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(54) **SECURING DISPLAYED DATA ON COMPUTING DEVICES**

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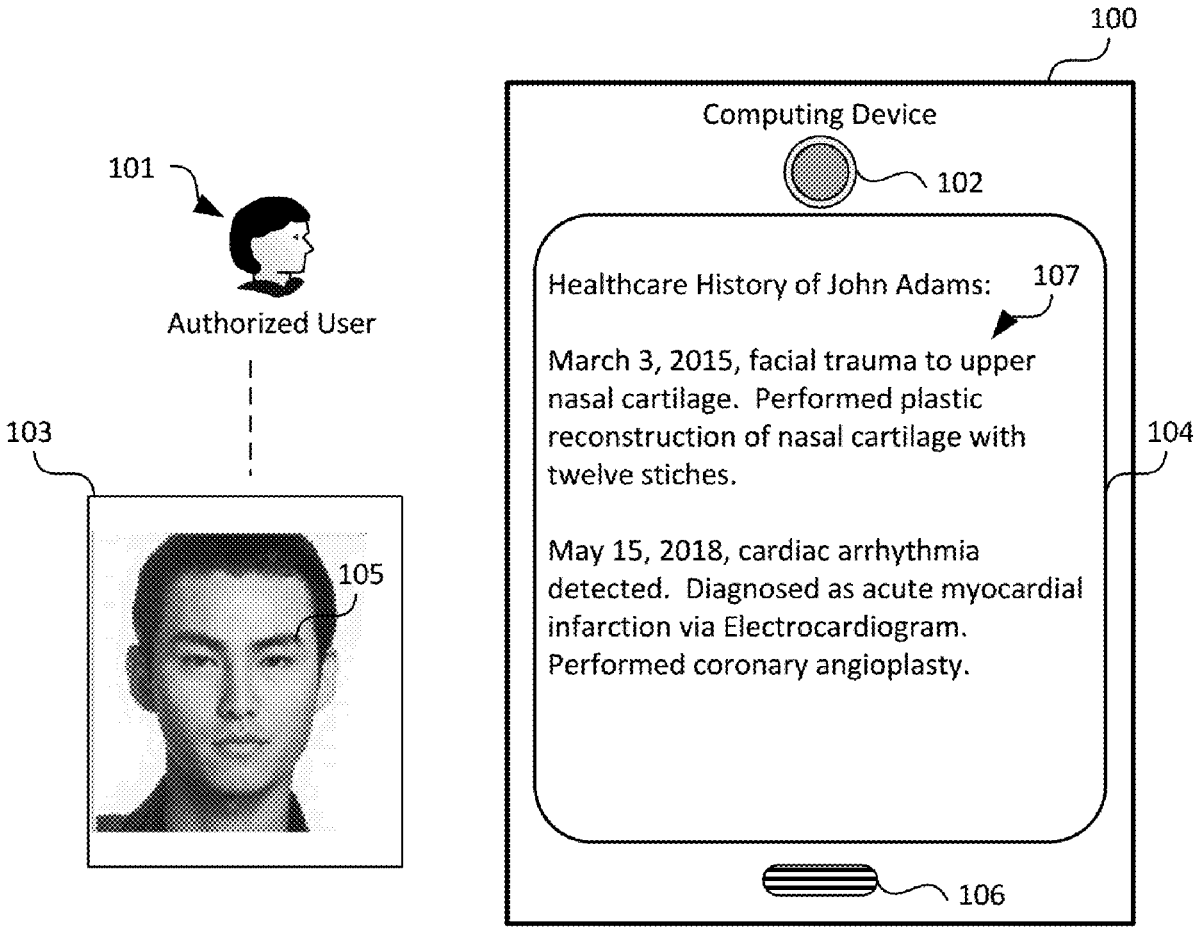
(57) **ABSTRACT**

Techniques for securing displayed data on computing devices are disclosed. One example technique includes upon determining that the computing device is unlocked, capturing and analyzing an image in a field of view of the camera of the computing device to determine whether the image includes a human face. In response to determining that the image includes a human face, the technique includes determining facial attributes of the human face in the image via facial recognition and whether the human face is that of an authorized user of the computing device. In response to determining that the human face is not one of an authorized user of the computing device, the technique includes converting user data on the computing device from an original language to a new language to output on a display of the computing device, thereby securing the displayed user data even when the computing device is unlocked.



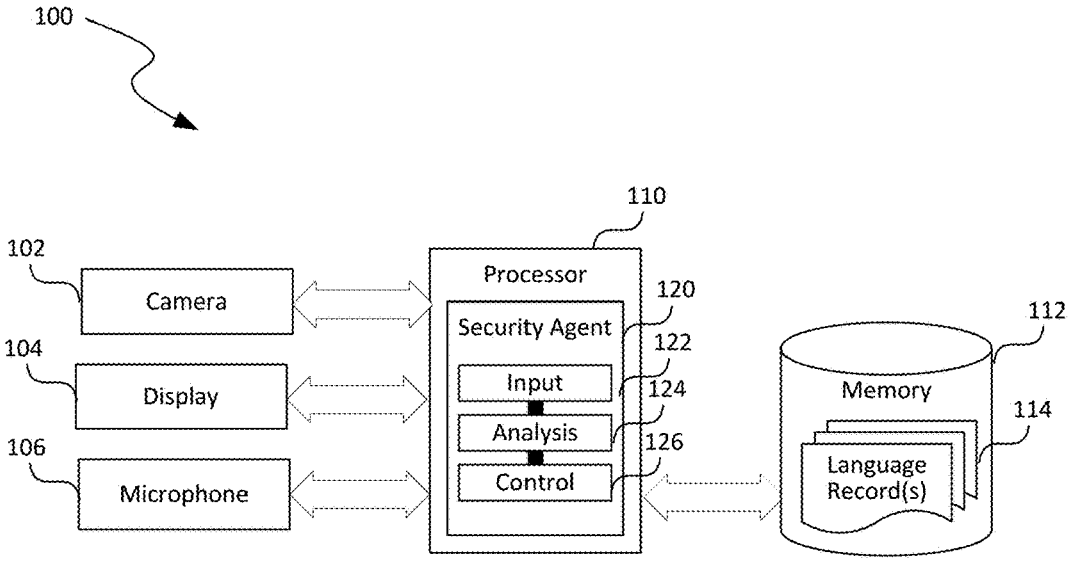

100
110
102
Camera
104
Display
106
Microphone
Processor
120
Security Agent
122
Input
124
Analysis
126
Control
112
Memory
114
Language Record(s)

FIG. 1

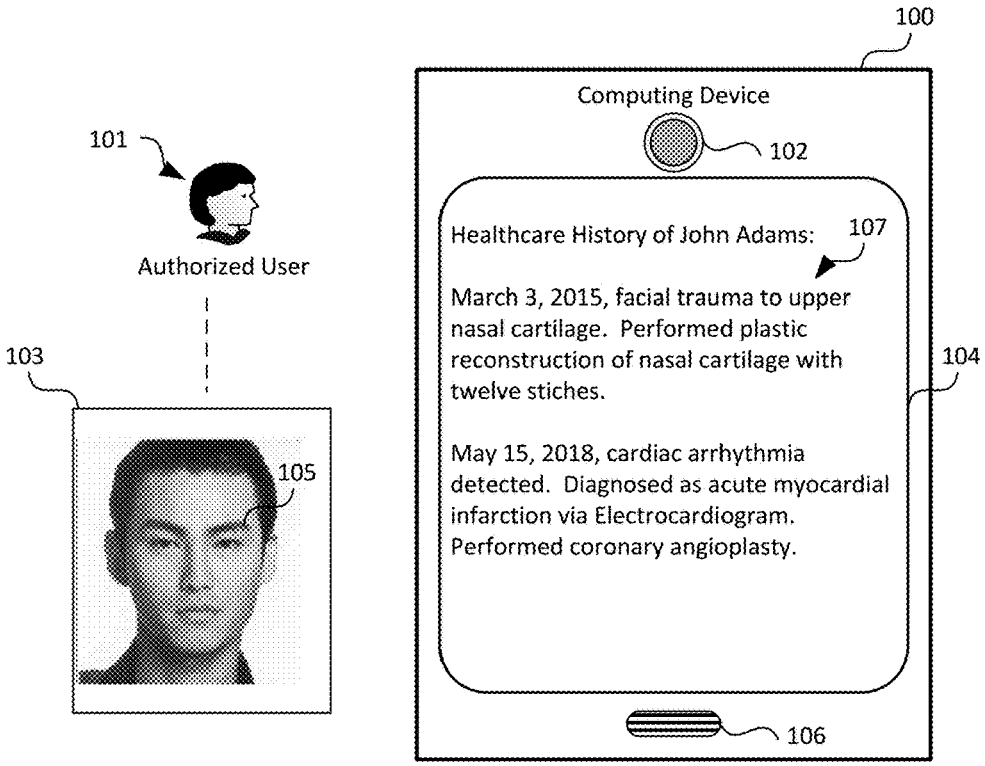

100
Computing Device
102
101
Authorized User
103
105
Healthcare History of John Adams:
107
March 3, 2015, facial trauma to upper nasal cartilage. Performed plastic reconstruction of nasal cartilage with twelve stiches.
May 15, 2018, cardiac arrhythmia detected. Diagnosed as acute myocardial infarction via Electrocardiogram. Performed coronary angioplasty.
104
106

