In accordance with an aspect of the present invention, there is provided a vital signs detecting device, the device comprising a detection unit; a multimode optical fiber configured to be connected to a light source and to the detection unit; a mechanical structure configured for receiving a pressure exerted by a person's body as a result of one or more of a group consisting of a movement of the person’s body, a respiratory action of the person’s body and a heart beat action of the person’s body and to cause microbending of the multimode optical fiber under the exerted pressure and; wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure. When the pressure is exerted to the mechanical structure, the first set of microbending elements and the second set of microbending elements are configured to be interlinked so as to cause the microbending of the multimode optical fiber disposed therebetween.

The first set of microbending elements may be comprised in a first layer of the mechanical structure and the second set of microbending elements may be comprised in a second layer and further wherein the multimode optical fiber may be disposed between the first and second layers.

The first and second layers may each comprise a mesh-like structure.

The mechanical structure may be interwoven with the multimode optical fiber such that the first set of microbending elements may be disposed on a top surface of the multimode optical fiber and the second set of microbending elements may be disposed on a bottom surface of the multimode optical fiber.

The mechanical structure may comprise a mesh-like structure.

The device may further comprise the light source for inputting light into the multimode optical fiber and the detection unit may comprise a light detection unit for detecting light modulation in the multimode optical fiber.

The device may further comprise a mirror attached to the multimode optical fiber at one end thereof for reflecting light to the other end of the optical fiber.

The device may further comprise a 1x2 fiber coupler for connecting the light source and the light detection unit to the multimode optical fiber at said other end of the optical fiber.

The device may further comprise a 1x2 fiber coupler connected to the multimode optical fiber at one end thereof, the 1x2 fiber coupler configured for redirecting light to the other end of the optical fiber.

The device may further comprise a second 1x2 fiber coupler for connecting the light source and the light detection unit to the multimode optical fiber at said other end of the optical fiber.

The detection unit may be adapted for determining at least a heart rate of the person based on light intensity variations caused by bending losses induced by the microbending.

The detection unit may comprise a signal processing unit.

The signal processing unit may be configured to extract information of at least one of a group consisting of heart beat rate, breathing rate and body movement.

The body movement information may be extracted based on a signal deviation tracking process implemented in the signal processing unit.

For an application associated with breathing, the breathing rate information may be extracted based on a signal filtering process and at least one process

selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis, the processes being implemented in the signal processing unit.

For an application associated with heart beat, the heart beat rate information may be extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis, the processes being implemented in the signal processing unit.

The signal processing unit may comprise a display function for displaying the extracted information.

The signal processing unit may have an alarm function implemented thereon for activating an alarm based on the extracted information.

In use, the multimode optical fiber and the mechanical structure may function as a fiber mode converter.

In accordance with another aspect of the present invention, there is provided a method for detecting vital signs, the method comprising providing a detection unit; connecting a multimode optical fiber to a light source and to the detection unit; providing a mechanical structure for receiving a pressure exerted by a person's body as a result of one or more of a group consisting of a movement of the person’s body, a respiratory action of the person’s body and a heart beat action of the person’s body and to cause microbending of the multimode optical fiber under the exerted pressure; wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure, and wherein the first set of microbending elements and the second set of microbending elements are configured to be interlinked, when the pressure is exerted to the mechanical structure, so as to cause the microbending of the multimode optical fiber disposed therebetween.

The first set of microbending elements may be comprised in a first layer of the mechanical structure and the second set of microbending elements may be

comprised in a second layer and further wherein the multimode optical fiber may be disposed between the first and second layers.

The first and second layers may each comprise a mesh-like structure.

The mechanical structure may be interwoven with the multimode optical fiber such that the first set of microbending elements may be disposed on a top surface of the multimode optical fiber and the second set of microbending elements may be disposed on a bottom surface of the multimode optical fiber.

The mechanical structure may comprise a mesh-like structure.

The method may further comprise inputting light into the multimode optical fiber and detecting light modulation in the multimode optical fiber.

The method may further comprise attaching a mirror to the multimode optical fiber at one end thereof for reflecting light to the other end of the optical fiber.

The method may further comprise using a 1x2 fiber coupler for connecting the light source and a light detection unit to the multimode optical fiber at said other end of the optical fiber.

The method may further comprise connecting a 1x2 fiber coupler to the multimode optical fiber at one end thereof, the 1x2 fiber coupler configured for redirecting light to the other end of the optical fiber.

The method may further comprise using a second 1x2 fiber coupler for connecting the light source and a light detection unit to the multimode optical fiber at said other end of the optical fiber.

