



US 20250265861A1

(19) **United States**

(12) **Patent Application Publication**
Knight et al.

(10) **Pub. No.: US 2025/0265861 A1**

(43) **Pub. Date: Aug. 21, 2025**

(54) **DIGITAL IMAGING SYSTEMS AND METHODS OF ANALYZING PIXEL DATA OF AN IMAGE OF A SKIN AREA OF A USER FOR DETERMINING SKIN HYPERPIGMENTATION**

G06Q 30/0601 (2023.01)

G06T 7/70 (2017.01)

G06T 11/00 (2006.01)

(52) **U.S. Cl.**

CPC **G06V 40/10** (2022.01); **G06Q 30/0631**

(2013.01); **G06T 7/70** (2017.01); **G06T 11/00**

(2013.01); **G06Q 10/083** (2013.01); **G06T**

2207/20081 (2013.01)

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(21) Appl. No.: **19/198,674**

(22) Filed: **May 5, 2025**

Related U.S. Application Data

(63) Continuation of application No. 17/553,666, filed on Dec. 16, 2021, now Pat. No. 12,322,201.

Publication Classification

(51) **Int. Cl.**

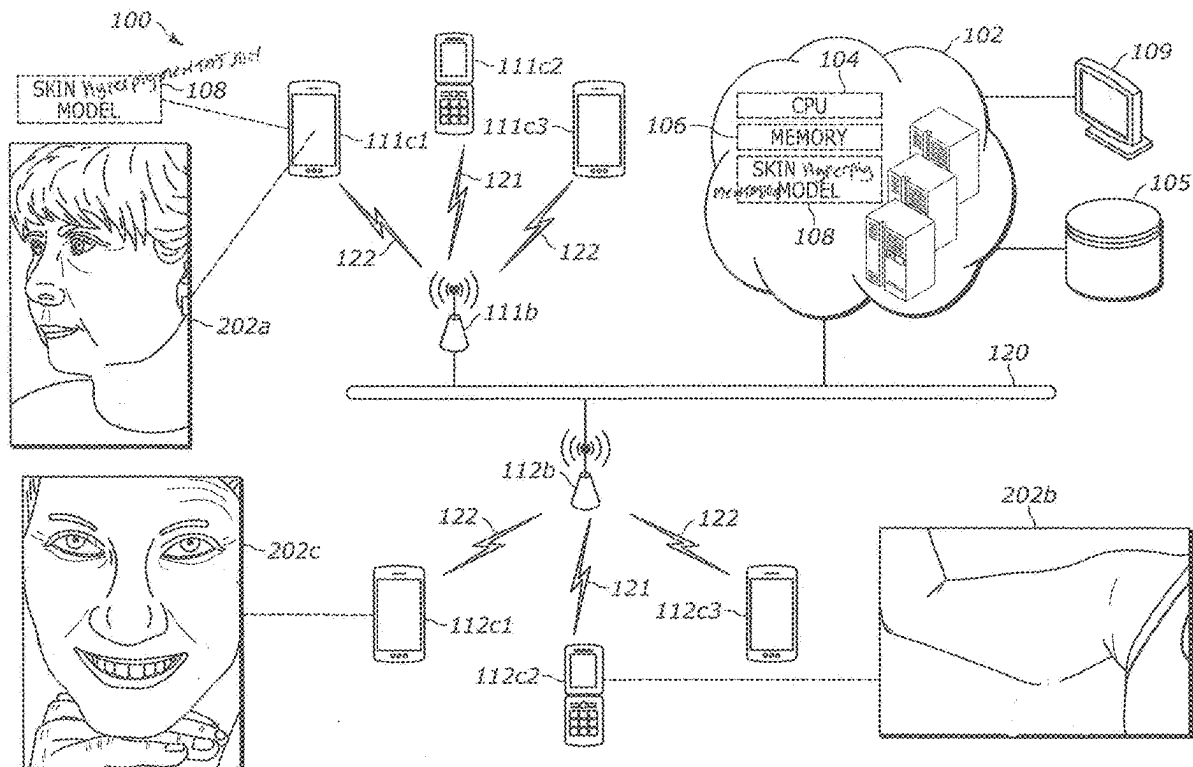
G06V 40/10 (2022.01)

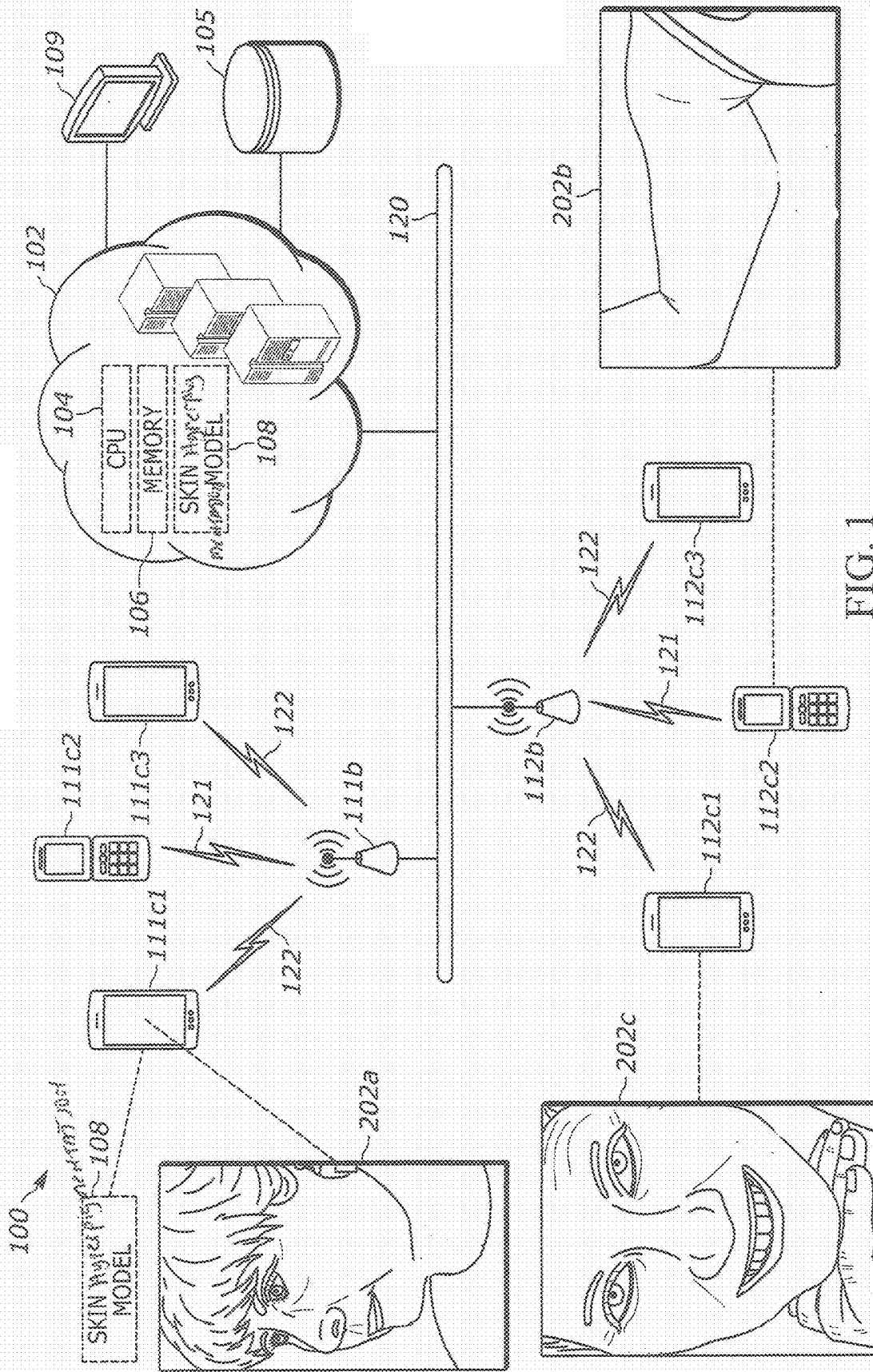
G06Q 10/083 (2024.01)

(57)

ABSTRACT

Digital imaging systems and methods are described for analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation. A plurality of training images of a plurality of individuals are aggregated, each of the training images comprising pixel data of a respective skin area of an individual. A skin hyperpigmentation model, trained with the pixel data, is operable to output, across a range of a skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation. An image of a user comprising pixel data of at least a portion of a user skin area is received and analyzed, by the skin hyperpigmentation model, to determine a user-specific skin hyperpigmentation value of the user skin area. A user-specific electronic recommendation addressing at least one feature identifiable within the pixel data is generated and rendered, on a display screen of a user computing device.