FIG. 2

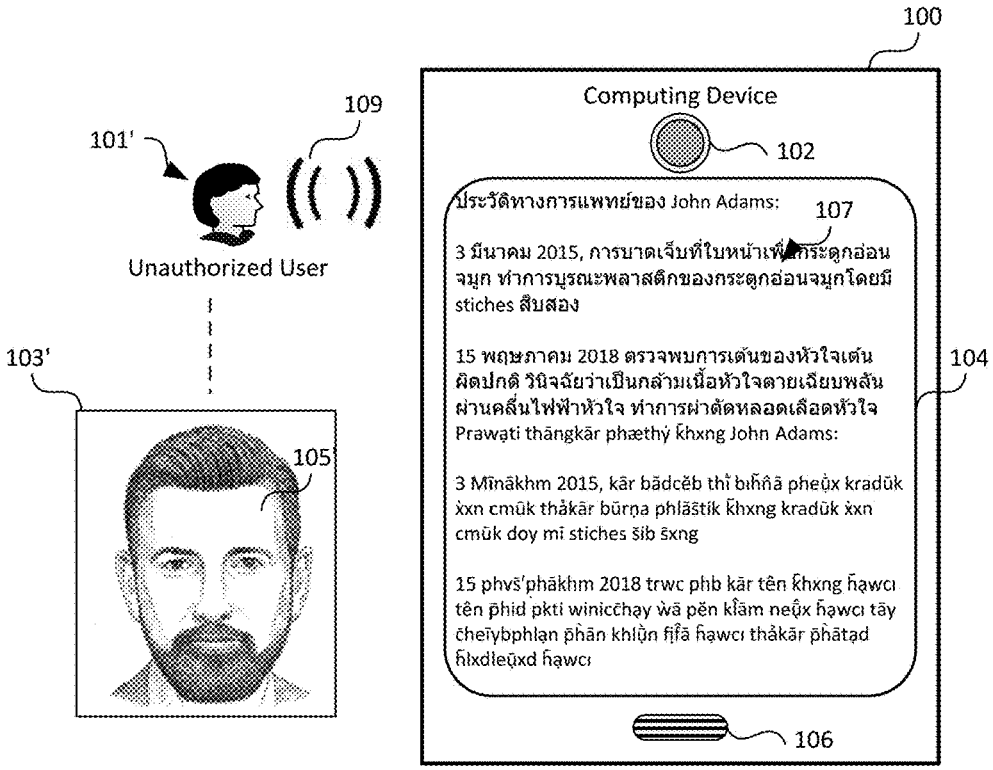

100
Computing Device
102
109
101'
Unauthorized User
107
ประวัติทางการแพทย์ของ John Adams:
3 มีนาคม 2015, การบาดเจ็บที่ใบหน้าเพื่อกระดูกอ่อนจมูก ทำการบูรณะพลาสติกของกระดูกอ่อนจมูกโดยมี stiches สิบสอง
15 พฤษภาคม 2018 ตรวจพบการเต้นของหัวใจเต้นผิดปกติ วินิจฉัยว่าเป็นกล้ามเนื้อหัวใจตายเฉียบพลันผ่านคลื่นไฟฟ้าหัวใจ ทำการผ่าตัดหลอดเลือดหัวใจ
Prawạti thāngkār phæthý k̂hxng John Adams:
3 Mīnākhm 2015, kār bādcĕb thī̀ bıh̃ñā pheụ̂x kradūk x̀xn cmūk thảkār būrṇa phlāstík k̂hxng kradūk x̀xn cmūk doy mī stiches s̄ib s̄xng
15 phvs̄'phākhm 2018 trwc phb kār tên k̂hxng h̄ạwcı tên p̄hid pkti winicc̄hạy ẁā pĕn kl̂ām neụ̂x h̄ạwcı tāy c̄heīybphlạn p̄h̀ān khlụ̂n fịf̂ā h̄ạwcı thảkār p̄h̀ātạd h̄lxdleụ̄xd h̄ạwcı
104
103'
105
106

FIG. 3A

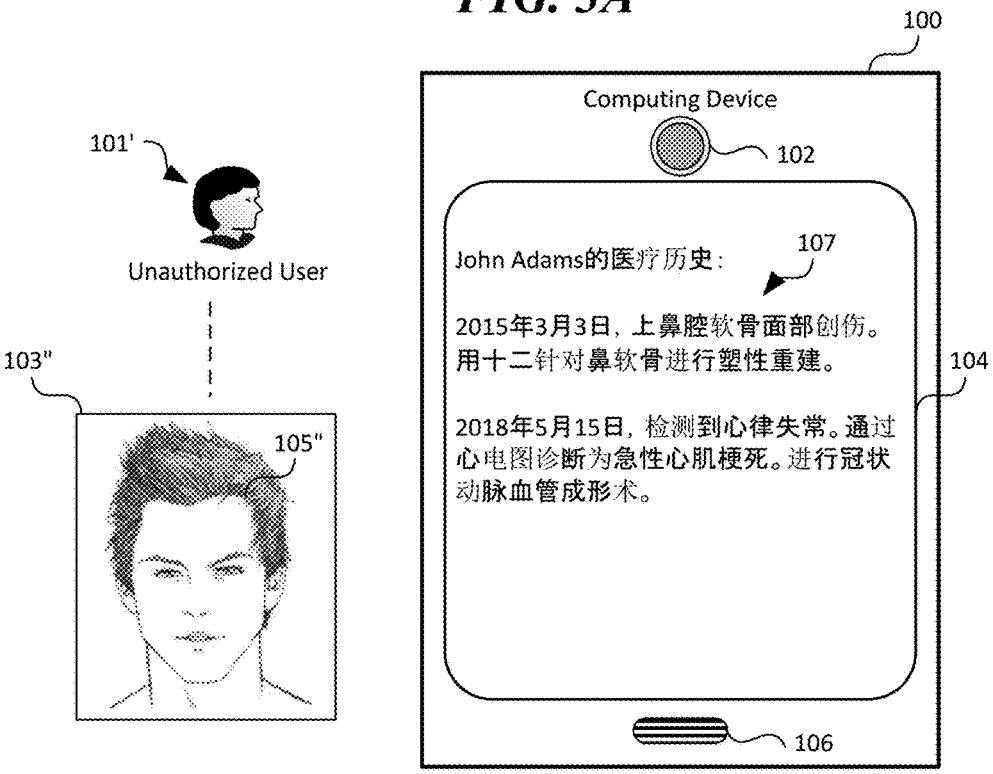

100
Computing Device
102
101'
Unauthorized User
107
John Adams的医疗历史：
2015年3月3日，上鼻腔软骨面部创伤。用十二针对鼻软骨进行塑性重建。
2018年5月15日，检测到心律失常。通过心电图诊断为急性心肌梗死。进行冠状动脉血管成形术。
104
103"
105"
106

FIG. 3B

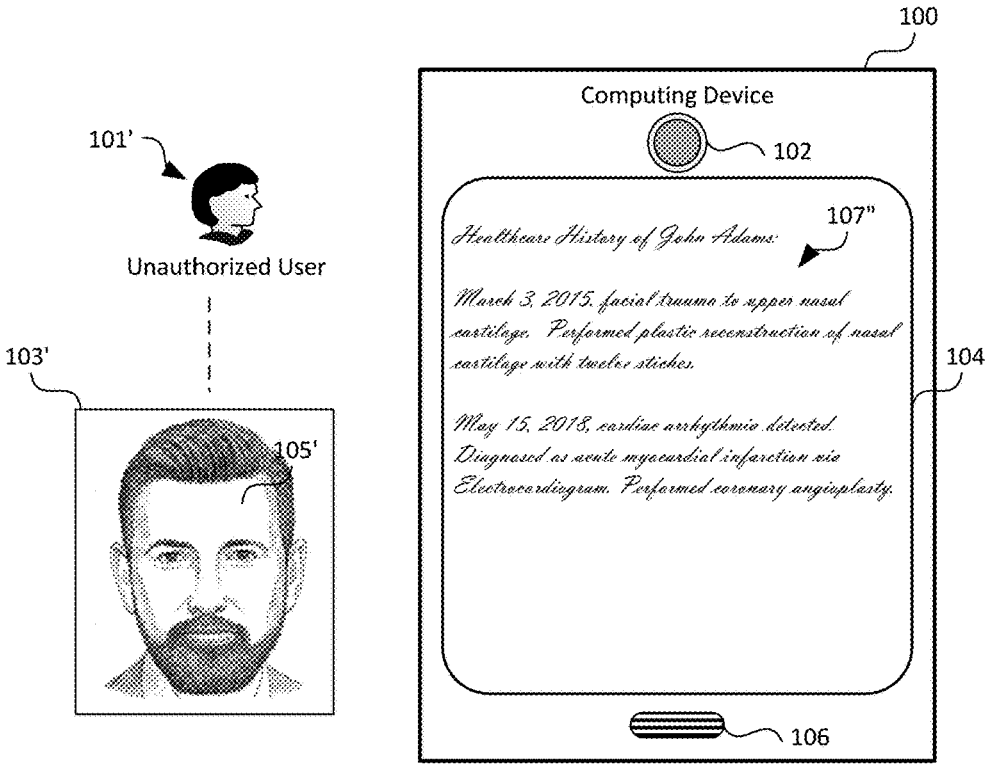

100
Computing Device
102
101'
Unauthorized User
103'
105'
107"
Healthcare History of John Adams:
March 3, 2015, facial trauma to upper nasal cartilage. Performed plastic reconstruction of nasal cartilage with twelve stiches.
May 15, 2018, cardiac arrhythmia detected. Diagnosed as acute myocardial infarction via Electrocardiogram. Performed coronary angioplasty.
104
106

