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Smart Pen and Related Method for Detecting Ink Applied by a Smart Pen onto a Writing Surface

SMART PEN AND RELATED METHOD FOR DETECTING INK APPLIED BY A SMART PEN ONTO A WRITING SURFACE

Introduction

The present disclosure is directed to "smart" writing devices, such as smart pens, as well as related methods for detecting ink applied onto a writing surface, such as paper, when using a smart pen. Currently, smart pens are known that include cameras to allow images to be captured of a writing surface as the pen is moved across or adjacent to the surface. However, such existing smart pens are not equipped to differentiate content created on the writing surface using the pen from other content contained on the writing surface.

Summary

The present disclosure proposes to solve the challenge described above by providing a smart pen that is capable of efficiently and effectively differentiating between content created by writing or marking on a writing surface with the smart pen and other content contained on the writing surface (e.g., pre-existing written or printed content). As a result, the smart pen may be used to automatically identify, when desired, any pen-generated content for subsequent use and/or analysis.

Specifically, the smart pen may be provided with a specialized type of ink that is configured to reflect light when illuminated with a given light source, thereby allowing the ink to be easily identified or detected within images captured via a camera of the smart pen. For instance, in one implementation, the ink used within the pen may correspond to a fluorescent ink including fluorescent particles configured to reflect UV/IR light. In such instance, the smart pen may include a suitable light source, such as an ultraviolet and/or infrared light source, that is synchronized with the operation of the camera. As a result, when images of the writing surface are captured in synchronization with the light source being activated or turned on, the ink applied

to the writing surface may be clearly identifiable and detectable within the images, thereby allowing the content generated via the smart pen to be differentiated from any other content included on the writing surface.

The synchronization between the light source and camera may take any suitable form. For instance, the light source may be activated or turned on for every image captured by the camera. Alternatively, the light source may be activated in an alternating or blinking pattern such that light source is only activated for every other image captured by the camera. In such an embodiment, a first image captured by the camera may simply depict the adjacent writing surface in general (e.g., with the light source turned off) while the next image captured by the camera may illuminate or highlight any writing generated by the smart pen (e.g., when the light source is turned on or otherwise activated). In other embodiments, the light source may be activated using any other suitable pattern or at any other suitable frequency relative to the frequency at which the camera is configured to capture images of the writing surface.

Detailed Description

FIG. 1 illustrates a schematic diagram of one embodiment of a writing device **100** in accordance with aspects of the present disclosure. In the embodiment shown in **FIG. 1**, the writing device **100** is configured as a "smart" writing device, such as a "smart" pen.

As shown in **FIG. 1**, the writing device **100** may generally include an outer housing **110** and an ink cartridge **130** positioned within the housing **110**. In general, the ink cartridge **120** may be configured to contain ink for application onto an associated writing surface, such as a piece of paper, as the writing device **100** is being used to write or mark on such surface. It should be appreciated that, in one embodiment, the ink cartridge **120** may be configured to be

refilled when the ink contained therein runs low. Alternatively, the ink cartridge **120** may be disposable.

In several embodiments, the ink cartridge **120** may contain a non-standard or unconventional ink type. For instance, in a particular embodiment, the ink may include additives that absorb and/or reflect light when exposed to a certain type(s) of light, such as light across a given radiation spectrum. As a result, the ink may only become visible along the writing surface and/or its appearance on the writing surface may vary (e.g., by becoming more prevalent or noticeable) when exposed to such light. For example, in one embodiment, the ink may correspond to "invisible" fluorescent ink (also referred to as "black light ink") that includes fluorescent particles that temporarily absorb UV/IR light and then reflect it back outwardly. In such an embodiment, the ink may only be visible, for example, when exposed to UV/IR light. However, when the source of UV/IR light is removed or turned off, the ink may not be visible to the naked eye (or at least may be difficult to view). In other embodiments, the ink may correspond to any other suitable ink type that is configured to become visible and/or is adapted to change its appearance on a writing surface when exposed to a certain type of light.