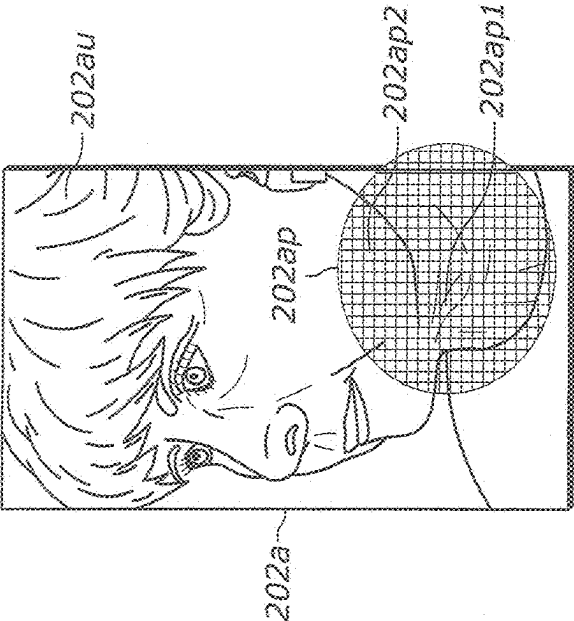


FIG. 2A

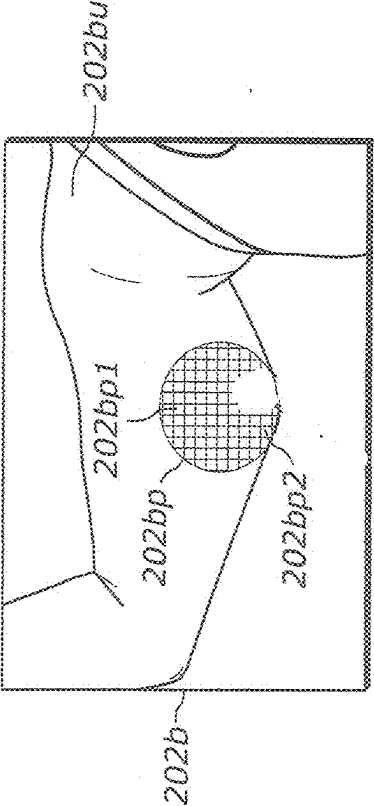


FIG. 2B

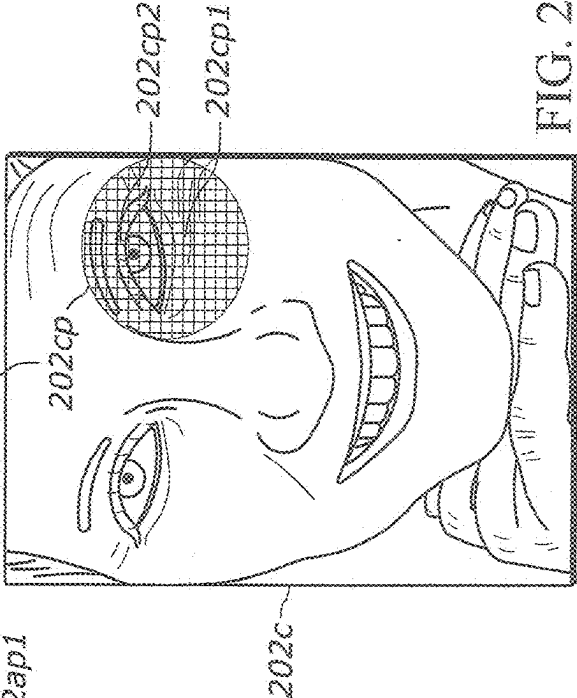


FIG. 2C

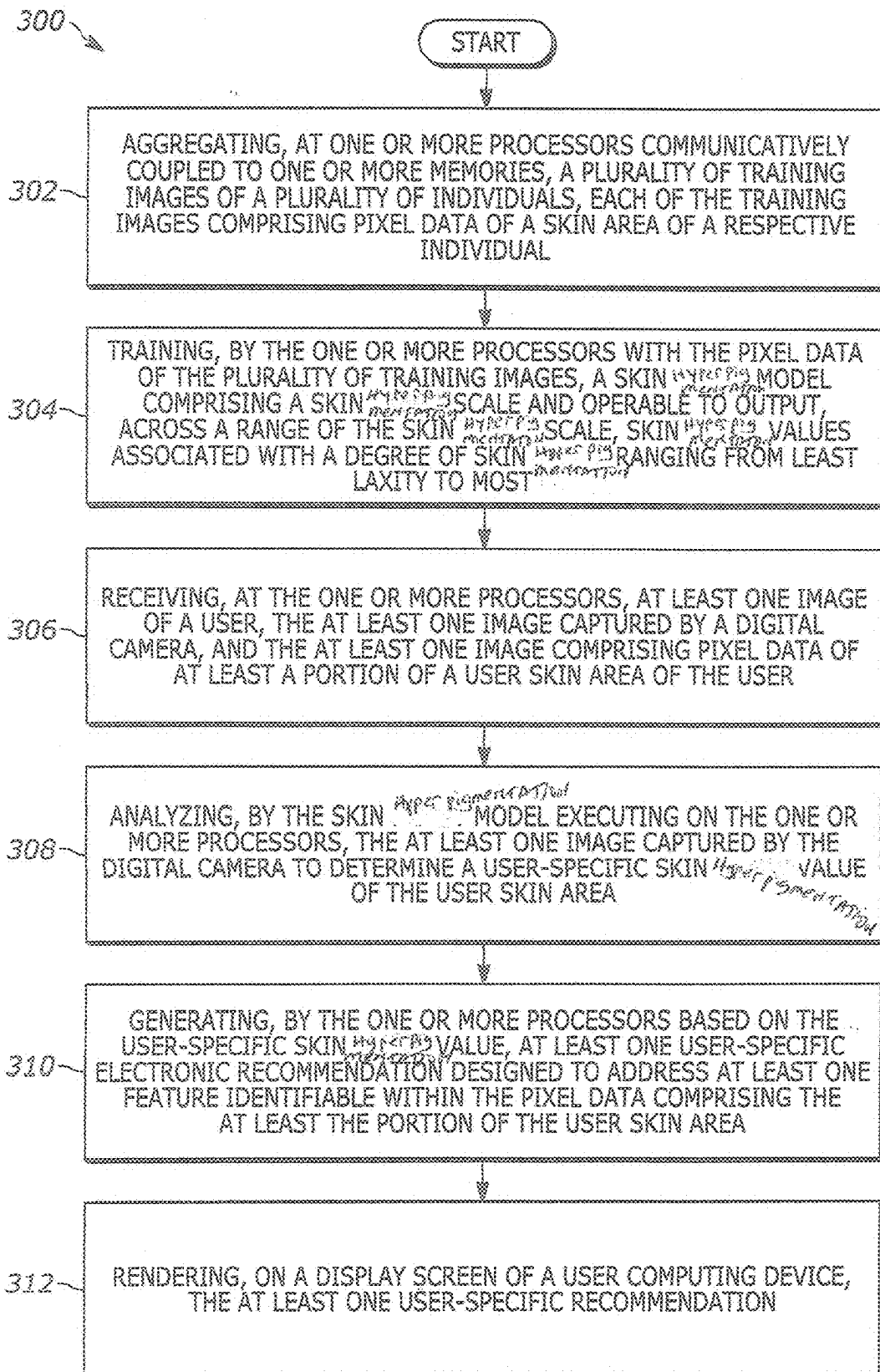


FIG. 3

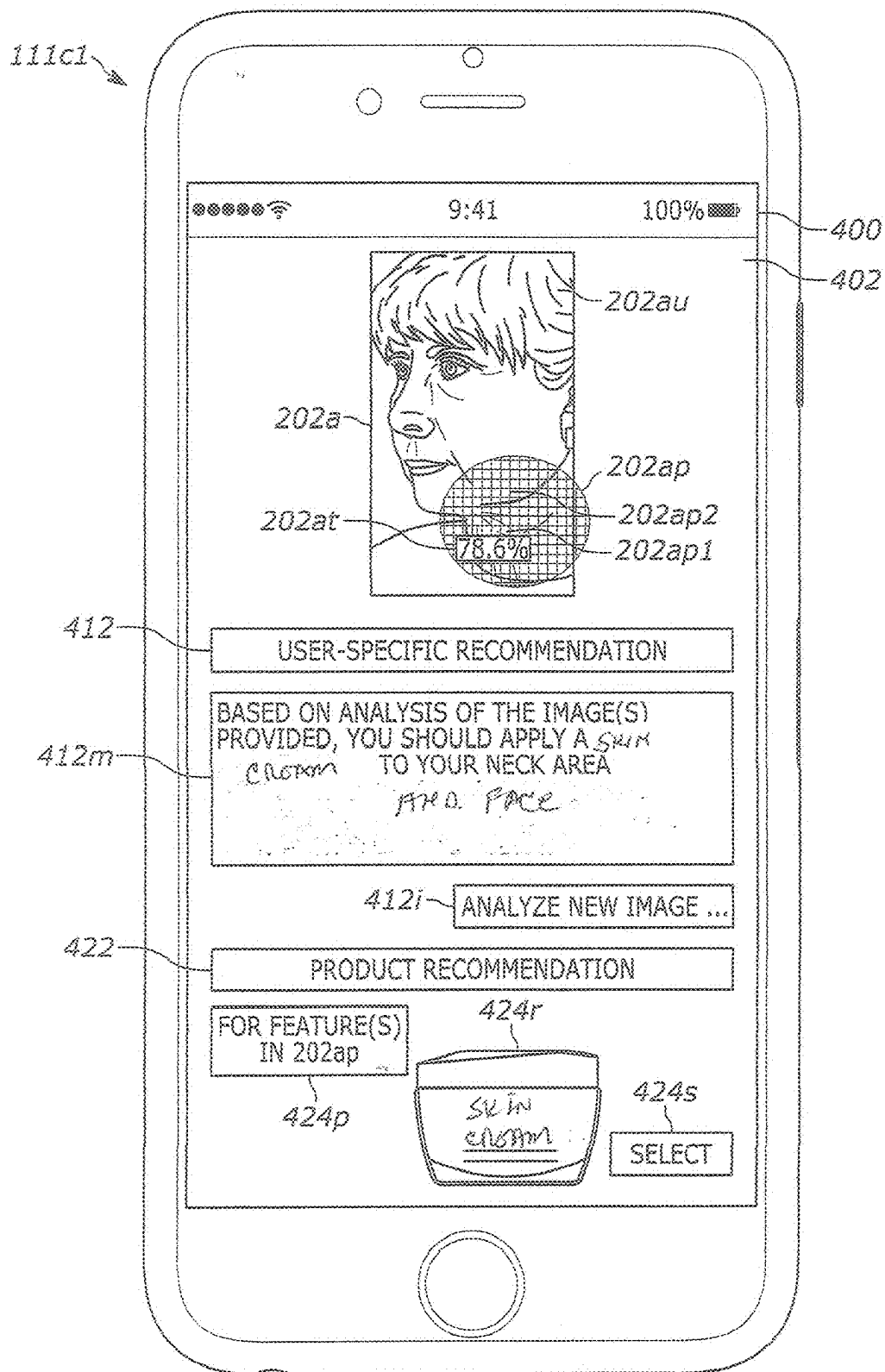


FIG. 4

**DIGITAL IMAGING SYSTEMS AND
METHODS OF ANALYZING PIXEL DATA OF
AN IMAGE OF A SKIN AREA OF A USER
FOR DETERMINING SKIN
HYPERPIGMENTATION**

FIELD OF THE INVENTION

[0001] The present disclosure generally relates to digital imaging systems and methods, and more particularly to digital imaging systems and methods of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation.

BACKGROUND OF THE INVENTION

[0002] Individuals can develop hyper- or hypopigmentation in various spots on their bodies. Skin hyperpigmentation describes the quality or state of skin being darker than the surrounding skin. The skin is the body's largest organ, and like the other organs, its health, and as a result its appearance, is affected by various factors including age, exposure to toxins, harsh weather, nutrient deficiencies, and individual habits, such as smoking. Skin hyperpigmentation can be most noticeable to others when it's on an individual's face. But other parts of the head or body can also show signs of skin hyperpigmentation as well.

[0003] In some instances, highly reactive chemical compounds, generally referred to as free radicals, can also contribute to skin hyperpigmentation. Chronic exposure to free radicals can cause damage to human cells, tissues, and organs of the body, including the skin. Over time, exposure to free radicals can cause an individual's skin to produce more melanin. Deposits of melanin in localized regions of the skin causes the appearance of hyperpigmentation.

[0004] In addition, inflammation in the skin can cause deposition of melanin and hence hyperpigmentation. Therefore unmanaged inflammation over a chronic period of time can cause risk of hyperpigmentation in the skin. A main cause of skin hyperpigmentation is aging because cumulative UV exposure is known to cause the majority of aging and damage to the skin.

[0005] Hyperpigmentation can be avoided through a number of routes. Avoiding skin exposure, by covering skin with clothing or using SPF, can limit the chance for hyperpigmentation. Treating inflammation in the skin can also reduce the possibility of hyperpigmentation from occurring.

[0006] Use of cosmeceutical products, moisturizers, skin creams, and/or other such skin hyperpigmentation products can be used to mitigate the appearance of skin hyperpigmentation. However, such products are typically differently formulated and/or designed to address different ages, skin types, and/or body areas of a multitude of individuals, where a given cosmeceutical product, moisturizer, skin cream, and/or other such skin hyperpigmentation products product may affect one individual having a first set of age and/or otherwise skin hyperpigmentation characteristics differently than a second individual having a second set of age and/or otherwise skin hyperpigmentation characteristics. The problem is acutely pronounced given the various versions, brands, and types of cosmeceutical products, moisturizers, skin creams, and/or other such skin hyperpigmentation products currently available to individuals, where each of these different versions, brands, and types of products have different chemical compositions, ingredients, and/or other-

wise different designs or formulations, all of which can vary significantly in their capability and effectiveness of treating skin hyperpigmentation of a specific individual. This problem is particularly acute because such existing skin hyperpigmentation products—which may be differently designed or formulated—provide little or no feedback or guidance to assist an individual address his or her own personal skin hyperpigmentation issues.

[0007] For the foregoing reasons, there is a need for digital imaging systems and methods of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation.

SUMMARY OF THE INVENTION

[0008] Generally, as described herein, the digital imaging systems and methods of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation, provide a digital imaging, and artificial intelligence (AI), based solution for overcoming problems, whether actual or perceived, that arise from skin hyperpigmentation issues. As described herein, skin hyperpigmentation refers to the quality or state of skin being darker than the surrounding skin.

