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STRETCHABLE SENSORS FOR WEARABLE DEVICES

Morteza Khaleghimeybodi
Meta Platforms Technologies, LLC

Shantonu Biswas
Meta Platforms Technologies, LLC

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Inventors:
Morteza Khaleghimeybodi
Shantonu Biswas

FIELD OF THE INVENTION

[0001] This disclosure relates generally to stretchable electronics, and more specifically to stretchable sensors for wearable devices.

BACKGROUND

[0002] Wearable devices sometimes include sensors to measure biological signals. One of the challenges with available sensors (e.g., electrodes, optical, etc.) are making them comfortable for long term wear. Sensors typically have to be in good contact with skin of the user and are made out of relatively stiff materials that can have bio-compatibility issues, making them uncomfortable for long term wear.

DETAILED DESCRIPTION

[0003] Embodiments described herein are directed toward stretchable biological sensors for wearable devices. A stretchable sensor is a sensor that is soft and malleable, such that it is able to be stretched, bent, deformed, etc. One or more stretchable sensors may be integrated to a wearable device. The wearable device may be, e.g., hearables, a watch, a bracelet, a ring, a glove, a necklace, a piece of clothing, a headset (e.g., smart glasses, head-mounted display, etc.),

or some combination thereof. A wearable device may include one or more stretchable sensors, and a controller.

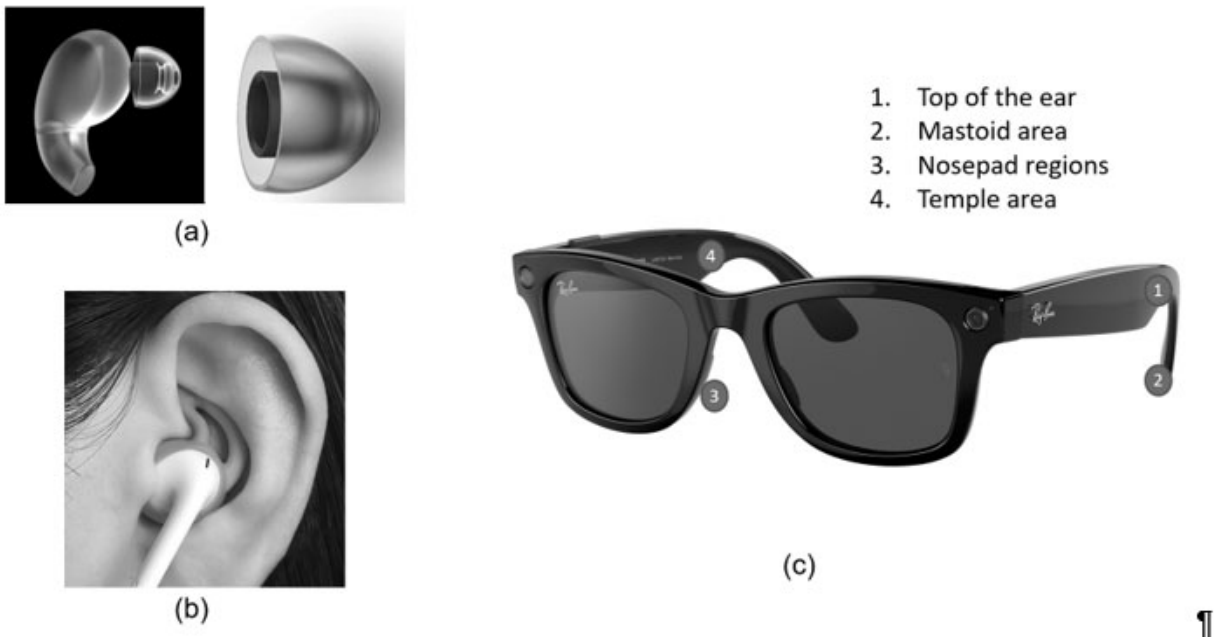

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Figure 1

[0004] Figure 1 illustrates various examples of a wearable device. Each of the embodiments of wearable devices are in contact with the skin of a user in different places. For example, (a) and (b) are examples of stretchable sensors integrated into hearables and (c) is an example headset. Stretchable sensors are comfortable relative to conventional sensors and may be placed in these locations. For example, in conventional hearables, sensors are placed within a rigid body of the hearables and when the user inserts the device in the ear-canal, the sensors may lose contact with the skin. In contrast, for a hearable that includes a stretchable sensor, the stretchable sensor is flexible and stretchable and may be embedded within the soft silicone eartip (e.g., image at right in (a)). Thus, when the user inserts the device inside the ear-canal, the stretchable sensor automatically adapts to a shape of the ear-canal and retains good contact with anatomy, thus enabling reliable biosensing functionalities.

