Non-transitory recording medium and paper sheet handling apparatus

Abstract

A paper sheet handling apparatus includes: a displacement amount detector that includes a pressing part intended to press a paper sheet against a transporting face of a paper sheet transporting path and having an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path, the displacement amount detector detecting a displacement amount of displacement of the pressing part from the initial position in a direction perpendicular to the transporting face, the pressing part being displaced according to a thickness of a paper sheet passing between the transporting face and the pressing part; a reference displacement amount storage; a paper sheet thickness storage; and a tape thickness threshold storage.

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Appl. No.: 17/819026

Filed: August 11, 2022

Prior Publication Data

Document Identifier	Publication Date
US 20220383685 A1	Dec. 01, 2022

Related U.S. Application Data

continuation parent-doc WO PCT/JP2020/006504 20200219 PENDING child-doc US 17819026

Publication Classification

Int. Cl.: G07D7/189 (20160101); **G07D7/164** (20160101); **G07D7/20** (20160101); **G07D7/2033** (20160101); **G07D7/206** (20160101); **G07D11/16** (20190101); G07D11/14 (20190101)

U.S. Cl.:

CPC   **G07D7/189** (20170501); **G07D7/164** (20130101); **G07D7/20** (20130101); **G07D7/2033** (20130101); **G07D7/206** (20170501); **G07D7/2083** (20130101); **G07D7/2091** (20130101); **G07D11/16** (20190101); B65H2301/141 (20130101); B65H2301/142 (20130101); B65H2301/211 (20130101); B65H2301/212 (20130101); B65H2511/13 (20130101); B65H2557/64 (20130101); G07D11/14 (20190101); G07D2205/0012 (20130101); G07D2207/00 (20130101); G07D2211/00 (20130101)

Field of Classification Search

CPC: G07D (7/189); G07D (7/164); G07D (7/20); G07D (7/2033); G07D (7/206); G07D (7/2083); G07D (7/2091); G07D (11/16); G07D (11/14); G07D (2205/0012); G07D (2207/00); G07D (2211/00); G07D (7/183); B65H (2301/141); B65H (2301/142); B65H (2301/211); B65H (2301/212); B65H (2511/13); B65H (2557/64); G01B (5/068)

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Background/Summary

TECHNICAL FIELD
(1) The present invention relates to a non-transitory recording medium and an apparatus for handling paper sheets such as bills.

BACKGROUND ART
(2) A bill handling apparatus has conventionally known as an example of a paper sheet handling apparatus.

(3) A bill handling apparatus has functions for determining the number of, and the denomination of, bills inserted into a money insertion port of the apparatus and for inspecting, for example, the registration numbers and the authenticity of the bills, and also has, for example, a function for determining, as a taped note, a bill having tape applied thereto such that this bill is not provided to a customer in a withdrawal process. For example, a customer may apply tape to a torn bill for the purpose of recovering the bill.

(4) With respect to such a bill handling apparatus, a taped note is typically determined using a thickness detection means. Thus, the accuracy of the determination is largely dependent on the performance of the thickness detection means. It is known that thickness detection means are used for a paper sheet handling apparatus such as a bill handling apparatus for the purpose of preventing multi-feeding or forgery of paper sheets (see, for example, Japanese Laid-open Patent Publication No. 2012-041194, Japanese Laid-open Patent Publication No. 2002-032816, and Japanese Laid-open Patent Publication No. 09-301576).

SUMMARY OF THE INVENTION
(5) A non-transitory recording medium in an aspect is a non-transitory recording medium having a paper sheet handling program recorded thereon, the paper sheet handling program that causes a processor for a paper sheet handling apparatus to perform a process, the paper sheet handling apparatus including: a displacement amount detector that includes a pressing part intended to press a paper sheet against a transporting face of a paper sheet transporting path and having an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path, the displacement amount detector detecting a displacement amount of displacement of the pressing part from the initial position in a direction perpendicular to the transporting face, the pressing part being displaced according to a thickness of a paper sheet passing between the transporting face and the pressing part; a reference displacement amount storage that stores a reference displacement amount; a paper sheet thickness storage that stores a thickness of one paper sheet; and a tape thickness threshold storage that stores a tape thickness threshold, the process including: on the basis of the displacement amount detected by the displacement amount detector, the reference displacement amount stored by the reference displacement amount storage, the thickness of one paper sheet stored by the paper sheet thickness storage, and the tape thickness threshold stored by the tape thickness threshold storage, determining which of one paper sheet, a paper sheet having tape applied thereto, two paper sheets laid on top of one another, or another paper sheet is passing between the transporting face and the pressing part; when a determination that one paper sheet is passing between the transporting face and the pressing part is made, updating a value of the reference displacement amount stored by the reference displacement amount storage to a displacement amount detected by the displacement amount detector at a time of the determination; and when a determination that two paper sheets laid on top of one another are passing between the transporting face and the pressing part is made, calculating