The method may further comprise determining at least a heart rate of the person based on light intensity variations caused by bending losses induced by the microbending.

The method may further comprise extracting information of at least one of a group consisting of heart beat rate, breathing rate and body movement from the light intensity variations.

The body movement information may be extracted based on a signal deviation tracking process.

For an application associated with breathing, the breathing rate information may be extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis.

For an application associated with heart beat, the heart beat rate information may be extracted based a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis.

The method may further comprise displaying the extracted information.

The method may further comprise activating an alarm based on the extracted information.

The multimode optical fiber under the exerted pressure may function as a fiber mode converter.

In accordance with another aspect of the present invention, there is provided a data storage medium having computer code means stored thereon for instructing a computing device to execute a method for vital signs detection, the method comprising the steps of receiving an optical signal from a multimode optical fiber; and determining at least a heart rate of a person based on light intensity variations caused by bending losses induced by a mechanical structure configured for receiving a pressure exerted by the person's body and to cause microbending of the multimode optical fiber under the exerted pressure, wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure, and wherein the first set of microbending elements and the second set of microbending elements are configured to be interlinked, when the pressure is exerted to the mechanical structure, so as to cause the microbending of the multimode optical fiber disposed therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 is a schematic diagram illustrating a sensor mat in an example embodiment.

Figure 2 is a schematic diagram showing a microbending multimode fiber under deformation in an example embodiment.

Figure 3 is a schematic diagram illustrating a sensor system in an example embodiment.

Figure 4 is a schematic block diagram for illustrating processing of a modulated signal in a sensor device of an example embodiment.

Figure 5 is a schematic flow chart illustrating a work flow of a sensing device in an example embodiment.

CLAIMS

1. A vital signs detecting device, the device comprising,

a detection unit;

a multimode optical fiber configured to be connected to a light source and to the detection unit;

a mechanical structure configured for receiving a pressure exerted by a person's body as a result of one or more of a group consisting of a movement of the person’s body, a respiratory action of the person’s body and a heart beat action of the person’s body, and to cause microbending of the multimode optical fiber under the exerted pressure and;

wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure,

wherein the first set of microbending elements and the second set of microbending elements are configured to be interlinked, when the pressure is exerted to the mechanical structure, so as to cause the microbending of the multimode optical fiber disposed therebetween.

2. The device as claimed in claim 1, wherein the first set of microbending elements are comprised in a first layer of the mechanical structure and the second set of microbending elements are comprised in a second layer and further wherein the multimode optical fiber is disposed between the first and second layers.

3. The device as claimed in claim 2, wherein the first and second layers each comprise a mesh-like structure.

4. The device as claimed in claim 1, wherein the mechanical structure is interwoven with the multimode optical fiber such that the first set of microbending elements are disposed on a top surface of the multimode optical fiber and the second set of microbending elements are disposed on a bottom surface of the multimode optical fiber.

5. The device as claimed in claim 4, wherein the mechanical structure comprises a mesh-like structure.

6. The device as claimed in any one of the preceding claims, further comprising the light source for inputting light into the multimode optical fiber and the detection unit comprises a light detection unit for detecting light modulation in the multimode optical fiber.

7. The device as claimed in claim 6, further comprising a mirror attached to the multimode optical fiber at one end thereof for reflecting light to the other end of the optical fiber.

8. The device as claimed in claim 7, further comprising a 1x2 fiber coupler for connecting the light source and the light detection unit to the multimode optical fiber at said other end of the optical fiber.

9. The device as claimed in claim 6, further comprising a 1x2 fiber coupler connected to the multimode optical fiber at one end thereof, the 1x2 fiber coupler configured for redirecting light to the other end of the optical fiber.

10. The device as claimed in claim 9, further comprising a second 1x2 fiber coupler for connecting the light source and the light detection unit to the multimode optical fiber at said other end of the optical fiber.

11. The device as claimed in any one of the preceding claims, wherein the detection unit is adapted for determining at least a heart rate of the person based on light intensity variations caused by bending losses induced by the microbending.

12. The device as claimed in claim 11, wherein the detection unit comprises a signal processing unit.

13. The device as claimed in claim 12, wherein the signal processing unit is configured to extract information of at least one of a group consisting of heart beat rate, breathing rate and body movement.

14. The device as claimed in claim 13, wherein the body movement information is extracted based on a signal deviation tracking process implemented in the signal processing unit.

15. The device as claimed in any one of claims 13 to 14, wherein for an application associated with breathing, the breathing rate information is extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis, the processes being implemented in the signal processing unit.