[0009] The digital systems and methods described herein allow a user to submit a specific user image to imaging server(s) (e.g., including its one or more processors), or otherwise a computing device (e.g., such as locally on the user's mobile device), where the imaging server(s) or user computing device implements or executes a skin hyperpigmentation model trained with pixel data of potentially 10,000s (or more) images of individuals having various degrees of skin hyperpigmentation. The skin hyperpigmentation model may generate, based on a skin hyperpigmentation value of a user's skin area, a user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area. For example, the at least one feature can comprise pixels or pixel data indicative of a degree of skin hyperpigmentation, from least hyperpigmentation to most hyperpigmentation (based on hyperpigmentation values across a range of hyperpigmentation values determined in training images of individuals' respective skin areas). In some embodiments, the user-specific recommendation (and/or product specific recommendation) may be transmitted via a computer network to a user computing device of the user for rendering on a display screen. In other embodiments, no transmission to the imaging server of the user's specific image occurs, where the user-specific recommendation (and/or product specific recommendation) may instead be generated by the skin hyperpigmentation model, executing and/or implemented locally on the user's mobile device and rendered, by a processor of the mobile device, on a display screen of the mobile device. In various embodiments, such rendering may include graphical representations, overlays, annotations, and the like for addressing the feature in the pixel data.

[0010] More specifically, as describe herein, a digital imaging method of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation is disclosed. The digital imaging method comprises: (a) aggregating, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual; (b) training, by the one or more processors with

the pixel data of the plurality of training images, a skin hyperpigmentation model comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation; (c) receiving, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; (d) analyzing, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; (e) generating, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area;

[0011] and (f) rendering, on a display screen of a user computing device, the at least one user-specific recommendation.

[0012] In addition, as described herein, a digital imaging system is disclosed, configured to analyze pixel data of an image of a skin area of a user for determining skin hyperpigmentation, the digital imaging system comprising: an imaging server comprising a server processor and a server memory; an imaging application (app) configured to execute on a user computing device comprising a device processor and a device memory, the imaging app communicatively coupled to the imaging server; and a skin hyperpigmentation model trained with pixel data of a plurality of training images of individuals and operable to output, across a range of a skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation, wherein the skin hyperpigmentation model is configured to execute on the server processor or the device processor to: receive, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; analyze, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; generate, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and render, on a display screen of a user computing device, the at least one user-specific recommendation.

[0013] Further, as described herein, a tangible, non-transitory computer-readable medium storing instructions for analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation is disclosed. The instructions, when executed by one or more processors may cause the one or more processors to: (a) aggregate, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual; (b) train, by the

one or more processors with the pixel data of the plurality of training images, a skin hyperpigmentation model comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation; (c) receive, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; (d) analyze, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; (e) generate, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and (f) render, on a display screen of a user computing device, the at least one user-specific recommendation.

[0014] In accordance with the above, and with the disclosure herein, the present disclosure includes improvements in computer functionality or in improvements to other technologies at least because the disclosure describes that, e.g., an imaging server, or otherwise computing device (e.g., a user computer device), is improved where the intelligence or predictive ability of the imaging server or computing device is enhanced by a trained (e.g., machine learning trained) skin hyperpigmentation model. The skin hyperpigmentation model, executing on the imaging server or computing device, is able to accurately identify, based on pixel data of other individuals, a user-specific skin hyperpigmentation value for at least a portion of a user skin area and a user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data of a specific user comprising the at least the portion of the user skin area. That is, the present disclosure describes improvements in the functioning of the computer itself or “any other technology or technical field” because an imaging server or user computing device is enhanced with a plurality of training images (e.g., 10,000s of training images and related pixel data as feature data) to accurately predict, detect, or determine pixel data of a user-specific images, such as newly provided customer images. This improves over the prior art at least because existing systems lack such predictive or classification functionality and are simply not capable of accurately analyzing user-specific images to output a predictive result to address at least one feature (e.g., related to skin hyperpigmentation) identifiable within the pixel data comprising the at least the portion of the user skin area.

[0015] For similar reasons, the present disclosure relates to improvement to other technologies or technical fields at least because the present disclosure describes or introduces improvements to computing devices in the field(s) of skin hyperpigmentation and/or dermatology, whereby the trained skin hyperpigmentation model executing on the imaging device(s) or computing devices improve the field(s) of skin hyperpigmentation and/or dermatology with digital and/or artificial intelligence based analysis of user or individual images to output a predictive result to address user-specific

pixel data of at least one feature identifiable within the pixel data comprising the at least the least the portion of the user skin area.

[0016] In addition, the present disclosure includes specific features other than what is well-understood, routine, conventional activity in the field, or adding unconventional steps that confine the claim to a particular useful application, e.g., analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation as described herein.

[0017] Advantages will become more apparent to those of ordinary skill in the art from the following description of the preferred embodiments which have been shown and described by way of illustration. As will be realized, the present embodiments may be capable of other and different embodiments, and their details are capable of modification in various respects. Accordingly, the drawings and description are to be regarded as illustrative in nature and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The Figures described below depict various aspects of the system and methods disclosed therein. It should be understood that each Figure depicts an embodiment of a particular aspect of the disclosed system and methods, and that each of the Figures is intended to accord with a possible embodiment thereof. Further, wherever possible, the following description refers to the reference numerals included in the following Figures, in which features depicted in multiple Figures are designated with consistent reference numerals.

[0019] There are shown in the drawings arrangements which are presently discussed, it being understood, however, that the present embodiments are not limited to the precise arrangements and instrumentalities shown, wherein:

[0020] FIG. 1 illustrates an example digital imaging system configured to analyze pixel data of an image of a skin area of a user for determining skin hyperpigmentation, in accordance with various embodiments disclosed herein.

[0021] FIG. 2A illustrates an example image and its related pixel data that may be used for training and/or implementing a skin hyperpigmentation model, in accordance with various embodiments disclosed herein.

[0022] FIG. 2B illustrates a further example image and its related pixel data that may be used for training and/or implementing a skin hyperpigmentation model, in accordance with various embodiments disclosed herein.

[0023] FIG. 2C illustrates a further example image and its related pixel data that may be used for training and/or implementing a skin hyperpigmentation model, in accordance with various embodiments disclosed herein.

[0024] FIG. 3 illustrates a diagram of a digital imaging method of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation, in accordance with various embodiments disclosed herein.

[0025] FIG. 4 illustrates an example user interface as rendered on a display screen of a user computing device in accordance with various embodiments disclosed herein.

[0026] The Figures depict preferred embodiments for purposes of illustration only. Alternative embodiments of the systems and methods illustrated herein may be employed without departing from the principles of the invention described herein.

DETAILED DESCRIPTION OF THE INVENTION

[0027] FIG. 1 illustrates an example digital imaging system **100** configured to analyze pixel data of an image (e.g., any one or more of images **202a**, **202b**, and/or **202c**) of a skin area, or otherwise body or body area, of a user for determining skin hyperpigmentation, in accordance with various embodiments disclosed herein. As referred to herein, a “body” may refer to any portion of the human body including the torso, waist, face, head, arm, leg, or other appendage or portion or part of the body thereof. In the example embodiment of FIG. 1, digital imaging system **100** includes server(s) **102**, which may comprise one or more computer servers. In various embodiments server(s) **102** comprise multiple servers, which may comprise a multiple, redundant, or replicated servers as part of a server farm. In still further embodiments, server(s) **102** may be implemented as cloud-based servers, such as a cloud-based computing platform. For example, imaging server(s) **102** may be any one or more cloud-based platform(s) such as MICROSOFT AZURE, AMAZON AWS, or the like. Server(s) **102** may include one or more processor(s) **104** as well as one or more computer memories **106**. Server(s) **102** may be referred to herein as “imaging server(s).”

[0028] The memories **106** may include one or more forms of volatile and/or non-volatile, fixed and/or removable memory, such as read-only memory (ROM), electronic programmable read-only memory (EPROM), random access memory (RAM), erasable electronic programmable read-only memory (EEPROM), and/or other hard drives, flash memory, MicroSD cards, and others. The memory(s) **106** may store an operating system (OS) (e.g., Microsoft Windows, Linux, UNIX, etc.) capable of facilitating the functionalities, apps, methods, or other software as discussed herein. The memory(s) **106** may also store a skin hyperpigmentation model **108**, which may be an artificial intelligence based model, such as a machine learning model, trained on various images (e.g., images **202a**, **202b**, and/or **202c**), as described herein. Additionally, or alternatively, the skin hyperpigmentation model **108** may also be stored in database **105**, which is accessible or otherwise communicatively coupled to imaging server(s) **102**. The memories **106** may also store machine readable instructions, including any of one or more application(s), one or more software component(s), and/or one or more application programming interfaces (APIs), which may be implemented to facilitate or perform the features, functions, or other disclosure described herein, such as any methods, processes, elements or limitations, as illustrated, depicted, or described for the various flowcharts, illustrations, diagrams, figures, and/or other disclosure herein. For example, at least some of the applications, software components, or APIs may be, include, otherwise be part of, an imaging based machine learning model or component, such as the skin hyperpigmentation model **108**, where each may be configured to facilitate their various functionalities discussed herein. It should be appreciated that one or more other applications may be envisioned and that are executed by the processor(s) **104**.

[0029] The processor(s) **104** may be connected to the memories **106** via a computer bus responsible for transmitting electronic data, data packets, or otherwise electronic signals to and from the processor(s) **104** and memories **106** in order to implement or perform the machine readable instructions, methods, processes, elements or limitations, as

illustrated, depicted, or described for the various flowcharts, illustrations, diagrams, figures, and/or other disclosure herein.

[0030] The processor(s) **104** may interface with the memory **106** via the computer bus to execute the operating system (OS). The processor(s) **104** may also interface with the memory **106** via the computer bus to create, read, update, delete, or otherwise access or interact with the data stored in the memories **106** and/or the database **104** (e.g., a relational database, such as Oracle, DB2, MySQL, or a NoSQL based database, such as MongoDB). The data stored in the memories **106** and/or the database **105** may include all or part of any of the data or information described herein, including, for example, training images and/or user images (e.g., either of which including any one or more of images **202a**, **202b**, and/or **202c**) or other information of the user, including demographic, age, race, skin type, or the like.

[0031] The imaging server(s) **102** may further include a communication component configured to communicate (e.g., send and receive) data via one or more external/network port(s) to one or more networks or local terminals, such as computer network **120** and/or terminal **109** (for rendering or visualizing) described herein. In some embodiments, imaging server(s) **102** may include a client-server platform technology such as ASP.NET, Java J2EE, Ruby on Rails, Node.js, a web service or online API, responsive for receiving and responding to electronic requests. The imaging server(s) **102** may implement the client-server platform technology that may interact, via the computer bus, with the memories(s) **106** (including the applications(s), component (s), API(s), data, etc. stored therein) and/or database **105** to implement or perform the machine readable instructions, methods, processes, elements or limitations, as illustrated, depicted, or described for the various flowcharts, illustrations, diagrams, figures, and/or other disclosure herein. According to some embodiments, the imaging server(s) **102** may include, or interact with, one or more transceivers (e.g., WWAN, WLAN, and/or WPAN transceivers) functioning in accordance with IEEE standards, 3GPP standards, or other standards, and that may be used in receipt and transmission of data via external/network ports connected to computer network **120**. In some embodiments, computer network **120** may comprise a private network or local area network (LAN). Additionally, or alternatively, computer network **120** may comprise a public network such as the Internet.

