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Inventor(s)

Zigras; Ioannis A

Electronic Devices Having Morphing Device Housings Allowing Wearable and Handheld Modes of Operation

Abstract

An electronic device includes a first device housing and a second device housing that are slidable relative to each other. A flexible display spans a major surface of the electronic device. A strap can be attached to the electronic device so as to span a second major surface of the electronic device, where sliding the first device housing toward the second device housing changes the perimeter of an arm insertion aperture defined by the strap and device housings. A deformable device housing arm can extend between the device housing(s) and the strap and can wrap around a user's arm. The first device housing and second device housing can be manufactured from a flexible material to wrap around an arm allowing a first coupler coupled to the first device housing to attach to a second coupler coupled to the second device housing.

Inventors: Zigras; Ioannis A (Chicago, IL)

Applicant: Motorola Mobility LLC (Chicago, IL)

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Background/Summary

CROSS REFERENCE TO PRIOR APPLICATIONS [0001] This application is a divisional application claiming priority and benefit under 35 U.S.C. § 121 from U.S. application Ser. No. 17/704,488, filed Mar. 25, 2022, which is incorporated by reference for all purposes, and which claims priority Greek patent application No. 20220100219 filed Mar. 8, 2022.

BACKGROUND

Technical Field

[0002] This disclosure relates generally to electronic devices, and more particularly to electronic devices having housings that allow a form factor of the electronic device to change.

Background Art

[0003] Portable electronic communication devices, especially smartphones, have become ubiquitous. People all over the world use such devices to stay connected. These devices have been designed in various mechanical configurations. These electronic devices come in different form factors. A first configuration, known as a “candy bar,” is generally rectangular in shape, has a rigid form factor, and has a display disposed along a major face of the electronic device. By contrast, a “clamshell” device has a mechanical hinge that allows one housing to pivot relative to the other. It would be desirable to have additional electronic devices with mechanical features offering additional user configurability.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 illustrates one explanatory sliding electronic device in accordance with one or more embodiments of the disclosure.

[0005] FIG. 2 illustrates one explanatory sliding electronic device in an open position.

[0006] FIG. 3 illustrates one explanatory sliding electronic device in a closed position.

[0007] FIG. 4 illustrates a sectional side view of one explanatory electronic device in accordance with one or more embodiments of the disclosure in a first mechanical configuration.

[0008] FIG. 5 illustrates a sectional side view of the electronic device of FIG. 4 in a second mechanical configuration that is wearable.

[0009] FIG. 6 illustrates a sectional side view of the electronic device of FIG. 4 with a strap component detached from the device housing.

[0010] FIG. 7 illustrates the strap component detached from the electronic device of FIG. 6 in a wearable configuration.

[0011] FIG. 8 illustrates a sectional side view of another explanatory electronic device in accordance with one or more embodiments of the disclosure in a first mechanical configuration that is wearable.

[0012] FIG. 9A illustrates a sectional side view of the electronic device of FIG. 8 in a second mechanical configuration.

[0013] FIG. 9B illustrates a first optional configuration for portions of the electronic device of FIG.

9A.

[0014] FIG. 9C illustrates a second optional configuration for portions of the electronic device of FIG. 9A.

[0015] FIG. 10 illustrates a sectional view of yet another explanatory electronic device in accordance with one or more embodiments of the disclosure in a first mechanical configuration.

[0016] FIG. 11 illustrates a sectional side view of the electronic device of FIG. 10 in a second mechanical configuration that is wearable.

[0017] FIG. 12 illustrates a sectional side view of the electronic device of FIG. 10 in a third mechanical configuration that is wearable.

[0018] FIG. 13 illustrates a sectional view of yet another electronic device in accordance with one or more embodiments of the disclosure in a first mechanical configuration.

[0019] FIG. 14 illustrates a sectional view of the electronic device of FIG. 13 in a second mechanical configuration that is wearable.

[0020] FIG. 15 illustrates a strap component detached from the electronic device of FIG. 14 in a wearable configuration.

[0021] FIG. 16 illustrates one explanatory electronic device in accordance with one or more embodiments of the disclosure in a wearable configuration.