FIG. 3C

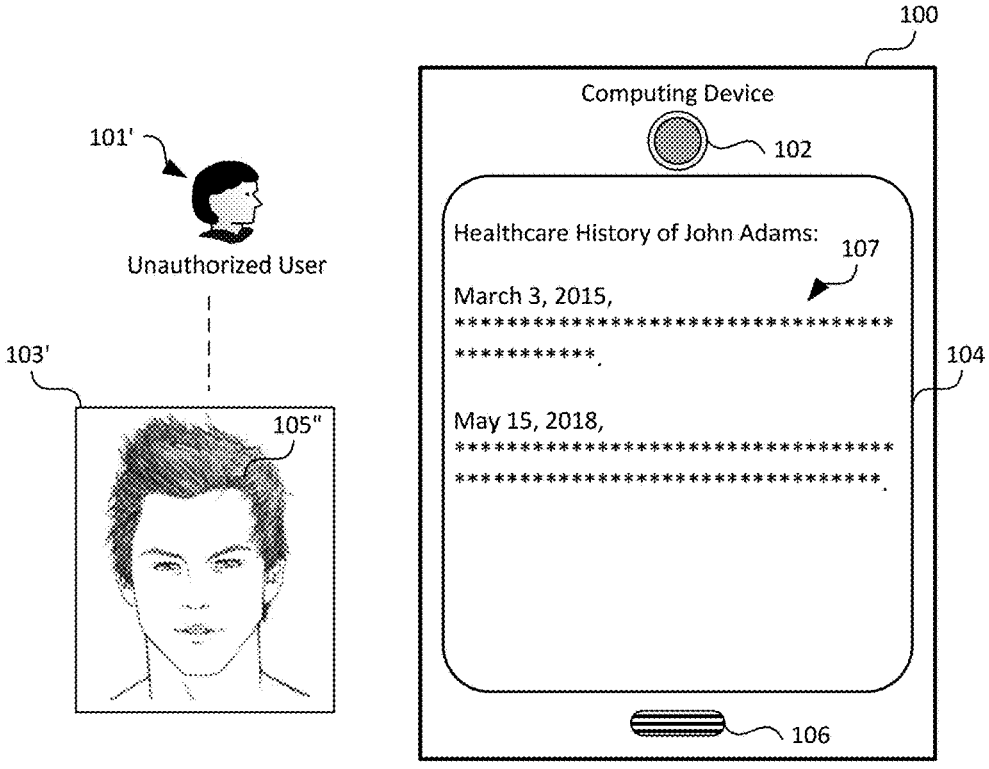

100
Computing Device
102
101'
Unauthorized User
103'
105"
Healthcare History of John Adams:
107
March 3, 2015,
**********.
May 15, 2018,
**********.
104
106

FIG. 3D

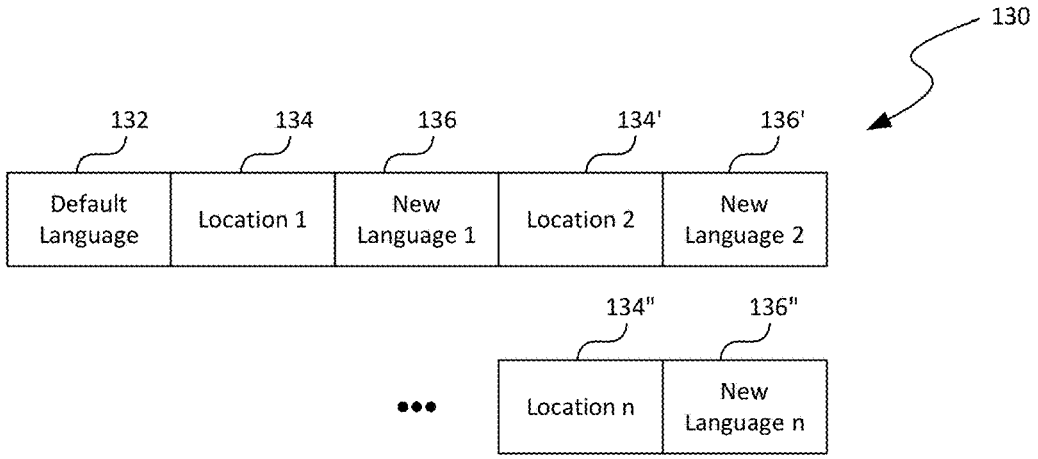

130
132
134
136
134'
136'
Default Language
Location 1
New Language 1
Location 2
New Language 2
134"
136"
Location n
New Language n

FIG. 4

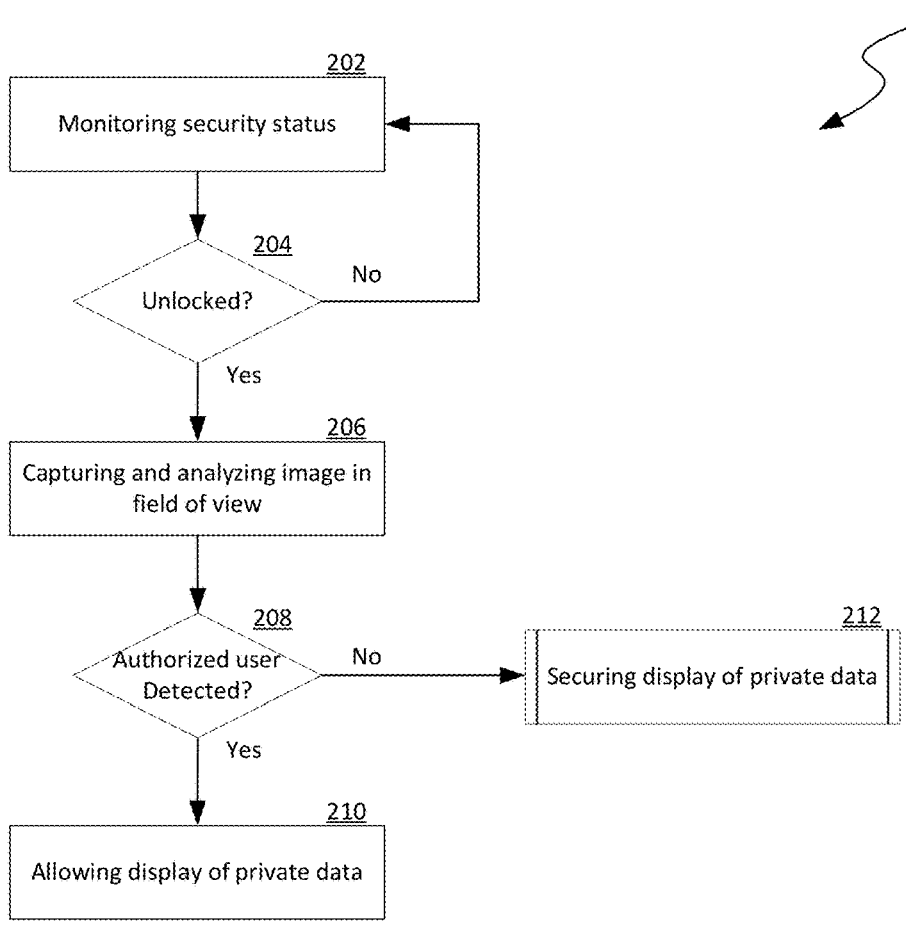

200
202
Monitoring security status
204
Unlocked?
No
Yes
206
Capturing and analyzing image in field of view
208
Authorized user Detected?
No
212
Securing display of private data
Yes
210
Allowing display of private data

FIG. 5A

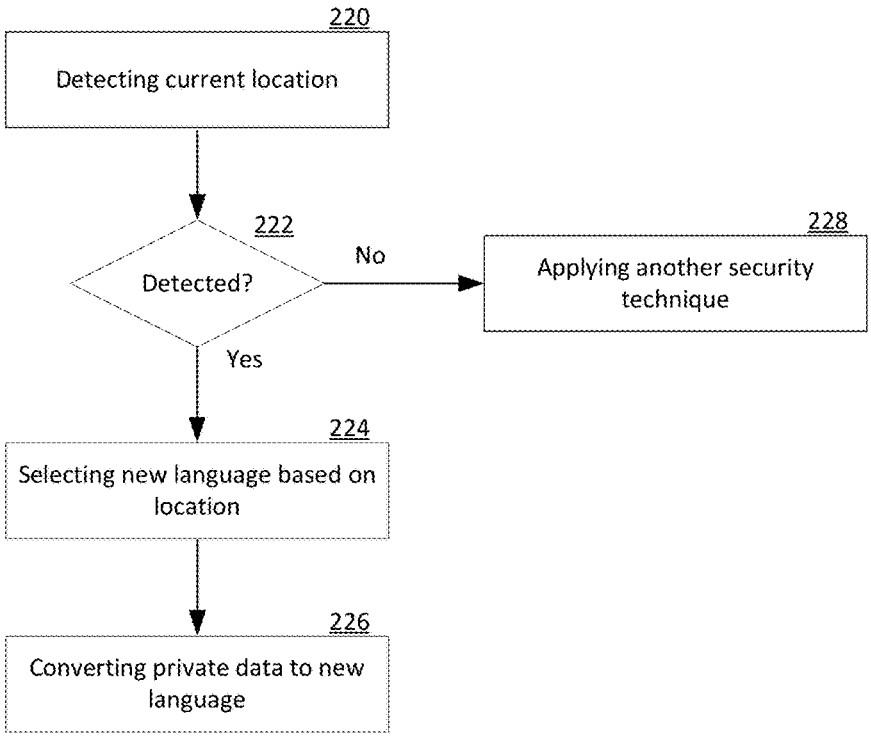

220
Detecting current location
222
Detected?
No
228
Applying another security technique
Yes
224
Selecting new language based on location
226
Converting private data to new language