[0032] Imaging server(s) **102** may further include or implement an operator interface configured to present information to an administrator or operator and/or receive inputs from the administrator or operator. As shown in FIG. 1, an operator interface may provide a display screen (e.g., via terminal **109**). Imaging server(s) **102** may also provide I/O components (e.g., ports, capacitive or resistive touch sensitive input panels, keys, buttons, lights, LEDs), which may be directly accessible via or attached to imaging server(s) **102** or may be indirectly accessible via or attached to terminal **109**. According to some embodiments, an administrator or operator may access the server **102** via terminal **109** to review information, make changes, input training data or images, and/or perform other functions.

[0033] As described above herein, in some embodiments, imaging server(s) **102** may perform the functionalities as discussed herein as part of a “cloud” network or may otherwise communicate with other hardware or software

components within the cloud to send, retrieve, or otherwise analyze data or information described herein.

[0034] In general, a computer program or computer based product, application, or code (e.g., the model(s), such as AI models, or other computing instructions described herein) may be stored on a computer usable storage medium, or tangible, non-transitory computer-readable medium (e.g., standard random access memory (RAM), an optical disc, a universal serial bus (USB) drive, or the like) having such computer-readable program code or computer instructions embodied therein, wherein the computer-readable program code or computer instructions may be installed on or otherwise adapted to be executed by the processor(s) **104** (e.g., working in connection with the respective operating system in memories **106**) to facilitate, implement, or perform the machine readable instructions, methods, processes, elements or limitations, as illustrated, depicted, or described for the various flowcharts, illustrations, diagrams, figures, and/or other disclosure herein. In this regard, the program code may be implemented in any desired program language, and may be implemented as machine code, assembly code, byte code, interpretable source code or the like (e.g., via Golang, Python, C, C++, C #, Objective-C, Java, Scala, ActionScript, JavaScript, HTML, CSS, XML, etc.).

[0035] As shown in FIG. 1, imaging server(s) **102** are communicatively connected, via computer network **120** to the one or more user computing devices **111c1-111c3** and/or **112c1-112c3** via base stations **111b** and **112b**. In some embodiments, base stations **111b** and **112b** may comprise cellular base stations, such as cell towers, communicating to the one or more user computing devices **111c1-111c3** and **112c1-112c3** via wireless communications **121** based on any one or more of various mobile phone standards, including NMT, GSM, CDMA, UMMTS, LTE, 5G, or the like. Additionally or alternatively, base stations **111b** and **112b** may comprise routers, wireless switches, or other such wireless connection points communicating to the one or more user computing devices **111c1-111c3** and **112c1-112c3** via wireless communications **122** based on any one or more of various wireless standards, including by non-limiting example, IEEE 802.11a/b/c/g (WIFI), the BLUETOOTH standard, or the like.

[0036] Any of the one or more user computing devices **111c1-111c3** and/or **112c1-112c3** may comprise mobile devices and/or client devices for accessing and/or communications with imaging server(s) **102**. In various embodiments, user computing devices **111c1-111c3** and/or **112c1-112c3** may comprise a cellular phone, a mobile phone, a tablet device, a personal data assistance (PDA), or the like, including, by non-limiting example, an APPLE iPhone or iPad device or a GOOGLE ANDROID based mobile phone or table. In still further embodiments, user computing devices **111c1-111c3** and/or **112c1-112c3** may comprise a home assistant device and/or personal assistant device, e.g., having display screens, including, by way of non-limiting example, any one or more of a GOOGLE HOME device, an AMAZON ALEXA device, an ECHO SHOW device, or the like. In additional embodiments, user computing devices **111c1-111c3** and/or **112c1-112c3** may comprise a retail computing device. A retail computing device would be configured in the same or similar manner, e.g., as described herein for user computing devices **111c1-111c3**, including having a processor and memory, for implementing, or communicating with (e.g., via server(s) **102**), a skin hyperpig-

mentation model **108** as described herein. However, a retail computing device may be located, installed, or otherwise positioned within a retail environment to allow users and/or customers of the retail environment to utilize the digital imaging systems and methods on site within the retail environment. For example, the retail computing device may be installed within a kiosk for access by a user. The user may then upload or transfer images (e.g., from a user mobile device) to the kiosk to implement the digital imaging systems and methods described herein. Additionally, or alternatively, the kiosk may be configured with a camera to allow the user to take new images (e.g., in a private manner where warranted) of himself or herself for upload and transfer. In such embodiments, the user or consumer himself or herself would be able to use the retail computing device to receive and/or have rendered a user-specific electronic recommendation, as described herein, on a display screen of the retail computing device. Additionally, or alternatively, the retail computing device may be a mobile device (as described herein) as carried by an employee or other personnel of the retail environment for interacting with users or consumers on site. In such embodiments, a user or consumer may be able to interact with an employee or otherwise personnel of the retail environment, via the retail computing device (e.g., by transferring images from a mobile device of the user to the retail computing device or by capturing new images by a camera of the retail computing device), to receive and/or have rendered a user-specific electronic recommendation, as described herein, on a display screen of the retail computing device. In addition, the one or more user computing devices **111c1-111c3** and/or **112c1-112c3** may implement or execute an operating system (OS) or mobile platform such as Apple's iOS and/or Google's Android operation system. Any of the one or more user computing devices **111c1-111c3** and/or **112c1-112c3** may comprise one or more processors and/or one or more memories for storing, implementing, or executing computing instructions or code, e.g., a mobile application or a home or personal assistant application, as described in various embodiments herein. As shown in FIG. 1, skin hyperpigmentation model **108** may also be stored locally on a memory of a user computing device (e.g., user computing device **111c1**).

[0037] User computing devices **111c1-111c3** and/or **112c1-112c3** may comprise a wireless transceiver to receive and transmit wireless communications **121** and/or **122** to and from base stations **111b** and/or **112b**. Pixel based images **202a**, **202b**, and/or **202c** may be transmitted via computer network **120** to imaging server(s) **102** for training of model (s) and/or imaging analysis as describe herein.

[0038] In addition, the one or more user computing devices **111c1-111c3** and/or **112c1-112c3** may include a digital camera and/or digital video camera for capturing or taking digital images and/or frames (e.g., which can be any one or more of images **202a**, **202b**, and/or **202c**). Each digital image may comprise pixel data for training or implementing model(s), such as AI or machine learning models, as described herein. For example, a digital camera and/or digital video camera of, e.g., any of user computing devices **111c1-111c3** and/or **112c1-112c3**, may be configured to take, capture, or otherwise generate digital images (e.g., pixel based images **202a**, **202b**, and/or **202c**) and, at least in some embodiments, may store such images in a memory of a respective user computing devices.

[0039] Still further, each of the one or more user computer devices **111c1-111c3** and/or **112c1-112c3** may include a display screen for displaying graphics, images, text, product recommendations, data, pixels, features, and/or other such visualizations or information as described herein. In various embodiments, graphics, images, text, product recommendations, data, pixels, features, and/or other such visualizations or information may be received by imaging server(s) **102** for display on the display screen of any one or more of user computer devices **111c1-111c3** and/or **112c1-112c3**. Additionally, or alternatively, a user computer device may comprise, implement, have access to, render, or otherwise expose, at least in part, an interface or a guided user interface (GUI) for displaying text and/or images on its display screen.

[0040] FIGS. 2A-2C illustrate example images **202a**, **202b**, and **202c** that may be collected or aggregated at imaging server(s) **102** and may be analyzed by, and/or used to train, a skin hyperpigmentation model (e.g., an AI model such as a machine learning imaging model as describe herein). Each of these images may comprise pixel data (e.g., RGB data) corresponding representing feature data and corresponding to each of the personal attributes of the respective users **202au**, **202bu**, and **202cu**, within the respective image. The pixel data may be captured by a digital camera of one of the user computing devices (e.g., one or more user computer devices **111c1-111c3** and/or **112c1-112c3**).

[0041] Generally, as described herein, pixel data (e.g., pixel data **202ap**, **202bp**, and/or **202cp**) comprises individual points or squares of data within an image, where each point or square represents a single pixel (e.g., pixel **202ap1** and pixel **202ap2**) within an image. Each pixel may be a specific location within an image. In addition, each pixel may have a specific color (or lack thereof). Pixel color may be determined by a color format and related channel data associated with a given pixel. For example, a popular color format includes the red-green-blue (RGB) format having red, green, and blue channels. That is, in the RGB format, data of a pixel is represented by three numerical RGB components (Red, Green, Blue), that may be referred to as a channel data, to manipulate the color of pixel's area within the image. In some implementations, the three RGB components may be represented as three 8-bit numbers for each pixel. Three 8-bit bytes (one byte for each of RGB) is used to generate 24 bit color. Each 8-bit RGB component can have 256 possible values, ranging from 0 to 255 (i.e., in the base 2 binary system, an 8 bit byte can contain one of 256 numeric values ranging from 0 to 255). This channel data (R, G, and B) can be assigned a value from 0 255 and be used to set the pixel's color. For example, three values like (250, 165, 0), meaning (Red=250, Green=165, Blue=0), can denote one Orange pixel. As a further example, (Red=255, Green=255, Blue=0) means Red and Green, each fully saturated (255 is as bright as 8 bits can be), with no Blue (zero), with the resulting color being Yellow. As a still further example, the color black has an RGB value of (Red=0, Green=0, Blue=0) and white has an RGB value of (Red=255, Green=255, Blue=255). Gray has the property of having equal or similar RGB values. So (Red=220, Green=220, Blue=220) is a light gray (near white), and (Red=40, Green=40, Blue=40) is a dark gray (near black).

[0042] In this way, the composite of three RGB values creates the final color for a given pixel. With a 24-bit RGB

color image using 3 bytes there can be 256 shades of red, and 256 shades of green, and 256 shades of blue. This provides 256×256×256, i.e., 16.7 million possible combinations or colors for 24 bit RGB color images. In this way, the pixel's RGB data value shows how much of each of Red, and Green, and Blue pixel is comprised of. The three colors and intensity levels are combined at that image pixel, i.e., at that pixel location on a display screen, to illuminate a display screen at that location with that color. In is to be understood, however, that other bit sizes, having fewer or more bits, e.g., 10-bits, may be used to result in fewer or more overall colors and ranges.

[0043] As a whole, the various pixels, positioned together in a grid pattern, form a digital image (e.g., pixel data **202ap**, **202bp**, and/or **202cp**). A single digital image can comprise thousands or millions of pixels. Images can be captured, generated, stored, and/or transmitted in a number of formats, such as JPEG, TIFF, PNG and GIF. These formats use pixels to store represent the image.

[0044] FIG. 2A illustrates an example image **202a** and its related pixel data (e.g., pixel data **202ap**) that may be used for training and/or implementing a skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**), in accordance with various embodiments disclosed herein. Example image **202a** illustrates a user skin area of user **202au** or individual at a body area location comprising the user's neck. Image **202a** is comprised of pixel data, including pixel data **202ap**. Pixel data **202ap** includes a plurality of pixels including pixel **202ap1** and pixel **202ap2**. Pixel **202ap2** is a pixel positioned in image **202a** comprising a body area location of the user, including the user's chin or cheek. Pixel **202ap1** is a dark pixel (e.g., a pixel with low R, G, and B values) positioned in image **202a** from the body area location (e.g., chin or cheek, e.g., of pixel **202ap2**) as identifiable within the portion of the user skin area of pixel data **202ap**. Pixel data **202ap** includes various remaining pixels including remaining portions of user **202au**, including other body area location(s) (e.g., check, neck, head, etc.). Pixel data **202ap** further includes pixels representing further features including the user's position, posture, body portions, and other features as shown in FIG. 2A.