[0022] FIG. 17 illustrates the explanatory electronic device of FIG. 16 in a hand-held configuration.

[0023] FIG. 18 illustrates various embodiments of the disclosure.

[0024] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] Embodiments of the disclosure are now described in detail. Referring to the drawings, like numbers indicate like parts throughout the views. As used in the description herein and throughout the claims, the following terms take the meanings explicitly associated herein, unless the context clearly dictates otherwise: the meaning of “a,” “an,” and “the” includes plural reference, the meaning of “in” includes “in” and “on.”

[0026] Relational terms such as first and second, top and bottom, and the like may be used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions. As used herein, components may be “operatively coupled” when information can be sent between such components, even though there may be one or more intermediate or intervening components between, or along the connection path.

[0027] The terms “substantially,” “essentially,” “approximately,” “about,” or any other version thereof, are defined as being close to as understood by one of ordinary skill in the art, and in one non-limiting embodiment the term is defined to be within ten percent, in another embodiment within five percent, in another embodiment within one percent, and in another embodiment within one-half percent. The term “coupled” as used herein is defined as connected, although not necessarily directly and not necessarily mechanically. Also, reference designators shown herein in parenthesis indicate components shown in a figure other than the one in discussion. For example, talking about a device (10) while discussing figure A would refer to an element, 10, shown in figure other than figure A.

[0028] Embodiments of the disclosure provide an electronic device having device housings that slide, bend, and otherwise morph so as to allow the electronic device to be used in both wearable and handheld modes of operation. In the wearable mode of operation, the electronic device can be worn as a watch. In the handheld mode of operation, the electronic device can be used as a traditional smartphone or handheld computer.

[0029] By including the morphing housings, electronic devices configured in accordance with embodiments of the disclosure provide ultimate portability in that they free up space in that they need not occupy space in a pocket. Instead, the electronic device can be worn on a wrist when not in use as a smartphone or other similar device. Additionally, the electronic devices described herein help to ensure that the electronic device does not get lost when not in use in the handheld mode. By attaching the electronic device to a wrist, it is less likely to be inadvertently dropped, lost, or damaged.

[0030] Another advantage offered by embodiments of the disclosure is that when the electronic device is transitioned to the wearable mode, in some configurations it can help a user “disconnect” from their device by concealing the visible display. Some embodiments of the disclosure allow the electronic device to be worn in a “jewelry” orientation where the display is not visible, thereby subtly helping prevent a user from constantly checking the device for updates and notifications.

[0031] In one or more embodiments, the electronic device comprises a first device housing and a second device housing that is slidable relative to the first device housing. A flexible display spans a first major surface of the electronic device. A strap spans a second major surface of the electronic device, with a first end of the strap coupled to the first device housing and a second end of the strap coupled to the second device housing.

[0032] In one or more embodiments, sliding the first device housing relative to the second device housing transitions the electronic device between a wearable and a handheld mode of operation. In one or more embodiments, sliding the first device housing relative to the second device housing changes a perimeter of an arm insertion aperture defined by the strap, the first device housing and the second device housing.

[0033] In another embodiment, an electronic device comprises a first device housing and a second device housing that is slidable relative to the first device housing. The electronic device includes a flexible display spanning a first major surface of the electronic device. A first coupler is attached to a first device housing minor face, while a second coupler is attached to a second device housing minor face.

[0034] In one or more embodiments, the first device housing and the second device housing are manufactured from a flexible material such that each can be deformed sufficiently to allow the first coupler to attach to the second coupler with the first device housing and second device housing defining a loop that can be positioned about a wrist. Where, for example, the first coupler and the second coupler are configured as magnets, this allows the electronic device to be wrapped around a wrist when not used in a handheld mode of operation.

[0035] In some embodiments, an electronic device comprises a device housing defining a component chamber having one or more of an energy storage device or one or more circuit components carried by a substrate situated therein and a deformable device housing arm extending distally from a side of the component chamber. In one or more embodiments, a strap is coupled to, and extends distally away from, a terminal edge of the deformable device housing arm.