a thickness of one paper sheet by subtracting the reference displacement amount stored by the reference displacement amount storage from a displacement amount detected by the displacement amount detector at a time of the determination, updating the thickness of one paper sheet stored by the paper sheet thickness storage to the calculated thickness of one paper sheet, calculating a tape thickness threshold on the basis of the calculated thickness of one paper sheet, and updating the tape thickness threshold stored by the tape thickness threshold storage to the calculated tape thickness threshold.

(6) An apparatus in an aspect is a paper sheet handling apparatus including: a displacement amount detector that includes a pressing part intended to press a paper sheet against a transporting face of a paper sheet transporting path and having an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path, the displacement amount detector detecting a displacement amount of displacement of the pressing part from the initial position in a direction perpendicular to the transporting face, the pressing part being displaced according to a thickness of a paper sheet passing between the transporting face and the pressing part; a reference displacement amount storage that stores a reference displacement amount; a paper sheet thickness storage that stores a thickness of one paper sheet; a tape thickness threshold storage that stores a tape thickness threshold; a determinator that, on the basis of the displacement amount detected by the displacement amount detector, the reference displacement amount stored by the reference displacement amount storage, the thickness of one paper sheet stored by the paper sheet thickness storage, and the tape thickness threshold stored by the tape thickness threshold storage, determines which of one paper sheet, a paper sheet having tape applied thereto, two paper sheets laid on top of one another, or another paper sheet is passing between the transporting face and the pressing part; a reference displacement amount updater that, when the determinator makes a determination that one paper sheet is passing between the transporting face and the pressing part, updates a value of the reference displacement amount stored by the reference displacement amount storage to a displacement amount detected by the displacement amount detector at a time of the determination; a paper sheet thickness calculator that, when the determinator makes a determination that two paper sheets laid on top of one another are passing between the transporting face and the pressing part, calculates a thickness of one paper sheet by subtracting the reference displacement amount stored by the reference displacement amount storage from a displacement amount detected by the displacement amount detector at a time of the determination; a paper sheet thickness updater that updates the thickness of one paper sheet stored by the paper sheet thickness storage to the thickness of one paper sheet calculated by the paper sheet thickness calculator; a tape thickness threshold calculator that calculates a tape thickness threshold on the basis of the thickness of one paper sheet calculated by the paper sheet thickness calculator; and a tape thickness threshold updater that updates the tape thickness threshold stored by the tape thickness threshold storage to the tape thickness threshold calculated by the tape thickness threshold calculator.

(7) The object and advantages of the present invention will be realized by the elements set forth in the claims or combinations thereof.

Description

BRIEF DESCRIPTION OF DRAWINGS
(1) FIG. **1** exemplifies the appearance configuration of a paper sheet handling apparatus in accordance with an embodiment;
(2) FIG. **2** exemplifies the hardware configuration of a paper sheet handling apparatus in accordance with an embodiment;
(3) FIG. **3** schematically exemplifies the configuration of a displacement amount detection unit;
(4) FIG. **4**A schematically exemplifies an operation performed when one bill passes between a

transporting face and a pressing roller;

(5) FIG. **4**B schematically exemplifies an operation performed when a bill having tape applied thereto passes between a transporting face and a pressing roller;

(6) FIG. **4**C schematically exemplifies an operation performed when two bills laid on top of one another pass between a transporting face and a pressing roller;

(7) FIG. **5** exemplifies functional configurations pertaining to a bill determination process performed by a paper sheet handling apparatus in accordance with an embodiment; and

(8) FIG. **6** is a flowchart exemplifying the flow of a bill determination process performed by a paper sheet handling apparatus in accordance with an embodiment.

DESCRIPTION OF EMBODIMENTS

(9) The following displacement amount detection means may be used as a thickness detection means for determination of a taped note. The displacement amount detection means includes a pressing part that is intended to press a paper sheet against the transporting face of a paper sheet transporting path and has an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path. The displacement amount detection means detects the amount of displacement of the pressing part, which is displaced according to the thickness of a paper sheet passing between the transporting face and the pressing part, from the initial position in a direction perpendicular to the transporting face.