[0045] FIG. 2B illustrates a further example image **202b** and its related pixel data (e.g., pixel data **202bp**) that may be used for training and/or implementing a skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**), in accordance with various embodiments disclosed herein. Example image **202b** illustrates a user skin area of user **202bu** or individual at a body area location comprising the user's arm. Image **202b** is comprised of pixel data, including pixel data **202bp**. Pixel data **202bp** includes a plurality of pixels including pixel **202bp1** and pixel **202bp2**. Pixel **202bp1** is a pixel positioned in image **202b** comprising a body area location of the user, including the user's arm. Pixel **202bp2** is a lighter pixel (e.g., a pixel with high R, G, and B values) positioned in image **202b** where user **202bu** has a rough amount of skin from the body area location (e.g., arm, e.g., of pixel **202bp1**) identifiable within the portion of the user skin area of pixel data **202bp**. Pixel data **202bp** further includes pixels representing further features including the user's shoulder, elbow, forearm, posture, body portions, and other features as shown in FIG. 2B.

[0046] FIG. 2C illustrates a further example image **202cu** and its related pixel data (e.g., **202cp**) that may be used for training and/or implementing a skin hyperpigmentation

model (e.g., skin hyperpigmentation model **108**), in accordance with various embodiments disclosed herein. Example image **202c** illustrates a user skin area of user **202cu** or individual at a body area location comprising the user's head or face, and, in particular, eye. Image **202c** is comprised of pixel data, including pixel data **202cp**. Pixel data **202cp** includes a plurality of pixels including pixel **202cp1** and pixel **202cp2**. Pixel **202cp2** is a pixel positioned in image **202c** comprising a body area location of the user, including the user's head or face, and, in particular, eye. Pixel **202cp1** is a dark pixel (e.g., a pixel with low R, G, and B values) positioned in image **202c** where user **202cu** has a dark amount of skin from the body area location (e.g., head, face, or eye, e.g., of pixel **202cp2**) identifiable within the portion of the user skin area of pixel data **202cp**. Pixel data **202cp** includes various remaining pixels including remaining portions of user **202cu**, including other body area location(s) (e.g., check, neck, etc.). Pixel data **202cp** further includes pixels representing further features including the user's position, posture, body portions, and other features as shown in FIG. 2C.

[0047] FIG. 3 illustrates a diagram of a digital imaging method **300** of analyzing pixel data of an image (e.g., any of images **202a**, **202b**, and/or **202c**) of a skin area of a user for determining skin hyperpigmentation, in accordance with various embodiments disclosed herein. Images, as described herein, are generally pixel images as captured by a digital camera (e.g., a digital camera of user computing device **111c1**). In some embodiments an image may comprise or refer to a plurality of images such as a plurality of images (e.g., frames) as collected using a digital video camera. Frames comprise consecutive images defining motion, and can comprise a movie, a video, or the like.

[0048] At block **302**, method **300** comprises aggregating, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual. At block **304**, method **300** comprises training, by the one or more processors with the pixel data of the plurality of training images, a skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation. In various embodiments, a skin hyperpigmentation scale can be an internalized scale or otherwise custom scale, unique to the skin hyperpigmentation model, where a least or small hyperpigmentation value may be determined from an image or set of images having skin areas with low skin hyperpigmentation values, i.e., images where the pixel data (e.g., lighter pixel data having higher RGB value(s)) indicates that a skin area is rough across a skin area of the user. Similarly, a most or large hyperpigmentation value may be determined from an image or set of images having skin areas with high skin hyperpigmentation values, i.e., images where the pixel data (e.g., darker pixel data having lower RGB value(s)) indicates that a skin area is rough in a skin area of the user. Additionally, or alternatively, skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) is trained to detect patterns or groups of pixels within a given image. Such patterns or groups of pixels may be determined as having the same or similar RGB values (e.g., homogenous

values) in similar areas or portions of the given image. For example, a pattern or group of pixels may have similar RGB values along one or more body area location(s), including, for example, a jawline, arm, other such body portion of a user having curves or contours. Such curves or contours, identifiable within the pixel data, may track along the underlying bone or muscle tissue of a user, which in an image of the user, are expressed as the patterns or groups of pixels having the same or similar RGB values (e.g., homogeneous values) for a given portion of the image. In such instances, the patterns or groups of pixels can indicate a given body area location (e.g., a jawline), where a user-specific skin hyperpigmentation value may be determined based on the patterns or groups pixels. For example, in some embodiments, a hyperpigmentation of skin can be determined from a body area location (e.g., as determined from the patterns or groups of pixels). Additionally, or alternatively, a grouping or pattern of the pixels for the body area location itself can suggest skin hyperpigmentation. For example, a tighter grouping or pattern of pixels may indicate rough skin, but a looser grouping or pattern may indicate smooth skin.

[0049] In some embodiments, the skin hyperpigmentation scale may be a percentage scale, e.g., with skin hyperpigmentation model outputting skin hyperpigmentation values from 0% to 100%, where 0% represents least hyperpigmentation and 100% represents most hyperpigmentation. Values can range across this scale where a skin hyperpigmentation value of 67% represents one or more pixels of a skin area detected within an image that has a higher skin hyperpigmentation value than a skin hyperpigmentation value of 10% as detected for one or more pixels of a skin area within the same image or a different image (of the same or different user).

[0050] In some embodiments, the skin hyperpigmentation scale may be a numerical or decimal based scale, e.g., with skin hyperpigmentation model outputting skin hyperpigmentation values, e.g., from 0 to 10, where 0 represents least hyperpigmentation and 10 represents most hyperpigmentation. Values can range across this scale where a skin hyperpigmentation value of 78.9 represents one or more pixels of a skin area detected within an image that has a higher skin hyperpigmentation value than a skin hyperpigmentation value of 21.3 as detected for one or more pixels of a skin area within the same image or a different image (of the same or different user).

[0051] Skin hyperpigmentation values may be determined at the pixel level or for a given skin area (e.g., one or more pixels) in an image. Additionally, or alternatively, a comprehensive skin hyperpigmentation value, which can be a user-specific skin hyperpigmentation value as described herein, may be determined by averaging (or otherwise statistically analyzing) skin hyperpigmentation values for one or more pixels of a given skin area.

[0052] In various embodiments, skin hyperpigmentation model is an artificial intelligence (AI) based model trained with at least one AI algorithm. Training of skin hyperpigmentation model **108** involves image analysis of the training images to configure weights of skin hyperpigmentation model **108**, and its underlying algorithm (e.g., machine learning or artificial intelligence algorithm) used to predict and/or classify future images. For example, in various embodiments herein, generation of skin hyperpigmentation model **108** involves training skin hyperpigmentation model

108 with the plurality of training images of a plurality of individuals, where each of the training images comprise pixel data of a skin area of a respective individual. In some embodiments, one or more processors of a server or a cloud-based computing platform (e.g., imaging server(s) **102**) may receive the plurality of training images of the plurality of individuals via a computer network (e.g., computer network **120**). In such embodiments, the server and/or the cloud-based computing platform may train the skin hyperpigmentation model with the pixel data of the plurality of training images.

[0053] In various embodiments, a machine learning imaging model, as described herein (e.g., skin hyperpigmentation model **108**), may be trained using a supervised or unsupervised machine learning program or algorithm. The machine learning program or algorithm may employ a neural network, which may be a convolutional neural network, a deep learning neural network, or a combined learning module or program that learns in two or more features or feature datasets (e.g., pixel data) in a particular areas of interest. The machine learning programs or algorithms may also include natural language processing, semantic analysis, automatic reasoning, regression analysis, support vector machine (SVM) analysis, decision tree analysis, random forest analysis, K-Nearest neighbor analysis, naïve Bayes analysis, clustering, reinforcement learning, and/or other machine learning algorithms and/or techniques. In some embodiments, the artificial intelligence and/or machine learning based algorithms may be included as a library or package executed on imaging server(s) **102**. For example, libraries may include the TENSORFLOW based library, the PYTORCH library, and/or the SCIKIT-LEARN Python library.

[0054] Machine learning may involve identifying and recognizing patterns in existing data (such as training a model based on pixel data within images having pixel data of a skin area of a respective individual) in order to facilitate making predictions or identification for subsequent data (such as using the model on new pixel data of a new individual in order to determine a user-specific skin hyperpigmentation value of the user skin area of a user).

[0055] Machine learning model(s), such as the skin hyperpigmentation model described herein for some embodiments, may be created and trained based upon example data (e.g., “training data” and related pixel data) inputs or data (which may be termed “features” and “labels”) in order to make valid and reliable predictions for new inputs, such as testing level or production level data or inputs. In supervised machine learning, a machine learning program operating on a server, computing device, or otherwise processor(s), may be provided with example inputs (e.g., “features”) and their associated, or observed, outputs (e.g., “labels”) in order for the machine learning program or algorithm to determine or discover rules, relationships, patterns, or otherwise machine learning “models” that map such inputs (e.g., “features”) to the outputs (e.g., labels), for example, by determining and/or assigning weights or other metrics to the model across its various feature categories. Such rules, relationships, or otherwise models may then be provided subsequent inputs in order for the model, executing on the server, computing device, or otherwise processor(s), to predict, based on the discovered rules, relationships, or model, an expected output.

[0056] In unsupervised machine learning, the server, computing device, or otherwise processor(s), may be required to find its own structure in unlabeled example inputs, where, for example multiple training iterations are executed by the server, computing device, or otherwise processor(s) to train multiple generations of models until a satisfactory model, e.g., a model that provides sufficient prediction accuracy when given test level or production level data or inputs, is generated. The disclosures herein may use one or both of such supervised or unsupervised machine learning techniques.

[0057] Image analysis may include training a machine learning based model (e.g., the skin hyperpigmentation model) on pixel data of images of one or more individuals comprising pixel data of respective skin areas of the one or more individuals. Additionally, or alternatively, image analysis may include using a machine learning imaging model, as previously trained, to determine, based on the pixel data (e.g., including their RGB values) one or more images of the individual(s), a user-specific skin hyperpigmentation value of the user skin area. The weights of the model may be trained via analysis of various RGB values of individual pixels of a given image. For example, dark or low RGB values (e.g., a pixel with values R=25, G=28, B=31) may indicate a hyperpigmentation of skin from body area location(s) (e.g., cheek, neck, head, etc.) of a user. A red toned RGB value (e.g., a pixel with values R=215, G=90, B=85) may indicate irritated skin. A lighter RGB values (e.g., a pixel with R=181, G=170, and B=191) may indicate a lighter value, such as a normal skin tone color. Together, when a pixel with skin toned RGB value and/or a pixel with a lighter higher RGB value is positioned within a given image, or is otherwise surrounded by, a group or set of pixels having skin toned colors, then that may indicate an area on the skin where stretching of the skin occurs, respectively, as identified within the given image. In this way, pixel data (e.g., detailing one or more features of an individual, such as user skin area(s) of various individuals having different specific skin hyperpigmentation values(s) within 10,000s training images may be used to train or use a machine learning imaging model to determine a user-specific skin hyperpigmentation value of a given user skin area.