[0036] In one or more embodiments, a first coupler is coupled to an end of the strap. A second coupler and a third coupler are situated on the device housing at different places. In one or more embodiments, the first coupler is selectively attachable to, and detachable from, either the second coupler or the third coupler. This multi-coupler coupling capability allows the strap to be positioned such that it abuts the device housing when the electronic device is being used in a handheld mode but freed from the device housing when being used in a wearable mode.

[0037] Some embodiments of the disclosure provide an electronic device that includes at least a first device housing and a second device housing. In one or more embodiments, the first device housing is configured to slide relative to the second device housing. Illustrating by example, in one explanatory embodiment, the first device housing slides into and out of the second device housing to change an overall length of the sliding electronic device. In other embodiments, the second device housing can slide into and out of the first device housing to achieve the same result.

Accordingly, in one or more embodiments a sliding electronic device includes a first device housing and a second device housing that slide relative to each other to transition between a closed position, an open position, and a plurality of partially open positions therebetween.

[0038] In one or more embodiments, a flexible display is coupled to the first device housing and the second device housing. The flexible display engages a rotor in one or both device housings. When the first device housing and second device housing slide relative to each other, the flexible display wraps around the rotor to extend further from, or back into, the device housing in which the rotor(s) is/are situated.

[0039] In one or more embodiments, the rotor not only facilitates the perceived “extension” of the flexible display that occurs during an opening operation, but also works to improve the reliability and usability of the flexible display. This is true because the rotor defines a service loop about which the flexible display curves. The service loop prevents the flexible display from being damaged or developing memory in the folded position when the electronic device is in the closed position.

[0040] In one or more embodiments, a “rollable” electronic device includes a strap that adjusts to be worn around wrist. In other embodiments, the electronic device includes a foldable display that flexes. The foldable display, in combination with a strap, can be morphed to form a circular loop that enables the user to wear it around wrist.

[0041] In one or more embodiments, an electronic device includes a rollable display that extends, but also flexes, to improve wearability around wrist. In one or more embodiments, electronics situated within the electronic device are offset and not stacked directly beneath a center of the display.

[0042] In one or more embodiments, when the electronic device slides closed, a flexible strap attached thereto allows for the electronic device to be worn as a watch. In one or more embodiments, the flexible strap can be detached from the device housing to reduce the overall thickness of the electronic device (where desired). When detached, in one or more embodiments the flexible strap can be worn around the wrist as jewelry. In one or more embodiments, the strap can wrap in an orientation perpendicular to the display to control device width and display length.

[0043] In one or more embodiments, the flexible strap is replaceable for various wrist sizes and customer cosmetic preferences. In one or more embodiments, the display of the electronic device is positioned in an off-center orientation, thereby allowing for the flexible strap to close the electronic device when in the wearable device orientation. This can fill the height gap when the electronic device is in the handheld mode of operation.

[0044] In some embodiments, no strap is included. Instead, the first device housing and second device housing are manufactured from flexible material such that each can be deformed. A first coupler is attached to a first device housing minor face, while a second coupler is attached to a second device housing minor face. Accordingly, the electronic device can be wrapped around the wrist with the first coupler and the second coupler attaching to retain the electronic device around the wrist. Such an electronic device can be positioned in a watch orientation, with the display facing outward, or in a jewelry orientation with the display facing inward. Where the electronic device includes a first device housing that is slidable relative to the second device housing, sliding the device housings relative to each other allows for customizing the length of the electronic device so it will fit different wrist sizes.

[0045] Turning now to FIG. 1, illustrated therein is one explanatory electronic device **100** configured in accordance with one or more embodiments of the disclosure. The electronic device **100** of FIG. 1 is a portable electronic device. For illustrative purposes, the electronic device **100** is shown as a smartphone.

[0046] The electronic device **100** includes a first device housing **101** and a second device housing **102**. In one or more embodiments, the first device housing **101** slides relative to the second device housing **102**. In the illustrative embodiment of FIG. 1, the first device housing **101** can selectively

slide into, and out of, the second device housing **102**. However, in other embodiments the opposite will be true, with the second device housing **102** being selectively slidable into and out of the first device housing **101**.

