

SYSTEM AND METHOD FOR IDENTIFYING VEINS

TECHNICAL FIELD

5 **[0001]** The present disclosure generally relates to systems and methods for identifying presence of veins under a skin of a patient.

BACKGROUND

10 **[0002]** Venipuncture is one of the most commonly performed clinical procedures. Up to 84% of patients admitted to a hospital require venipuncture. However, venipuncture may be challenging in patients with various disorders that cause their veins to be inaccessible, or not easily visible to the caregiver. Such patients may be, for example, patients with renal failure, obesity, a history of intra-venous drug use, as well as elderly patients.

15 **[0003]** There is also a need to determine which veins may be unsuitable for venipuncture. Such unsuitable veins may be veins with branch points, tortuous veins, veins of inadequate caliber, or an area of valve or thrombus.

[0004] Significant variation in first-attempt venipuncture success rate has been reported, ranging from 18% to 86%. Multiple unsuccessful venipuncture attempts may cause pain, delays in obtaining venous blood samples required for medical investigations, and delays in treatment via an intra-venous line. Such delays may be critical in emergency cases.

20 **[0005]** Currently available devices are cumbersome and require the user to hold the illuminating device in one hand while using the other available hand to perform the procedure. The currently available devices would only offer illumination from a single source. Such light source angle relative to the target puncture area cannot be easily manipulated since to avoid obstruction of view such devices require a positioning at an acute angle relative to the intended location of puncture and would therefore provide poor illumination results.

[0006] There is therefore a need for a system and method for easily and quickly identifying veins that are suitable for venipuncture.

30 SUMMARY

[0007] The present disclosure provides a system for identifying peripheral veins, said system comprising at least two illuminating units, each illuminating unit comprising a housing, said housing adapted to be placed onto a finger of a user, wherein said housing has a shape and

size, which conform to the shape and size of a human finger, to enable maneuverability of each illuminating unit in three-dimensional space; and at least one illumination source, said at least one illumination source configured to illuminate light at a wavelength selected from the entire visible light spectrum for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye.

[0008] The illumination source is configured to illuminate light at a wavelength selected from the red spectrum.

[0009] The illumination source is configured to illuminate light at a wavelength selected between 610 nm and 760 nm

[0010] The system further comprises a display unit for displaying the highlighted veins to a user. Each illuminating unit comprises a camera for acquiring images of the highlighted veins and a transmitter for transmitting said images to the display unit. The transmitter is a wireless transmitter. Each illuminating unit is adapted to be placed onto a different finger of a user.

[0011] The system further comprises an intensity control unit configured to control the intensity of said at least one illumination source.

[0012] The system further comprises a color control unit configured to control the wavelength at which said at least one illumination source illuminates. Each illuminating unit is connected to an external device, said external device comprising a power source. each illuminating unit comprises an internal power source within said housing. each illuminating unit comprises at least one illumination source at a top end of said each illuminating unit. each illuminating unit comprises more than one illumination source on a side of said housing of each illuminating unit. The at least two illuminating units are connected to an external light source via a fiber optic connection. The at least two illuminating units are connected via an electrical connection. The housing is made of a flexible material.

[0013] The at least two illuminating units is configured to be placed onto a thumb of a user and another unit of said at least two illuminating units is configured to be placed onto an index finger of the user.

[0014] The present disclosure provides a method for identifying peripheral veins, said method comprising providing at least two illuminating units, each illuminating unit comprising a housing, said housing adapted to be placed onto a finger of a user; at least one illumination source, said illumination source configured to illuminate light at a wavelength selected from the entire visible light spectrum for highlighting visibility of peripheral veins

which are otherwise invisible to a naked eye; maneuvering said at least two illuminating units in three-dimensional space such to control angle of illumination towards a skin of a patient, distance between said at least two illuminating units, and pressure applied onto the skin of the patient via said at least two illuminating units; and identifying peripheral veins within or under the skin of the patient.

[0015] The method further comprising compressing a vein by applying pressure via said at least two illuminating units onto a skin of a patient, to differentiate between a valve and a thrombus, and between a patent vein and a thrombus.

[0016] The method further comprising anchoring a vein in a stable position by applying pressure via said at least two illuminating units onto a skin of a patient.

