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DIGITAL INK PROCESSING SYSTEM, METHOD, AND PROGRAM

Abstract

A digital ink processing system, method, and program are provided that are capable of presenting, to a user, useful and highly relevant information as a search result when a search is performed using digital ink. A processor included in a tablet enables a pointing operation of an electronic pen relative to a stroke or strokes. The processor, after enabling the pointing operation of the electronic pen, performs a search for content related to a semantic attribute of the stroke or strokes pointed at, or requests an external server to perform the search. The processor performs control so as to display the related content retrieved by the search on a display with the stroke or strokes.

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Background/Summary

BACKGROUND

Technical Field

[0001] The present disclosure relates to a digital ink processing system, method, and program for processing digital ink.

Description of the Related Art

[0002] Patent Document 1 discloses a technique of performing a search by setting as a search key at least a portion of information displayed on a screen of an information processing apparatus such as a personal computer, and display a search result in a pop-up window on the screen.

PRIOR ART DOCUMENT

Patent Document

[0003] Patent Document 1: Japanese Patent Laid-Open No. 2015-114955

SUMMARY OF DISCLOSURE

Technical Problems

[0004] In digital ink representative of a set of strokes, strokes often convey meaning only as a group. However, when a user, while editing the digital ink, points to a section to set it as a search key to attempt a search, the search key may fail to convey any meaning or the search key may convey wrong meaning, resulting in a failure to return appropriate search results.

[0005] An aspect of the present disclosure is to provide a digital ink processing system, method, and program that are capable of presenting, to a user, useful and highly relevant information as a search result when a search is performed using digital ink.

Technical Solution

[0006] According to a first aspect of the present disclosure, a digital ink processing system includes an electronic pen, and a tablet that generates digital ink describing a stroke or strokes according to an input made by the electronic pen through a display. The tablet has a processor, and the processor enables a pointing operation of the electronic pen relative to the stroke or strokes. After enabling the pointing operation of the electronic pen relative to the stroke or strokes, the processor performs a search for content related to a semantic attribute of the stroke or strokes pointed at, or requests an external server to perform the search, and performs control so as to display content retrieved by the search on the display with the stroke or strokes.

[0007] Further, the processor may perform control so as to cause the stroke or strokes for which the pointing operation has been enabled to be highlighted on the display as compared to before the enablement.

[0008] Further, the processor may enable the pointing operation of the electronic pen relative to a stroke or strokes to which a semantic attribute has been assigned.

[0009] The system may further include a digital ink server that analyzes the digital ink transmitted from the tablet and assigns the semantic attribute to the stroke or strokes. The processor may enable

the pointing operation of the electronic pen relative to a stroke or strokes for which semantic data representative of the semantic attribute has been acquired from the digital ink server.
[0010] Further, the processor may enable the pointing operation of the electronic pen relative to a stroke or strokes on which a user operation of adding a mark or an annotation has been performed.
[0011] The system may further include a content server that stores content in association with use IDs (use identifications). The processor may transmit data, which includes the use ID and the semantic attribute, to the content server and request a search to acquire, from the content server, content that relates to the semantic attribute and that is usable.
[0012] Further, the processor may acquire a different one of the content depending on the degree of occurrence of the semantic attribute based on the same use ID.
[0013] Further, the use ID may be a pen ID that identifies the electronic pen.
[0014] Further, in a case where the digital ink is generated using a first electronic pen that is assigned a first pen ID, while a second electronic pen is used that is assigned a second pen ID different from the first pen ID, the processor may prohibit or restrict editing of the digital ink while accepting the pointing operation.
[0015] Further, the content server may perform a charging process according to usage of content, for a user of the content and a business entity that provides the content.
[0016] According to a second aspect of the present disclosure, a digital ink processing method executed by a processor is provided, wherein the processor is configured to generate digital ink describing a stroke or strokes according to an input made by an electronic pen through a display. The method includes enabling a pointing operation of the electronic pen relative to the stroke or strokes. The method includes, after enabling the pointing operation of the electronic pen relative to the stroke or strokes, performing a search for content related to a semantic attribute of the stroke or strokes pointed at, or requesting an external server to perform the search. The method includes performing control so as to display content retrieved by the search on the display with the stroke or strokes.
[0017] According to a third aspect of the present disclosure, a digital ink processing program is provided that causes a processor configured to generate digital ink describing a stroke or strokes according to an input made by an electronic pen through a display to execute: a step of enabling a pointing operation of the electronic pen relative to the stroke or strokes, a step of, after enabling the pointing operation of the electronic pen relative to the stroke or strokes, performing a search for content related to a semantic attribute of the stroke or strokes pointed at, or requesting an external server to perform the search, and a step of performing control so as to display content retrieved by the search on the display with the stroke or strokes.
BRIEF SUMMARY
[0018] The present disclosure makes it possible to present, to a user, useful and highly relevant information as a search result when a search is performed using digital ink.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS
[0019] FIG. **1** is an overall configuration diagram of a digital ink processing system according to an embodiment of the present disclosure.
[0020] FIG. **2** is a block diagram of a digital ink server, a content server, and a user terminal illustrated in FIG. **1**.
[0021] FIG. **3** is a sequence diagram concerning a semantic interpretation operation of the digital ink processing system.
[0022] FIG. **4**A is a schematic diagram illustrating a set of strokes in a legible form.
[0023] FIG. **4**B is a diagram illustrating an example of a data structure of digital ink.