FIG. 5B

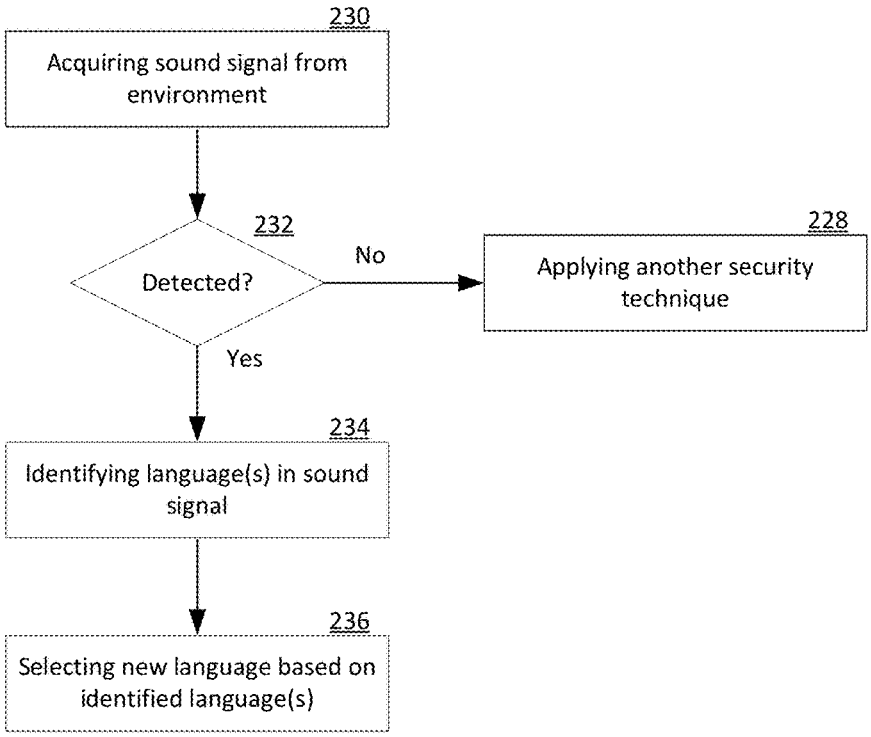

230
Acquiring sound signal from environment
232
Detected?
No
228
Applying another security technique
Yes
234
Identifying language(s) in sound signal
236
Selecting new language based on identified language(s)

FIG. 5C

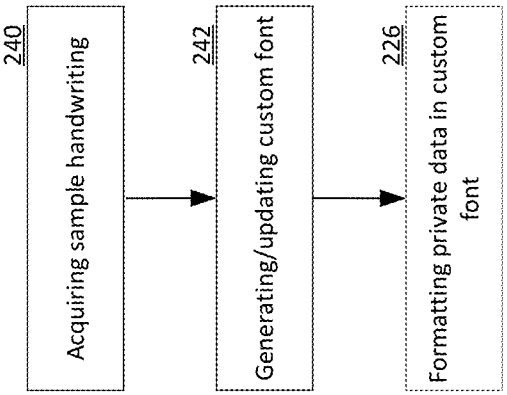
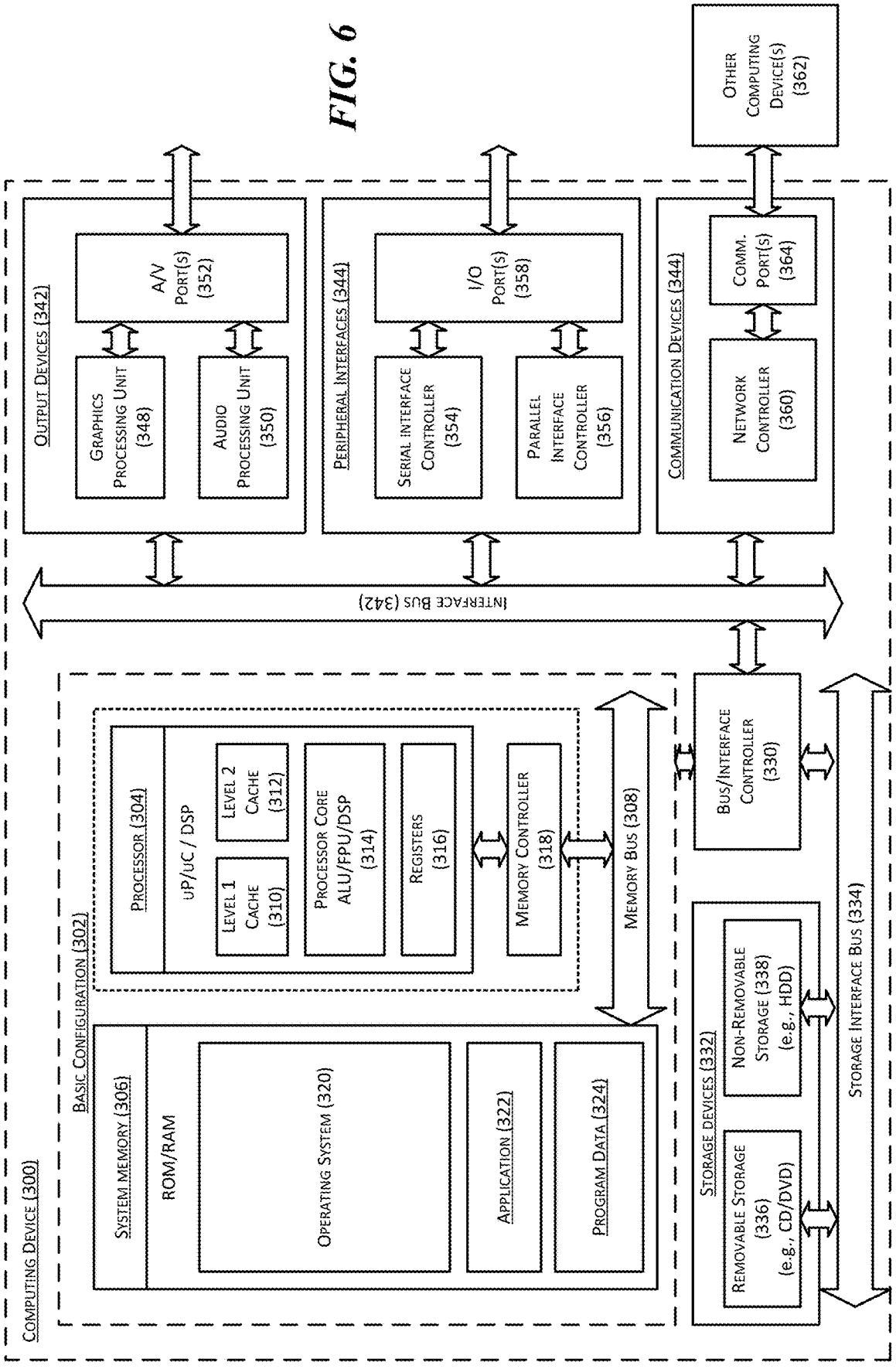

240
Acquiring sample handwriting
242
Generating/updating custom font
226
Formatting private data in custom font

FIG. 5D

FIG. 6


Computing Device (300)
Basic Configuration (302)
Processor (304)
uP/uC / DSP
Level 1 Cache (310)
Level 2 Cache (312)
Processor Core ALU/FPU/DSP (314)
Registers (316)
Memory Controller (318)
System Memory (306)
ROM/RAM
Operating System (320)
Application (322)
Program Data (324)
Memory Bus (308)
Bus/Interface Controller (330)
Storage Devices (332)
Removable Storage (336) (e.g., CD/DVD)
Non-Removable Storage (338) (e.g., HDD)
Storage Interface Bus (334)
Interface Bus (342)
Output Devices (342)
Graphics Processing Unit (348)
A/V Port(s) (352)
Audio Processing Unit (350)
Peripheral Interfaces (344)
Serial Interface Controller (354)
I/O Port(s) (358)
Parallel Interface Controller (356)
Communication Devices (344)
Network Controller (360)
Comm. Port(s) (364)
Other Computing Device(s) (362)

SECURING DISPLAYED DATA ON COMPUTING DEVICES

BACKGROUND

[0001] Smartphones, laptops, tablet computers, and other types of computing devices typically include certain access control features to protect privacy and security of data on computing devices. For example, a smartphone can be secured with a password, a passcode, a fingerprint, a facial image, or other suitable types of credential. In a locked or secured mode, the smartphone can be display only non-private data, such as a current date, time, weather forecast, etc. An authorized user can unlock the smartphone by providing a valid credential to gain access to private data on the smartphone. Examples of private data can include personal photos, contact information, personal identification information (e.g., social security numbers), health information, or other suitable types of data.

SUMMARY

[0002] This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0003] Even though computing devices, such as smartphones, can be secured with various types of credentials, such a single layer security can still pose security risks to private data on computing devices. For example, an unauthorized user can unlock a smartphone with a compromised password/passcode or a forged fingerprint or facial image. Upon unlocking the smartphone, the unauthorized user can have full access to all private data on the smartphone even though the user is not authorized to view such private data. In another example, a smartphone can be accidentally unlocked, for instance, when being connected to a trusted Bluetooth speaker or headphone. Upon being unlocked, anyone can access the private data on the smartphone without providing credentials.