[0047] In one or more embodiments, one of the first device housing **101** or second device housing **102** includes rails that couple to tracks in the other of the first device housing **101** or the second device housing **102**. For instance, the first device housing **101** can have rails that couple to tracks in the second device housing **102**. In another embodiment, the first device housing **101** may have a rail and a track, with the second device housing **102** having a complementary rail and track that engage the rail and track of the first device housing **101** to facilitate the sliding operation. Other techniques that allow the first device housing **101** and the second device housing **102** to slide relative to each other between a closed position (shown below in FIG. **3**) and the open position of FIG. **1** will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0048] In one or more embodiments the first device housing **101** and the second device housing **102** are manufactured from a rigid material such as a rigid thermoplastic, metal, or composite material, although other materials can be used. In other embodiments, one or both of the first device housing **101** and/or the second device housing **102** are flexible. Illustrating by example, the first device housing **101** and/or second device housing **102** may be manufactured from a malleable, bendable, or physically deformable material such as a flexible thermoplastic, flexible composite material, flexible fiber material, flexible metal, organic or inorganic textile or polymer material, or other materials. Where either the first device housing **101** or second device housing **102** is a deformable housing, it can be manufactured from a single flexible housing member or from multiple flexible housing members. In other embodiments, the second device housing **1002** could be a composite of multiple components. Still other constructs will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0049] In the illustrative embodiment of FIG. **1**, the electronic device **100** includes a single sliding mechanism where the first device housing **101** slides relative to the second device housing **102**. However, in other embodiments two or more sliding mechanisms can be incorporated into the electronic device **100** to allow it to slide at multiple locations, such as in a telescoping configuration.

[0050] This illustrative electronic device **100** of FIG. **1** includes a display **103**. The display **103** can optionally be touch-sensitive. Users can deliver user input to the display **103** of such an embodiment by delivering touch input from a finger, stylus, or other objects disposed proximately with the display **103**.

[0051] In one or more embodiments the flexible display **104** may be formed from multiple layers of flexible material such as flexible sheets of polymer or other materials. In this illustrative embodiment, the flexible display **104** is fixedly coupled to the first device housing **101** and extends into the second device housing **102** and around the display roller mechanism **105**. The flexible display **104** spans the engagement line at which the first device housing **101** slides into, and out of, the second device housing **102** in this illustrative embodiment.

[0052] Features can be incorporated into the first device housing **101** and/or the second device housing **102**. Examples of such features include a camera or an optional speaker port. A user interface component, which may be a button, fingerprint sensor, or touch sensitive surface, can also be disposed along the first device housing **101** or second device housing **102**. In other embodiments, these features may be omitted.

[0053] A block diagram schematic **106** of the electronic device **100** is also shown in FIG. **1**. The block diagram schematic **106** includes one or more electronic components that can be coupled to a printed circuit board assembly disposed within either or both of the first device housing **101** or the second device housing **102** of the electronic device **100**. The components of the block diagram schematic **106** can be electrically coupled together by conductors or a bus disposed along one or more printed circuit boards. For example, some components of the block diagram schematic **106**

can be configured as a first electronic circuit fixedly situated within the first device housing **101**, while other components of the block diagram schematic **106** can be configured as a second electronic circuit fixedly situated within the second device housing **102**. A flexible substrate can then extend from the first electronic circuit in the first device housing **101** to the second electronic circuit in the second device housing **102** to electrically couple the first electronic circuit to the second electronic circuit.

[0054] In one or more embodiments, the electronic device **100** comprises an energy storage device **107** and one or more circuit components **108** carried by a substrate. The one or more circuit components **108** are configured to operate the flexible display **104** and other components of the electronic device **100**. In one or more embodiments, the energy storage device **107** and the substrate carrying the one or more circuit components **108** are situated in an off-center alignment relative to the flexible display **104**.

[0055] In one or more embodiments, the electronic device **100** includes one or more processors **110**. In one embodiment, the one or more processors **110** can include an application processor and, optionally, one or more auxiliary processors. One or both of the application processor or the auxiliary processor(s) can include one or more processors. One or both of the application processor or the auxiliary processor(s) can be a microprocessor, a group of processing components, one or more ASICs, programmable logic, or other type of processing device.