[0024] FIG. **5**A is a diagram illustrating a result of grouping of the strokes.
[0025] FIG. **5**B is a diagram illustrating a result of assignment of semantic attributes to groups obtained by the grouping in FIG. **5**A.
[0026] FIG. **6**A is a transition diagram illustrating a first state change in a display of the user terminal.
[0027] FIG. **6**B is a transition diagram illustrating the first state change in the display of the user terminal.
[0028] FIG. **7**A is a transition diagram illustrating a second state change in the display of the user terminal.
[0029] FIG. **7**B is a transition diagram illustrating the second state change in the display of the user terminal.
[0030] FIG. **8** is a sequence diagram concerning content citation operation of the digital ink processing system.
[0031] FIG. **9**A is a diagram illustrating an example of the data structure of electronic pen information.
[0032] FIG. **9**B is a diagram illustrating an example of the data structure of content management information.
[0033] FIG. **10**A is a transition diagram illustrating a third state change in the display of the user terminal.
[0034] FIG. **10**B is a transition diagram illustrating the third state change in the display of the user terminal.
[0035] FIG. **11**A is a diagram illustrating an example operation of a user terminal different from a user terminal on which handwriting input is performed.
[0036] FIG. **11**B is a diagram illustrating an example operation of a user terminal different from the user terminal on which handwriting input is performed.
[0037] FIG. **12**A is a diagram illustrating a first refined example of the operation of the digital ink processing system.
[0038] FIG. **12**B is a diagram illustrating the first refined example of the operation of the digital ink processing system.
[0039] FIG. **13**A is a diagram illustrating a second refined example of the operation of the digital ink processing system.
[0040] FIG. **13**B is a diagram illustrating the second refined example of the operation of the digital ink processing system.
[0041] FIG. **14** is a schematic diagram illustrating a first example of a flow of charging made at the time of a learning support service.
[0042] FIG. **15** is a schematic diagram illustrating a second example of the flow of charging made at the time of the learning support service.

DETAILED DESCRIPTION

Configuration of Digital Ink Processing System **10**

[0043] FIG. **1** is an overall configuration diagram of a digital ink processing system **10** according to an embodiment of the present disclosure. FIG. **2** is a block diagram of a digital ink server **20**, a content server **30**, and a user terminal **40** illustrated in FIG. **1**. The digital ink processing system **10** is configured to be capable of providing a "learning support service" to allow a user, such as a student, to learn efficiently using an electronic notebook. Specifically, the digital ink processing system **10** includes the digital ink server **20**, the content server **30**, one or more user terminals **40**, and one or more electronic pens **50**.
[0044] WILL (Wacom Ink Layer Language), InkML (Ink Markup Language), and ISF (Ink Serialized Format) are exemplary data formats of digital ink (or ink data), which are generally called "ink markup languages." Various types of software and programming languages can exchange data with each other by using a data structure format of JSON (JavaScript® Object

Notation) to describe such digital ink.
[0045] The digital ink server **20** is a computer that performs centralized control related to processing of digital ink Ink, and may be either of a cloud type or an on-premises type. Here, the digital ink server **20** is depicted as a single computer in the figure, but the digital ink server **20** may alternatively be implemented as a group of computers that form a distributed system.
[0046] The digital ink server **20** specifically includes a communication unit **21**, a control unit **22**, and a storage unit **23**. The communication unit **21** is an interface for transmitting and receiving electrical signals to and from an external device. The control unit **22** is formed of a processing/computing device including a CPU (Central Processing Unit) or a GPU (Graphics Processing Unit). The control unit **22** functions as a "processing engine" for the digital ink Ink by loading and executing a program stored in the storage unit **23**. The storage unit **23** is formed of a non-transitory computer-readable storage medium, such as an HDD (Hard Disk Drive) or an SSD (Solid State Drive). Thus, the storage unit **23** stores various data handled by the digital ink server **20**.
[0047] The content server **30** is a computer that performs centralized control related to provision of educational content including a textbook and a dictionary, and may be either of the cloud type or the on-premises type. Here, the content server **30** is depicted as a single computer in the figure, but the content server **30** may alternatively be implemented as a group of computers that form a distributed system.
[0048] The content server **30** specifically includes a communication unit **31**, a control unit **32**, and a storage unit **33**. The communication unit **31** is an interface for transmitting and receiving electrical signals to and from an external device. The control unit **32** is formed of a processing/computing device including a CPU or a GPU. The control unit **32** is configured to be capable of searching for and providing content suited for a user by loading and executing a program stored in the storage unit **33**.
[0049] The user terminal **40** is a terminal that functions as an electronic notebook, and is formed of, for example, a tablet, a smart phone, or a personal computer. The user terminal **40** specifically includes a touchscreen display **41**, a touch IC (Integrated Circuit) **44**, a display driver IC **45**, a host processor **46**, a memory **47**, and a communication module **48**.
[0050] The touchscreen display **41** includes a display panel **42** capable of outputting content in a visible form, and sensor electrodes **43** arranged on a display screen of the display panel **42** in an overlapping manner. The display panel **42** is capable of displaying a black-and-white image or a color image, and may be, for example, a liquid crystal panel or an organic EL (Electro-Luminescence) panel. The sensor electrodes **43** are formed of a planar arrangement of an X-Y sensor coordinate system including a plurality of X-line electrodes for sensing positions along an X-axis and a plurality of Y-line electrodes for sensing positions along a Y-axis.
[0051] The touch IC **44** is an integrated circuit for performing drive control of the sensor electrodes **43**. The touch IC **44** drives the sensor electrodes **43** on the basis of control signals supplied from the host processor **46**. The touch IC **44** thus implements a "pen detection function" of detecting the state of the electronic pen **50**, and a "touch detection function" of detecting a touch made by a finger or the like of a user.
[0052] The display driver IC **45** is an integrated circuit for performing drive control of the display panel **42**. The display driver IC **45** drives the display panel **42** on the basis of image signals supplied from the host processor **46** on a frame by frame basis. Images are thus displayed in a display area of the display panel **42**. These images may include a handwritten line drawn by the user using the electronic pen **50**—as well as an application window, an icon, and/or a cursor.
[0053] The host processor **46** is formed of a processing/computing device including an MPU (Micro-Processing Unit) or a CPU. The host processor **46** performs a process of generating digital ink Ink using data from the touch IC **44**, an ink reproduction process for displaying a drawing represented by the digital ink Ink, and so on, by loading and executing a program stored in the