[0004] Several embodiments of the disclosed technology can address at least some aspects of the foregoing security risks by implementing an additional layer of security on smartphones, tablet computer, laptops, or other suitable types of computing devices. In certain implementations, a computing device can include a camera, a processor, and a memory operatively coupled to one another. The memory can include instructions executed by the processor to provide a security agent that is configured to utilize the camera to capture an image in a field of view of the camera (e.g., a front-facing camera, a back-facing camera, or a combination thereof). The security agent can then be configured to analyze the captured image to determine whether the image includes one or more human faces, bodies, or other suitable anatomical parts. The descriptions herein use human faces to illustrate aspects of the disclosed technology. In other implementations, similar and/or additional analysis can be performed based on human bodies, postures, and/or other suitable anatomical features.

[0005] In certain embodiments, in response to determining that the image includes at least one human face, the security agent can be configured to determine one or more facial attributes of the human face by applying suitable facial recognition techniques. Based on the determined facial attributes, the security agent can be configured to determine whether only an authorized user is in the field of view of the camera. In response to determining that only the authorized user is in the field of view of the camera, the security agent can be configured to allow full or pre-configured access to private data on the computing device. On the other hand, in response to determining that at least one unauthorized user is in the field of view of the camera, the security agent can be configured to apply certain security techniques to obfuscate, obscure, or otherwise secure display of the private data on the computing device.

[0006] In one implementation, the security agent can be configured to convert private data from an original language into a new language that an unauthorized user is unlikely to understand. Conversion of the private data from the original language into the new language can be via machine translation or other suitable techniques. For example, private data originally in English can be machine translated to Latin, Thai, or other suitable languages. In other examples, versions of the private data can be pre-generated via human translation or other suitable language conversion techniques.

[0007] The security agent can be configured to select a new language that an unauthorized user is unlikely to understand in various ways. In one example, the security agent can be configured to determine a location (e.g., Thailand) of the computing device via, for instance, a global position system (GPS) sensor of the computing device. Based on the determined location, the security agent can be configured to select a new language (e.g., Latin) that is unlikely to be understood at the determined location. For example, the security agent can be configured to select the new language from a set of languages based on an adoption rate in the determined location. As such, the selected new language can have an adoption rate that is less than an adoption threshold (e.g., 1%) at the determined location, i.e., less than 1% of population at the determine location can understand the new language.

[0008] In another example, the security agent can also be configured to select the new language based on a race or ethnicity predicted according to the facial attributes of the image captured in the field of view of the camera. For instance, the security agent can determine that the facial attributes correspond to a person who is mostly likely Scandinavian. In response, the security agent can be configured to select a new language (e.g., Swahili) that is unfamiliar to the population in Scandinavia based on an adoption threshold.

[0009] In a further example, an authorized user can pre-configure one or more new languages for the security agent to use for one or more locations. For example, the authorized user can pre-configure a first language to be used at a first location and a second language to be used at a second location. For instance, Thai for United States while Danish for Japan. In another example, the authorized user can specify multiple languages for one or more of the locations. The security agent can be configured to select one of the specified languages based on, for instance, an adoption rate of each of the multiple languages. As such, the selected language can have a lowest adoption rate or based on other suitable criteria.

[0010] In yet further examples, the computing device can also include a microphone or other suitable types of sound sensor. The security agent can be configured to capture a

sound signal from an environment in which the computing device is located. The security agent can then be configured to analyze the captured sound signal to identify one or more languages from the sound signal via, for instance, speech recognition based on a language library. Based on the identified one or more languages (e.g., Vietnamese and Thai) in the environment, the security agent can be configured to select the new language (e.g., Portuguese) that is unlikely to be commonly understood or adopted in a population that commonly adopts the identified one or more languages. The selected new language can have an adoption rate that is less than an adoption threshold (e.g., 1%) for a population having another adoption rate of the identified language higher than another adoption threshold (e.g., 90%).

[0011] In a further example, the security agent can be configured to uniquely identify a person in the field of view of the camera. In one embodiment, the security agent can be configured to access a facial identification library having records of persons containing corresponding facial attributes, associated languages, or other suitable information. Based on the determined facial attributes from the image, the security agent can be configured to uniquely identify the person by comparing the facial attributes to those in the records of the facial identification library. Upon identifying the person in the field of view, the security agent can be configured to access a record of the person to determine one or more languages associated with the person and select a new language that the identified person would not understand or adopt.

[0012] In other implementations, the security agent can also be configured to obfuscate any displayed private data in a format or font that is understandable by the authorized user but less likely be understood by unauthorized users. For example, the security agent (or other suitable components on the computing device) can be configured to auto-generate a custom font based on the authorized user's handwriting. The custom font can be created by parsing one or more images of the authorized user's handwritten sample text. The authorized user can also optionally provide additional custom fonts for a language of choice. Once the custom font is generated, the security agent can be configured to modify an original private data by applying the custom font to generate a text that is, for instance, similar to the authorized user's handwriting. In another example, the security agent can also be configured to replace certain words or phrases in the private data with associated images or emoticons. In yet another example, the security agent can also be configured to replace certain data (e.g., social security numbers, birthdays, etc.) with random characters or punctuation marks, such as asterisks, dashes, etc. In further examples, the security agent can be configured to changing an orientation, a font color, a display brightness/contrast of the displayed private data in addition to or in lieu of the foregoing techniques of obfuscating the displayed private data.

[0013] Several embodiments of the disclosed technology can thus provide an additional layer of security measures in addition to or in lieu of passwords, passcodes, fingerprints, facial images, etc. for unlocking a computing device. Even when an unauthorized user gains access to the computing device, by, for instance, using a compromised password or passcode, the unauthorized user would not have access to information in the private data. For example, the private data may be in a new language that the unauthorized user does not understand, or the private data may be displayed in a custom font resembling the authorized user's handwriting. As such, security to private data on the computing device can be improved, and access to information in the private data can be limited to unauthorized users.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a schematic diagram illustrating various components of a computing device configured to secure displayed user data on the computing device in accordance with embodiments of the disclosed technology.

[0015] FIG. **2** is a schematic diagram illustrating an example front view of the computing device when operated by an authorized user in accordance with embodiments of the disclosed technology.

[0016] FIGS. **3**A-**3**D are schematic diagrams illustrating example front views of the computing device when operated by an unauthorized user in accordance with embodiments of the disclosed technology.

[0017] FIG. **4** is a schematic diagram illustrating an example data schema for a language record in accordance with embodiments of the disclosed technology.

[0018] FIGS. **5**A-**5**D are flowcharts illustrating processes of securing display data in a computing device in accordance with embodiments of the disclosed technology.

[0019] FIG. **6** is a computing device suitable for certain components of the computing system in FIGS. **1**-**3**D.

DETAILED DESCRIPTION

[0020] Certain embodiments of systems, devices, components, modules, routines, data structures, and processes for securing displayed data on computing devices are described below. In the following description, specific details of components are included to provide a thorough understanding of certain embodiments of the disclosed technology. A person skilled in the relevant art will also understand that the technology can have additional embodiments. The technology can also be practiced without several of the details of the embodiments described below with reference to FIGS. **1**-**6**.

[0021] As used herein, the term "locked" generally refers to an operating mode of a computing device that is secured with a password, a passcode, a fingerprint, a facial image, or other suitable types of credential. When the computing device is locked, the computing device only allows limited output of data on a display of the computing device. For example, a locked computing device (e.g., a smartphone) can allow display of non-private data, such as a date, time, weather forecast, or other suitable data not associated with an authorized user of the computing device. In contrast, the term "unlocked" generally refers to another operating mode of the computing device that allows access and display of private data or other suitable types of content related to the authorized user. The computing device can be unlocked with a password, a passcode, a fingerprint, a facial image, or other suitable types of credential. Examples of private data includes personal photos, contact information, personal identification information (e.g., social security numbers), health information, or other suitable types of data.

[0022] Also used herein, the term "facial recognition" generally refers to a technology capable of identifying or verifying a person from a digital image or a video frame from a video source. One example technique includes comparing selected facial features or facial attributes from a given image with those in records of a database. For

example, a facial recognition technique can identify facial features by extracting landmarks from an image of a human face. Example landmarks include relative position, size, and/or shape of eyes, nose, cheekbones, and jaw. These facial attributes can then be used to search for other images with matching facial attributes. Other example techniques can also include skin texture analysis, three-dimensional recognition, and other suitable techniques.

[0023] Further used herein, the term "language adoption" or "adoption" generally refers to skills of reading, speaking, listening, or otherwise understanding or discern meanings of expressions in a language. Different regions, countries, populations may have different adoption rates of certain languages. For example, a language (e.g., Danish) may have a low adoption rate in Asian countries, such as Thailand and Vietnam. In another example, a population (e.g., population in Taiwan) with a high adoption rate of a first language (e.g., Chinese) may have a low adoption rate of a second language (e.g., Hindi). Records of adoption rates can be compiled for various regions, countries, and populations and used to secure displayed data on computing devices, as described herein.

[0024] Even though computing devices, such as smartphones, can be secured with various types of credentials, such a single layer security can still pose security risks to private data on computing devices. For example, an unauthorized user can unlock a smartphone with a compromised password/passcode or a forged fingerprint or facial image. Upon unlocking the smartphone, the unauthorized user can have full access to all private data on the smartphone even though the user is not authorized to view such private data. In another example, a smartphone can be accidentally unlocked, for instance, when being connected to a trusted Bluetooth speaker or headphone. Upon being unlocked, anyone can access the private data on the smartphone without providing credentials.