[0058] In some embodiments training, by the one or more processors (e.g., of imaging server(s) 102) with the pixel data of the plurality of training images, the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) comprises training the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) to detect a hyperpigmentation of skin from a body area location of the user to determine the user-specific skin hyperpigmentation value of the user skin area. In such embodiments the skin hyperpigmentation model may be trained to recognize that pixels with lighter values (e.g., lighter or higher RGB values) indicate a hyperpigmentation of skin from body area location(s) (e.g., an arm) of a user. For example, pixel 202bp1 is a pixel positioned in image 202b comprising a body area location of the user, including the user's arm. Pixel 202bp2 is a lighter pixel (e.g., a pixel with high R, G, and B values) positioned in image 202b where user 202bu has a hyperpigmentation of skin from the body area location (e.g., arm, e.g., of pixel 202bp1) identifiable within the portion of the user skin area of pixel data 202bp. Skin hyperpigmentation model 108 may be trained to recognize (by assigning greater weights to lighter pixels) that such lighter pixels (e.g., pixel

202bp2) against a pixel or group pixels having type skin tone colors (e.g., pixel 202bp1) indicates that hyperpigmentation of skin from the body area location occurs. The amount of hyperpigmentation can be determined from the amount or count of pixels detected from the lighter pixels to the body area location. For example, skin hyperpigmentation model 108 may be trained to recognize (by assigning greater weights to pixels within a zone between the lighter pixels and the body area location) that such zone (e.g., between or including pixels 202bp1 and 202bp2) represents an amount of skin from the body area location (e.g., arm). In this way the skin hyperpigmentation model can identify patterns within the pixel data to determine a user-specific skin hyperpigmentation value of the user skin area.

[0059] Additionally, or alternatively, training, by the one or more processors (e.g., of imaging server(s) 102) with the pixel data of the plurality of training images, the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) may comprise training the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) to detect a darker amount of skin within the skin area to determine the user-specific skin hyperpigmentation value of the user skin area. In such embodiments the skin hyperpigmentation model may be trained to recognize that pixels with darker values (e.g., darker or lower RGB values) indicate a darker amount of skin within the skin area of a user. For example, pixel 202ap2 is a pixel positioned in image 202a comprising a body area location of the user, including the user's chin or cheek. Pixel 202ap1 is a dark pixel (e.g., a pixel with low R, G, and B values) positioned in image 202a where user 202au has a dark amount of skin identifiable within the portion of the user skin area of pixel data 202ap. Skin hyperpigmentation model 108 may be trained to recognize (by assigning greater weights to darker pixels) that such darker pixels (e.g., pixel 202ap1) against a pixel or group pixels having skin tone colors indicates that a darker amount of skin occurs. The amount of hyperpigmentation can be determined from the amount or count of pixels detected from the dark pixels of the user skin area. For example, skin hyperpigmentation model 108 may be trained to recognize (by assigning greater weights to pixels within darker weights in a pattern across skin tone colors) that such pattern (e.g., of 202ap1) represents or is a swelling amount of skin from in the user skin area. In this way the skin hyperpigmentation model can identify patterns within the pixel data to determine a user-specific skin hyperpigmentation value of the user skin area.

[0060] Training, by the one or more processors (e.g., imaging server(s) 102) with the pixel data of the plurality of training images, the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) may comprise training the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) to detect a hyperpigmentation of skin from a body area location of the user within the skin area (as described herein) to determine the user-specific skin hyperpigmentation value of the user skin area.

[0061] In various embodiments, a skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) may be further trained, by one or more processors (e.g., imaging server(s) 102), with the pixel data of the plurality of training images, to output one or more location identifiers indicating one or more corresponding body area locations of respective individuals. In such embodiments, the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108),

executing on the one or more processors (e.g., imaging server(s) **102**) and analyzing the at least one image of the user, can determine a location identifier indicating a body area location of the user's skin area. For example, body area locations may comprise a user's cheek, a user's neck, a user's head, a user's groin, a user's underarm, a user's chest, a user's back, a user's leg, a user's arm, or a user's bikini area. For example, each of images **202a**, **202b**, and **202c** illustrate example body area locations including a user's neck, a user's arm, and a user's face, head, or eye, respectively. With reference to FIG. 3, at block **306** method **300** comprises receiving, at the one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**), at least one image of a user. The at least one image may have been captured by a digital camera. In addition, the at least one image may comprise pixel data of at least a portion of a user skin area of the user.

[**0062**] At block **308**, method **300** comprises analyzing, by the skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) executing on the one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**), the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area.

[**0063**] At block **310**, method **300** comprises generating, by the one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**) based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area.

[**0064**] At block **312**, method **300** comprises rendering, on a display screen of a user computing device, the at least one user-specific recommendation. A user computing device may comprise at least one of a mobile device, a tablet, a handheld device, or a desktop device, for example, as described herein for FIG. 1. In some embodiments, the user computing device (e.g., user computing device **111c1**) may receive the at least one image comprising the pixel data of the at least the portion of the user skin area. In such embodiments, the user computing device may execute the skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) locally and generate, based on output of the skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**), the user-specific recommendation. The user computing device **111c1** may then render the user-specific recommendation on its display screen.

[**0065**] Additionally, or alternatively, in other embodiments, the imaging server(s) **102** may analyze the user image remote from the user computing device to determine the user-specific skin hyperpigmentation value and/or user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area. For example, in such embodiments imaging server or a cloud-based computing platform (e.g., imaging server(s) **102**) receives, across computer network **120**, the at least one image comprising the pixel data of at the at least the portion of the user skin area. The server or a cloud-based computing platform may then execute skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) and generate, based on output of the skin hyperpigmentation model (e.g., skin hyper-

pigmentation model **108**), the user-specific recommendation. The server or a cloud-based computing platform may then transmit, via the computer network (e.g., computer network **120**), the user-specific recommendation to the user computing device for rendering on the display screen of the user computing device.

[**0066**] In some embodiments, the user may submit a new image to the skin hyperpigmentation model for analysis as described herein. In such embodiments, one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**) may receive a new image of the user. The new image may be captured by a digital camera of user computing device **111c1**. The new image may comprise pixel data of at least a portion of a user skin area of the user. The skin hyperpigmentation model (e.g., skin hyperpigmentation model **108**) may then analyze, on the one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**), the new image captured by the digital camera to determine a new user-specific skin hyperpigmentation value of the user skin area. A new user-specific electronic recommendation or comment may be generated, based on the new user-specific skin hyperpigmentation value, regarding at least one feature identifiable within the pixel data of the new image. The new user-specific recommendation or comment (e.g., message) may then be rendered on a display screen of a user computing device of the user.

[**0067**] In some embodiments, a user-specific electronic recommendation may be displayed on the display screen of a user computing device (e.g., user computing device **111c1**) with a graphical representation of the user's skin as annotated with one or more graphics or textual renderings corresponding to the user-specific skin hyperpigmentation value. In still further embodiments, the at least one user-specific electronic recommendation may be rendered in real-time or near-real time during or after receiving the at least one image having the user skin area.

[**0068**] In additional embodiments, a user-specific electronic recommendation may comprise a product recommendation for a manufactured product. In such embodiments, the user-specific electronic recommendation may be displayed on the display screen of a user computing device (e.g., user computing device **111c1**) with instructions (e.g., a message) for treating, with the manufactured product, the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area. In still further embodiments, either the user computing device **111c1** and/or imaging server(s) may initiate, based on the product recommendation, the manufactured product for shipment to the user.

[**0069**] With regard to manufactured product recommendations, in some embodiments, one or more processors (e.g., imaging server(s) **102** and/or a user computing device, such as user computing device **111c1**) may generate a modified image based on the at least one image of the user, e.g., as originally received. In such embodiments, the modified image may depict a rendering of how the user's skin is predicted to appear after treating the at least one feature with the manufactured product. For example, the modified image may be modified by updating, smoothing, or changing colors of the pixels of the image to represent a possible or predicted change after treatment of the at least one feature within the pixel data with the manufactured product. The modified

image may then be rendered on the display screen of the user computing device (e.g., user computing device 111c1).

[0070] Additionally, or alternatively, a recommendation may be also made for the user's skin in the at least one image of the user, e.g., as originally received. In such embodiments, a user-specific electronic recommendation may display on the display screen of the user computing device (e.g., user computing device 111c1) with instructions for treating the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area.

[0071] FIG. 4 illustrates an example user interface 402 as rendered on a display screen 400 of a user computing device 111c1 in accordance with various embodiments disclosed herein. For example, as shown in the example of FIG. 4, user interface 402 may be implemented or rendered via an application (app) executing on user computing device 111c1.

[0072] For example, as shown in the example of FIG. 4, user interface 402 may be implemented or rendered via a native app executing on user computing device 111c1. In the example of FIG. 4, user computing device 111c1 is a user computer device as described for FIG. 1, e.g., where 111c1 is illustrated as an APPLE iPhone that implements the APPLE iOS operating system and has display screen 400. User computing device 111c1 may execute one or more native applications (apps) on its operating system. Such native apps may be implemented or coded (e.g., as computing instructions) in a computing language (e.g., SWIFT) executable by the user computing device operating system (e.g., APPLE iOS) by the processor of user computing device 111c1.

[0073] Additionally, or alternatively, user interface 402 may be implemented or rendered via a web interface, such as via a web browser application, e.g., Safari and/or Google Chrome app(s), or other such web browser or the like.

[0074] As shown in the example of FIG. 4, user interface 402 comprises a graphical representation (e.g., image 202a) of the user's skin. Image 202a may be the at least one image of the user (or graphical representation thereof), having pixels depicting skin hyperpigmentation, and as analyzed by the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) as described herein. In the example of FIG. 4, graphical representation (e.g., image 202a) of the user's skin is annotated with one or more graphics (e.g., area of pixel data 202a1) or textual rendering (e.g., text 202at) corresponding to the user-specific skin hyperpigmentation value. For example, the area of pixel data 202ap may be annotated or overlaid on top of the image of the user (e.g., image 202a) to highlight the area or feature(s) identified within the pixel data (e.g., feature data and/or raw pixel data) by the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108). In the example of FIG. 4, the area of pixel data 202ap and the feature(s) identified within include the user-specific skin hyperpigmentation of the user's skin area, and other features shown in area of pixel data 202ap. In various embodiments, the pixels identified as the specific features indicating skin hyperpigmentation (e.g., pixel 202ap1 as a dark pixel indicating a dark amount of skin) from a body area location (e.g., pixel 202ap2 positioned at a cheek of the user) may be highlighted or otherwise annotated when rendered.

[0075] Textual rendering (e.g., text 202at) shows a user-specific skin hyperpigmentation value (e.g., 78.6%) which illustrates that the user has a skin hyperpigmentation value of 78.6% in the region defined by pixel data 202ap. The

78.6% value indicates that the user has a high amount of skin hyperpigmentation in the user skin area. It is to be understood that other textual rendering types or values are contemplated herein, where textual rendering types or values may be rendered, for example, as measurements, numerical values, amounts of pixels detected as lax, or derivatives thereof, or the like. Additionally, or alternatively, color values may use and/or overlaid on a graphical representation shown on user interface 402 (e.g., image 202a) to indicate a high degree of skin hyperpigmentation, a low degree of skin hyperpigmentation, or skin hyperpigmentation values within normal ranges or values (e.g., 25% to 50% skin hyperpigmentation value).

[0076] User interface 402 may also include or render a user-specific electronic recommendation 412. In the embodiment of FIG. 4, user-specific electronic recommendation 412 comprises a message 412m to the user designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area. As shown in the example of FIG. 4, message 412m recommends to the user to apply a skin cream to the user's skin.

[0077] In particular, message 412m recommends use of a skin cream to the user's skin. The skin cream recommendation can be made based on the high skin hyperpigmentation value (e.g., 78.6%) as detected by the skin hyperpigmentation model where the skin cream product is designed to address the issue of skin hyperpigmentation detected in the pixel data of image 202a or otherwise assumed based on the high skin hyperpigmentation value. The product recommendation can be correlated to the identified feature within the pixel data, and the user computing device 111c1 and/or server(s) 102 can be instructed to output the product recommendation when the feature (e.g., excessive skin hyperpigmentation) is identified.

