CLAIMS

What is claimed is:

1. A finger vein sensor comprising:

an image sensor horizontally positioned at a top end of the finger vein sensor, wherein the image sensor faces down in vertical direction to capture at least one infrared image of finger vein pattern of a finger of a target human, and

an infrared light source positioned at a bottom end of the finger vein sensor, wherein the infrared light source faces up and shines infrared light upward in vertical direction,

wherein the finger rests on a transparent finger resting surface immediately over the infrared light source, the infrared light from the infrared light source irradiates the fingerprint side of the finger vertically from the bottom end of the finger vein sensor to generate the infrared image of finger vein pattern of the finger on the image sensor, and the image sensor captures the infrared image of finger vein pattern of the finger.

2. The finger vein sensor of claim 1, wherein the infrared light source comprises a plurality of infrared light-emitting diodes (LED), a plurality of infrared light bulbs, and/or any other infrared light sources, wherein the plurality of infrared LED and the plurality of infrared light bulbs are arranged in one or more rows and one or more columns.

3. The finger vein sensor of claim 1, further comprising a lens positioned between the finger and the image sensor, and an infrared filter positioned between the lens and the image sensor for improving quality of the infrared image of finger vein pattern of the finger.

4. The finger vein sensor of claim 3, further comprising a transparent finger resting surface for resting the finger on the transparent finger resting surface.

5. The finger vein sensor of claim 4, further comprising a finger vein sensor enclosure having a lower compartment for positioning infrared light source and an upper compartment for positioning the image sensor and the lens.

6. The finger vein sensor of claim 5, wherein an upper surface of the lower compartment forms the transparent finger resting surface, and a lower surface of the upper compartment comprises a transparent surface.

7. A finger vein sensor comprising:

an image sensor horizontally positioned in a user-facing side of an upper end of the finger vein sensor, wherein the image sensor faces center of the finger vein sensor in horizontal direction to capture at least one infrared image of finger vein pattern of a finger of a target human;

an infrared light source positioned at a lower end of the finger vein sensor, wherein the infrared light source faces upward and shines infrared light upward in vertical direction; and

an optical reflector positioned in an optical path between the image sensor and the infrared light source, wherein the optical reflector reflects a vertically oriented infrared image of finger vein pattern of the finger into a horizontally oriented infrared image of finger vein pattern of the finger,

wherein the finger rests on a transparent finger resting surface immediately over the infrared light source, the infrared light from the infrared light source irradiates the fingerprint side of the finger vertically from the bottom end of the finger vein sensor to generate a vertically oriented infrared image of finger vein pattern of the finger, the vertically oriented infrared image of finger vein pattern of the finger is reflected by the optical reflector to form an horizontally oriented infrared image of finger vein pattern of the finger, and the horizontally oriented infrared image of finger vein pattern of the finger is captured by the horizontally oriented image sensor.

8. The finger vein sensor of claim 7, wherein the infrared light source comprises a plurality of infrared light-emitting diodes (LED), a plurality of infrared light bulbs, and/or any other infrared light sources, wherein the plurality of infrared LED and the plurality of infrared light bulbs are arranged in one or more rows and one or more columns.

9. The finger vein sensor of claim 7, wherein the optical reflector comprises a reflecting mirror, a triangular reflecting glass, or any other optical reflecting devices.

10. The finger vein sensor of claim 7, wherein further comprising a lens positioned between the finger and the image sensor, and an infrared filter positioned between the lens and the image sensor for improving quality of the infrared image of finger vein pattern of the finger.

11. The finger vein sensor of claim 10, further comprising a transparent finger resting surface such that the finger is rested on the transparent finger resting surface.

12. The finger vein sensor of claim 11, further comprising a finger vein sensor enclosure having a lower compartment for positioning the infrared light source and an upper compartment for positioning the image sensor and the lens.

13. The finger vein sensor of claim 12, wherein an upper surface of the lower compartment forms the transparent finger resting surface, and a lower surface of the upper compartment comprises a transparent surface.

14. A finger vein sensor comprising:

an image sensor horizontally positioned in a left side of an upper end of the finger vein sensor, wherein the image sensor faces center of the finger vein sensor in horizontal direction to capture at least one infrared image of finger vein pattern of a finger of a target human;

an infrared light source positioned at a bottom end of the finger vein sensor; wherein the infrared light source faces upward and shines infrared light upward in vertical direction, and

an optical reflector positioned in an optical path between the image sensor and the infrared light source, wherein the optical reflector reflects a vertically oriented infrared image of finger vein pattern of the finger to a horizontally oriented infrared image of finger vein pattern of the finger,

wherein the finger rests on a transparent finger resting surface immediately over the infrared light source, the infrared light from the infrared light source irradiates the fingerprint side of the finger vertically from the bottom end of the finger vein sensor to generate a vertically oriented infrared image of finger vein pattern of the finger, the vertically oriented infrared image of finger vein pattern of the finger is reflected by the optical reflector to form an horizontally oriented infrared image of finger vein pattern of the finger, and the horizontally oriented infrared image of finger vein pattern of the finger is captured by the horizontally oriented image sensor.

15. The finger vein sensor of claim 14, wherein the infrared light source comprises a plurality of infrared light-emitting diodes (LED), a plurality of infrared light bulbs, and/or any other infrared light sources, wherein the plurality of infrared LED and the plurality of infrared light bulbs are arranged in one or more rows and one or more columns.

16. The finger vein sensor of claim 14, wherein the image sensor is removed from the left side of the upper end of the finger vein sensor and vertically positioned in a right side of the upper end of the finger vein sensor, wherein the image sensor faces center of the finger vein sensor in horizontal direction.

17. The finger vein sensor of claim 14, wherein the optical reflector comprises a reflecting mirror, a triangular reflecting glass, or any other optical reflecting devices.

18. The finger vein sensor of claim 14, further comprising a lens positioned between the finger and the image sensor, and an infrared filter positioned between the lens and the image sensor for improving quality of the infrared image of finger vein pattern of the finger.

19. The finger vein sensor of claim 18, further comprising a finger vein sensor enclosure having a lower compartment for positioning the infrared light source and an upper compartment for positioning the image sensor and the lens.

20. The finger vein sensor of claim 19, wherein an upper surface of the lower compartment forms a transparent finger resting surface, and a lower surface of the upper compartment comprises a transparent surface.