[0017] The method further comprising increasing amount of light directed into a skin of a patient for increasing visibility of a vein within or under the skin, by applying pressure via said at least two illuminating units onto a skin of a patient.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] Some non-limiting exemplary embodiments or features of the disclosed subject matter are illustrated in the following drawings:

[0019] FIG. 1 is a schematic illustration of a system for identifying veins, according to embodiments of the disclosure;

[0020] FIG. 2A is a schematic illustration of a system for identifying veins, during operation, according to embodiments of the disclosure;

[0021] FIG. 2B is a schematic illustration of a display of a system for identifying veins, according to embodiments of the present disclosure;

[0022] FIG. 3 is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure;

[0023] FIGs. 4A-4C are schematic illustrations of an illuminating unit for identifying veins in perspective view, inner front view, and inner side view, respectively, according to embodiments of the present disclosure;

[0024] FIG. 5 is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure;

[0025] FIG. 6 is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure;

[0026] FIG. 7 is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure; and

[0027] FIG. 8 is a schematic flowchart illustrating a method for identifying veins, according to embodiments of the present disclosure.

5 [0028] With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the disclosure. In this regard, the description taken with the drawings makes apparent to those skilled in the art how embodiments of the disclosure may be practiced.

[0029] Identical or duplicate or equivalent or similar structures, elements, or parts that
10 appear in one or more drawings are generally labeled with the same reference numeral, optionally with an additional letter or letters to distinguish between similar entities or variants of entities, and may not be repeatedly labeled and/or described. References to previously presented elements are implied without necessarily further citing the drawing or description in which they appear.

15 [0030] Dimensions of components and features shown in the figures are chosen for convenience or clarity of presentation and are not necessarily shown to scale or true perspective. For convenience or clarity, some elements or structures are not shown or shown only partially and/or with different perspective or from different point of views.

20 DETAILED DESCRIPTION

[0031] Some embodiments of the present disclosure provide systems and methods for identifying veins prior to venipuncture procedure, in a user friendly, quick and precise manner. Current systems and methods for identifying veins include using illuminating devices that are rigid and do not enable any flexibility in maneuvering such devices.
25 However, the present disclosure provides systems and methods for identifying veins while enabling maneuverability of the illuminating units, since the units are configured to be placed onto a finger of a user, e.g., a caregiver.

[0032] The illuminating units of the present disclosure include a housing that conforms to the shape and size of a finger of a user, thus allowing these illuminating units to be
30 maneuverable in three dimensional space by the user of these units. The angle of illumination, the distance between two illuminating units, and the amount of pressure applied onto a skin of a user (via pressure applied onto the illuminating units) may be controlled by a user of the systems of the present disclosure in order to provide accurate identification of

veins suitable for venipuncture procedure. Current illuminating systems are incapable of controlling such features, and are thus incapable of providing sufficient identification of veins.

5 **[0033]** Some embodiments of the present disclosure may include a system, a method, and/or a computer program product. The computer program product may include a tangible non-transitory computer readable storage medium (or media) having computer readable program instructions thereon for causing a processor to carry out aspects of the present disclosure. Computer readable program instructions for carrying out operations of the present disclosure may be assembler instructions, instruction-set-architecture (ISA) instructions, machine
10 instructions, machine dependent instructions, microcode, firmware instructions, state-setting data, or either source code or object code written in any combination of one or more programming languages, including any object oriented programming language and/or conventional procedural programming languages.

15 **[0034]** Before explaining at least one embodiment of the disclosure in detail, it is to be understood that the disclosure is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The disclosure is capable of other embodiments or of being practiced or carried out in various ways.

20 **[0035]** Reference is now made to FIG. 1, which is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure. One system for identifying veins, according to embodiments of the present disclosure, may be system 100. System 100 may comprise at least two illuminating units 102 and 104. Each of illuminating units 102 and 104 may comprise a housing that may be configured to being positioned onto one of the fingers of a user's hand 101. For example, each of housing 103 of unit 102 and
25 housing 105 of unit 104 may have the shape and size of a human finger. Since human fingers may vary in size and shape, the material from which housing 103 and 105 of units 102 and 104, respectively, may be made of, should be flexible and stretchable to enable a good fit on substantially any finger size and shape. For example, the size of human fingers may vary between 12mm to 20mm in width. In some embodiments, the material from which housing
30 103 and housing 105 may be made of, may be silicone. In other embodiments, other flexible materials may be used. Housing 103 and 105 may be similar to sleeves each placed over any one of a user's fingers.

[0036] In some embodiments, more than two illuminating units 102 and 104 may be implemented, such that each of more than two fingers of the user may have attached thereon an illuminating unit. In some embodiments, even each of three to five fingers may have attached thereon an illuminating unit, in order to increase the area of illumination, compared
5 to when only each of two fingers have an illuminating unit attached thereon.