(10) When the displacement amount detection means is used, the pressing part is not in contact with the transporting face when being located at the initial position, so the thickness of, for example, one paper sheet or a taped note cannot be detected as an absolute amount. An accurate displacement amount may be incapable of being detected due to a temporal variation in the displacement amount detection means, e.g., a temporal variation in the initial position of the pressing part or a temporal variation in an output value of a sensor of the displacement amount detection means. As a result, the determination for a taped note may not be incapable of being accurately performed.

(11) The following describes embodiments of the present invention by referring to the drawings.

(12) FIG. **1** exemplifies the appearance configuration of a paper sheet handling apparatus in accordance with an embodiment.

(13) For example, a paper sheet handling apparatus **10** exemplified in FIG. **1** may be an automated teller machine (ATM) installed in a financial institution such as a bank or in a convenience store, or may be a bill handling apparatus.

(14) The paper sheet handling apparatus **10** includes a customer operation screen **11**, a cash insertion-ejection unit **12**, a bankbook acceptance unit **13**, a card acceptance port **14**, and a receipt issuance port **15**.

(15) The customer operation screen **11**, which is, for example, a touch panel display, displays various screens such as a transaction screen and accepts an operation input from a customer.

(16) The cash insertion-ejection unit **12** accepts coins and bills to be deposited and ejects coins and bills to be withdrawn. Note that a bill is an example of a paper sheet.

(17) The bankbook acceptance unit **13** accepts and returns a bankbook.

(18) The card acceptance port **14** accepts a card to be used for a transaction (e.g., a cash card) and returns the card.

(19) The receipt issuance port **15** ejects an issued receipt (a receipt on which transaction details are printed).

(20) FIG. **2** exemplifies the hardware configuration of a paper sheet handling apparatus in accordance with an embodiment.

(21) A paper sheet handling apparatus **10** exemplified in FIG. **2** includes a main control unit **21**, a storage apparatus **22**, an input apparatus **23**, a display apparatus **24**, a bill processing unit **25**, a coin processing unit **26**, a card processing unit **27**, a receipt processing unit **28**, a communication processing unit **29**, and a bankbook processing unit **30**, which are connected to each other by a bus

(22) The main control unit **21** includes a processor such as a central processing unit (CPU), and a random access memory (RAM). The processor controls the entirety of the operations of the paper sheet handling apparatus **10** by executing various programs, such as programs for an operating system (OS) and application programs. The RAM temporarily stores a portion of a program executed by the processor and is used as a working storage region for the processor. Alternatively, the main control unit **21** may be formed from, for example, a field programmable gate array (FPGA) and/or an application specific integrated circuit (ASIC). For example, the main control unit **21** may perform a bill determination process. The bill determination process is a process for determining which of one bill, a bill having tape applied thereto, two bills laid on top of one another (double-fed bills), or another bill is passing a predetermined position on a transporting path on which inserted bills are transported one by one as a general rule (transporting path in the bill processing unit **25**).

(23) The storage apparatus **22** stores, for example, various programs executed by the processor of the main control unit **21** and various data necessary for execution of the programs. The storage apparatus **22** includes a reference-displacement-amount storage region in which a reference displacement amount is stored, a bill-thickness storage region in which the thickness of one bill is stored, and a tape-thickness-threshold storage region in which a tape thickness threshold is stored. The reference displacement amount is also a displacement amount detected by a displacement amount detection unit **32** (described hereinafter) when it is determined according to the bill determination process performed by the main control unit **21** that one bill is passing a predetermined position on the transporting path. Initial values are stored in advance in the reference-displacement-amount storage region, the bill-thickness storage region, and the tape-thickness-threshold storage region. For example, the storage apparatus **22** may be a hard disk drive (HDD).

(24) The input apparatus **23** and the display apparatus form the customer operation screen **11**. The display apparatus **24** is, for example, a liquid crystal display (LCD). The input apparatus **23** is a touch panel disposed on the display apparatus **24**. The input apparatus **23** detects an operation input to the input apparatus **23** and reports the detection result to the main control unit **21**.

(25) The bill processing unit **25** allows a bill to be inserted/ejected into/from the cash insertion-ejection unit **12**. The bill processing unit **25** also counts the number of inserted bills, inspects the inserted bills, and counts the number of bills to be ejected. The bill processing unit **25** includes the displacement amount detection unit **32**, which is intended to detect a displacement amount used by the main control unit **21** in the bill determination process. Details of the displacement amount detection unit **32** are described hereinafter using FIGS. **3**, **4**A, **4**B, and **4**C.

(26) The coin processing unit **26** allows a coin to be inserted/ejected into/from the cash insertion-ejection unit **12**. The coin processing unit **26** also counts the number of inserted coins, inspects the inserted coins, and counts the number of coins to be ejected.