In addition, the writing device **100** may also include one or more sensors configured to detect one or more operating parameters and/or conditions associated with the writing device **100**. For instance, as shown in **FIG. 1**, the writing device **100** may include one or more inertial measurement units (IMU) **140**. As is generally understood, the IMU(s) **140** may include sensors and circuitry for determining data associated with the orientation/movement of the writing device **100**, such as one or more gyroscopes and one or more accelerometers. For instance, the IMU(s) **140** may be configured to monitor the movement and/or orientation of the writing device **100** relative to an adjacent writing surface.

As further shown in **FIG. 1**, the writing device **100** may also include a controller **150** having one or more processors **152** and associated memory devices **154**. The processor(s) **152** can include any suitable processing device, such as a microprocessor, microcontroller, integrated circuit, logic device, or other suitable processing device. Similarly, the memory device(s) **154** can include one or more computer-readable media, including, but not limited to, non-transitory computer-readable media, RAM, ROM, hard drives, flash drives, or other memory devices. In several embodiments, the memory device(s) **154** can store information accessible by the processor(s) **152**, including computer-readable instructions that can be executed by the one or more processors **152**. The instructions can be any set of instructions that when executed by the processor(s) **152**, cause the processor(s) **152** to perform operations. For instance, as will be described below, the instructions can be executed by the processor(s) **152** to control the operation of one or more of the components of the writing device **100** to allow for the detection of ink applied via the writing device **100** onto a given writing surface. It should be appreciated that the instructions can be implemented in hardware or in software. When software is used, any suitable programming, scripting, or other type of language or combinations of languages may be used to implement the teachings contained herein. The memory device(s) **154** can also store data for manipulation by the processor(s) **152**.

Additionally, the writing device **100** may also a suitable power source, such as a battery **160**, to power the various power-consuming components of the device **100**. In one embodiment, a socket can be provided for re-charging the battery **160**. Additionally, in one embodiment, a portion of the writing device **100** may be configured to be placed into a socket configured to receive the writing device **100** (similar to a pen cap or pen holder) to re-charge the battery **160**. Other suitable schemes for re-charging the battery **160** may also be used without

deviating from the scope of the present disclosure. For example, the writing device **100** can be provided with, obtain, and/or use power that is provided via wireless charging, a charging cradle, etc. while the device **100** is in use and/or not in use.

Moreover, as shown in FIG. 1, the writing device **100** may also include one or more image capture devices or cameras **170**, such as one or more image sensors and associated lenses, for capturing images of the writing surface for the writing device **100** and/or images of any other surrounding environment. In such an embodiment, the image sensor(s) may capture light (e.g., visible light, infrared light, ultraviolet light, etc.) received through the lens(s) and subsequently convert the light to digital images. Any suitable image sensor(s) can be used to convert the light to digital images, such as CMOS image sensors, CCD image sensors, or combinations thereof. As will be described below, the camera(s) **170** may be configured to capture images of the adjacent writing surface as the writing device **100** is being used to write or mark on such surface. The images may then be analyzed by the controller **150** to detect the ink applied by the writing device **100** into the writing surface.

In addition, the writing device **100** may also include one or more light source(s) **180**. In one embodiment, the light source(s) **180** may be provided in operative association with the camera(s) **170**, such as by serving as the flash for the camera(s). Alternatively, the light source(s) **180** may be separate and apart from the camera(s) **170**. In several embodiments, the light source(s) **180** may be selected based on the type of ink contained within the ink cartridge **120** such that the light generated by the light source(s) **180** is configured to illuminate or visually highlight the ink that has been applied to the adjacent writing surface. Specifically, the light source(s) **180** may be selected so as to be capable of generating light across the radiation spectrum within which the ink is adapted to reflect such light. For instance, when the ink

corresponds to fluorescent ink, the light source(s) **180** may be configured to generate light across the ultraviolet and/or infrared spectrum such that the fluorescent particles contained within the ink absorb the light transmitted from the light source(s) **180** and reflect such light back outwardly from the adjacent writing surface(s).