[0078] User interface 402 also include or render a section for a product recommendation 422 for a manufactured product 424r (e.g., skin cream as described above). The product recommendation 422 generally corresponds to the user-specific electronic recommendation 412, as described above. For example, in the example of FIG. 4, the user-specific electronic recommendation 412 is displayed on display screen 400 of user computing device 111c1 with instructions (e.g., message 412m) for treating, with the manufactured product (manufactured product 424r (e.g., skin cream)) at least one feature (e.g., 78.6% skin hyperpigmentation at pixel 202ap1) identifiable in the pixel data (e.g., pixel data 202ap) comprising the at least the portion of the user skin area (e.g., pixel 202ap1).

[0079] As shown in FIG. 4, user interface 402 recommends a product (e.g., manufactured product 424r (e.g., skin cream)) based on the user-specific electronic recommendation 412. In the example of FIG. 4, the output or analysis of image(s) (e.g., image 202a) of skin hyperpigmentation model (e.g., skin hyperpigmentation model 108), e.g., user-specific electronic recommendation 412 and/or its related values (e.g., 78.6% skin hyperpigmentation) or related pixel data (e.g., 202ap1 and/or 202ap2), may be used to generate or identify recommendations for corresponding product(s). Such recommendations may include products such as skin cream, cosmeceutical products, skin creams, and/or other such skin hyperpigmentation products, or the like, to address the user-specific issue as detected within the pixel data by the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108).

[0080] In the example of FIG. 4, user interface 402 renders or provides a recommended product (e.g., manufactured product 424r) as determined by skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) and its related image analysis of image 202a and its pixel data and various features. In the example of FIG. 4, this is indicated and annotated (424p) on user interface 402.

[0081] User interface 402 may further include a selectable UI button 424s to allow the user (e.g., the user of image 202a) to select for purchase or shipment the corresponding product (e.g., manufactured product 424r). In some embodiments, selection of selectable UI button 424s may cause the recommended product(s) to be shipped to the user (e.g., individual 501) and/or may notify a third party that the individual is interested in the product(s). For example, either user computing device 111c1 and/or imaging server(s) 102 may initiate, based on user-specific electronic recommendation 412, the manufactured product 424r (e.g., skin cream) for shipment to the user. In such embodiments, the product may be packaged and shipped to the user. In various embodiments, graphical representation (e.g., image 202a), with graphical annotations (e.g., area of pixel data 202ap), textual annotations (e.g., text 202at), user-specific electronic recommendation 412 may be transmitted, via the computer network (e.g., from an imaging server 102 and/or one or more processors) to user computing device 111c1, for rendering on display screen 400. In other embodiments, no transmission to the imaging server of the user's specific image occurs, where the user-specific recommendation (and/or product specific recommendation) may instead be generated locally, by the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) executing and/or implemented on the user's mobile device (e.g., user computing device 111c1) and rendered, by a processor of the mobile device, on display screen 400 of the mobile device (e.g., user computing device 111c1).

[0082] In some embodiments, any one or more of graphical representations (e.g., image 202a), with graphical annotations (e.g., area of pixel data 202ap), textual annotations (e.g., text 202at), user-specific electronic recommendation 412, and/or product recommendation 422 may be rendered (e.g., rendered locally on display screen 400) in real-time or near-real time during or after receiving the at least one image having the user skin area. In embodiments where the image is analyzed by imaging server(s) 102, the image may be transmitted and analyzed in real-time or near real-time by imaging server(s) 102.

[0083] In some embodiments, the user may provide a new image that may be transmitted to imaging server(s) 102 for updating, retraining, or reanalyzing by skin hyperpigmentation model 108. In other embodiments, a new image that may be locally received on computing device 111c1 and analyzed, by skin hyperpigmentation model 108, on the computing device 111c1.

[0084] In addition, as shown in the example of FIG. 4, the user may select selectable button 412i to for reanalyzing (e.g., either locally at computing device 111c1 or remotely at imaging server(s) 102) a new image. Selectable button 412i may cause user interface 402 to prompt the user to attach for analyzing a new image. Imaging server(s) 102 and/or a user computing device such as user computing device 111c1 may receive a new image of the user comprising pixel data of at least a portion of a user skin area of the user. The new image may be captured by the digital camera.

The new image (e.g., just like image 202a) may comprise pixel data of at least a portion of the user skin area. The skin hyperpigmentation model (e.g., skin hyperpigmentation model 108), executing on the memory of the computing device (e.g., imaging server(s) 102), may analyze the new image captured by the digital camera to determine a new user-specific skin hyperpigmentation value of the user's skin area. The computing device (e.g., imaging server(s) 102) may generate, based on the new user-specific skin hyperpigmentation value, a new user-specific electronic recommendation or comment regarding at least one feature identifiable within the pixel data of the new image. For example, the new user-specific electronic recommendation may include a new graphical representation including graphics and/or text (e.g., showing a new user-specific skin hyperpigmentation value, e.g., 60%). The new user-specific electronic recommendation may include additional recommendations, e.g., that the user has incorrectly applied a skin cream as detected with the pixel data of the new image. A comment may include that the user has corrected the at least one feature identifiable within the pixel data (e.g., the user-specific skin hyperpigmentation value is now correct) by use of a recommended manufactured product or otherwise.

[0085] In some embodiments, a delta user-specific skin hyperpigmentation value may be generated, by the one or more processors (e.g., a processor of imaging server(s) 102 and/or user computing device such as user computing device 111c1) based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value. In such embodiments, the new user-specific recommendation or comment may be further based on the delta user-specific skin hyperpigmentation value. The delta user-specific skin hyperpigmentation value, a representation of the delta user-specific skin hyperpigmentation value (e.g., a graph or other graphical depiction), or a comment (e.g., text) based on the delta user-specific skin hyperpigmentation value, may be rendered on the display screen of the user computing device (e.g., user computing device 111c1) to illustrate or describe the difference (delta) between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value as previously determined. Additionally, or alternatively, a delta user-specific skin hyperpigmentation value may be generated based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value where the new user-specific recommendation comprises a recommendation of a hair removal product or hair removal technique for the user corresponding to the delta user-specific skin hyperpigmentation value. As one example, the delta user-specific hyperpigmentation value, determined based on a first image captured at a first time and a second image captured at a second time, may indicate whether the user's skin would benefit (e.g., experience less skin irritation and/or achieve a closer shave) from either a wet shaving razor, a dry shaving razor, and/or an electronic shaving razor, or based on other such razor characteristics. In such embodiments, the new user-specific recommendation may display the recommendation for a shaving razor, specific to the user's skin hyperpigmentation value(s), on a display screen of the user computing screen. Additionally, or alternatively, as further examples, the user computing device, based on a delta user-specific skin hyperpigmentation value for the user, may

recommend a range of one or more hair removal product(s) or hair removal technique(s), which may include shaving using a wet razor, shaving using a dry shaver, removing hair with epilators, waxes, and/or the like.

[0086] In various embodiments, the new user-specific recommendation or comment may be transmitted via the computer network, from server(s) 102, to the user computing device of the user for rendering on the display screen of the user computing device.

[0087] In other embodiments, no transmission to the imaging server of the user's new image occurs, where the new user-specific recommendation (and/or product specific recommendation) may instead be generated locally, by the skin hyperpigmentation model (e.g., skin hyperpigmentation model 108) executing and/or implemented on the user's mobile device (e.g., user computing device 111c1) and rendered, by a processor of the mobile device, on a display screen of the mobile device (e.g., user computing device 111c1).

Aspects of the Disclosure

[0088] The following aspects are provided as examples in accordance with the disclosure herein and are not intended to limit the scope of the disclosure.

[0089] 1. A digital imaging method of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation, the digital imaging method comprising the steps of: (a) aggregating, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual; (b) training, by the one or more processors with the pixel data of the plurality of training images, a skin hyperpigmentation model comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation; (c) receiving, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; (d) analyzing, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; (e) generating, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and (f) rendering, on a display screen of a user computing device, the at least one user-specific recommendation.

[0090] 2. The digital imaging method of aspect 1, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with a graphical representation of the user's skin as annotated with one or more graphics or textual renderings corresponding to the user-specific skin hyperpigmentation value.

[0091] 3. The digital imaging method of any one of aspects 1-2, wherein the at least one user-specific electronic

recommendation is rendered in real-time or near-real time, during, or after receiving the at least one image having the user skin area.

[0092] 4. The digital imaging method of any one of aspects 1-3, wherein the at least one user-specific electronic recommendation comprises a product recommendation for a manufactured product.

[0093] 5. The digital imaging method of aspect 4, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with instructions for treating, with the manufactured product, the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area.

[0094] 6. The digital imaging method of aspect 4, further comprising the steps of initiating, based on the product recommendation, the manufactured product for shipment to the user.

[0095] 7. The digital imaging method of aspect 4, further comprising the steps of generating, by the one or more processors, a modified image based on the at least one image, the modified image depicting how the user's skin is predicted to appear after treating the at least one feature with the manufactured product; and rendering, on the display screen of the user computing device, the modified image.

[0096] 8. The digital imaging method of any one of aspects 1-7, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with instructions for treating the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area.

[0097] 9. The digital imaging method of any one of aspects 1-8, wherein the skin hyperpigmentation model is an artificial intelligence (AI) based model trained with at least one AI algorithm.

[0098] 10. The digital imaging method of any one of aspects 1-9, wherein the skin hyperpigmentation model is further trained, by the one or more processors with the pixel data of the plurality of training images, to output one or more location identifiers indicating one or more corresponding body area locations of respective individuals, and wherein the skin hyperpigmentation model, executing on the one or more processors and analyzing the at least one image of the user, determines a location identifier indicating a body area location of the user skin area.

[0099] 11. The digital method of aspect 10, wherein the body area location comprises the user's head, the user's groin, the user's underarm, the user's cheek, the user's neck, the user's chest, the user's back, the user's leg, the user's arm, or the user's bikini area.

[0100] 12. The digital method of any one of aspects 1-11, wherein training, by the one or more processors with the pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a darker amount of skin from a body area location of the user to determine the user-specific skin hyperpigmentation value of the user skin area.

[0101] 13. The digital method of any one of aspects 1-12, wherein training, by the one or more processors with the pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a darker amount of skin within the skin area to determine the user-specific skin hyperpigmentation value of the user skin area.

[0102] 14. The digital method of any one of aspects 1-13, wherein training, wherein training, by the one or more processors with the pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a darker amount of skin from a body area location of the user within the skin area to determine the user-specific skin hyperpigmentation value of the user skin area.

[0103] 15. The digital method of any one of aspects 1-14, further comprising: receiving, at the one or more processors, a new image of the user, the new image captured by the digital camera, and the new image comprising pixel data of at least a portion of a user skin area of the user; analyzing, by the skin hyperpigmentation model executing on the one or more processors, the new image captured by the digital camera to determine a new user-specific skin hyperpigmentation value of the user skin area; generating, based on the new user-specific skin hyperpigmentation value, a new user-specific electronic recommendation or comment regarding at least one feature identifiable within the pixel data of the new image; and rendering, on a display screen of a user computing device of the user, the new user-specific recommendation or comment.

[0104] 16. The digital imaging method of aspect 15, wherein a delta user-specific skin hyperpigmentation value is generated based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value, wherein the new user-specific recommendation or comment is further based on the delta user-specific skin hyperpigmentation value, and wherein the delta user-specific skin hyperpigmentation value, a representation of the delta user-specific skin hyperpigmentation value, or a comment based on the delta user-specific skin hyperpigmentation value, is rendered on the display screen of the user computing device.