memory **47**.
[0054] The memory **47** is formed of a non-transitory computer-readable storage medium. Here, the computer-readable storage medium is a portable medium, such as a magneto-optical disk, a ROM (Read Only Memory), a CD-ROM (Compact Disc-Read Only Memory), or a flash memory, or a storage device, such as an HDD or an SSD, contained in a computer system.
[0055] The communication module **48** is configured to be capable of transmitting and receiving electrical signals to and from an external device using cable communication or wireless communication. Thus, the user terminal **40** is capable of, for example, transmitting and receiving digital ink Ink to and from the digital ink server **20**, and receiving related content C**1** and C**2** from the content server **30**, through a network NW.
[0056] The electronic pen **50** is a pen-type pointing device and is configured to be capable of performing one-way or two-way communication through capacitive coupling with the user terminal **40**. The user is able to draw a picture or a character on the user terminal **40** by holding the electronic pen **50** and moving the electronic pen **50** with a pen tip in contact with a touch surface of the touchscreen display **41**. The electronic pen **50** is, for example, a stylus of an active capacitive coupling type (AES (active electrostatic)) or an electromagnetic induction type (EMR (electro magnetic resource)).
Operations of Digital Ink Processing System **10**
[0057] The digital ink processing system **10** according to this embodiment has the above-described configuration. Next, first and second operations of the digital ink processing system **10** will be described below, mainly referring to sequence diagrams of FIGS. **3** and **8**. The "first operation" refers to an operation related to "semantic interpretation" of interpreting a collection of strokes and automatically assigning a semantic attribute (or a meaning attribute) to the collection of strokes. Meanwhile, the "second operation" refers to an operation related to "content citation" of timelily citing and displaying content related to the semantic attribute.
First Operation: Semantic Interpretation Operation
[0058] First, the first operation of the digital ink processing system **10**, i.e., a semantic interpretation operation, will now be described below. The first operation is implemented jointly by the user terminal **40** (more specifically, the host processor **46**) and the digital ink server **20** (more specifically, the control unit **22**).
[0059] In step S**01** in FIG. **3**, the user terminal **40** performs an authentication using identification information (hereinafter referred to as a pen ID) of the electronic pen **50**. When a pen ID received and obtained from the electronic pen **50** has been previously registered, the user terminal **40** permits editing of digital ink Ink by the electronic pen **50**. Meanwhile, when the pen ID has not been registered, the user terminal **40** does not permit editing of the digital ink Ink by the electronic pen **50**.
[0060] In step S**02**, the user terminal **40** accepts an input made using the electronic pen **50** that has been permitted to make edits in step S**01**, wherein the input includes a variety of writing operations by the user. Examples of the writing operations include addition, deletion, and change of strokes, selection of an icon, and addition of a mark or an annotation.
[0061] In step S**03**, the user terminal **40** updates the digital ink Ink, either periodically or aperiodically, to reflect the writing operation accepted in step S**02** in the digital ink Ink. In the former case, the digital ink Ink may be updated when a predetermined time has passed since the last update time, for example. In the latter case, the digital ink Ink may be updated when an update instruction operation by the user is received, for example.
[0062] In step S**04**, the user terminal **40** generates digital ink Ink in WILL (Ver. 3.0) format, for example, using data obtained through the writing operation in step S**02**.
[0063] FIG. **4**A is a schematic diagram illustrating a set G**0** of strokes in a visible (legible) form. Here, the set G**0** represents a handwritten shopping list, and includes items of "milk," "bread," "eggs," and "apples" arranged in order from top to bottom. FIG. **4**B is a diagram illustrating an

example of the data structure of the digital ink Ink. The digital ink Ink has a data structure in which [1] document metadata, [2] semantic data (ink semantics), [3] device data (devices), [4] stroke data (strokes), [5] grouping data (groups), and [6] context data (contexts) are arranged in order.

[0064] When the digital ink Ink is generated, the document metadata, the device data, the stroke data, and the context data have already been determined, but the semantic data and the grouping data are not yet determined. That is, (1) grouping of strokes and (2) assignment of semantic attributes, which will be described below, are not yet completed with respect to the digital ink Ink. Hereinafter, digital ink Ink in which both the grouping data and the semantic data have NULL values may be referred to as "pre-assignment ink."

[0065] In step S**05**, the user terminal **40** transmits the pre-assignment ink generated in step S**04**, with the pen ID associated therewith, to the digital ink server **20**.

[0066] In step S**06**, the digital ink server **20** receives the data transmitted from the user terminal **40** in step S**05**, thus acquiring the pre-assignment ink and the pen ID.

[0067] In step S**07**, the digital ink server **20** analyzes the stroke data included in the pre-assignment ink acquired in step S**06**, and performs grouping of the strokes. Specifically, the digital ink server **20** groups the set G**0** of strokes into one or more groups (for example, five groups G**1** to G**5**) on the basis of, for example, the order, positions, and shapes of the strokes identified by the stroke data or the pen pressure of the electronic pen **50**. As a result of this grouping, grouping data is obtained that describes what stroke elements are included in what groups or what groups are included in what groups.

[0068] In step S**08**, the digital ink server **20** performs a process of assigning semantic attributes to the groups G**1** to G**5** of strokes obtained by the grouping in step S**07**. Specifically, the digital ink server **20** uses a discriminator (e.g., a hierarchical neural network) subjected to machine learning to infer a semantic attribute of each of the groups G**1** to G**5** and to assign the semantic attribute to each of the groups. As a result of this process, grouping data is obtained that describes a semantic attribute of each group, wherein the semantic attribute includes a type and a value in a pair.