[0025] Several embodiments of the disclosed technology can address at least some aspects of the foregoing security risks by implementing an additional layer of security on smartphones, tablet computer, laptops, or other suitable types of computing devices. In certain implementations, upon determining that the computing device is unlocked, a security agent on the computing device can be configured to capture and analyze an image in a field of view of the camera of the computing device to determine whether the image includes a human face. In response to determining that the image includes a human face, the security agent can be configured to determine facial attributes of the human face in the image via facial recognition and whether the human face is that of an authorized user of the computing device. In response to determining that the human face is not one of an authorized user of the computing device, the security agent can be configured to convert user data on the computing device from an original language to a new language upon receiving a request to output the user data on the display of the computing device. As such, the outputted user data on the display of the computing device can be secured even when the computing device is unlocked, as described in more detail below with reference to FIGS. **1-6**.

[0026] FIG. **1** is a schematic diagram illustrating various components of a computing device **100** configured to secure displayed user data on the computing device **100** in accordance with embodiments of the disclosed technology. In FIG. **1** and in other Figures herein, individual software components, objects, classes, modules, and routines may be a computer program, procedure, or process written as source code in C, C++, C#, Java, and/or other suitable programming languages. A component may include, without limitation, one or more modules, objects, classes, routines, properties, processes, threads, executables, libraries, or other components. Components may be in source or binary form. Components may include aspects of source code before compilation (e.g., classes, properties, procedures, routines), compiled binary units (e.g., libraries, executables), or artifacts instantiated and used at runtime (e.g., objects, processes, threads).

[0027] Components within a system may take different forms within the system. As one example, a system comprising a first component, a second component and a third component can, without limitation, encompass a system that has the first component being a property in source code, the second component being a binary compiled library, and the third component being a thread created at runtime. The computer program, procedure, or process may be compiled into object, intermediate, or machine code and presented for execution by one or more processors of a personal computer, a network server, a laptop computer, a smartphone, and/or other suitable computing devices.

[0028] Equally, components may include hardware circuitry. A person of ordinary skill in the art would recognize that hardware may be considered fossilized software, and software may be considered liquefied hardware. As just one example, software instructions in a component may be burned to a Programmable Logic Array circuit or may be designed as a hardware circuit with appropriate integrated circuits. Equally, hardware may be emulated by software. Various implementations of source, intermediate, and/or object code and associated data may be stored in a computer memory that includes read-only memory, random-access memory, magnetic disk storage media, optical storage media, flash memory devices, and/or other suitable computer readable storage media excluding propagated signals.

[0029] As shown in FIG. **1**, the computing device **100** can include a camera **102**, a display **104**, a microphone **106**, a processor **110**, and a memory **112** operatively coupled to one another. The computing device **100** can be a smartphone, a laptop computer, a tablet computer, a desktop computer, a computer server, and/or other suitable types of computing device. Even though the camera **102**, the display **104**, and the microphone **106** are shown as integral parts of the computing device **100**, in certain implementations, at least one of the camera **102**, the display **104**, and the microphone **106** can be remote from and communicatively coupled to the processor **110** via a wired/wireless connection. In further implementations, the computing device **100** can include a keyboard, a network interface card, a speaker, and/or other suitable components in addition to or in lieu of those shown in FIG. **1**.

[0030] The camera **102** can be configured to capture an image in a field of view of the camera **102** and provide the image to the processor **110** for further processing. In certain embodiments, the camera **102** can include front facing lenses at the computing device **100**. In other embodiments, the camera **102** can include both front facing and rear facing lenses. The display **104** can be configured to output data to a user, and in certain embodiments, also to receive user input. In one example, the display **104** can include a touchscreen. In other examples, the display **104** can include a

liquid crystal display, a light emitting diode, or other suitable types of display. The microphone **106** can be configured to capture a sound signal from an environment in which the computing device **100** is located.

[0031] As shown in FIG. **1**, the memory **112** can include one or more language records **114** configured by an authorized user **101** (FIG. **2**) for applying additional security measures to private data **107** (FIG. **2**) of the authorized user **101** on the computing device **100**. In certain examples, the individual language records can contain identification of one or more languages adopted by the authorized user **101** of the computing device **100**. In other examples, the individual language records can also contain identification of one or more languages pre-configured by the authorized user **101** of the computing device **100** to be used for a corresponding location in lieu of a default language. An example data schema suitable for the language records is described in more detail below with reference to FIG. **4**.

[0032] Also shown in FIG. **1**, the processor **110** can be configured to execute suitable instructions, for example, from the memory **112** to provide a security agent **120** for providing additional security for user data or content on the computing device **100**. As described in more detail below, the security agent **120** can be configured to utilize the camera to capture and analyze an image in a field of view of the camera **102**. The security agent can then be configured to analyze the captured image to determine whether to apply various security measures to private data **107** (FIG. **2**) on the computing device **100**. In the illustrated embodiment, the security agent **120** can include an input component **122**, an analysis component **124**, and a control component **126**. In other embodiments, the security agent **120** can also include an output component, a network component, and/or other suitable types of components.

[0033] The input component **122** can be configured to interface with the camera **102**, the display **104**, the microphone **106**, and other suitable components (e.g., an operating system) of the computing device **100**. For example, the input component **122** can be configured to receive an indication from the operating system that indicates to the security agent **120** that the computing device **100** is unlocked. In response to receiving the indication, the input component **122** can be configured to utilize the camera **102** to capture an image in a field of view of the camera **102**.

[0034] The input component **122** can then forward the captured image to the analysis component **124** to analyze the captured image and determine whether the image includes one or more human faces, bodies, or other suitable anatomical parts. In certain implementations, the analysis component **122** can utilize various object detection models (not shown) developed via, for instance, machine learning techniques. In other implementations, the analysis component **122** can utilize preconfigured rules, conditions, and/or other suitable criteria for determining whether the captured image includes a human face or other anatomical parts.

[0035] In certain embodiments, in response to determining that the image includes at least one human face, the analysis component **122** can be configured to determine one or more facial attributes of the human face in the image by applying suitable facial recognition techniques. Based on the determined facial attributes, the analysis component **122** can be configured to determine whether only an authorized user **101** (shown in FIG. **2**) is in the field of view of the camera **102**.

[0036] In response to determining that only the authorized user **101** is in the field of view of the camera **102**, the analysis component **122** can be configured to indicate to the control component **126** to allow full or pre-configured access to private data or content on the computing device **100**. For example, as shown in FIG. **2**, the camera **102** can be configured to capture an image **103** that includes a face **105**. By determining various facing attributes, the analysis component **124** can determine that the face **105** belongs to an authorized user **101**. In response, the analysis component **124** can indicate to the control component **126** to output private data **107** of the authorized user **101** without applying various security techniques described in more detail below. In the illustrated example, the outputted private data **107** in the display **104** includes the authorized user's medical history listed below:

[0037] "Healthcare History of John Adams:

[0038] Mar. 3, 2015, facial trauma to upper nasal cartilage. Performed plastic reconstruction of nasal cartilage with twelve stiches.

[0039] May 15, 2018, cardiac arrhythmia detected. Diagnosed as acute myocardial infarction via Electrocardiogram. Performed coronary angioplasty."

In other examples, the private data **107** can also include social security numbers, passwords, and/or other suitable types of data. On the other hand, in response to determining that at least one unauthorized user **101'** (shown in FIGS. **3**A-**3**D) is in the field of view of the camera **102**, the analysis component **122** can be configured to indicate to the control component **126** to apply certain security techniques to obfuscate, obscure, or otherwise secure display of the private data outputted on the display **104** of the computing device **100**, as described below in more detail with reference to FIGS. **3**A-**3**D.

[0040] As shown in FIG. **3**A, the analysis component **124** (FIG. **1**) can be configured to capture and analyze the image **103'** and determine that the image **103'** includes a face **105'** of an unauthorized user **101'**. In response, the analysis component **124** can be configured to indicate to the control component **126** (FIG. **1**) to convert any private data **107** requested to be outputted on the display **104** from an original language into a new language that the unauthorized user **101'** is unlikely to understand but has been adopted by the authorized user **101** (FIG. **1**). The control component **126** can then convert the private data **107** from the original language into the new language via machine translation or other suitable techniques. For example, as shown in FIG. **1**A, the private data **107** originally in English can be machine translated to Thai or other suitable languages. In other examples, versions of the private data **107** can be pre-generated via human translation or other suitable language conversion techniques.

[0041] Prior to or during conversion of the private data **107**, the control component **126** can be configured to select the new language that an unauthorized user **101'** is unlikely to understand in various ways. In one example, the control component **126** can be configured to determine a location (e.g., Finland) of the computing device **100** via, for instance, a global position system (GPS) sensor (not shown) of the computing device **100**. Based on the determined location, the control component **126** can be configured to select a new language (e.g., Thai) that is unlikely to be understood at the determined location. For instance, the control component **126** can be configured to select the new language from a set

of languages based on an adoption rate in the determined location. As such, the selected new language can have an adoption rate that is less than an adoption threshold (e.g., 1%) at the determined location, i.e., less than 1% of population at the determine location can understand the new language.

[0042] In another example, the control component **126** can also be configured to select the new language based on a race or ethnicity predicted according to the facial attributes of the image **103'** captured in the field of view of the camera **102**. For instance, as shown in FIG. **3**A, the control component **126** can be configured to determine that the facial attributes of the face **105'** in the image **103'** correspond to a person who is mostly likely Scandinavian. In response, the control component **126** can be configured to select a new language (e.g., Thai) that is unfamiliar to the population in Scandinavia based on an adoption threshold.