(27) The card processing unit **27** allows a card to be inserted/ejected into/from the card acceptance port **14**. The card processing unit **27** reads/writes information (data) from/to a magnetic stripe on an inserted card or an integrated circuit (IC) chip therein.

(28) The receipt processing unit **28** issues a receipt on which transaction details are printed, and ejects the same through the receipt issuance port **15**.

(29) The communication processing unit **29** is connected to a network (not illustrated) and communicates with, for example, a host computer (not illustrated) over the network.

(30) The bankbook processing unit **30** allows a bankbook to be inserted/ejected into/from the bankbook acceptance unit **13**. The bankbook processing unit **30** reads information (data) recorded on a magnetic stripe on an inserted bankbook and updates the bankbook.

(31) FIG. **3** schematically exemplifies the configuration of a displacement amount detection unit.

(32) A displacement amount detection unit **32** exemplified in FIG. **3** includes a pressing roller **41**, a

displacement conveyance lever **42**, and a displacement amount detection sensor **43**.

(33) The pressing roller **41** is intended to, for example, press a bill **45** against a transporting face **44** of a transporting path on which bills **45** are transported one by one as a general rule so that the inserted bills can be inspected. The initial position of the pressing roller **41** is distant from the transporting face **44** by a prescribed distance (C). The prescribed distance (C) is less than the thickness of one bill. The prescribed distance (C) is provided between the transporting face **44** and the pressing roller **41** in order to prevent a jam from occurring when a bill **45** passes between the transporting face **44** and the pressing roller **41**. Note that, in FIG. **3**, the transporting direction of a bill **45** is a rightward direction (the same is true for FIGS. **4**A, **4**B, and **4**C).

(34) The displacement conveyance lever **42** conveys, to the displacement amount detection sensor **43** with a shaft **42**a as a fulcrum, a displacement of the pressing roller **41** from the initial position, wherein the pressing roller **41** is displaced according to the thickness of a bill **45** passing between the transporting face **44** and the pressing roller **41**. The transporting face **44** is not displaced.

(35) The displacement amount detection sensor **43** detects, from the displacement of the pressing roller **41** conveyed from the displacement conveyance lever **42**, the amount of displacement of the pressing roller **41** from the initial position in a direction perpendicular to the transporting face **44**.

(36) FIGS. **4**A, **4**B, and **4**C schematically exemplify operations of the displacement amount detection unit. Specifically, FIG. **4**A schematically exemplifies an operation performed when one bill passes between the transporting face and the pressing roller. FIG. **4**B schematically exemplifies an operation performed when a bill having tape applied thereto passes between the transporting face and the pressing roller. FIG. **4**C schematically exemplifies an operation performed when two bills laid on top of one another pass between the transporting face and the pressing roller.

(37) In the operation exemplified in FIG. **4**A, the pressing roller **41** is displaced according to a thickness (B) of one bill **45** passing between the transporting face **44** and the pressing roller **41**, and the displacement amount detection sensor **43** detects a displacement amount (B−C) provided in this situation, i.e., the amount of displacement of the pressing roller **41** from the initial position in a direction perpendicular to the transporting face **44**.

(38) In the operation exemplified in FIG. **4**B, the pressing roller **41** is displaced according to a thickness (t+B (t is the thickness of tape **46**)) of a bill **45** having tape **46** applied thereto passing between the transporting face **44** and the pressing roller **41**, and the displacement amount detection sensor **43** detects a displacement amount (t+B−C) provided in this situation, i.e., the amount of displacement of the pressing roller **41** from the initial position in a direction perpendicular to the transporting face **44**.

(39) In the operation exemplified in FIG. **4**C, the pressing roller **41** is displaced according to a thickness (B+B) of two bills **45** laid on top of one another passing between the transporting face **44** and the pressing roller **41**, and the displacement amount detection sensor **43** detects a detection amount (B+B−C) provided in this situation, i.e., the amount of displacement of the pressing roller **41** from the initial position in a direction perpendicular to the transporting face **44**.

(40) As indicated above, the displacement amount detection unit **32** cannot detect the absolute amount of the thickness of one bill, because the initial position of the pressing roller **41** is, as exemplified in FIG. **3**, distant from the transporting face **44** by the prescribed distance (C). However, the thickness of one bill can be determined by calculation using displacement-amount detection values obtained in the operations exemplified in FIGS. **4**A and **4**C. Specifically, the thickness (B) of one bill can be calculated by subtracting the displacement-amount detection value (B−C) obtained in the operation exemplified in FIG. **4**A (the operation performed when one bill **45** passes between the transporting face **44** and the pressing roller **41**) from the displacement-amount detection value (B+B−C) obtained in the operation exemplified in FIG. **4**C (the operation performed when two bills **45** laid on top of one another pass between the transporting face **44** and the pressing roller **41**).

