scan of the position indicator **2***b* may be performed in the local scan mode for the position indicator **2***a*. This allows the user to use the position indicator **2***b* with eraser function to perform an input without moving the position indicator **2***a* with pen function from the input surface **10***a*.
[0079] According to the position detection apparatus **1** and the position detection process of the

present embodiment, the Y-axis global scan of the position indicator **2***b* is performed first in the case where the controller **28** shifts to the global scan mode when the detection of the position of the position indicator **2***a* is not confirmed in the determination process after the end of the X-axis global scan. This can prevent the situation where the position indicator **2***b* as a non-priority position indicator cannot be detected, while realizing the quick global scan by setting the global scan mode and the intermediate mode.

[0080] Although the position detection apparatus **1** described in the present embodiment has both of the configuration for detecting the position indicator **2***a* after the shift to the local scan mode for the position indicator **2***b* (for example, S**41** to S**44**) and the configuration for preventing the situation where the position indicator **2***b* as a non-priority position indicator cannot be detected while realizing the quick global scan by setting the global scan mode and the intermediate mode (for example, S**1***a*, S**1***b*, and S**40**), the present disclosure also includes a position detection apparatus with one of the configurations.

[0081] Next, the position detection apparatus **1** and the position detection process according to a second embodiment of the present disclosure will be described.

[0082] FIG. **9** depicts an appearance of the position detection apparatus **1** and the position indicators **2***a* to **2***c* according to the second embodiment of the present disclosure. Although the basic configuration of the position detection apparatus **1** is the same as the position detection apparatus **1** according to the first embodiment, the position detection apparatus **1** is different from the position detection apparatus **1** according to the first embodiment in that the position detection apparatus **1** also corresponds to the detection of the position indicator **2***c*. Although the basic structure of the position indicator **2***c* is similar to the position indicator **2***a*, the position indicator **2***c* is different from the position indicator **2***a* in that the position indicator **2***c* includes a side switch **5**, and the resonant frequency varies depending on whether or not the side switch **5** is pressed. Hereinafter, the position indicator **2***a* will be referred to as a pen **1** (P**1**), the position indicator **2***c* with the side switch **5** not pressed will be referred to as a pen **2** (P**2**), and the position indicator **2***c* with the side switch **5** pressed will be referred to as a pen **3** (P**3**) in some cases. The position indicator **2***b* as an eraser will be simply called an eraser in some case.

[0083] FIGS. **10**A and **10**B depict an outline of the position detection process carried out by the controller **28** according to the present embodiment. FIG. **10**A illustrates a global scan mode of performing a global scan for scanning the entire sensor **10** to detect the position of each position indicator **2**, and FIG. **10**B illustrates a local scan mode of performing a local scan for scanning a neighborhood area of the detected position in the sensor **10**. FIG. **10**B illustrates a local scan mode for the position indicator **2***b* as an eraser, which will be described in detail later. Although not illustrated in FIGS. **10**A and **10**B, there is an intermediate mode for confirming the position detected in the global scan mode between the global scan mode and the local scan mode as in the first embodiment.

[0084] One of the differences from the position detection process illustrated in FIGS. **3**A and **3**B is that the controller **28** in the global scan mode performs four types of Y-axis global scans in a time-division manner. Specifically, the Y-axis global scans are performed in the order of pen **2** (P**2**GSy), pen **3** (P**3**GSy), eraser (EGSy), and pen **1** (P**1**GSy). Note that four types of Y-axis global scans are performed in a time-division manner, and therefore, the time length of the time period TG is twice the time length of the time period TG in the first embodiment.

[0085] As illustrated in FIG. **10**B, the local scan of the position indicator **2***b* and the partial global scan of the position indicator **2***a* (first partial global scan) are also alternately performed in the local scan mode for the position indicator **2***b* as an eraser in the present embodiment. Note that "P**1**GSp" illustrated in FIG. **10**B represents a partial global scan of the pen **1**.