[0037] In some embodiments, each of illuminating units 102 and 104 may comprise at least one illumination source. Illuminating unit 102 may comprise illumination source 112, and illuminating unit 104 may comprise illumination source 114. In some embodiments, illumination sources 112 and 114 may be located at the tip of illuminating units 102 and 104,
10 though other locations along the housing of units 102 and 104 are possible. When illuminations sources 112 and 114 are located at the top end of units 102 and 104, respectively, e.g., at the tip of each of units 102 and 104, the user wearing units 102 and 104 on his fingers may easily maneuver and control a plurality of features of illuminating units 102 and 104. For example, a user may wear or place illuminating unit 102 on the thumb of
15 the user, while the user may wear or place illuminating unit 104 on the index finger of the user. In other embodiments, other fingers may be used. The user may then change and control the distance between the at least two illuminating units, e.g., units 102 and 104, by changing the distance of the user's fingers onto which the at least two illuminating units are positioned. The user may further control the angle at which the skin of a patient is illuminated, by
20 changing the angle at which the illuminating units are directed towards the skin of the patient. Typically, light should be emitted towards the skin at an angle between 30 to 45 degrees with respect to the illumination source. An angle less than 30 degrees may result in insufficient area of halo to effectively illuminate the required region. An angle greater than 45 degrees may result in emitted light becoming too dispersed, thus lacking in intensity.

[0038] In some embodiments, the user may maneuver each of the fingers independently, thus maneuvering each illuminating unit independently of the other illuminating units. The design of illuminating units 102 and 104, as configured to be positioned onto a finger of a user, enables a user to direct light into the skin of a patient in substantially any angle, thus enabling great flexibility in maneuvering the illuminating units until a vein is detected and
25 identified. The user may also control the amount of pressure applied onto the skin of the patient via each illuminating unit independently of other illuminating units, thus increasing the intensity of light directed into the skin. By applying pressure onto the skin the user may anchor the identified vein during venipuncture procedure, or compress the vein to
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differentiate between a valve and a thrombus or between a patent vein and a thrombus. According to some embodiments, both a valve and a thrombus may appear as a localized area of dilatation. In case a user is applying pressure via two illuminating units, each positioned onto a single finger, the user may apply opposing pressure between those two
5 fingers. The skin or tissue that may be caught between the fingers may be compressed. This compression may cause the blood to flow away of the area of compression in case of a valve. The area of dilatation would then disappear, and reappear when compression is released. In case of thrombus, the area of dilatation would not disappear but rather remain as is no matter how much compression is applied onto the tissue. In case of a normal region of patent vein,
10 the area of dilation would disappear when the tissue is compressed and reappear when compression is released, similarly to the way a valve reacts.

[0039] In addition, by applying pressure onto the skin of a patient, the user may acquire an unrestricted view of the area of illumination.

[0040] In some embodiments, illumination sources 112 and 114 may be covered by a
15 material that may provide a barrier between the illumination sources and the skin of the patient but may further provide a good refractive index. For example, the illumination sources may be covered with PMMA integrated lens, which are in epoxy state during production. Polycarbonate may also be used as a proper cover for the illumination sources. Glass is optional as well, though avoided due to high costs and potential safety hazard.

[0041] According to some embodiments, system 100 may comprise a control unit 110,
20 which may comprise a color control unit 106, which may be configured to control the wavelength at which either of the at least two illuminating units illuminates the skin of a patient. In some embodiments, the wavelengths each of the illuminating units emit may be selected from the entire white or visible light spectrum. In some embodiments, the
25 wavelengths each of the illuminating units may emit may be selected from the red spectrum for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye. Light in the red spectrum may be absorbed by blood components, such as hemoglobin and may thus highlight presence of veins compared to the tissue surrounding the highlighted veins. In some embodiments, the wavelength of illumination may be selected between violet
30 and red, e.g., between 400 nm to 760 nm, in other embodiments, the wavelength may be selected within the red spectrum, e.g., selected between 610 nm to 760 nm. In some embodiments, the color temperature may be selected between 4500K to 7500K in Kelvin.

[0042] In some embodiments, control unit 110 may further comprise an intensity control unit 108, which may be configured to control the level of intensity of light illuminated by either of the at least two illuminating units.

[0043] In some embodiments, control unit 110 may comprise a power source, e.g., a battery or a rechargeable battery. In some embodiments, the battery may be of several voltages. In other embodiments, the control unit may be powered by lithium polymer batteries. In some embodiments, control unit 110 may further comprise a wireless transmitter and an antenna. In case each (or either) of the at least two illuminating units 102 and 104 comprise a camera for acquiring images of the illuminated skin of a patient, control unit 110 may comprise a wireless transmitter and antenna for transmitting the acquired images to a display unit for displaying the images to the user, either for ease of view to the user, or for teaching purposes.