(41) FIG. **5** exemplifies functional configurations pertaining to a bill determination process

performed by a paper sheet handling apparatus in accordance with an embodiment.

(42) A paper sheet handling apparatus **10** exemplified in FIG. **5** includes a displacement amount detector **51**, a reference displacement amount storage **52**, a bill thickness storage **53**, a tape thickness threshold storage **54**, a determinator **55**, a reference displacement amount updater **56**, a bill thickness calculator **57**, a bill thickness updater **58**, a tape thickness threshold calculator **59**, and a tape thickness threshold updater **60**.

(43) The displacement amount detector **51** includes a pressing part **51***a* that is intended to press a bill against the transporting face of a bill transporting path and has an initial position at which the pressing part **51***a* is not in contact with the transporting face of the bill transporting path. The displacement amount detector **51** detects the amount of displacement of the pressing part **51***a*, which is displaced according to the thickness of a bill passing between the transporting face and the pressing part **51***a*, from the initial position in a direction perpendicular to the transporting face. For example, the displacement amount detector **51** and the pressing part **51***a* may correspond to the displacement amount detection unit **32** and the pressing roller **41**.

(44) The reference displacement amount storage **52** stores a reference displacement amount. The reference displacement amount storage **52** stores a reference displacement amount in advance as an initial value. For example, the reference displacement amount storage **52** may correspond to the reference-displacement-amount storage region of the storage apparatus **22**.

(45) The bill thickness storage **53** stores the thickness of one bill. The bill thickness storage **53** stores the thickness of one bill in advance as an initial value. For example, the bill thickness storage **53** may correspond to the bill-thickness storage region of the storage apparatus **22**.

(46) The tape thickness threshold storage **54** stores a tape thickness threshold. The tape thickness threshold storage **54** stores a tape thickness threshold in advance as an initial value. For example, the tape thickness threshold storage **54** may correspond to the tape-thickness-threshold storage region of the storage apparatus **22**.

(47) On the basis of a displacement amount detected by the displacement amount detector **51**, the reference displacement amount stored by the reference displacement amount storage **52**, the thickness of one bill stored by the bill thickness storage **53**, and the tape thickness threshold stored by the tape thickness threshold storage **54**, the determinator **55** determines which of one bill, a bill having tape applied thereto, two bills laid on top of one another, or another bill is passing between the transporting face and the pressing part **51***a*. For example, the determinator **55** may correspond to the function of a portion of the main control unit **21**.

(48) For example, the determinator **55** may determine that one bill is passing between the transporting face and the pressing part **51***a* when a displacement amount detected by the displacement amount detector **51** is less than a first threshold based on the reference displacement amount stored by the reference displacement amount storage **52** and the tape thickness threshold stored by the tape thickness threshold storage **54**. For example, the determinator **55** may determine that a bill having tape applied thereto is passing between the transporting face and the pressing part **51***a* when a displacement amount detected by the displacement amount detector **51** is equal to or greater than the first threshold and less than a second threshold based on the thickness of one bill stored by the bill thickness storage **53** and the reference displacement amount stored by the reference displacement amount storage **52**. For example, the determinator **55** may determine that two bills laid on top of one another are passing between the transporting face and the pressing part **51***a* when a displacement amount detected by the displacement amount detector **51** is equal to or greater than the second threshold and less than a third threshold based on the thickness of one bill stored by the bill thickness storage **53** and the reference displacement amount stored by the reference displacement amount storage **52**. The first threshold is, for example, the total of the tape thickness threshold stored by the tape thickness threshold storage **54** and the reference displacement amount stored by the reference displacement amount storage **52**. The second threshold is, for example, the total of the thickness of one bill stored by the bill thickness storage

53 and the reference displacement amount stored by the reference displacement amount storage **52**. The third threshold is, for example, the total of the reference displacement amount stored by the reference displacement amount storage **52** and twice the thickness of one bill stored by the bill thickness storage **53**.

(49) When the determinator **55** determines that one bill is passing between the transporting face and the pressing part **51***a*, the reference displacement amount updater **56** updates the value of the reference displacement amount stored by the reference displacement amount storage **52** to the displacement amount detected by the displacement amount detector **51** at the time of the determination. For example, the reference displacement amount updater **56** may correspond to the function of another portion of the main control unit **21**.