[0069] For example, the above-mentioned discriminator is configured to receive input of feature amounts of the strokes (e.g., coordinates of starting points, intermediate points, and ending points, curvatures, etc.), and to output labels of semantic attributes. Examples of the "type" include a text (including a language type), a drawing (including a drawing type), a mathematical equation, a chemical formula, a list, a table, and so on. Examples of the "value" include a handwritten character or character string (e.g., "milk"), a name of a hand-drawn object (e.g., "pencil" for an illustration of a pencil), and so on.

[0070] FIG. **5**A is a diagram illustrating a result of the grouping of the strokes. As will be understood from the figure, the set G**0** includes group G**1**, and group G**1** is made up of four groups G**2** to G**5**. FIG. **5**B is a diagram illustrating a result of the assignment of semantic attributes to the groups obtained by the grouping in FIG. **5**A. The type and value of group G**1** are "LIST" and "NULL," respectively. The type and value of group G**2** are "LIST_ITEM" and "milk," respectively. The type and value of group G**3** are "LIST_ITEM" and "bread," respectively. The type and value of group G**4** are "LIST_ITEM" and "eggs," respectively. The type and value of group G**5** are "LIST_ITEM" and "apples," respectively.

[0071] In step S**09** in FIG. **3**, the digital ink server **20** updates the pre-assignment ink such that the grouping data obtained in step S**07** and the semantic data obtained in step S**08** are added to the pre-assignment ink. Hereinafter, the digital ink Ink with the grouping data and the semantic data added thereto may be referred to as "post-assignment ink."

[0072] In step S**10**, the digital ink server **20** transmits the post-assignment ink updated in step S**09** to the user terminal **40**.

[0073] In step S**11**, the user terminal **40** receives the data transmitted from the digital ink server **20** in step S**10**, thus acquiring the post-assignment ink including the grouping data and the semantic data.

[0074] In step S**12**, the user terminal **40** stores the post-assignment ink acquired in step S**11** in the memory **47**.
[0075] In step S**13**, the user terminal **40** checks that a determination condition concerning the grouping of strokes is satisfied, and enables a pointing operation relative to at least one group. An example of the "determination condition" is acquisition of semantic data from the digital ink server **20**. In this case, groups G**2** to G**5** for which the semantic attributes have valid (other than NULL) values are chosen as targets of the enablement. It is to be noted that the enablement of the pointing operation is deferred for group G**1**, for which the semantic attribute has an invalid (NULL) value and thus no meaning is identified, or for one or more strokes that are in the midst of being written and thus have no meaning yet.
[0076] In step S**14**, the user terminal **40** causes groups G**2** to G**5** of strokes, for which the enablement has been performed in step S**13**, to be highlighted as compared to before the enablement. The "highlighting" means to change the mode of display to a mode that makes visual recognition easier for the user. Examples of highlighting include changing a display color, increasing a stroke width, adding an indication mark, and so on.
[0077] FIGS. **6**A and **6**B are transition diagrams illustrating a first state change in a display of the user terminal **40**. In more detail, FIG. **6**A illustrates the state of the display before the enablement, while FIG. **6**B illustrates the state of the display after the enablement. In the example of FIG. **6**B, underlines are added at four positions corresponding to groups G**2** to G**5** in the set G**0** of strokes. This allows the user to understand at a glance that the pointing operation has been enabled for the four words, "milk," "bread," "eggs," and "apples."
[0078] The first operation of the digital ink processing system **10** is thus finished. Once the first operation is finished, the digital ink processing system **10** can start the second operation.
[0079] Although, in the example described above, the pointing operation is enabled when the user terminal **40** has acquired the semantic data from the digital ink server **20**, the determination condition is not limited to this example. For example, the determination condition may be acquisition of grouping data or semantic data through analysis of the digital ink Ink by the user terminal **40** itself, or arrival of a timing at which the digital ink Ink is automatically or manually stored. In addition, the determination condition may be receipt by the user terminal **40** of an operation of adding a mark or an annotation to at least a part of the set G**0** of strokes.
[0080] FIGS. **7**A and **7**B are transition diagrams illustrating a second state change in the display of the user terminal **40**. As illustrated in FIG. **7**A, the user performs a writing operation of enclosing "eggs" with a circle (a so-called lasso) using the electronic pen **50** in a state in which no enablement has been performed for any part of the set G**0** of strokes. As a result, along with the set G**0** of strokes, a window **60** for checking whether or not an enablement is necessary for "eggs" is newly displayed. Here, when an [ON] button in the window **60** is touched, the state of the display of the user terminal **40** transitions from the state of FIG. **7**A to the state of FIG. **7**B.
[0081] As illustrated in FIG. **7**B, the word (eggs) corresponding to group G**4** in the set G**0** of strokes is highlighted. This allows the user to understand at a glance that the pointing operation has been enabled only for the word "eggs."
Second Operation: Content Citation Operation
[0082] Next, the second operation of the digital ink processing system **10**, that is, the content citation operation, will now be described below. The second operation is implemented jointly by the user terminal **40** (more specifically, the host processor **46**) and the content server **30** (more specifically, the control unit **32**).
[0083] In step S**21** in FIG. **8**, the user terminal **40** accepts an operation (i.e., the pointing operation) of pointing at one of groups G**2** to G**5**, for which the enablement has been performed, in the set G**0** of strokes displayed on the touchscreen display **41** using the electronic pen **50**. The pointing operation may be, for example, an operation of continuously pressing the position of "eggs" (group G**4**) in FIG. **6**B or FIG. **7**B.