[0056] The application processor and the auxiliary processor(s) can be operable with the various components of the electronic device **100**. Each of the application processor and the auxiliary processor(s) can be configured to process and execute executable software code to perform the various functions of the electronic device **100**. A storage device, such as memory **111**, can optionally store the executable software code used by the one or more processors **110** during operation.

[0057] In this illustrative embodiment, the electronic device **100** also includes a communication circuit **112** that can be configured for wired or wireless communication with one or more other devices or networks. The networks can include a wide area network, a local area network, and/or personal area network. The communication circuit **112** may also utilize wireless technology for communication, such as, but are not limited to, peer-to-peer or ad hoc communications such as HomeRF, Bluetooth and IEEE 802.11, and other forms of wireless communication such as infrared technology. The communication circuit **112** can include wireless communication circuitry, one of a receiver, a transmitter, or transceiver, and one or more antennas **113**.

[0058] In one embodiment, the one or more processors **110** can be responsible for performing the primary functions of the electronic device **100**. For example, in one embodiment the one or more processors **110** comprise one or more circuits operable with one or more user interface devices, which can include the display **103**, to present, images, video, or other presentation information to a user. The executable software code used by the one or more processors **110** can be configured as one or more modules **114** that are operable with the one or more processors **110**. Such modules **114** can store instructions, control algorithms, logic steps, and so forth.

[0059] In one embodiment, the one or more processors **110** are responsible for running the operating system environment of the electronic device **100**. The operating system environment can include a kernel and one or more drivers, and an application service layer, and an application layer. The operating system environment can be configured as executable code operating on one or more processors or control circuits of the electronic device **100**. The application layer can be responsible for executing application service modules. The application service modules may support one or more applications **109** or “apps.” The applications of the application layer can be configured as clients of the application service layer to communicate with services through application program interfaces (APIs), messages, events, or other inter-process communication interfaces. Where auxiliary processors are used, they can be used to execute input/output functions, actuate user feedback devices, and so forth.

[0060] In one embodiment, the one or more processors **110** may generate commands or execute control operations based on information received from the sensors **115** of the electronic device **100**. The one or more processors **110** may also generate commands or execute control operations based upon information received from a combination of the one or more sensors **115**, the flexible display **104**, and/or the other input devices such as the user interface component. Alternatively, the one or more processors **110** can generate commands or execute control operations based upon information received from the one or more sensors **115** or the flexible display **104** alone. Moreover, the one or more processors **110** may process the received information alone or in combination with other data, such as the information stored in the memory **111**.

[0061] The one or more sensors **115** may include a microphone, an earpiece speaker, a second loudspeaker, and a user interface component such as a button or touch-sensitive surface. The one or more other sensors **115** may also include key selection sensors, proximity sensors, a touch pad sensor, a touch screen sensor, a capacitive touch sensor, and one or more switches. Touch sensors may be used to indicate whether any of the user actuation targets present on the display **103** are being actuated. Alternatively, touch sensors disposed in the electronic device **100** can be used to determine whether the electronic device **100** is being touched at side edges or major faces of the first device housing **101** or the second device housing **102**. The touch sensors can include surface and/or housing capacitive sensors in one embodiment. The other sensors **115** can also include audio sensors and video sensors.

[0062] The other sensors **115** can also include motion detectors, such as one or more accelerometers or gyroscopes. For example, an accelerometer may be embedded in the electronic circuitry of the electronic device **100** to show vertical orientation, constant tilt and/or whether the electronic device **100** is stationary. A gyroscope can be used in a similar fashion.

[0063] Other components **116** operable with the one or more processors **110** can include output components such as video outputs, audio outputs, and/or mechanical outputs. Examples of output components include audio outputs such as speaker port, earpiece speaker, or other alarms and/or buzzers and/or a mechanical output component such as vibrating or motion-based mechanisms. Still other components will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0064] In one or more embodiments, a strap attachment chassis **117** is provided to allow a strap **118**, which may be flexible, to be attached to one or both of the first device housing **101** and/or second device housing **102**. In one or more embodiments, the strap attachment chassis **117** includes clasps, magnets, latches, hooks, loops, or other mechanical features that allow the strap **118** to be selectively attached to, or detached from, one or both of the first device housing **101** and/or second device housing **102**.