[0105] 17. The digital imaging method of aspect 15, wherein a delta user-specific skin hyperpigmentation value is generated based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value, wherein the new user-specific recommendation comprises a recommendation of a hair removal product or hair removal technique for the user corresponding to the delta user-specific skin hyperpigmentation value.

[0106] 18. The digital method of any one of aspects 1-17, wherein the one or more processors comprises at least one of a server or a cloud-based computing platform, and the server or the cloud-based computing platform receives the plurality of training images of the plurality of individuals via a computer network, and wherein the server or the cloud-based computing platform trains the skin hyperpigmentation model with the pixel data of the plurality of training images.

[0107] 19. The digital method of aspect 18, wherein the server or a cloud-based computing platform receives the at least one image comprising the pixel data of the at least the portion of the user skin area of the user, and wherein the server or a cloud-based computing platform executes the skin hyperpigmentation model and generates, based on output of the skin hyperpigmentation model, the user-specific recommendation and transmits, via the computer network, the user-specific recommendation to the user computing device for rendering on the display screen of the user computing device.

[0108] 20. The digital method of any one of aspects 1-19, wherein the user computing device comprises at least one of a mobile device, a tablet, a handheld device, a desktop device, a home assistant device, or a personal assistant device.

[0109] 21. The digital method of any one of aspects 1-20, wherein the user computing device receives the at least one image comprising the pixel data of at least the portion of the user skin area of the user, and wherein the user computing device executes the skin hyperpigmentation model and generates, based on output of the skin hyperpigmentation model, the user-specific recommendation, and renders the user-specific recommendation on the display screen of the user computing device.

[0110] 22. The digital method of any one of aspects 1-22, wherein the at least one image comprises a plurality of images.

[0111] 23. The digital method of aspect 22, wherein the plurality of images are collected using a digital video camera.

[0112] 24. A digital imaging system configured to analyze pixel data of an image of a skin area of a user for determining skin hyperpigmentation, the digital imaging system comprising: an imaging server comprising a server processor and a server memory; an imaging application (app) configured to execute on a user computing device comprising a device processor and a device memory, the imaging app communicatively coupled to the imaging server; and a skin hyperpigmentation model trained with pixel data of a plurality of training images of individuals and operable to output, across a range of a skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation, wherein the skin hyperpigmentation model is configured to execute on the server processor or the device processor to cause the server processor or the device processor to: receive, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; analyze, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; generate, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and render, on a display screen of a user computing device, the at least one user-specific recommendation.

[0113] 25. A tangible, non-transitory computer-readable medium storing instructions for analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation, that when executed by one or more processors cause the one or more processors to: (a) aggregate, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual; (b) train, by the one or more processors with the pixel data of the plurality of training images, a skin hyperpigmentation model comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin

hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation; (c) receive, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user; (d) analyze, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area; (e) generate, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and (f) render, on a display screen of a user computing device, the at least one user-specific recommendation.

Additional Considerations

[0114] Although the disclosure herein sets forth a detailed description of numerous different embodiments, it should be understood that the legal scope of the description is defined by the words of the claims set forth at the end of this patent and equivalents. The detailed description is to be construed as exemplary only and does not describe every possible embodiment since describing every possible embodiment would be impractical. Numerous alternative embodiments may be implemented, using either current technology or technology developed after the filing date of this patent, which would still fall within the scope of the claims.

[0115] The following additional considerations apply to the foregoing discussion. Throughout this specification, plural instances may implement components, operations, or structures described as a single instance. Although individual operations of one or more methods are illustrated and described as separate operations, one or more of the individual operations may be performed concurrently, and nothing requires that the operations be performed in the order illustrated. Structures and functionality presented as separate components in example configurations may be implemented as a combined structure or component. Similarly, structures and functionality presented as a single component may be implemented as separate components. These and other variations, modifications, additions, and improvements fall within the scope of the subject matter herein.

[0116] Additionally, certain embodiments are described herein as including logic or a number of routines, subroutines, applications, or instructions. These may constitute either software (e.g., code embodied on a machine-readable medium or in a transmission signal) or hardware. In hardware, the routines, etc., are tangible units capable of performing certain operations and may be configured or arranged in a certain manner. In example embodiments, one or more computer systems (e.g., a standalone, client or server computer system) or one or more hardware modules of a computer system (e.g., a processor or a group of processors) may be configured by software (e.g., an application or application portion) as a hardware module that operates to perform certain operations as described herein.

[0117] The various operations of example methods described herein may be performed, at least partially, by one or more processors that are temporarily configured (e.g., by software) or permanently configured to perform the relevant operations. Whether temporarily or permanently configured,

such processors may constitute processor-implemented modules that operate to perform one or more operations or functions. The modules referred to herein may, in some example embodiments, comprise processor-implemented modules.

[0118] Similarly, the methods or routines described herein may be at least partially processor-implemented. For example, at least some of the operations of a method may be performed by one or more processors or processor-implemented hardware modules. The performance of certain of the operations may be distributed among the one or more processors, not only residing within a single machine, but deployed across a number of machines. In some example embodiments, the processor or processors may be located in a single location, while in other embodiments the processors may be distributed across a number of locations.

[0119] The performance of certain of the operations may be distributed among the one or more processors, not only residing within a single machine, but deployed across a number of machines. In some example embodiments, the one or more processors or processor-implemented modules may be located in a single geographic location (e.g., within a home environment, an office environment, or a server farm). In other embodiments, the one or more processors or processor-implemented modules may be distributed across a number of geographic locations.

[0120] This detailed description is to be construed as exemplary only and does not describe every possible embodiment, as describing every possible embodiment would be impractical, if not impossible. A person of ordinary skill in the art may implement numerous alternate embodiments, using either current technology or technology developed after the filing date of this application.

[0121] Those of ordinary skill in the art will recognize that a wide variety of modifications, alterations, and combinations can be made with respect to the above described embodiments without departing from the scope of the invention, and that such modifications, alterations, and combinations are to be viewed as being within the ambit of the inventive concept.

[0122] The patent claims at the end of this patent application are not intended to be construed under 35 U.S.C. § 112(f) unless traditional means-plus-function language is expressly recited, such as “means for” or “step for” language being explicitly recited in the claim(s). The systems and methods described herein are directed to an improvement to computer functionality and improve the functioning of conventional computers.

[0123] The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm.”

[0124] Every document cited herein, including any cross referenced or related patent or application and any patent application or patent to which this application claims priority or benefit thereof, is hereby incorporated herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or

discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern.

[0125] While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. A digital imaging method of analyzing pixel data of an image of a skin area of a user for determining skin hyperpigmentation, the digital imaging method comprising the steps of:

- a. aggregating, at one or more processors communicatively coupled to one or more memories, a plurality of training images of a plurality of individuals, each of the training images comprising pixel data of a skin area of a respective individual;
- b. training, by the one or more processors with the pixel data of the plurality of training images, a skin hyperpigmentation model comprising a skin hyperpigmentation scale and operable to output, across a range of the skin hyperpigmentation scale, skin hyperpigmentation values associated with a degree of skin hyperpigmentation ranging from least hyperpigmentation to most hyperpigmentation;
- c. receiving, at the one or more processors, at least one image of a user, the at least one image captured by a digital camera, and the at least one image comprising pixel data of at least a portion of a user skin area of the user;
- d. analyzing, by the skin hyperpigmentation model executing on the one or more processors, the at least one image captured by the digital camera to determine a user-specific skin hyperpigmentation value of the user skin area;
- e. generating, by the one or more processors based on the user-specific skin hyperpigmentation value, at least one user-specific electronic recommendation designed to address at least one feature identifiable within the pixel data comprising the at least the portion of the user skin area; and
- f. rendering, on a display screen of a user computing device, the at least one user-specific recommendation
- g. receiving, at the one or more processors, a new image of the user, the new image captured by the digital camera, and the new image comprising pixel data of at least a portion of a user skin area of the user;
- h. analyzing, by the skin hyperpigmentation model executing on the one or more processors, the new image captured by the digital camera to determine a new user-specific skin hyperpigmentation value of the user skin area;
- i. generating, based on the new user-specific skin hyperpigmentation value, a new user-specific electronic recommendation or comment regarding at least one feature identifiable within the pixel data of the new image; and

- j. rendering, on a display screen of a user computing device of the user, the new user-specific recommendation or comment;

wherein a delta user-specific skin hyperpigmentation value is generated based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value, wherein the new user-specific recommendation comprises a recommendation of a hair removal product or hair removal technique for the user corresponding to the delta user-specific skin hyperpigmentation value.

2. The digital imaging method of claim 1, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with a graphical representation of the user's skin as annotated with one or more graphics or textual renderings corresponding to the user-specific skin hyperpigmentation value.

3. The digital imaging method of claim 1, wherein the at least one user-specific electronic recommendation is rendered in real-time or near-real time, during, or after receiving the at least one image having the user skin area.

4. The digital imaging method of claim 1, wherein the at least one user-specific electronic recommendation comprises a product recommendation for a manufactured product.

5. The digital imaging method of claim 4, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with instructions for treating, with the manufactured product, the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area.

6. The digital imaging method of claim 4, further comprising the steps of:

initiating, based on the product recommendation, the manufactured product for shipment to the user.

7. The digital imaging method of claim 4, further comprising the steps of:

generating, by the one or more processors, a modified image based on the at least one image, the modified image depicting how the user's skin is predicted to appear after treating the at least one feature with the manufactured product; and

rendering, on the display screen of the user computing device, the modified image.

8. The digital imaging method of claim 1, wherein the at least one user-specific electronic recommendation is displayed on the display screen of the user computing device with instructions for treating the at least one feature identifiable in the pixel data comprising the at least the portion of the user skin area.

9. The digital imaging method of claim 1, wherein the skin hyperpigmentation model is an artificial intelligence (AI) based model trained with at least one AI algorithm.

10. The digital imaging method of claim 1,

wherein the skin hyperpigmentation model is further trained, by the one or more processors with the pixel data of the plurality of training images, to output one or more location identifiers indicating one or more corresponding body area locations of respective individuals, and

wherein the skin hyperpigmentation model, executing on the one or more processors and analyzing the at least

one image of the user, determines a location identifier indicating a body area location of the user skin area.

11. The digital method of claim **10**, wherein the body area location comprises the user's cheek, the user's neck, the user's head, the user's groin, the user's underarm, the user's chest, the user's back, the user's leg, the user's arm, or the user's bikini area.

12. The digital method of claim **1**, wherein training, by the one or more processors with the pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a darker amount of skin from a body area location of the user to determine the user-specific skin hyperpigmentation value of the user skin area.

13. The digital method of claim **1**, wherein training, by the one or more processors with the pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a darker amount of skin within the skin area to determine the user-specific skin hyperpigmentation value of the user skin area.

14. The digital method of claim **1**, wherein training, wherein training, by the one or more processors with the

pixel data of the plurality of training images, the skin hyperpigmentation model comprises training the skin hyperpigmentation model to detect a dark amount of skin from a body area location of the user within the skin area to determine the user-specific skin hyperpigmentation value of the user skin area.

15. The digital imaging method of claim **1**, wherein a delta user-specific skin hyperpigmentation value is generated based on a comparison between the new user-specific skin hyperpigmentation value and the user-specific skin hyperpigmentation value, wherein the new user-specific recommendation or comment is further based on the delta user-specific skin hyperpigmentation value, and wherein the delta user-specific skin hyperpigmentation value, a representation of the delta user-specific skin hyperpigmentation value, or a comment based on the delta user-specific skin hyperpigmentation value, is rendered on the display screen of the user computing device.

16. The digital method of claim **1**, wherein the user computing device receives the at least one image the user-specific recommendation on the display screen of the user computing device.

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