[0084] In step S**22**, the user terminal **40** reads the post-assignment ink stored in the memory **47** and acquires the semantic attribute of group G**4** pointed in step S**21**. Specifically, the user terminal **40** analyzes the grouping data of the post-assignment ink, thereby identifying a group ID corresponding to the position pointed at by the electronic pen **50**. Then, the user terminal **40** analyzes the semantic data of the post-assignment ink, thereby identifying the semantic attribute corresponding to the group ID.
[0085] In step S**23**, the user terminal **40** receives, with the sensor electrode **43**, a data signal transmitted from the electronic pen **50**, thereby acquiring the pen ID of the electronic pen **50**.
[0086] In step S**24**, the user terminal **40** transmits the semantic data acquired in step S**22**, with the pen ID acquired in step S**23** associated therewith, to the content server **30**. That is, the user terminal **40** requests the content server **30** to perform a search for content.
[0087] In step S**25**, the content server **30** receives the data transmitted from the user terminal **40** in step S**24**, thereby acquiring the pen ID and the semantic attribute.
[0088] In step S**26**, the content server **30** performs a search for content using the semantic attribute and the pen ID acquired in step S**25**. Specifically, the content server **30** sequentially performs [1] a search for content using the pen ID, and [2] a search within the content using the semantic attribute. Here, the pen ID serves as identification information (hereinafter, a use ID) for determining whether or not use of content is permitted. As the use ID, not only the pen ID but also identification information of user terminal **40** (hereinafter, a terminal ID), identification information of the user (hereinafter, a user ID), or a combination thereof may be used.
[0089] FIG. **9**A is a diagram illustrating an example of the data structure of electronic pen information **62**. The electronic pen information **62** indicates correspondence relationships between a “pen ID,” which is the identification information of the electronic pen **50**, a “school” to which the user belongs, and a “year/class” to which the user belongs. The pen ID corresponds to the use ID that manages usage of content. Examples of the “school” include a primary school, a junior high school, a high school, a college, a preparatory school, and so on. For the “year/class,” various years or classes can be chosen according to the type of the school.
[0090] FIG. **9**B is a diagram illustrating an example of the data structure of content management information **64**. The content management information **64** indicates correspondence relationships between a “school” to which the user belongs, a “year/class” to which the user belongs, and “content types” that are available for use. Each of the “school” and the “year/class” is basically defined in the same manner as in the electronic pen information **62**. Further, examples of the content types include titles of books, including textbooks, reference books, and workbooks, names of study subject, names of publishers, and so on.
[0091] The content server **30** reads the electronic pen information **62** and the content management information **64**, and uses the “school” and the “year/class” as search keys to thereby acquire at least one type of content corresponding to the pen ID. Then, employing any of a variety of search methods, the content server **30** acquires, from within the content being searched, information (hereinafter referred to as “related content C**1**”) that matches or approximately matches the “(value of) semantic attribute” that is used as a search key.
[0092] In step S**27** in FIG. **8**, the content server **30** transmits the related content C**1** as a search result of step S**26**, with the pen ID associated therewith, to the user terminal **40**.
[0093] In step S**28**, the user terminal **40** receives the data transmitted from the content server **30** in step S**27**, thereby acquiring the related content C**1** and the pen ID.
[0094] In step S**29**, the user terminal **40** temporarily stores the related content C**1** acquired in step S**28** in the memory **47**.
[0095] In step S**30**, the user terminal **40** displays the related content C**1**, which is retrieved by the search, and the set G**0** of strokes simultaneously on the touchscreen display **41**.
[0096] FIGS. **10**A and **10**B are transition diagrams illustrating a third state change in the display of the user terminal **40**. In more detail, FIG. **10**A illustrates the state of the display before the related

content C**1** appears, while FIG. **10**B illustrates the state of the display after the related content C**1** appears. As will be understood from these figures, the related content C**1** is displayed near (here, at the lower right of) "eggs" as a result of the pointing operation performed on the position of "eggs." The related content C**1** includes "eggs" written in English and "Imi: tamago" written in Japanese.
[0097] The user can easily recognize that a Japanese translation of the English word "eggs," which has been pointed at using the electronic pen **50**, is "tamago (plural)." Thus, the digital ink processing system **10** provides a learning support service that facilitates learning with increased efficiency.
[0098] Here, the administrator of the electronic notebook may decide to lend the user in school the electronic notebook while prohibiting the user from taking the electronic notebook out of school. In such cases, by associating the use ID of the content with the pen ID, it is possible to allow the user to receive the above-described learning support service even at home.
[0099] FIG. **11**A illustrates a case in which a user terminal **40**B is different from a user terminal **40**A on which handwriting input is performed using the electronic pen **50**. For example, the user is able to edit the digital ink Ink using the same electronic pen **50**, which has been brought back home from school. Alternatively, the digital ink processing system **10** may be configured to refer to the terminal ID included in the "device data" of the digital ink Ink, and if the user terminal **40**B does not match the terminal ID restrict or prohibit editing of the digital ink Ink on the user terminal **40**B.
[0100] Meanwhile, as illustrated in FIG. **11**B, when the user has pointed at a relevant region using the electronic pen **50**, the user terminal **40**B is allowed to display the related content C**1** on the touchscreen display **41** as in the case of the user terminal **40**A. Thus, even in a situation in which it is difficult to freely move the user terminal **40**A, the user is able to receive the learning support service at a variety of places by carrying his or her own electronic pen **50**.
Refined Examples of Operation
[0101] Hereinafter, refined examples of the operation of the digital ink processing system **10** will be described with reference to FIGS. **12**A to **13**B.
First Refined Example
[0102] It is conceivable that, as the learning of the user progresses and his or her degree of achievement increases, information that the user desires to know will gradually change. Accordingly, the user terminal **40** may be configured to display different related content C**1** and C**2** depending on the degree of achievement of the user. For example, in the sequence diagram of FIG. **8**, additional step S**31** may be inserted between steps S**23** and S**24**.
[0103] In step S**31** in FIG. **8**, the user terminal **40** performs a search in the semantic data with the "value" (for example, eggs) of the semantic attribute acquired in step S**22** used as a keyword. The target of this search is not limited to the digital ink Ink being edited but may include digital ink Ink stored in the memory **47** of the user terminal **40** itself or in the digital ink server **20**. For example, the user terminal **40** may count the number of "values" that match or approximately match the keyword, and calculate the number as the "degree of occurrence." Thereafter, in steps S**24** and S**25**, transmission and reception of data including the degree of occurrence are performed between the user terminal **40** and the content server **30**.
[0104] In step S**26**, the content server **30** performs a search for content using the pen ID, the semantic attribute, and the degree of occurrence acquired in step S**25**. Specifically, the content server **30** sequentially performs [1] a search for content using the pen ID, [2] a selection of content using the degree of occurrence, and [3] a search in the content using the semantic attribute.
[0105] FIG. **12**A is a diagram illustrating an example of the data structure of a determination table **66**. The determination table **66** indicates correspondence relationships between the "number of occurrences," which indicates the degree of occurrence, and the "degree of achievement" of typical users. In the example of this figure, the determination table **66** describes determination criterions that determine [1] the degree of achievement to be low when the number of occurrences is less than 9, [2] the degree of achievement to be intermediate when the number of occurrences is 10 or more