[0065] It is to be understood that FIG. **1** is provided for illustrative purposes only and for illustrating components of one electronic device **100** in accordance with embodiments of the disclosure and is not intended to be a complete schematic diagram of the various components required for an electronic device. Therefore, other electronic devices in accordance with embodiments of the disclosure may include various other components not shown in FIG. **1** or may include a combination of two or more components or a division of a particular component into two or more separate components, and still be within the scope of the present disclosure.

[0066] Turning now to FIG. **2**, illustrated therein is the electronic device **100** in an open position **200**. The open position **200** is also known as a handheld mode or handheld operating configuration.

[0067] In the axially displaced open position **200**, the first device housing **101** slides out of the second device housing **102**, thereby revealing the flexible display **104**. In such a configuration, front surfaces of the first device housing **101** and the second device housing **102** effectively define a plane. Since this illustrative embodiment includes a flexible display **104**, the flexible display **104** has been elongated into a flat position. This transitions the electronic device **100** into a handheld mode of operation.

[0068] Turning now to FIG. 3, illustrated therein is the electronic device **100** in a closed state. The closed state is also known as a wearable configuration or wearable mode of operation.

[0069] In this state, the first device housing **101** slides **301** into the second device housing **102** toward the second device housing **102** to a closed position **300**. This causes the overall length of the electronic device **100** to get shorter. Additionally, the flexible display **104** inserts into the second device housing **102** by passing around the display roller mechanism (**105**) and becoming concealed within the second device housing **102**. This transitions the electronic device **100** into a wearable mode of operation. When the electronic device **100** opens again, the concealed portions of the flexible display **104** are again revealed.

[0070] In some embodiments, features can be included to further retain the electronic device **100** in the closed position **300**. Illustrating by example, in another embodiment, a mechanical latch can be included to retain the first device housing **101** and the second device housing **102** in the closed position **300**. In still another embodiment, magnets can be incorporated into the first device housing **101** and the second device housing **102**. For instance, magnets can be placed in the first device housing **101** and the second device housing **102** to retain the first device housing **101** and the second device housing **102** in the closed position **300**.

[0071] In still other embodiments, frictional elements can be incorporated into the mechanical interface existing between the first device housing **101** and the second device housing **102** to retain the first device housing **101** and the second device housing **102** in a particular position. A stator motor could be integrated into electronic device **100** to drive the first device housing **101** and second device housing **102** together and apart as well.

[0072] Turning now to FIG. 4, illustrated therein is a sectional view of one explanatory electronic device **400** configured in accordance with one or more embodiments of the disclosure. In FIG. 4, the electronic device is shown in a handheld configuration.

[0073] The electronic device includes a first device housing **401** and a second device housing **402** that is slidable relative to the first device housing. A flexible display **404** spans a first major surface **403** of the electronic device **400**. A strap **405** spans a second major surface **406** of the electronic device.

[0074] In one or more embodiments, the strap **405** includes a first end **407** coupled to the first device housing **401**. The strap **405** also includes a second end **408** coupled to the second device housing **402**. The first end **407** and the second end **408** of the strap **405** could be perdurably coupled to the first device housing **401** and the second device housing **402**, respectively, in some embodiments. However, in other embodiments the first end **407** and the second end **408** of the strap **405** are configured to be attachable to, or detachable from, the first device housing **401** and the second device housing **402**, respectively.

[0075] Illustrating by example, the strap **405** of FIG. 4 includes a first fastener **409** and a second fastener **410** allowing the first end **407** and the second end **408** to selectively attach to, and detach from, the first device housing **401** and the second device housing **402**, respectively. The first fastener **409** is coupled to the first end **407** of the strap **405**, while the second fastener **410** is coupled to the second end **408** of the strap **405**.

[0076] As will be shown below with reference to FIGS. 6-7, the first device housing **401** includes a third fastener that is selectively attachable to, or detachable from, the first fastener **409** coupled to the first end **407** of the strap **405**. Similarly, the second device housing **402** includes a fourth fastener that is selectively attachable to, or detachable from, the second fastener **410** coupled to the second end **408** of the strap **405**. In one or more embodiments, these fasteners are pivotable such that the first fastener **409** of the strap **405** can pivot about the first device housing **401** when coupled to the third fastener of the first device housing **401**. Similarly, the second fastener **410** of the strap **405** can pivot about the second device housing **402** when coupled to the fourth fastener of the second device housing **402**.