Further as shown in **FIG. 1**, the writing device **100** may also include a communications interface **190** for communicating data to one or more remote devices. In general, the communications interface **190** may include one or more transmitters, receivers, ports, circuits, and other interfaces for communicating digital information over a wired communication link, wireless communication link, or combination of wired and wireless communication links. As an example, the communications interface **190** can communicate data to a remote server over a network (e.g., the Internet) for subsequent processing of the data. As another example, the communications interface **190** can communication data to a user device (e.g., a smartphone, tablet, etc.) via a wireless interface, such as Bluetooth interface or other suitable communication link.

In accordance with aspects of the present disclosure, the controller **150** may, in one embodiment, be configured to coordinate or synchronize the operation of the camera(s) **170** and the light source(s) **180** such that the light source(s) **180** is activated or turned on each time the camera(s) **170** captures an image of the adjacent writing surface. Alternatively, the light source(s) **180** may only be activated or turned on periodically as the camera(s) **170** is capturing images of the adjacent writing surface. For instance, in one embodiment, the controller **150** may be configured to control the operation of the light source(s) **180** such that the light source(s) **180** is turned on/off or blinked at a frequency that is equal to the frequency at which the camera(s) **170** is capturing images. As such, by synchronizing the operation of the camera(s) **170** and the

light source(s) **180**, the light source(s) **180** may alternate between being activated or turned on and deactivated or turned off across successive images captured by the camera(s) **170**. In other words, every other image provided by the camera(s) **170** may be captured when the light source(s) **180** is activated/turned on and, thus, is actively illuminating the field of view of the camera(s) **170**. Accordingly, when capturing images of a portion(s) of the writing surface across which ink has been applied via the writing device **100**, every other image may depict the ink illuminated by or otherwise reflecting the light from the light source(s) **180**. Such images may then be analyzed by the controller **150** (e.g., using a suitable image processing algorithm) to identify the markings/writings on the writing surface that have been applied via the writing device **100**.

Referring now to **FIG. 2**, a flow chart illustrating one embodiment of a method **200** for detecting ink applied onto a writing surface via a smart pen is illustrated in accordance with aspects of the present subject matter. Although the operations of the method **200** are shown and described in a particular order, certain operations can be performed in a different order or at the same time.

As shown in **FIG. 2**, at **202**, the smart pen is placed adjacent to and/or oriented relative to a portion(s) of a writing surface across which ink from the smart pen has been applied such that a field view of the camera(s) of the smart pen is directed towards such portion(s) of the writing surface. As a result, the camera(s) may be configured to capture images of the portion(s) of the writing surface across which the smart pen has been used to mark or write on the surface.

Additionally, at **204**, the operation of the camera(s) and the light source(s) of the smart pen may be controlled such that images are captured of the writing surface when the ink previously applied by the smart pen is illuminated by the light generated via the light source(s).

For instance, as indicated above, the controller of the smart pen may be configured to synchronize the operation of the camera(s) and the light source(s) such that the light source is turned on or activated for every other image captured by the camera(s) (also referred to herein as "light-activated images"). Accordingly, for such light-activated images, the light from the light source(s) may be reflected off of the ink applied by the smart pen, thereby illuminating the ink depicted within the images.

Moreover, at **206**, the images captured by the camera(s) may be analyzed to identify any writings or markings made by the smart pen across the writing surface. Specifically, in one implementation, the controller of the smart pen may be configured to execute a suitable image processing algorithm or computer-vision technique that allows the controller to identify the illuminated ink contained within each light-activated image captured via the camera(s) As a result, the controller may differentiate any content on the imaged writing surface that was generated via the smart pen from other content on the writing surface, such as printed content or content written using a different pen.