and less than 20, and [3] the degree of achievement to be high when the number of occurrences is 20 or more. Note that, although the number of occurrences is used as an example of the degree of occurrence in this figure, the frequency of occurrences may be used in combination therewith or alternatively.

[0106] The content server **30** identifies the degree of achievement of the user from the degree of occurrence using the determination table **66**, and thereafter selects content that matches the degree of achievement from among a plurality of types of content corresponding to the pen ID. Suppose, for example, that the related content C**2**, which is different from the related content C**1** illustrated in FIG. **10**B, has been acquired for a user who has a higher degree of achievement. Thereafter, steps S**27** to S**29** are performed in a manner similar to that described above.

[0107] In step S**30**, the user terminal **40** displays the related content C**2** retrieved by the search on the touchscreen display **41** with the set G**0** of strokes. As illustrated in FIG. **12**B, the related content C**2** is displayed together at a position near "eggs," on which the pointing operation is performed. The related content C**2** includes a string of characters of an example sentence "Birds lay eggs." in which the English word "eggs" is used.

[0108] As described above, when different related content C**1** or C**2** is displayed depending on the degree of occurrence of the semantic attribute in the same use ID (here, pen ID), suitable information can be presented to each individual user having a different degree of achievement. Note that there is a high correlation between the degree of occurrence and the degree of interest of the user, and therefore, it may be useful to perform a display similar to the display in the case of the degree of achievement described above.

Second Refined Example

[0109] Electronic notebooks are respectively used by individuals, and a condition may be undesirable in which an electronic notebook of one person can be freely edited by another person. Accordingly, the user terminal **40** may be configured to be capable of changing editing rights depending on the pen ID of an electronic pen **50**A or **50**B.

[0110] As illustrated in FIG. **13**A, the pen ID (for example, ID=002) of the electronic pen **50**B, which has been recognized by the user terminal **40**, is different from the pen ID (for example, ID=001) of the electronic pen **50**A, which has been used in the handwriting input. In this case, the user terminal **40** displays, on the touchscreen display **41**, a message **70** that indicates that editing of the digital ink Ink is restricted. In the situation in which the message **70** is displayed, the user terminal **40** prohibits or restricts editing of the digital ink Ink using the electronic pen **50**B. Here, "prohibiting" means an operation of rejecting an operation related to editing. Meanwhile, "restricting" means an operation of disabling some of functions related to editing.

[0111] Meanwhile, as illustrated in FIG. **13**B, when the user points at the relevant region using the electronic pen **50**B, the user terminal **40** displays the related content C**1** on the touchscreen display **41** as in the case of the electronic pen **50**A. Thus, while the user can prevent his or her electronic notebook from being freely edited by others, any other person could receive content citation service thereon.

Charging Flow of Learning Support Service

[0112] Here, along with provision of the above-described learning support service, charging and payment are made as for [1] a usage fee of a semantic interpretation service and [2] a usage fee of the content citation service. Hereinafter, a flow of charging performed between the digital ink server **20**, the content server **30**, the user terminal **40**, and a business entity-side server **80** will be described.

[0113] Here, the business entity-side server **80** is a server managed by a business entity (e.g., a publisher) that provides content. Note that, although it is assumed for the ease of description that the user terminal **40** is involved in the flow of charging, a school-side server (not illustrated) that manages the individual user terminals **40** may be additionally or alternatively involved in the flow of charging.

First Example

[0114] FIG. **14** is a schematic diagram illustrating a first example of the flow of charging made at the time of the learning support service. [0115] [T11] The user terminal **40** makes access to the digital ink server **20** each time the semantic interpretation service is used. [0116] [T12] The digital ink server **20** totals usage of the semantic interpretation service for each user on each cutoff date for usage fees, and performs a charging process of charging the usage fees of the service in accordance with a predetermined charging rule. [0117] [T13] The digital ink server **20** provides, to each user terminal **40**, a notice of demand for the usage fee determined by the charging process. When the user, receiving this notice, makes a payment by a due date, the payment of the usage fee by the user is completed. [0118] [T14] Meanwhile, the user terminal **40** makes access to the content server **30** each time the content citation service is used. [0119] [T15] The content server **30** totals usage of content involved in the content citation service for each user on each cutoff date for usage fees. [0120] [T16] The content server **30** provides, to the business entity-side server **80**, a notice of usage of content by each user. [0121] [T17] The business entity-side server **80** performs a charging process of charging the usage fees of the content in accordance with a predetermined charging rule on the basis of a result of the totaling of the usage. [0122] [T18] The business entity-side server **80** provides, to each user terminal **40**, a notice of demand for the usage fee determined by the charging process. When the user, receiving this notice, makes a payment by a due date, the payment of the usage fee by the user is completed. [0123] [T19] The business entity-side server **80** provides, to the content server **30**, a notice of payment of a fee for provision of a service platform in accordance with a predetermined contract rule (e.g., a variable fee system that charges a fee in proportion to the usage fees of the content).