[0043] In a further example, the authorized user **101** (FIG. **2**) can pre-configure one or more new languages for the control component **126** to use for one or more locations. For example, the authorized user **101** can pre-configure a first language to be used at a first location and a second language to be used at a second location. For instance, Thai for United States while Danish for Japan. In another example, the authorized user can specify multiple languages for one or more of the locations. The control component **126** can be configured to select one of the specified languages based on, for instance, an adoption rate of each of the multiple pre-configured languages. As such, the selected language can have a lowest adoption rate or based on other suitable criteria.

[0044] In yet further examples, the control component **126** can be configured to capture a sound signal **109** from an environment in which the computing device **100** is located. The control component **126** can then be configured to analyze the captured sound signal **109** to identify one or more languages from the sound signal **109** via, for instance, speech recognition based on a language library stored at the computing device **100** or accessible via a computer network (not shown). Based on the identified one or more languages (e.g., Danish) in the environment, the control component **126** can be configured to select the new language (e.g., Thai) that is unlikely to be commonly understood or adopted in a population that commonly adopts the identified one or more languages. The selected new language can have an adoption rate that is less than an adoption threshold (e.g., 1%) for a population having another adoption rate of the identified language higher than another adoption threshold (e.g., 90%).

[0045] In a further example, the control component **126** can be configured to uniquely identify a person in image **103"** captured in the field of view of the camera **102**, as shown in FIG. **3**B. In the illustrated embodiment, the control component **126** can be configured to access a facial identification library (not shown) having records of persons containing corresponding facial attributes, associated languages, or other suitable information. Based on the determined facial attributes from the image **103"**, the control component **126** can be configured to uniquely identify the person by comparing the facial attributes of the face **105"** to those in the records of the facial identification library. Upon identifying the person in the field of view, the control component **126** can be configured to access a record of the person to determine one or more languages associated with the person and select a new language that the identified person would not understand or adopt.

[0046] In other implementations, as shown in FIG. **3**C, the control component **126** (FIG. **1**) can also be configured to obfuscate any displayed private data **107** in a format or font that is understandable by the authorized user **101** (FIG. **2**) but less likely be understood by unauthorized users **101'**. For example, the control component **126** (or other suitable components on the computing device **100**) can be configured to auto-generate a custom font based on the authorized user's handwriting. The custom font can be created by parsing one or more images of the authorized user's handwritten sample text. The authorized user **101** can also optionally provide additional custom fonts for a language of choice. Once the custom font is generated, the control component **126** can be configured to modify an original private data **107** (shown in FIG. **2**) by applying the custom font to generate a text of the private data **107"** that is, for instance, similar to the authorized user's handwriting.

[0047] In a further example, as shown in FIG. **3**D, the control component **126** (FIG. **1**) can also be configured to replace certain data with random characters or punctuation marks, such as asterisks, dashes, etc. In the illustrated example, the authorized user's private data **107** is replaced with asterisks. In other examples, the control component **126** can also be configured to replace certain words or phrases in the private data **107** (FIG. **2**) with associated images or emoticons. In further examples, the control component **126** can be configured to changing an orientation, a font color, a display brightness/contrast of the displayed private data **107"** in addition to or in lieu of the foregoing techniques of obfuscating the displayed private data **107"**.

[0048] Several embodiments of the disclosed technology can thus provide an additional layer of security measures in addition to or in lieu of passwords, passcodes, fingerprints, facial images, etc. for unlocking a computing device **100**. Even when an unauthorized user **101'** gains access to the computing device **100**, by, for instance, using a compromised password or passcode, the unauthorized user **101'** would not have access to information in the private data **107**. For example, the private data **107** may be in a new language that the unauthorized user **101'** does not understand, or the private data **107** may be displayed in a custom font resembling the authorized user's handwriting. As such, security to private data **107** on the computing device can be improved, and access to information in the private data **107** can be limited to unauthorized users **101'**.

[0049] FIG. **4** is a schematic diagram illustrating an example data schema **130** for a language record **114** in accordance with embodiments of the disclosed technology. As shown in FIG. **4**, the data schema **130** can include a default language field **132**, a first location field **134**, a first new language field **136**, a second location field **134'**, a second new language field **136'**, a Nth location field **134"**, and a Nth new language field **136"**. The default language field **132** can be configured to contain data indicating a default language for outputting the private data **107** (FIG. **2**) on the display **104** (FIG. **2**) of the computing device **100**. The first, second, and Nth location fields **134**, **134'**, and **134"** can be configured to contain data corresponding to a continent, region, country, province, state, city, county, or other suitable geographical locations. The first, second, and Nth new language fields **136**, **136'**, and **136"** can be configured to contain data individually identifying one or more lan-

guages to be used for the corresponding locations in lieu of the default language. Though particular fields are shown in FIG. **4** for illustration purposes, in other embodiments, the data schema **130** can also include suitable fields for a date, time, or other suitable types of data.

[0050] FIGS. **5**A-**5**D are flowcharts illustrating processes of securing display data in a computing device **100** in accordance with embodiments of the disclosed technology. Though various embodiments of the processes are described below in the context of the computing device **100**, in other embodiments, the processes can also be implemented in computing devices with additional and/or different components.

[0051] As shown in FIG. **5**A, a process **200** can include monitoring a security status of the computing device **100** at stage **202**. In certain embodiments, the security status can indicate that the computing device **100** is locked or unlocked. In other embodiments, the security status can indicate other suitable types of security status of the computing device. The process **200** can then include a decision stage **204** to determine whether the computing device **100** is unlocked. In response to determining that the computing device **100** is locked, the process **200** reverts to continuing monitoring for the security status of the computing device **100** at stage **202**. In response to determining that the computing device **100** is unlocked, the process **200** proceeds to capturing and analyzing an image in a field of view of the camera (FIG. **1**) of the computing device **100**. Various analysis techniques of the image are described in more detail above with reference to FIG. **1**.

[0052] The process **200** can then include another decision stage **208** to determine whether a face or other suitable anatomical parts of an authorized user is detected in the captured image. In response to determining that the image includes a face or other suitable anatomical parts of an authorized user, the process **200** proceeds to allowing display of private data in a default language, font, font color, or other formatting. In response to determining that the image does not include a face or other suitable anatomical parts of an authorized user, the process **200** proceeds to securing display of private data at stage **212**. Various techniques of securing display of the private data are described below with reference to FIGS. **5**B-**5**D.

[0053] As shown in FIG. **5**B, example operations for security display of the private data can include detecting a current location of the computing device **100** at stage **220**. The operations can then include a decision stage **222** to determine whether a location is successfully detected. In response to determining that a location is not successfully detected, the operations proceed to applying another security technique at stage **228**. Otherwise, the operations proceed to selecting a new language based on the determined location of the computing device **100**, as described above in more detail with reference to FIGS. **3**A-**3**D. The operations can then proceed to converting the private data to the new language before allowing the private data to be outputted on the display of the computing device **100** at stage **226**.

[0054] As shown in FIG. **5**C, additional example operations for security display of the private data can include acquiring a sound signal from an environment in which the computing device is located at stage **230**. The operations can then include a decision stage **232** to determine whether a sound signal is acquired. In response to determining that the sound signal is not successfully acquired, the operations include applying another security technique at stage **228**. Otherwise, the operations proceed to identifying one or more languages spoken in the acquired sound signal at stage **234**, as described in more detail above with reference to FIG. **3**A. The operations can then include selecting a new language based on the identified one or more languages in the sound signal such that the outputted private data in the new language is less likely to be understood by unauthorized users.

[0055] As shown in FIG. **5**D, additional example operations for security display of the private data can include acquiring sample handwriting of an authorized user at stage **240**. The sample handwriting can be one or more images of handwritten text by the authorized user or other suitable data corresponding to the handwriting of the authorized user. The operations can then include generating or updating a custom font based on the sample handwriting from the authorized user at stage **242**. The operations can then include formatting the private data in the custom font before allowing the private data to be outputted on the display of the computing device **100** at stage **226**.

[0056] FIG. **6** is a computing device **300** suitable for certain components of the computing system **100** in FIGS. **1**-**3**D. For example, the computing device **300** can be suitable for the computing device **100** of FIGS. **1**-**3**D. In a very basic configuration **302**, the computing device **300** can include one or more processors **304** and a system memory **306**. A memory bus **308** can be used for communicating between processor **304** and system memory **306**.

[0057] Depending on the desired configuration, the processor **304** can be of any type including but not limited to a microprocessor (μP), a microcontroller (μC), a digital signal processor (DSP), or any combination thereof. The processor **304** can include one more level of caching, such as a level-one cache **310** and a level-two cache **312**, a processor core **314**, and registers **316**. An example processor core **314** can include an arithmetic logic unit (ALU), a floating-point unit (FPU), a digital signal processing core (DSP Core), or any combination thereof. An example memory controller **318** can also be used with processor **304**, or in some implementations memory controller **318** can be an internal part of processor **304**.

[0058] Depending on the desired configuration, the system memory **306** can be of any type including but not limited to volatile memory (such as RAM), non-volatile memory (such as ROM, flash memory, etc.) or any combination thereof. The system memory **306** can include an operating system **320**, one or more applications **322**, and program data **324**. This described basic configuration **302** is illustrated in FIG. **6** by those components within the inner dashed line.