[0005] As noted above, a stretchable sensor is a sensor that is soft and malleable, such that it is able to be stretched, bent, deformed, etc. A stretchable sensor may be formed from a stretchable electronics layer, and one or more stretchable layers. The stretchable electronics layer includes electronics that are part of a flexible substrate. The electronics may include electrical traces, electrodes, optical emitters, optical detectors, some other circuit components, or some combination thereof. The stretchable electronics layer may be sandwiched between two stretchable layers. The stretchable electronics layer provides a stretchable base for the stretchable electronics layer, and also protects sensitive components of the stretchable electronics layer. The flexible substrate and/or the stretchable layer may be, e.g., elastomers, fabrics, etc., or some combination thereof. In embodiments, where the stretchable layer is an elastomer, the elastomer may be, e.g., nitrile rubber, butyl rubber, polybutadiene rubber, synthetic polyisoprene, neoprene, silicone, polyacrylic, polyether block amides, ethylene-vinyl acetate, fluoroelastomer (FKM), or thermoplastic polyurethane (TPU), some other flexible and soft material base, or some combination thereof. The elastomer substrate could also have other additives to enhance conductivity or UV stability or chemical stability etc. under different use cases. The elastomer substrate may be conductive, non-conductive, or some combination thereof.

[0006] In some embodiments, the stretchable sensors are configured to monitor electrical signals from a wearer of the wearable device. In these embodiments, some or all of the stretchable sensors may be in direct contact with the skin, or may be indirectly coupled to the skin (e.g., through a stretchable layer). Portions of the stretchable electronics layer and/or portions of the stretchable layer between the electronics and the skin may be formed from a conductor. The conductor may be a biocompatible material which either doesn’t interact with human body or does not elicit any undesirable local or systematic effect to humans.

[0007] Figure 2 illustrates an example of how electrical traces can stretch. The top portion of Figure 2 illustrates four traces in a neutral position (no deforming force applied). Not the electronic traces have a pseudo-sinusoidal shape. The bottom portion of Figure 2 illustrates the four traces subject to a deforming force that stretches the four traces laterally.

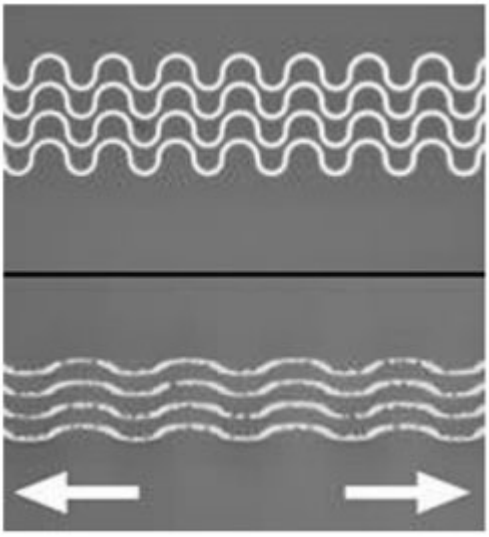

Figure 2

[0008] Figure 3 illustrates an example circuit design and layout architecture of an example stretchable electronics layer that includes a Photoplethysmography (PPG) sensor. Different components of this stretchable PPG sensor (e.g., photodetector, multi-wavelength LEDs, passive electrical components, etc.) can be placed in different locations of the wearable devices giving designs flexibility.