[0044] In some embodiments, system 100 may comprise a wired connection between units 102 and 104 to an external unit, e.g., control unit 110. For example, unit 102 may be connected to external unit 110 via a wired connection 122, and unit 104 may be connected to external unit 100 via wired connection 124. Connections 122 and 124 may be electrical connections.

[0045] In some embodiments, system 100 may comprise an external light source (not shown), which may be, for example, encapsulated in an external unit, e.g., unit 110. In such case, system 100 may comprise a fiber optic connection between the external light source and each of illuminating units 102 and 104. The fiber optic connection may transfer the light from the external light source to each of the illuminating units 102 and 104, which are to be in contact with the skin of the patient and are to direct the emitted light towards the skin of the user in order to identify, locate and highlight veins.

[0046] Reference is now made to FIG. 2A, which is a schematic illustration of a system for identifying veins, during operation, according to embodiments of the disclosure. According to some embodiments, during operation of system 100, each of the illuminating units, e.g., units 102 and 104 may illuminate the skin of a patient. Typically, the illumination emitted from units 102 and 104 is in the shape of a circle, for example, illuminating unit 102 may illuminate light circle 132, while illuminating unit 104 may illuminate light circle 134. The wavelengths that each of illuminating units 102 and 104 may illuminate at, may be selected from the entire white or visible light spectrum. In some embodiments, the wavelengths that each of the illuminating units 102 and 104 may illuminate at, may be selected from the red spectrum, for example, between 610 nm to 760 nm. Each of illuminating units 102 and 104

may either illuminate at the same wavelength or at different wavelengths within the red spectrum for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye.

[0047] According to some embodiments, in between these two light circles 132 and 134, there may appear a vein as a silhouette highlighted with respect to its surrounding. Since illuminating units illuminate the skin of a patient with light in the red spectrum, which is light that may be absorbed by blood components, e.g., hemoglobin, the red light may assist in highlighting veins transferring blood in contrast to the surrounding tissue of the highlighted veins.

[0048] Reference is now made to FIG. 2B, which is a schematic illustration of a display of a system for identifying veins, according to embodiments of the present disclosure. According to some embodiments, a user of system 100 may directly view the skin of the patient that is illuminated by the at least two illuminating units, e.g., units 102 and 104, in order to identify a highlighted vein. However, in other embodiments, system 100 may comprise a display unit. The display unit may be connected to system 100, wither through an electrical wired connection, or wirelessly. The display unit may display images acquired by a camera that is included in either or all of the illuminating units, e.g., illuminating units 102 and 104. Once images of the illuminated skin of the patient are acquired by at least one camera, the images may be transmitted to the display unit, e.g., via a wireless transmitter, and may be displayed by the display unit. For example, the display unit may comprise a display 210, which may display an image of the light circle 220 and may further display an image of a vein, e.g., vein 200.

[0049] Reference is now made to Fig. 3, which is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure. According to some embodiments, a system for identifying veins within or under a skin of a patient, may be system 300. System 300 may comprise at least two illuminating units 302 and 304. Each of illuminating units 302 and 304 may comprise a housing that is configured to be placed onto a finger of a user. Thus, units 302 and 304 may be in the shape and size of a finger of a human. Since the size and shape of a human finger may vary between people, the material from which units 302 and 304 may be made of, may be flexible such to fit substantially any size and shape of finger. In some embodiments, more than two illuminating units 302 and 304 may be implemented, such that each of more than two fingers of the user may have attached thereon an illuminating unit. In some embodiments, even each of three to five

fingers may have attached thereon an illuminating unit, in order to increase the area of illumination, compared to when only each of two fingers have an illuminating unit attached thereon.

5 **[0050]** According to some embodiments, illuminating unit 302 may comprise element 332, which may assist in attaching the internal structure of unit 302 to the housing or casing of unit 302. That is, in order to attach the electronic components housed within unit 302 to the flexible housing or casing of unit 302, element 332 may act as a bridge between such internal components and the housing of unit 302. Similarly, illuminating unit 304 may comprise element 334, which may connect between the internal components of unit 304 and the
10 flexible housing or casing of unit 304.

[0051] According to some embodiments, each of units 302 and 304 may comprise at least one illumination source, e.g., unit 302 may comprise illumination source 312 and unit 304 may comprise illumination source 314. Illumination sources 312 and 314 may illuminate light at wavelengths selected from the entire white or visible light spectrum. In some
15 embodiments, the wavelengths which each of the illumination sources 312 and 314 may emit, may be selected from the red spectrum, e.g., between 610 nm to 760 nm, for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye. Illumination source 312 may illuminate at the same or different wavelength compared to illumination source 314.