[0059] The computing device **300** can have additional features or functionality, and additional interfaces to facilitate communications between basic configuration **302** and any other devices and interfaces. For example, a bus/interface controller **330** can be used to facilitate communications between the basic configuration **302** and one or more data storage devices **332** via a storage interface bus **334**. The data storage devices **332** can be removable storage devices **336**, non-removable storage devices **338**, or a combination thereof. Examples of removable storage and non-removable storage devices include magnetic disk devices such as flexible disk drives and hard-disk drives (HDD), optical disk drives such as compact disk (CD) drives or digital versatile disk (DVD) drives, solid state drives (SSD), and tape drives

to name a few. Example computer storage media can include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, program modules, or other data. The term "computer readable storage media" or "computer readable storage device" excludes propagated signals and communication media.

[0060] The system memory **306**, removable storage devices **336**, and non-removable storage devices **338** are examples of computer readable storage media. Computer readable storage media include, but not limited to, RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other media which can be used to store the desired information and which can be accessed by computing device **300**. Any such computer readable storage media can be a part of computing device **300**. The term "computer readable storage medium" excludes propagated signals and communication media.

[0061] The computing device **300** can also include an interface bus **340** for facilitating communication from various interface devices (e.g., output devices **342**, peripheral interfaces **344**, and communication devices **346**) to the basic configuration **302** via bus/interface controller **330**. Example output devices **342** include a graphics processing unit **348** and an audio processing unit **350**, which can be configured to communicate to various external devices such as a display or speakers via one or more A/V ports **352**. Example peripheral interfaces **344** include a serial interface controller **354** or a parallel interface controller **356**, which can be configured to communicate with external devices such as input devices (e.g., keyboard, mouse, pen, voice input device, touch input device, etc.) or other peripheral devices (e.g., printer, scanner, etc.) via one or more I/O ports **358**. An example communication device **346** includes a network controller **360**, which can be arranged to facilitate communications with one or more other computing devices **362** over a network communication link via one or more communication ports **364**.

[0062] The network communication link can be one example of a communication media. Communication media can typically be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and can include any information delivery media. A "modulated data signal" can be a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media can include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), microwave, infrared (IR) and other wireless media. The term computer readable media as used herein can include both storage media and communication media.

[0063] The computing device **300** can be implemented as a portion of a small-form factor portable (or mobile) electronic device such as a cell phone, a personal data assistant (PDA), a personal media player device, a wireless web-watch device, a personal headset device, an application specific device, or a hybrid device that include any of the above functions. The computing device **300** can also be implemented as a personal computer including both laptop computer and non-laptop computer configurations.

[0064] From the foregoing, it will be appreciated that specific embodiments of the disclosure have been described herein for purposes of illustration, but that various modifications may be made without deviating from the disclosure. In addition, many of the elements of one embodiment may be combined with other embodiments in addition to or in lieu of the elements of the other embodiments. Accordingly, the technology is not limited except as by the appended claims.

I/we claim:

1. A method for securing displayed content on a computing device having a camera, a display, and a processor operatively coupled to one another, the method comprising:
- determining, with the processor, whether the computing device is unlocked; and
- in response to determining that the computing device is unlocked, with the processor,
  - capturing an image in a field of view of the camera of the computing device;
  - analyzing the captured image to determine whether the captured image includes a human face; and
  - in response to determining that the captured image includes a human face,
    - analyzing the human face in the image to obtain facial attributes via facial recognition;
    - determining whether the human face is that of an authorized user of the computing device based on the obtained facial attributes; and
    - in response to determining that the human face is not that of the authorized user of the computing device, converting content on the computing device from an original language to a new language upon receiving a request to output the content on the display of the computing device, thereby securing the displayed content even when the computing device is unlocked.

2. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:
- determining a current location of the computing device; and
- selecting the new language as one from the multiple languages having an adoption rate at the determined location that is less than an adoption threshold.

3. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:
- determining a current location of the computing device;
- accessing a stored database record at the computing device, the database record containing identification of multiple languages adopted by the authorized user of the computing device; and
- selecting the new language as one of the multiple languages adopted by the authorized user and having an adoption rate at the determined location that is less than an adoption threshold.

4. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:
- determining a race or ethnicity associated with the determined facial attributes;

accessing a stored database record at the computing device, the database record containing identification of multiple languages adopted by the authorized user of the computing device; and

selecting the new language as one of the multiple languages adopted by the authorized user and having an adoption rate that is less than an adoption threshold for the determined race or ethnicity.

5. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:

accessing a stored database record at the computing device, the database record containing identification of a language pre-configured by the authorized user of the computing device; and

set the language pre-configured by the authorized user as the new language.

6. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:

accessing a set of stored database records at the computing device, the individual database records containing identification of a language pre-configured by the authorized user of the computing device to be used for a corresponding location;

determining a language from the database records based on the determined location of the computing device; and

setting the language pre-configured by the authorized user as the new language.

7. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:

accessing a stored database record at the computing device, the database record containing identification of multiple languages adopted and pre-configured by the authorized user of the computing device to be used for the determined location;

selecting, from the multiple languages in the database record, one of the multiple languages that has a lowest adoption rate at the determined location; and

setting the selected language as the new language.

8. The method of claim **1** wherein the computing device further includes a microphone, and wherein converting content on the computing device from the original language to the new language includes:

acquiring a sound signal via the microphone from an environment in which the computing device is located;

identifying a language spoken in the environment from the acquired sound signal via speech recognition; and

selecting the new language from a set of languages based on the identified one or more languages, the selected new language having an adoption rate that is less than an adoption threshold for a population having another adoption rate of the identified language higher than another adoption threshold.

9. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:

comparing the determined facial attributes to those in a facial identification library to uniquely identify a person captured in the image; and

selecting the new language from a set of languages that are known to be unadopted by the uniquely identified person.

10. A computing device, comprising:

a camera;

a display; and

a processor operatively coupled to the camera, display, and a memory having instructions executable by the processor to cause the computing device to:

upon determining that the computing device is unlocked,

capture and analyze an image in a field of view of the camera of the computing device to determine whether the image includes a human face; and

in response to determining that the image includes a human face,

determine facial attributes of the human face in the image via facial recognition;

based on the facial attributes, determine whether the human face is that of an authorized user of the computing device; and

in response to determining that the human face is not one of an authorized user of the computing device, convert user data on the computing device from an original language to a new language upon receiving a request to output the user data on the display of the computing device, thereby securing the displayed user data even when the computing device is unlocked.

11. The computing device of claim **10** wherein to convert user data on the computing device from the original language to the new language includes to:

determine a current location of the computing device;

access a database record on the computing device, the database record containing identification of multiple languages adopted by the authorized user of the computing device; and

select the new language as one of the multiple languages adopted by the authorized user and having an adoption rate at the determined location that is less than an adoption threshold.

12. The computing device of claim **10** wherein to convert user data on the computing device from the original language to the new language includes to:

determining a race or ethnicity associated with the determined facial attributes;

access a database record on the computing device, the database record containing identification of multiple languages adopted by the authorized user of the computing device; and

select the new language as one of the multiple languages adopted by the authorized user and having an adoption rate that is less than an adoption threshold for the determined race or ethnicity.

13. The computing device of claim **10** wherein to convert user data on the computing device from the original language to the new language includes to:

access a set of stored database records at the computing device, the individual database records containing identification of a language pre-configured by the authorized user of the computing device to be used for a corresponding location;

determining a language from the database records based on the determined location of the computing device; and

set the language pre-configured by the authorized user as the new language.

14. The computing device of claim **10** wherein to convert user data on the computing device from the original language to the new language includes to:

access a stored database record at the computing device, the database record containing identification of multiple languages adopted and pre-configured by the authorized user of the computing device to be used for the determined location;

select, from the multiple languages in the database record, one of the multiple languages that has a lowest adoption rate at the determined location; and

set the selected language as the new language.

15. The computing device of claim **10** wherein the computing device further includes a microphone, and wherein to convert user data on the computing device from the original language to the new language includes to:

acquire a sound signal via the microphone from an environment in which the computing device is located;

identify a language spoken in the environment from the acquired sound signal via speech recognition; and

select the new language from a set of languages based on the identified one or more languages, the selected new language having an adoption rate that is less than an adoption threshold for a population having another adoption rate of the identified language higher than another adoption threshold.

16. The method of claim **1** wherein converting content on the computing device from the original language to the new language includes:

comparing the determined facial attributes to those in a facial identification library to uniquely identify a person captured in the image; and

selecting the new language from a set of languages that are known to be unadopted by the uniquely identified person.

17. A method for securing displayed content on a computing device having a camera, a display, and a processor operatively coupled to one another, the method comprising:

upon determining, with the processor, that the computing device is unlocked, with the processor,

capturing an image in a field of view of the camera of the computing device;

analyzing the captured image to determine whether the captured image includes a human face; and

in response to determining that the captured image includes a human face,

analyzing the human face in the image to obtain facial attributes via facial recognition;

determining whether the human face is that of an authorized user of the computing device based on the obtained facial attributes; and

in response to determining that the human face is not that of the authorized user of the computing device, modifying user data on the computing device from an original font to a custom font of the authorized user upon receiving a request to output the user data on the display of the computing device, thereby securing the displayed user data even when the computing device is unlocked.

18. The method of claim **17** wherein modifying the user data includes modifying the user data on the computing device from the original font to the custom font generated based on a handwriting of the authorized user.

19. The method of claim **17**, further comprising in response to determining that the human face is not that of the authorized user of the computing device, replacing one or more words or phrases in the user data with punctuation marks.

20. The method of claim **17**, further comprising in response to determining that the human face is not that of the authorized user of the computing device, changing an orientation, a font color, a display brightness, a display contrast of the displayed user data.

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