(50) When the determinator **55** determines that two bills laid on top of one another are passing between the transporting face and the pressing part **51***a*, the bill thickness calculator **57** calculates the thickness of one bill by subtracting the reference displacement amount stored by the reference displacement amount storage **52** from the displacement amount detected by the displacement amount detector **51** at the time of the determination. For example, the bill thickness calculator **57** may correspond to the function of another portion of the main control unit **21**.

(51) The bill thickness updater **58** updates the thickness of one bill stored by the bill thickness storage **53** to the thickness of one bill calculated by the bill thickness calculator **57**. For example, the bill thickness updater **58** may correspond to the function of another portion of the main control unit **21**.

(52) The tape thickness threshold calculator **59** calculates a tape thickness threshold on the basis of the thickness of one bill calculated by the bill thickness calculator **57**. For example, the tape thickness threshold calculator **59** may calculate a tape thickness threshold by multiplying the thickness of one bill calculated by the bill thickness calculator **57** by a prescribed factor. In this example, the prescribed factor corresponds to the proportion of the thickness of tape to the thickness of one bill. For example, the tape thickness threshold calculator **59** may correspond to the function of another portion of the main control unit **21**.

(53) The tape thickness threshold updater **60** updates the tape thickness threshold stored by the tape thickness threshold storage **54** to the tape thickness threshold calculated by the tape thickness threshold calculator **59**. For example, the tape thickness threshold updater **60** may correspond to the function of another portion of the main control unit **21**.

(54) The following describes a bill determination process performed by the paper sheet handling apparatus **10**.

(55) FIG. **6** is a flowchart exemplifying the flow of a bill determination process performed by a paper sheet handling apparatus in accordance with an embodiment.

(56) The bill determination process exemplified in FIG. is performed every time a bill passes between the transporting face **44** and the pressing roller **41**.

(57) Upon the bill determination process exemplified in FIG. **6** being started, the main control unit **21** first obtains a displacement amount detected by the displacement amount detection unit **32** (S**11**).

(58) Next, the main control unit **21** determines whether the displacement amount obtained in S**11** is less than the total (t threshold+B−C) of a tape thickness threshold (t threshold) stored in the tape-thickness-threshold storage region of the storage apparatus **22** and a reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus (S**12**). Note that the expression "t threshold+B−C" is an example of the first threshold.

(59) When the result of the determination in S**12** is YES, the main control unit **21** determines that one bill (a bill having a normal thickness) is passing between the transporting face **44** and the pressing roller **41** (S**13**), and updates the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus **22** to the displacement amount obtained in S**11** (S**14**), and the bill determination process exemplified in FIG. **6** ends.

(60) Meanwhile, when the result of the determination in S12 is NO, the main control unit 21 determines whether the displacement amount obtained in S11 is equal to or greater than the total (t threshold+B−C) of the tape thickness threshold (t threshold) stored in the tape-thickness-threshold storage region of the storage apparatus 22 and the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus 22 and is less than the total (B+B−C) of the thickness (B) of one bill stored in the bill-thickness storage region of the storage apparatus 22 and the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus 22 (S15). Note that the expression "B+B−C" is an example of the second threshold.

(61) When the result of the determination in S15 is YES, the main control unit 21 determines that a bill having tape applied thereto is passing between the transporting face 44 and the pressing roller 41 (S16), and the bill determination process exemplified in FIG. 6 ends.

(62) Meanwhile, when the result of the determination in S15 is NO, the main control unit 21 determines whether the displacement amount obtained in S11 is equal to or greater than the total (B+B−C) of the thickness (B) of one bill stored in the bill-thickness storage region of the storage apparatus 22 and the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus 22 and is less than the total (Bx2+B−C) of twice (B×2) the thickness (B) of one bill stored in the bill-thickness storage region of the storage apparatus 22 and the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus 22 (S17). Note that the expression "Bx2+B−C" is an example of the third threshold.

(63) When the result of the determination in S17 is YES, the main control unit 21 determines that two bills laid on top of one another are passing between the transporting face 44 and the pressing roller 41 (S18). Then, the thickness of one bill is calculated by subtracting the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus 22 from the displacement amount obtained in S11 (S19), and the thickness (B) of one bill stored in the bill-thickness storage region of the storage apparatus 22 is updated to the thickness calculated in S19 (S20). A tape thickness threshold is calculated by multiplying the thickness of one bill calculated in S19 by the prescribed factor (the factor corresponding to the proportion of the thickness of tape to the thickness of one bill) (S21), and the tape thickness threshold (t threshold) stored in the tape-thickness-threshold storage region of the storage apparatus 22 is updated to the tape thickness threshold calculated in S21 (S22). After S22, the bill determination process exemplified in FIG. 6 ends.