20 **[0052]** In some embodiments, units 302 and 304 may be connected to an external device 310 via connections 322 and 324, respectively. Connections 332, 324 may be electrical connections.

[0053] In some embodiments, an external device 310 may comprise a power source (not shown), e.g., a battery, which may provide electrical power to illuminating units 302 and
25 304. External device 310 may comprise an operation switch or on/off switch 320 to control operation of all illuminating units of system 300, e.g., units 302 and 304. Once the on/off switch 320 of external device 310 is turned to 'ON' mode, electrical connection may be made between external device 310 and illuminating units 302 and 304. Once switch 320 is turned 'OFF', no electrical connection is made between units 302 and 304 to external device 310,
30 and thus no power may be transferred to units 302 and 304.

[0054] Reference is now made to FIG. 4A, which is a schematic illustration of a perspective view of an illuminating unit for identifying veins, according to embodiments of the disclosure. An illuminating unit for identifying veins within or under a skin of a patient may

be unit 402. According to some embodiments, unit 402 may comprise at least one illumination source 412, which may be located at the tip of unit 402, e.g., at the top end of unit 402. Illumination source 412 may be located at other locations along unit 402. Illumination source 412 may illuminate the skin of a patient at wavelengths selected from the entire white or visible light spectrum. In some embodiments, the wavelengths at which illumination source 412 may illuminate the skin may be selected from the red spectrum, e.g., between 610 nm and 760 nm.

[0055] Illuminating unit 402 may comprise an operation switch 432, which may control operation of unit 402. Once switch 432 is turned 'ON', unit 402 may begin emit light, whereas if switch 432 is turned 'OFF', unit 402 may not emit light via illumination source 412. In such case, illuminating unit 402 may be re-sterilized for multiple uses with different patients. In other embodiments, instead of an on-off button, the illuminating unit may be disposable, e.g., a tab may be removed from unit 402 in order to constantly activate illuminating unit 402 until power is completely consumed by the electronic components of unit 402.

[0056] In some embodiments, unit 402 may be designed in shape and size to conform to the shape and size of a finger of substantially any user. The material from which the casing or housing of unit 402 may be made of, may be flexible such to fit almost any size and shape of finger. According to some embodiments, once unit 402 is placed onto a finger of a user, it may be easily maneuvered, e.g., the angle at which illumination source 412 may be directed at may be controlled by the user, the amount of pressure applied onto the skin of the patient may be controlled, and the distance between unit 402 and an additional illuminating unit may further be controlled by the user. All of these maneuverings or control capabilities may affect the ease and time until identification of veins is made.

[0057] FIGs. 4B and 4C are schematic illustrations of an inner front view and an inner side view of illuminating unit 402. In some embodiments, in addition to illumination source 412 and switch 432, unit 402 may comprise casing or housing 442, which may be made of a flexible material, e.g., silicone. Unit 402 may further comprise an internal power source, e.g., power source 452, which may be a battery or more than one battery. According to some embodiments, unit 402 may comprise an electrical connection 466 between printed circuit board (PCB) 462 and power source 452 for providing power to all electronic components of unit 402. All of the electronic components housed within unit 402 may be powered via power

source 452, through their connection to PCB 462, e.g., illumination source 412, switch 432, and any other additional electrical component that may be encapsulated within unit 402.

[0058] Reference is now made to Fig. 5, which is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure. In some
5 embodiments, system 500 may comprise at least two illuminating units, e.g., illuminating units 502 and 504. Each of illuminating units 502 and 504 may comprise at least one illumination source. For example, illuminating unit 502 may comprise illumination source 512 and illuminating unit 504 may comprise illumination source 514. Illumination sources 512 and 514 may illuminate at a wavelength selected from the entire white or visible light
10 spectrum. In some embodiments, the wavelengths at which each of the illumination sources 512 and 514 may illuminate, may be selected from the red spectrum, e.g., between 610 nm and 760 nm. In some embodiments, instead of comprising illumination sources 512 and 514 that may be located along units 502 and 504, respectively, system 500 may comprise an external light source. System 500 may further comprise fiber optic connections 522 and 524
15 for transferring the light from the external light source to units 502 and 504, respectively.

[0059] In some embodiments, each of illuminating units 502 and 504 may comprise an internal power source. In case illuminating units 502 and 504 do not include an internal power source, system 500 may comprise an external device comprising an external power source. Accordingly, unit 502 may be electrically connected via connection 522 to the
20 external power source, and unit 504 may be electrically connected via connection 524 to the external power source.