[0086] The point of the present embodiment is that the order of the Y-axis global scans of the position indicator **2***a* and the position indicator **2***b* in the global scan mode is opposite the order in the first embodiment. That is, the pen **1** as a target of the partial global scan is a position indicator not prioritized over the eraser as a target of the local scan in the present embodiment. Due to the difference from the first embodiment, the mode needs to be shifted once to the global scan mode in the present embodiment to confirm the detection even when the pen **1** is detected in the partial global scan. However, after the shift to the global scan mode, the eraser as a priority position indicator prioritized over the pen **1** is detected again. As a result, the mode cannot be shifted to the local scan mode for the pen **1** even though the pen **1** as a non-priority position indicator is detected in the partial global scan. Therefore, the mode needs to be able to shift to the local scan mode for the pen **1** when the pen **1** is detected in the partial global scan.

[0087] FIGS. **11** and **12** depict a process flow chart illustrating a position detection process performed by the controller **28** to prevent such a state. The method of position detection performed by the controller **28** according to the present embodiment will now be described in detail with reference to FIGS. **11** and **12**.

[0088] The method illustrated in FIGS. **11** and **12** is different from the method illustrated in FIGS. **4** and **5** in that S**60** to S**62** are inserted between S**2** and S**3**, and S**63** to S**67** are adopted in place of S**41** to S**44**. The differences will be mainly described.

[0089] With reference to FIG. **12**, the controller **28** first determines whether the current detection frequency is for the pen **1** (that is, resonant frequency of the position indicator **2***a*) after performing S**13** (S**63**). As a result, if the controller **28** determines that the current detection frequency is for the pen **1**, the controller **28** returns the process to S**11** and continues the local scan of the pen **1**. On the other hand, if the controller **28** determines that the current detection frequency is not for the pen **1**, the controller **28** selects the partial global scan coils as at S**42** illustrated in FIG. **5** (S**64**) and performs the partial global scan similar to S**43** illustrated in FIG. **5** (S**65**). Note that the resonant frequency (assigned frequency) used in the partial global scan of S**65** is the resonant frequency (pen **1** frequency) of the pen **1**.

[0090] The controller **28** that has performed the partial global scan determines whether the pen **1** is detected based on whether the reflected signal from the pen **1** is detected (S**66**). The controller **28** that has determined that the reflected signal is “not detected” returns the process to S**11**. In this way, the local scan mode of the eraser continues, and the user can continue to use the eraser to perform an input. On the other hand, if the controller **28** determines that the reflected signal is “detected” at S**66**, the controller **28** sets a pen **1** detection flag to “True” (S**67**). The controller **28** then returns the process to S**1***a* to initialize the detection frequency (S**1***a*) and enter into the global scan mode again (S**1***b*). In this way, the Y-axis global scan of S**2** is performed in the order of the pen **2**, the pen **3**, the eraser, and the pen **1**.

[0091] Here, the controller **28** in the process of FIG. **11** performs a process of determining whether the pen **1** detection flag is “True” after the end of S**2** (S**60**). If the controller **28** determines that the pen **1** detection flag is “True” at S**60**, the controller **28** further performs a process of determining whether the current detection frequency is for the pen **1** (S**61**). The controller **28** that has obtained a positive determination result at S**61** skips S**3** and advances the process to S**4**. As a result, each process of the intermediate mode including the determination process of S**8** is skipped. Even if the position of the pen **2**, the pen **3**, or the eraser is detected at S**2**, the position is not eventually detected, and the next Y-axis global scan for the position indicator **2** is performed. The determination result of S**61** is positive when the Y-axis global scan for the pen **1** is performed. Therefore, S**3** is performed in this case, and the process can advance to the intermediate mode. Therefore, the mode can be switched to the local scan mode for the pen **1** when the pen **1** is detected in the partial global scan.

[0092] Note that the controller **28** that has determined “False” at S**60** skips the process of S**61** and S**62** and advances the process to S**3**. In this way, the mode can be shifted to the intermediate mode as usual regardless of the type of position indicator **2** when the pen **1** is not detected in the partial global scan. The controller **28** that has obtained a negative determination result at S**61** performs a process of setting the pen **1** detection flag to “False” (S**62**) and advances the process to S**3**. In this way, the determination result of S**60** can be fixed to "False" until the next partial global scan for the pen **1** is performed.