(64) Meanwhile, when the result of the determination in S17 is NO, the main control unit 21 determines that another bill (a bill having an abnormal thickness) is passing between the transporting face 44 and the pressing roller 41 (S23), and the bill determination process exemplified in FIG. 6 ends.

(65) A bill determined as one bill (a bill having a normal thickness) in the bill determination process exemplified in FIG. 6 is then stored in a bill cassette in which bills that can be used as bills to be ejected are stored. By contrast, a bill determined as a bill having tape applied thereto is then stored in a prescribed collection bill cassette so as not to be used as a bill to be ejected, and will be taken out by a store staff member such as a clerk at a later date. Bills determined as two bills laid on top of one another or another bill determined as a bill having an abnormal thickness is returned to a customer through the cash insertion-ejection unit 12.

(66) As described above, every time one bill passes between the transporting face 44 and the pressing roller 41, the paper sheet handling apparatus 10 updates the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus to a value corresponding to the state of a temporal variation in the displacement amount detection unit 32 at that time. Every time two bills laid on top of one another pass between the transporting face 44 and the pressing roller 41, the thickness (B) of one bill stored in the bill-thickness storage

region of the storage apparatus **22** and the tape thickness threshold (t threshold) stored in the tape-thickness-threshold storage region of the storage apparatus **22** are updated to values corresponding to the state of a temporal variation in the displacement amount detection unit at that time. Accordingly, even if the displacement amount detection unit **32** exhibits a temporal variation (e.g., even if the initial position of the pressing roller **41**, the output value of the displacement amount detection sensor **43**, or the like exhibits a temporal variation), it can be accurately determined which of one bill, a bill having tape applied thereto, two bills laid on top of one another, or another bill is passing between the transporting face **44** and the pressing roller **41**.

(67) The paper sheet handling apparatus **10** can be updated not only by bills inserted by customers. A store staff member may periodically insert one bill and two bills laid on top of one another into the paper sheet handling apparatus **10** so as to periodically update the reference displacement amount (B−C) stored in the reference-displacement-amount storage region of the storage apparatus **22**, the thickness (B) of one bill stored in the bill-thickness storage region of the storage apparatus **22**, and the tape thickness threshold (t threshold) stored in the tape-thickness-threshold storage region of the storage apparatus **22**.

(68) The paper sheet handling apparatus **10** performs the above-described bill determination process without distinguishing between denominations. The reason for this is that, as a general rule, bills issued by the same source (issued in the country) have substantially the same thickness, irrespective of denomination. However, after denominations are distinguished from each other, the above-described bill determination process may be performed for each denomination. In this case, for example, the storage apparatus **22** may include, for each denomination, a reference-displacement-amount storage region, a bill-thickness storage region, and a tape-thickness-threshold storage region, and the above-described bill determination process may be performed for each distinguished denomination.

(69) Embodiments of the present invention have been described, but the invention is not limited to the embodiments described above and can have various improvements or changes made therefor without departing from the gist of the invention.

Claims

1. A non-transitory recording medium having a paper sheet handling program recorded thereon, the paper sheet handling program causing a processor for a paper sheet handling apparatus to perform a process, the paper sheet handling apparatus including a displacement amount detector that includes a pressing part intended to press a paper sheet against a transporting face of a paper sheet transporting path and having an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path, the displacement amount detector detecting a displacement amount of displacement of the pressing part from the initial position in a direction perpendicular to the transporting face, the pressing part being displaced according to a thickness of a paper sheet passing between the transporting face and the pressing part, a reference displacement amount storage that stores a reference displacement amount, a paper sheet thickness storage that stores a thickness of one paper sheet, and a tape thickness threshold storage that stores a tape thickness threshold, the process comprising: on the basis of the displacement amount detected by the displacement amount detector, the reference displacement amount stored by the reference displacement amount storage, the thickness of one paper sheet stored by the paper sheet thickness storage, and the tape thickness threshold stored by the tape thickness threshold storage, determining which of one paper sheet, a paper sheet having tape applied thereto, two paper sheets laid on top of one another, or another paper sheet is passing between the transporting face and the pressing part; when a determination that one paper sheet is passing between the transporting face and the pressing part is made, updating a value of the reference displacement amount stored by the reference displacement amount storage to a displacement amount detected by the displacement amount

detector at a time of the determination; and when a determination that two paper sheets laid on top of one another are passing between the transporting face and the pressing part is made, calculating a thickness of one paper sheet by subtracting the reference displacement amount stored by the reference displacement amount storage from a displacement amount detected by the displacement amount detector at a time of the determination, updating the thickness of one paper sheet stored by the paper sheet thickness storage to the calculated thickness of one paper sheet, calculating a tape thickness threshold on the basis of the calculated thickness of one paper sheet, and updating the tape thickness threshold stored by the tape thickness threshold storage to the calculated tape thickness threshold.