[0060] As disclosed with respect to systems 100, 300 and 400, system 500 may comprise illuminating units that are each configured to be positioned onto a finger of a user in order to enable maneuverability in three dimensional space. Maneuverability of the illuminating
25 units may comprise directing the illuminating units at the patient's skin at almost any angle, pressing against the patient's skin at different levels of pressure, and bringing closer together or keeping apart at various distances, one illuminating unit from another illuminating unit.

[0061] In some embodiments, more than two illuminating units 502 and 504 may be implemented, such that each of more than two fingers of the user may have attached thereon
30 an illuminating unit. In some embodiments, even each of three to five fingers may have attached thereon an illuminating unit, in order to increase the area of illumination, compared to when only each of two fingers have an illuminating unit attached thereon.

[0062] Reference is now made to FIG. 6, which is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure. In some embodiments, a system for identifying veins may be system 600. In some embodiments, system 600 may comprise at least two illuminating units, e.g., illuminating units 602 and 604. Each of illuminating units 602 and 604 may comprise at least one illumination source, e.g., illumination source 612, 614, respectively. According to some embodiments, system 600 may comprise autonomous illuminating units that need not be powered by an external power source. In some embodiments, each or at least one of illuminating units 602 and 604 may comprise an internal power source to provide power to the electronic components housed within each of the illuminating units, e.g., to illumination sources 612, 614. In some embodiments, the two autonomous illuminating units 602 and 604 may be controlled via an external electronic computerized device, e.g., a smart phone, tablet, computer, etc.

[0063] In some embodiments, system 600 may comprise an electrical connection 620 between illuminating unit 602 and unit 604. For example, in case unit 602 may comprise an internal power source, connection 620 may be configured to transfer energy or electrical power from unit 602 to unit 604, and vice versa.

[0064] In some embodiments, unit 602 may comprise an illumination source, and connection 620 may be a fiber optic connection for transferring light from unit 602 to unit 604, such that light may be emitted from both illuminating units 602 and 604.

[0065] In some embodiments, more than two illuminating units 602 and 604 may be implemented, such that each of more than two fingers of the user may have attached thereon an illuminating unit. In some embodiments, even each of three to five fingers may have attached thereon an illuminating unit, in order to increase the area of illumination, compared to when only each of two fingers have an illuminating unit attached thereon.

[0066] Reference is now made to FIG. 7, which is a schematic illustration of a system for identifying veins, according to embodiments of the present disclosure. In some embodiments, a system for identifying veins, e.g., prior to a venipuncture procedure, may be system 700. In some embodiments, system 700 may comprise at least two illuminating units, e.g., illuminating units 702 and 704. According to some embodiments, each of illuminating units 702 and 704 may comprise a housing or casing that is configured to fit a finger of a user operating system 700. The housing or casing should be made of a flexible material that would fit substantially any size and shape of finger.

[0067] In some embodiments, more than two illuminating units 702 and 704 may be implemented, such that each of more than two fingers of the user may have attached thereon an illuminating unit. In some embodiments, even each of three to five fingers may have attached thereon an illuminating unit, in order to increase the area of illumination, compared
5 to when only each of two fingers have an illuminating unit attached thereon.

[0068] According to some embodiments, illuminating units 702 and 704 may comprise corresponding cavities 772 and 774, through which a finger of a user may be inserted such to maneuver units 702 and 704 while moving the user's fingers. The user may either insert its finger such that it reaches the distal end (the end of units 702 or 704 that is farthest from
10 external device 710) of either of units 702 and 704, or may insert its finger such that it exits through the distal end of units 702 and 704.

[0069] In some embodiments, illuminating unit 702 may comprise two (or more) illumination sources 712 and 716, while unit 704 may comprise two (or more) illumination sources 714 and 718. The location of illumination sources 712 and 716 along unit 702 may
15 be at the front side of unit 702, and not at the tip of unit 702, as disclosed, for example, with respect to system 600. Since the front side of unit 702 has a larger area compared to the tip of unit 702, more than one illumination sources may be positioned onto the front side of unit 702. Similarly, unit 704 may comprise two illumination sources located at the front side of unit 704.

[0070] In some embodiments, the illumination sources of either or all of the illuminating units may emit light at the same wavelength, whereas in other embodiments, each illumination source of each illuminating unit may emit light at a different wavelength. The wavelengths of light emitted by any illumination source may be selected from the entire white or visible light spectrum. In some embodiments, the wavelengths of light emitted by
20 any illumination source may be selected from the red spectrum, e.g., between 610 nm and 760 nm.