[0093] As described above, according to the position detection apparatus **1** and the position detection process of the present embodiment, the position of the pen **2**, the pen **3**, or the eraser is not detected when the mode shifts to the global scan mode after the detection of the position of the pen **1** as a result of the partial global scan. The position of the pen **1** can be detected even through the pen **1** is a non-priority position indicator. Therefore, the pen **1** as a non-priority position indicator can be shifted to the local scan mode in the partial global scan.

[0094] Although the preferred embodiments of the present disclosure have been described, the present disclosure is not limited to the embodiments in any way, and it is obvious that the present disclosure can be carried out in various modes without departing from the scope of the present disclosure.

[0095] For example, in the present embodiments, although the position indicator **2***a* with pen function and the position indicator **2***b* with eraser function are used to describe an example of the position detection process according to the present disclosure, the present disclosure can be widely applied to a plurality of position indicators with functions different from each other.

[0096] Although the shape of the position indicator **2***a* with pen function is a pen shape, and the shape of the position indicator **2***b* with eraser function is an eraser shape in the description of the present embodiments, switches for switching the pen function and the eraser function can be provided in position indicators, and the switches can be controlled to realize the pen function and the eraser function in the position indicators with the same shape.

[0097] In the example of the present embodiment, the global scan is carried out by performing the Y-axis global scan, followed by the X-axis global scan (see FIG. **4** and the like). The local scan is carried out by performing the X-axis local scan, followed by the Y-axis local scan (see FIG. **7**A). However, the present disclosure can also be favorably applied when one or both of the orders are changed.

[0098] It is to be noted that the embodiment of the present disclosure is not limited to the foregoing embodiment, and that various changes can be made without departing from the spirit of the present disclosure.

Claims

1. A position detection apparatus, comprising: a sensor; and a controller that, in operation, detects, via the sensor, a first position indicated by a first position indicator with a first frequency and a second position indicated by a second position indicator with a second frequency, wherein, in response to a detection of one of the first position indicator or the second position indicator, the controller switches to performing a local scan to detect a third position in a vicinity of the first position indicated by the first position indicator or the second position indicated by the second position indicator detected by the detection of one of the first position indicator or the second position indicator, and wherein, when the controller switches to performing the local scan, the controller determines whether a frequency used in the local scan is the second frequency, and if the controller determines that the frequency used in the local scan is not the second frequency, the controller performs a position detection process using the second frequency.

2. The position detection apparatus according to claim 1, wherein the position detection process performed using the second frequency is a partial global scan that is part of a global scan that scans all of the sensor, and the controller alternately performs the local scan and the partial global scan.

3. The position detection apparatus according to claim 2, wherein the controller, in operation, performs the global scan when the second position indicator is detected by performing the partial global scan.

4. The position detection apparatus according to claim 3, wherein the controller, in operation, determines whether the global scan was performed in response to detecting the second position indicator by performing the partial global scan when the global scan is performed, and if the controller determines that the global scan was performed in response to detecting the second position indicator by performing the partial global scan, the controller restricts a transition to the local scan when the global scan is not performed at the second frequency.

5. A position detection method, comprising: detecting, via a sensor, a first position indicated by a first position indicator using a first frequency; detecting, via the sensor, a second position indicated by a second position indicator using a second frequency; and in response to a detection of one of the first position indicator or the second position indicator, performing a local scan to detect a third position in a vicinity of the first position indicated by the first position indicator or the second position indicated by the second position indicator detected by the detection of the one of the first position indicator or the second position indicator; determining whether a frequency used in the local scan is the second frequency; and in response to determining that the frequency used in the local scan is not the second frequency, alternately performing the local scan and a position detection process using the second frequency.

6. The position detection method according to claim 5, wherein the position detection process performed using the second frequency is a partial global scan that is part of a global scan that scans all of the sensor, and wherein the method further comprises alternately performing the local scan and the partial global scan.

7. The position detection method according to claim 6, further comprising: performing a global scan when the second position indicator is detected by performing the partial global scan.

8. The position detection method according to claim 7, further comprising: determining whether the global scan was performed in response to detecting the second position indicator by performing the partial global scan when the global scan is performed, and in response to determining that the global scan was performed in response to detecting the second position indicator by performing the partial global scan, restricting a transition to the local scan when the global scan is not performed at the second frequency.