16. The device as claimed in any one of claims 13 to 15, wherein for an application associated with heart beat, the heart beat rate information is extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis, the processes being implemented in the signal processing unit.

17. The device as claimed in any one of claims 13 to 16, wherein the signal processing unit comprises a display function for displaying the extracted information.

18. The device as claimed in any one of claims 13 to 17, wherein the signal processing unit has an alarm function implemented thereon for activating an alarm based on the extracted information.

19. The device as claimed in any one of the preceding claims, wherein in use, the multimode optical fiber and the mechanical structure function as a fiber mode converter.

20. A method for detecting vital signs, the method comprising,

providing a detection unit;

connecting a multimode optical fiber to a light source and to the detection unit;

providing a mechanical structure for receiving a pressure exerted by a person's body as a result of one or more of a group consisting of a movement of the person’s body, a respiratory action of the person’s body and a heart beat action of the person’s body and for causing microbending of the multimode optical fiber under the exerted pressure;

wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure, and

wherein the first set of microbending elements and the second set of microbending elements are configured to be interlinked, when the pressure is exerted to the mechanical structure, so as to cause the microbending of the multimode optical fiber disposed therebetween.

21. The method as claimed in claim 20, wherein the first set of microbending elements are comprised in a first layer of the mechanical structure and the second set of microbending elements are comprised in a second layer and further wherein the multimode optical fiber is disposed between the first and second layers.

22. The method as claimed in claim 21, wherein the first and second layers each comprise a mesh-like structure.

23. The method as claimed in claim 20, wherein the mechanical structure is interwoven with the multimode optical fiber such that the first set of microbending

elements are disposed on a top surface of the multimode optical fiber and the second set of microbending elements are disposed on a bottom surface of the multimode optical fiber.

24. The method as claimed in claim 23, wherein the mechanical structure comprises a mesh-like structure.

25. The method as claimed in any one of claims 20 to 24, further comprising inputting light into the multimode optical fiber and detecting light modulation in the multimode optical fiber.

26. The method as claimed in claim 25, further comprising attaching a mirror to the multimode optical fiber at one end thereof for reflecting light to the other end of the optical fiber.

27. The method as claimed in claim 26, further comprising using a 1x2 fiber coupler for connecting the light source and a light detection unit to the multimode optical fiber at said other end of the optical fiber.

28. The method as claimed in claim 25, further comprising connecting a 1x2 fiber coupler to the multimode optical fiber at one end thereof, the 1x2 fiber coupler configured for redirecting light to the other end of the optical fiber.

29. The method as claimed in claim 28, further comprising using a second 1x2 fiber coupler for connecting the light source and a light detection unit to the multimode optical fiber at said other end of the optical fiber.

30. The method as claimed in any one of claims 20 to 29, further comprising,

determining at least a heart rate of the person based on light intensity variations caused by bending losses induced by the microbending.

31. The method as claimed in claim 30, further comprising extracting information of at least one of a group consisting of heart beat rate, breathing rate and body movement from the light intensity variations.

32. The method as claimed in claim 31, wherein the body movement information is extracted based on a signal deviation tracking process.

33. The method as claimed in any one of claims 31 to 32, wherein for an application associated with breathing, the breathing rate information is extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis. .

34. The method as claimed in any one of claims 31 to 33, wherein for an application associated with heart beat, the heart beat rate information is extracted based on a signal filtering process and at least one process selected from a group consisting of peak detection, valley detection, amplitude detection, Fast Fourier Transform and Wavelet analysis. .

35. The method as claimed in any one of claims 31 to 34, further comprising displaying the extracted information.

36. The method as claimed in any one of claims 31 to 35, further comprising activating an alarm based on the extracted information.

37. The method as claimed in any one of claims 20 to 36, wherein the multimode optical fiber under the exerted pressure functions as a fiber mode converter.

38. A data storage medium having computer code means stored thereon for instructing a computing device to execute a method for vital signs detection, the method comprising the steps of,

receiving an optical signal from a multimode optical fiber; and

determining at least a heart rate of a person based on light intensity variations caused by bending losses induced by a mechanical structure configured for receiving a pressure exerted by the person's body and to cause microbending of the multimode optical fiber under the exerted pressure,

wherein the multimode optical fiber is disposed between first and second sets of microbending elements of the mechanical structure substantially in a direction of the exerted pressure, and

wherein the first set of microbending elements and the second set of microbending elements are configured to be interlinked, when the pressure is exerted to the mechanical structure, so as to cause the microbending of the multimode optical fiber disposed therebetween.