[0071] In some embodiments, illuminating units 702 and 704 may be electrically connected to external device 710, which may comprise a power source, e.g., a battery or batteries. In some embodiments, unit 702 may be connected via an electrical connection 722 to external
30 device 710, and unit 704 may be connected via an electrical connection to external device 710. In some embodiments, external device 710 may comprise an operating switch or on-off switch 720, for the user to determine when to begin operation of system 700 and when to cease operation. Once a user turns switch 720 to 'ON' mode, power from the power source

housed within external device 1710, may be supplied or transferred to illuminating units 702 and 704 via electrical connections 722 and 724, respectively. However, when a user turns switch 720 to 'OFF' mode, there is no electrical connection between external device 710 and illuminating units 702 and 704.

5 **[0072]** In some embodiments, each or at least one of illuminating units 702 and/or 704 may comprise a camera for acquiring images of the illuminated skin of the patient, e.g., the light circles emitted by illuminating units 702 and 704, and thus for acquiring images of the highlighted and identified veins. In some embodiments, each or at least one of illuminating units 702 and 704 may further comprise a transmitter and possibly an antenna if it is not
10 integrated as part of the transmitter. The transmitter may transmit the acquired images to an external display unit, for ease of view of the identified veins by the user, or for tutoring purposes of other users besides the user operating system 700.

[0073] According to some embodiments, illuminating units 702 and 704 may be maneuvered by the user when the user moves his fingers, one with respect to the other such to distant or
15 bring closer at least two illuminating units 702 and 704, each positioned onto a different finger. The user may also maneuver each finger independently such to control the angle at which light is directed towards the skin of a patient by changing position of the illumination sources with respect to the skin. In addition, the user may control the amount of pressure applied by each illuminating unit independently of the other illuminating units. Typically,
20 the more pressure is applied, the more light is directed into the skin, the more highlighted a vein may be.

[0074] When the at least one illumination source is positioned at the tip of the illuminating unit, it is easier to change the angle of the light directed towards the skin, to almost any angle, whereas when the at least one illumination source is positioned at the sides of the
25 illuminating units, changing the angle of directed light may be more restricted, though still flexible.

[0075] Reference is now made to FIG. 8, which is a schematic flowchart illustrating a method for identifying veins, according to embodiments of the present disclosure. According to some embodiments, a method for identifying peripheral veins may be method 800. In
30 some embodiments, method 800 may comprise operation 802, which may comprise providing at least two illuminating units each adapted to be placed onto a finger of a user. In some embodiments, each of the illuminating units may comprise at least one illumination source configured to illuminate light at any wavelength of the entire white light or visible

light spectrum. In some embodiments, the at least one illumination source may be configured to illuminate light at a wavelength of red spectrum selected from red spectrum, e.g., at a wavelength selected from 610 nm to 760 nm such to highlight visibility of peripheral veins which are otherwise invisible to a naked eye. In some embodiments, method 800 may further
5 comprise operation 804, which may comprise maneuvering the at least two illuminating units in three-dimensional space such to control angle of illumination towards skin of a patient, distance between the at least two illuminating units, and pressure applied onto the skin via the at least two illuminating units. According to some embodiments, method 800 may further comprise operation 806, which may comprise identifying peripheral veins within or under
10 the skin of the patient. Thus, performing such maneuvering operations on the at least two illuminating units, leads to identification of suitable veins for venipuncture procedure.

[0076] According to some embodiments, method 800 may further comprise the operation of compressing a vein by applying pressure via said at least two illuminating units onto a skin of a patient, to differentiate between a valve and a thrombus or between a patent vein and a
15 thrombus. According to some embodiments, both a valve and a thrombus may appear as a localized area of dilatation. In case a user is applying pressure via two illuminating units, each positioned onto a single finger, the user may compress a vein by applying opposing pressure between those two fingers. The skin or tissue that may be caught between the fingers may be compressed. This compression may cause the blood to flow away of the area of
20 compression in case of a valve. The area of dilatation would then disappear, and reappear when compression is released. In case of thrombus, the area of dilatation would not disappear but rather remain as is no matter how much compression is applied onto the tissue. In case of a normal region of patent vein, the area of dilation would disappear when the tissue is compressed and reappear when compression is released, similarly to the way a valve
25 reacts.

[0077] In some embodiments, method 800 may further comprise the operation of anchoring a vein in a stable position by applying pressure via said at least two illuminating units onto a skin of a patient.

[0078] In some embodiments, method 800 may further comprise the operation of increasing
30 amount of light directed into a skin of a patient for increasing visibility of a vein within or under the skin, by applying pressure via said at least two illuminating units onto a skin of a patient.

[0079] Conjugated terms such as, by way of example, 'a thing property' implies a property of the thing, unless otherwise clearly evident from the context thereof.