Second Example

[0124] FIG. **15** is a schematic diagram illustrating a second example of the flow of charging made at the time of the learning support service. [0125] [T21] The user terminal **40** makes access to the digital ink server **20** each time the semantic interpretation service is used. [0126] [T22] The digital ink server **20** totals usage of the semantic interpretation service for each user on each cutoff date for usage fees, and performs a charging process of charging the usage fees of the service in accordance with a predetermined charging rule. [0127] [T23] The digital ink server **20** provides, to each user terminal **40**, a notice of demand for the usage fee determined by the charging process. When the user, receiving this notice, makes a payment by a due date, the payment of the usage fee by the user is completed. [0128] [T24] Meanwhile, the user terminal **40** makes access to the content server **30** each time the content citation service is used. [0129] [T25] The content server **30** totals usage of content involved in the content citation service for each user on each cutoff date for usage fees, and performs a charging process of charging the usage fees of the content in accordance with a predetermined charging rule. [0130] [T26] The content server **30** provides, to each user terminal **40**, a notice of demand for the usage fee determined by the charging process. When the user, receiving this notice, makes a payment by a due date, the payment of the usage fee by the user is completed. [0131] [T27] The content server **30** provides, to the business entity-side server **80**, a notice of payment of an amount obtained by subtracting a fee for provision of the service platform from the usage fees of the content.

[0132] [Example Modifications] It is needless to say that the present disclosure is not limited to the above-described embodiments, and that various modifications can be made thereto without departing from the principles of the disclosure. Also note that various features thereof may be combined optionally as long as no technical conflict arises.

[0133] Although, in the above-described embodiments, the digital ink processing system **10** is configured to provide a learning support service to support education for students, the type of the service and target users are not limited to the above-described examples.

[0134] Although the digital ink server **20** performs the grouping of strokes and the assignment of semantic attributes in the above-described embodiments, the user terminal **40** may be configured to

be capable of performing the grouping or both the grouping and the assignment in place of the digital ink server **20**. For example, the user terminal **40** itself may analyze the digital ink Ink to acquire the semantic attributes, or the user terminal **40** may acquire the semantic attributes through a manual input operation by the user.

[0135] Although the digital ink Ink in which the semantic data is defined has been used as an example in the description of the above-described embodiments, digital ink Ink in which the semantic data is not defined may be used. In this case, the digital ink Ink and the semantic data may be associated with each other and managed, so that an operation similar to that of the above-described embodiments can be realized.

[0136] [Summary of Embodiments] As described above, the digital ink processing system **10** includes the electronic pen **50**, and the user terminal **40** that is configured to be capable of accepting a writing operation by the electronic pen **50** through the touchscreen display **41** and generating the digital ink Ink describing the set G**0** of strokes. The user terminal **40** enables the pointing operation of the electronic pen **50** relative to groups G**2** to G**5** of strokes, which satisfy the determination condition concerning the grouping of strokes, within the set G**0** displayed on the touchscreen display **41**, while deferring the enablement of the pointing operation relative to group G**1** of strokes, which does not satisfy the determination condition. If any enabled pointing operation is received, the user terminal **40** performs a search for content related to the semantic attribute of the specified one of groups G**2** to G**5**, or requests an external entity to perform the search, and displays the related content C**1** or C**2** retrieved by the search on the touchscreen display **41** with the set G**0**.

[0137] In addition, according to a digital ink processing method and a digital ink processing program, the user terminal **40** performs the step (S**13**) of enabling the pointing operation of the electronic pen **50** relative to groups G**2** to G**5** of strokes which satisfy the determination condition concerning the grouping of strokes within the set G**0** of strokes displayed on the touchscreen display **41**, while deferring the enablement of the pointing operation relative to group G**1** of strokes which does not satisfy the determination condition, and the step (S**30**) of, if any enabled pointing operation is received (S**21**), performing a search for content related to the semantic attribute assigned to groups G**2**-G**5** or requesting an external entity to perform the search (S**24**), and displaying the related content C**1** or C**2** retrieved by the search on the touchscreen display **41** along with the set G**0**.

[0138] As described above, because the pointing operation of the electronic pen **50** is enabled only with respect to groups G**2** to G**5** of strokes which satisfy the determination condition concerning the grouping of strokes, a search for content will be permitted only with respect to groups G**2** to G**5** which are highly likely to have meanings as collections when the determination condition is properly set. This makes it possible to present, to the user, useful and highly relevant information as a search result when a search is performed using the digital ink Ink.

[0139] In addition, the user terminal **40** may cause groups G**2** to G**5**, for which the pointing operation has been enabled, to be highlighted as compared to before the enablement. This makes it easier for the user to visually recognize the enablement of the pointing operation and the positions thereof.

[0140] Further, the determination condition may be assignment of the semantic attribute to groups G**2**-G**5** of strokes. This makes it possible to perform a search using the assigned semantic attribute as a search key so that the user can obtain a more useful search result.