Figures

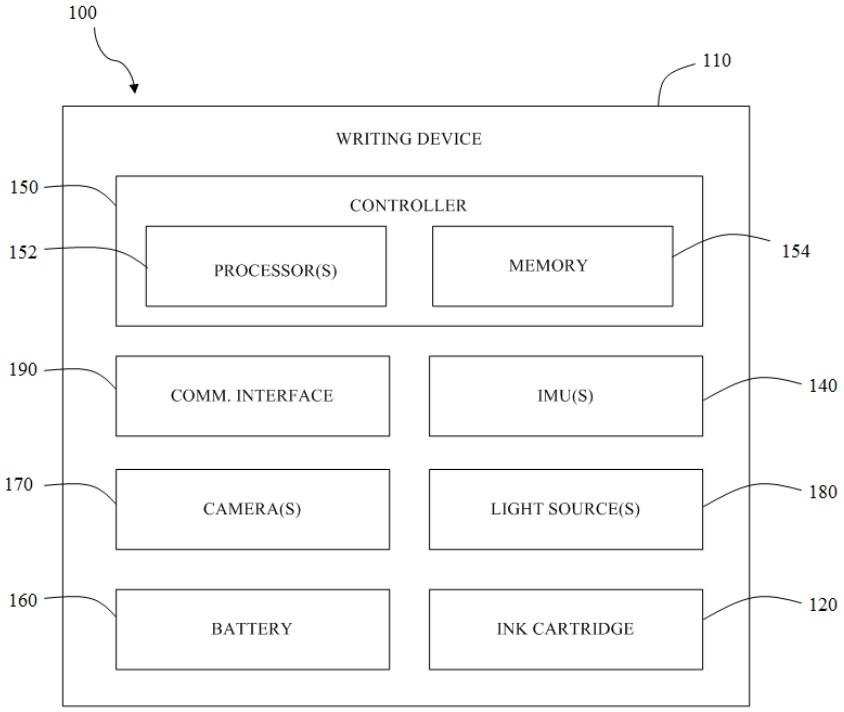

FIG. 1

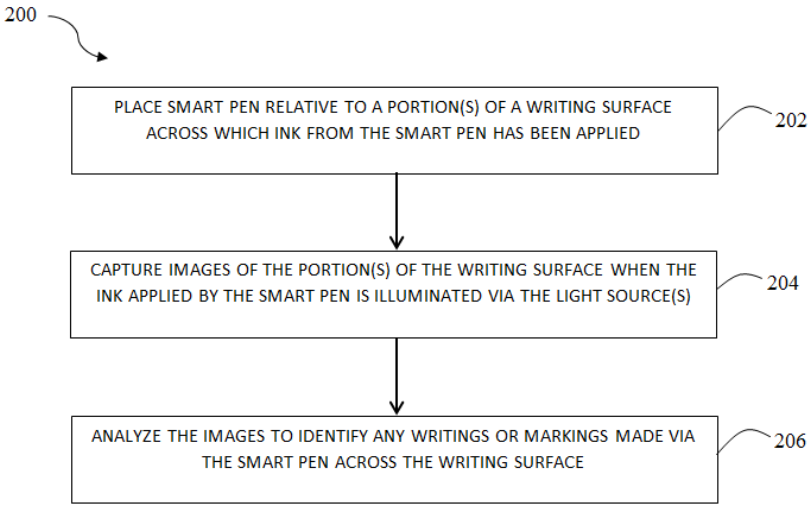

FIG. 2

Abstract

The present disclosure relates to a smart pen and related method for quickly and effectively differentiating between content created by writing or marking on a writing surface with the smart pen and other content contained on the writing surface (e.g., pre-existing written or printed content). For example, the smart pen may be provided with a specialized type of ink that is configured to reflect light when illuminated with a given light source, thereby allowing the ink to be easily identified or detected within images captured via a camera of the smart pen. As a result, when images of the writing surface are captured in synchronization with the light source being activated or turned on, the ink applied to the writing surface may be clearly identifiable and detectable within the images, thereby allowing the camera to differentiate between the content generated via the smart pen and any other content included on the writing surface. Keywords associated with the present disclosure include: smart pen; writing device; fluorescent ink; camera; ink detection; writing detection.