[0080] In case electrical or electronic equipment is disclosed it is assumed that an appropriate power supply is used for the operation thereof.

5 [0081] The flowchart and block diagrams illustrate architecture, functionality or an operation of possible implementations of systems, methods and computer program products according to various embodiments of the present disclosed subject matter. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of program code, which comprises one or more executable instructions for implementing the
10 specified logical function(s). It should also be noted that, in some alternative implementations, illustrated or described operations may occur in a different order or in combination or as concurrent operations instead of sequential operations to achieve the same or equivalent effect.

[0082] The corresponding structures, materials, acts, and equivalents of all means or step
15 plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprising", "including" and/or "having" and other conjugations
20 of these terms, when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0083] The terminology used herein should not be understood as limiting, unless otherwise
25 specified, and is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosed subject matter. While certain embodiments of the disclosed subject matter have been illustrated and described, it will be clear that the disclosure is not limited to the embodiments described herein. Numerous modifications, changes, variations, substitutions and equivalents are not precluded.

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CLAIMS

1. A system for identifying peripheral veins, said system comprising:
at least two illuminating units, each illuminating unit comprising:
a housing, said housing adapted to be placed onto a finger of a user, wherein said housing has a shape and size, which conform to the shape and size of a human finger, to enable maneuverability of each illuminating unit in three-dimensional space; and
at least one illumination source, said at least one illumination source configured to illuminate light at a wavelength selected from the entire visible light spectrum for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye.
2. The system of claim 1, wherein the at least one illumination source is configured to illuminate light at a wavelength selected from the red spectrum.
3. The system of claim 1, wherein the at least one illumination source is configured to illuminate light at a wavelength between 610 nm and 760 nm.
4. The system of claim 1, wherein said system further comprises a display unit for displaying the highlighted veins to a user.
5. The system of claim 4, wherein each illuminating unit comprises a camera for acquiring images of the highlighted veins and a transmitter for transmitting said images to the display unit.
6. The system of claim 5, wherein said transmitter is a wireless transmitter.
7. The system of claim 1, wherein each illuminating unit is adapted to be placed onto a different finger of a user.
8. The system of claim 1, wherein said system further comprises an intensity control unit configured to control the intensity of said at least one illumination source.

9. The system of claim 1, wherein said system further comprises a color control unit configured to control the wavelength at which said at least one illumination source illuminates.
10. The system of claim 1, wherein each illuminating unit is connected to an external device, said external device comprising a power source.
11. The system of claim 1, wherein each illuminating unit comprises an internal power source within said housing.
12. The system of claim 1, wherein each illuminating unit comprises at least one illumination source at a top end of said each illuminating unit.
13. The system of claim 1, wherein each illuminating unit comprises more than one illumination source on a side of the housing of each illuminating unit.
14. The system of claim 1, wherein said at least two illuminating units are connected to an external light source via a fiber optic connection.
15. The system of claim 1, wherein said at least two illuminating units are connected via an electrical connection.
16. The system of claim 1, wherein said housing is made of a flexible material.
17. The system of claim 1, wherein one of said at least two illuminating units is configured to be placed onto a thumb of a user and another unit of said at least two illuminating units is configured to be placed onto an index finger of the user.
18. A method for identifying peripheral veins, said method comprising:
 - providing at least two illuminating units, each illuminating unit comprising:
 - a housing, said housing adapted to be placed onto a finger of a user;

at least one illumination source, said illumination source configured to illuminate light at a wavelength selected from the entire visible light spectrum for highlighting visibility of peripheral veins which are otherwise invisible to a naked eye;

maneuvering said at least two illuminating units in three-dimensional space such to control angle of illumination towards a skin of a patient, distance between said at least two illuminating units, and pressure applied onto the skin of the patient via said at least two illuminating units;

and

identifying peripheral veins within or under the skin of the patient.

19. The method of claim 18, further comprising compressing a vein by applying pressure via said at least two illuminating units onto a skin of a patient, to differentiate between a valve and a thrombus, and between a patent vein and a thrombus.
20. The method of claim 18, further comprising anchoring a vein in a stable position by applying pressure via said at least two illuminating units onto a skin of a patient.
21. The method of claim 18, further comprising increasing amount of light directed into a skin of a patient for increasing visibility of a vein within or under the skin, by applying pressure via said at least two illuminating units onto a skin of a patient.
22. The method of claim 18, wherein said illumination source is configured to illuminate light at a wavelength selected from the red spectrum.
23. The method of claim 18, wherein said illumination source is configured to illuminate light at a wavelength selected between 610 nm and 760 nm.