[0141] Furthermore, while the digital ink server **20** analyzes the digital ink Ink transmitted from the user terminal **40** and thus assigns the semantic attributes to groups G**2** to G**5**, the determination condition may be acquisition of the semantic data representative of the semantic attributes from the digital ink server **20**. The assignment of the semantic attributes by the digital ink server **20** in place of the user terminal **40** reduces the analytical load on the user terminal **40**.

[0142] Furthermore, the determination condition may be acceptance of a user operation of adding a

mark or an annotation to groups G**2**-G**5**. This makes it possible for a user who performs the operation to specify, through the mark or annotation, a collection of strokes, in which the user finds meaning, leading to an increased likelihood that a more accurate semantic attribute will be obtained.
[0143] Furthermore, the content server **30** may store content in association with use IDs, and the user terminal **40** may transmit data including the use ID and the semantic attribute to the content server **30** and may request a search to thereby acquire, from the content server **30**, the related content C**1** or C**2** which is related to the semantic attribute and which is usable.
[0144] Furthermore, the user terminal **40** may acquire different related content C**1** or C**2** depending on the degree of occurrence of the semantic attribute based on the same use ID. When the degree of occurrence, which is highly correlated with the degree of achievement or degree of interest of the user, is taken into account, suitable information can be selected and presented to each of users who may vary in the degree of achievement or degree of interest.
[0145] Furthermore, the use ID may be the pen ID for identifying the electronic pen **50**. This makes it possible to associate the electronic pen **50** with content available for use, making it possible to present the same related content C**1** or C**2** when the same electronic pen **50** is used, regardless of which of the user terminals **40**A or **40**B may be used.
[0146] Furthermore, in the case where the digital ink Ink has been generated using the electronic pen **50**A that is assigned a first pen ID, and the electronic pen **50**B is used that is assigned a second pen ID different from the first pen ID, the user terminal **40** may prohibit or restrict editing of the digital ink Ink while accepting the pointing operation by the electronic pen **50**B. Thus, while the digital ink Ink generated by the user is prohibited from being freely edited, the same related content C**1** or C**2** as will be presented to the user will be presented even to a person other than the user.
[0147] Furthermore, the content server **30** may perform a charging process in accordance with usage of content for the user of the content and a business entity that provides the content. Thus, management of the content and management of usage fees can be accomplished in a centralized manner by a single apparatus.
DESCRIPTION OF REFERENCE SYMBOLS
[0148] **10**: Digital ink processing system [0149] **20**: Digital ink server [0150] **30**: Content server [0151] **40**. **40**A, **40**B: User terminal [0152] **41**: Touchscreen display [0153] **50**. **50**A. **50**B: Electronic pen [0154] **80**: Business entity-side server [0155] C**1**, C**2**: Related content [0156] G**0**: Set [0157] G**1** to G**5**: Group [0158] Ink: Digital ink

Claims

1. A computer, comprising: a display; and a processor configured to: generate strokes according to an input made by an electronic pen on the display; control the display to display the strokes in groups, wherein each group includes one or more strokes forming a unit; obtain semantic attributes of the groups of strokes using a discriminator subjected to machine learning to infer a semantic attribute of each of the groups; and for each of the groups, acquire content corresponding to the semantic attribute of the group and display the content on the display.
2. The computer according to claim 1, wherein the processor is configured to analyze the strokes to form the groups based on at least one of an order of the strokes; positions of the strokes; shapes of the strokes; or a pen pressure of the electronic pen.
3. The computer according to claim 1, wherein the semantic attribute includes a type of the group.
4. The computer according to claim 3, wherein the type is at least one of a text, a drawing, a mathematical equation, a chemical formula, a list, or a table.
5. The computer according to claim 1, wherein the semantic attribute includes a value of the group.
6. The computer according to claim 5, wherein the value includes at least one of a value of a handwritten character, a value of a handwritten character string, or a value of a name of a hand-

drawn object.
7. The computer according to claim 1, wherein the processor is configured to obtain the semantic attributes which are output from a digital ink server that analyzes the groups of strokes using the discriminator subjected to machine learning.
8. The computer according to claim 1, wherein the discriminator is a neural network.
9. The computer according to claim 1, wherein the discriminator is configured to receive input of feature amounts of the strokes and to output labels of semantic attributes, wherein the feature amounts include at least one of coordinates of starting points of the strokes, coordinates of intermediate points of the strokes, coordinates of ending points of the strokes, or curvatures of the strokes.
10. The computer according to claim 1, wherein the processor is configured to acquire the content corresponding to the semantic attribute by searching in a content server that stores multiple pieces of content.
11. The computer according to claim 1, wherein the semantic attributes are stored in association with the groups in a digital ink data structure.
12. A method, comprising generating strokes according to an input made by an electronic pen on a display; controlling the display to display the strokes in groups, wherein each group includes one or more strokes forming a unit; obtaining semantic attributes of the groups of strokes using a discriminator subjected to machine learning to infer a semantic attribute of each of the groups; and for each of the groups, acquiring content corresponding to the semantic attribute of the group and displaying the content on the display.
13. The method according to claim 12, wherein the semantic attribute includes a type of the group.
14. The method according to claim 13, wherein the type is at least one of a text, a drawing, a mathematical equation, a chemical formula, a list, or a table.
15. The method according to claim 12, wherein the semantic attribute includes a value of the group.
16. The method according to claim 15, wherein the value includes at least one of a value of a handwritten character, a value of a handwritten character string, or a value of a name of a hand-drawn object.
17. The method according to claim 11, comprising: obtaining the semantic attributes which are output from a digital ink server that analyzes the groups of strokes using the discriminator subjected to machine learning.
18. The method according to claim 12, wherein the discriminator is a neural network.
19. The method according to claim 12, comprising: acquiring the content corresponding to the semantic attribute by searching in a content server that stores multiple pieces of content.
20. The method according to claim 12, comprising: storing the semantic attributes in association with the groups in a digital ink data structure.