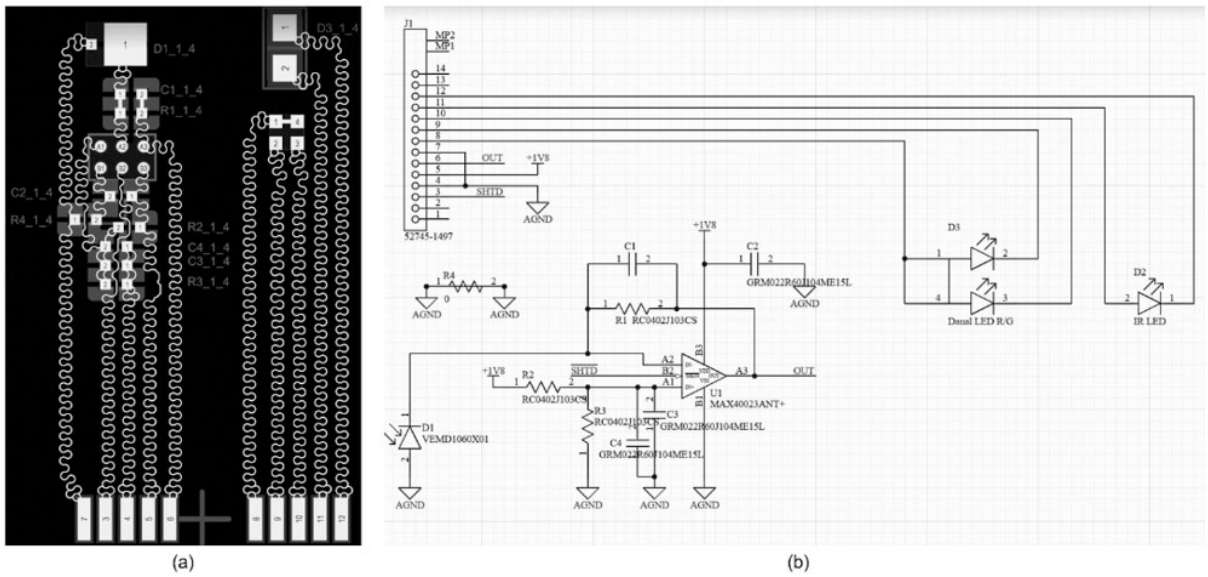

Figure 3

[0009] The controller controls components of the wearable device. The controller is electrically coupled to the one or more stretchable sensors. In some embodiments, the controller is electrically coupled to the one or more stretchable sensors. The controller may process signals received from the one or more stretchable sensors as they monitor biological signals of the user. For example, depending on the type of stretchable sensor, the controller may monitor heart rate, blood pressure, blood oxygen level, etc., of the user based on the monitored signals.

[0010] The flexibility and softness of the stretchable sensor function to mitigate discomfort of being placed in contact with skin of the user. Likewise, the portion of the stretchable sensor that is in contact with the skin can be biocompatible to mitigate irritation of the skin. In this manner, stretchable sensors are able to be integrated into soft eartips of hearables, portions of headsets, etc. In contrast, conventional sensors are relatively stiff, and have a tendency to be uncomfortable and have a difficult time maintaining contact with the skin of the user in wearable devices.

[0011] Embodiments of the invention may include or be implemented in conjunction with an artificial reality system. Artificial reality is a form of reality that has been adjusted in some manner before presentation to a user, which may include, e.g., a virtual reality (VR), an augmented reality (AR), a mixed reality (MR), a hybrid reality, or some combination and/or derivatives thereof. Artificial reality content may include completely generated content or generated content combined with captured (e.g., real-world) content. The artificial reality content may include video, audio, haptic feedback, or some combination thereof, any of which may be presented in a single channel or in multiple channels (such as stereo video that produces a three-dimensional effect to the viewer). Additionally, in some embodiments, artificial reality may also be associated with applications, products, accessories, services, or some combination thereof, that are used to create content in an artificial reality and/or are otherwise used in an artificial reality. The artificial reality system that provides the artificial reality content may be implemented on various platforms, including a wearable device (e.g., headset) connected to a host computer system, a standalone wearable device (e.g., headset), a mobile device or computing system, or any other hardware platform capable of providing artificial reality content to one or more viewers.

Additional Configuration Information

[0012] The foregoing description of the embodiments has been presented for illustration; it is not intended to be exhaustive or to limit the patent rights to the precise forms disclosed. Persons skilled in the relevant art can appreciate that many modifications and variations are possible considering the above disclosure.

[0013] Some portions of this description describe the embodiments in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and

representations are commonly used by those skilled in the data processing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logically, are understood to be implemented by computer programs or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations as modules, without loss of generality. The described operations and their associated modules may be embodied in software, firmware, hardware, or any combinations thereof.

[0014] Any of the steps, operations, or processes described herein may be performed or implemented with one or more hardware or software modules, alone or in combination with other devices. In one embodiment, a software module is implemented with a computer program product comprising a computer-readable medium containing computer program code, which can be executed by a computer processor for performing any or all the steps, operations, or processes described.

[0015] Embodiments may also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, and/or it may comprise a general-purpose computing device selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a non-transitory, tangible computer readable storage medium, or any type of media suitable for storing electronic instructions, which may be coupled to a computer system bus. Furthermore, any computing systems referred to in the specification may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

[0016] Embodiments may also relate to a product that is produced by a computing process described herein. Such a product may comprise information resulting from a computing process,

where the information is stored on a non-transitory, tangible computer readable storage medium and may include any embodiment of a computer program product or other data combination described herein.

[0017] Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the patent rights. It is therefore intended that the scope of the patent rights be limited not by this detailed description, but rather by any claims that issue on an application based hereon. Accordingly, the disclosure of the embodiments is intended to be illustrative, but not limiting, of the scope of the patent rights, which is set forth in the following claims.

What is claimed is:

1. An in-ear device (IED) comprising:

a soft ear tip configured to fit within an ear canal of a user, the soft ear tip including a stretchable electronics layer sandwiched between two stretchable layers, the stretchable electronics layer including a sensor configured to monitor a biological signal of the user, and

a body including a controller configured to perform an action based in part on the monitored biological signal, the body configured to fit within a portion of the soft ear tip.