2. The non-transitory recording medium of claim 1, wherein the process further comprises calculating the tape thickness threshold by multiplying the calculated thickness of one paper sheet by a prescribed factor.

3. The non-transitory recording medium of claim 1, wherein the process further comprises determining that one paper sheet is passing between the transporting face and the pressing part when the displacement amount detected by the displacement amount detector is less than a first threshold based on the reference displacement amount stored by the reference displacement amount storage and the tape thickness threshold stored by the tape thickness threshold storage.

4. The non-transitory recording medium of claim 3, wherein the process further comprises determining that a paper sheet having tape applied thereto is passing between the transporting face and the pressing part when the displacement amount detected by the displacement amount detector is equal to or greater than the first threshold and less than a second threshold based on the thickness of one paper sheet stored by the paper sheet thickness storage and the reference displacement amount stored by the reference displacement amount storage.

5. The non-transitory recording medium of claim 4, wherein the process further comprises determining that two paper sheets laid on top of one another are passing between the transporting face and the pressing part when the displacement amount detected by the displacement amount detector is equal to or greater than the second threshold and less than a third threshold based on the thickness of one paper sheet stored by the paper sheet thickness storage and the reference displacement amount stored by the reference displacement amount storage.

6. The non-transitory recording medium of claim 3, wherein the first threshold is a total of the tape thickness threshold stored by the tape thickness threshold storage and the reference displacement amount stored by the reference displacement amount storage.

7. The non-transitory recording medium of claim 4, wherein the second threshold is a total of the thickness of one paper sheet stored by the paper sheet thickness storage and the reference displacement amount stored by the reference displacement amount storage.

8. The non-transitory recording medium of claim 5, wherein the third threshold is a total of the reference displacement amount stored by the reference displacement amount storage and twice the thickness of one paper sheet stored by the paper sheet thickness storage.

9. A paper sheet handling apparatus comprising: a displacement amount detector that includes a pressing part intended to press a paper sheet against a transporting face of a paper sheet transporting path and having an initial position at which the pressing part is not in contact with the transporting face of the paper sheet transporting path, the displacement amount detector detecting a displacement amount of displacement of the pressing part from the initial position in a direction perpendicular to the transporting face, the pressing part being displaced according to a thickness of a paper sheet passing between the transporting face and the pressing part; a reference displacement amount storage that stores a reference displacement amount; a paper sheet thickness storage that stores a thickness of one paper sheet; a tape thickness threshold storage that stores a tape thickness threshold; a determinator that, on the basis of the displacement amount detected by the displacement amount detector, the reference displacement amount stored by the reference displacement amount storage, the thickness of one paper sheet stored by the paper sheet thickness

storage, and the tape thickness threshold stored by the tape thickness threshold storage, determines which of one paper sheet, a paper sheet having tape applied thereto, two paper sheets laid on top of one another, or another paper sheet is passing between the transporting face and the pressing part; a reference displacement amount updater that, when the determinator makes a determination that one paper sheet is passing between the transporting face and the pressing part, updates a value of the reference displacement amount stored by the reference displacement amount storage to a displacement amount detected by the displacement amount detector at a time of the determination; a paper sheet thickness calculator that, when the determinator makes a determination that two paper sheets laid on top of one another are passing between the transporting face and the pressing part, calculates a thickness of one paper sheet by subtracting the reference displacement amount stored by the reference displacement amount storage from a displacement amount detected by the displacement amount detector at a time of the determination; a paper sheet thickness updater that updates the thickness of one paper sheet stored by the paper sheet thickness storage to the thickness of one paper sheet calculated by the paper sheet thickness calculator; a tape thickness threshold calculator that calculates a tape thickness threshold on the basis of the thickness of one paper sheet calculated by the paper sheet thickness calculator; and a tape thickness threshold updater that updates the tape thickness threshold stored by the tape thickness threshold storage to the tape thickness threshold calculated by the tape thickness threshold calculator.

10. The paper sheet handling apparatus of claim 9, wherein the tape thickness threshold calculator calculates the tape thickness threshold by multiplying the thickness of one paper sheet calculated by the paper sheet thickness calculator by a prescribed factor.