[0077] In one or more embodiments, one or both of the first device housing **401** and/or the second

device housing **402** defines a component chamber **411**. In the illustrative embodiment of FIG. **4**, the component chamber **411** is situated between sides of the first device housing **401** and second device housing **402**, the bottom surfaces of the first device housing **401** and the second device housing **402**, and the flexible display **404**.

[0078] In the illustrative embodiment of FIG. **4**, one or more circuit components (**108**) carried by a substrate **412** and an energy storage device **107** are situated within the component chamber **411**. As shown in FIG. **4**, the substrate **412** and the energy storage device **107** are situated in the second device housing **402**, which means that they are situated in an off-center alignment **413** relative to the flexible display **404**.

[0079] In one or more embodiments, the flexible display comprises one or more layers that are coupled or laminated together to complete the flexible display **404**. In one or more embodiments, these layers comprise a flexible protective cover, a first adhesive layer, a flexible display layer, a second adhesive layer, and a flexible substrate. Other configurations of layers suitable for manufacturing the flexible display **404** will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0080] Beginning from the top of the layer stack, in one or more embodiments the flexible protective cover comprises an optically transparent substrate. In one or more embodiments the flexible protective cover may be manufactured from an optically transparent material such a thin film sheet of a thermoplastic material. Illustrating by example, in one embodiment the flexible protective cover is manufactured from a layer of optically transparent polyamide. In another embodiment, the flexible protective cover is manufactured from a layer of optically transparent polycarbonate. Other materials suitable for manufacturing the flexible protective cover will be obvious to those of ordinary skill in the art having the benefit of this disclosure. Illustrating by example, in other embodiments the housing could be manufactured from glass.

[0081] In one or more embodiments the flexible protective cover functions as a fascia by defining a cover for the flexible display layer. In one or more embodiments the flexible protective cover is optically transparent, in that light can pass through the flexible protective cover so that objects behind the flexible protective cover can be distinctly seen. The flexible protective cover may optionally include an ultra-violet barrier. Such a barrier can be useful in improving the visibility of flexible display layer in one or more embodiments.

[0082] Beneath the flexible protective cover is a first adhesive layer. In one or more embodiments, the first adhesive layer comprises an optically transparent adhesive. The optically transparent adhesive can be applied to two sides of a thin, optically transparent substrate such that the first adhesive layer functions as an optically transparent layer having optically transparent adhesive on both sides. This optically transparent version of “double-sided tape” can then be spooled and applied between the flexible protective cover and the flexible display layer to couple the two together.

[0083] In other embodiments the first adhesive layer will instead be applied between the flexible protective cover and the flexible display layer as an optically transparent liquid, gel, as a homogeneous adhesive layer, or in the form of another medium. Where so configured, the first adhesive layer can optionally be cured by heat, ultraviolet light, or other techniques. Other examples of materials suitable for use as the first adhesive layer will be obvious to those of ordinary skill in the art having the benefit of this disclosure. In one or more embodiments, the first adhesive layer mechanically couples the flexible display layer to the flexible protective cover.

[0084] In one or more embodiments, the flexible display layer is situated between the flexible substrate and the flexible protective cover. In other embodiments, a layer above the flexible display layer can be configured with enough stiffness to make the flexible substrate unnecessary. For example, in an embodiment where the flexible protective cover is configured with enough stiffness to retain the flexible display in the proper shape, the flexible substrate may be omitted.

[0085] The flexible display layer can optionally be touch-sensitive. In one or more embodiments,

the flexible display layer is configured as an organic light emitting diode (OLED) display layer coupled to the flexible substrate, which allows the flexible display layer to bend in accordance with various bending radii.

[0086] In one or more embodiments the flexible display layer may be formed from multiple layers of flexible material such as flexible sheets of polymer or other materials. Illustrating by example, the flexible display layer can include a layer of optically pellucid electrical conductors, a polarizer layer, one or more optically transparent substrates, and layers of electronic control circuitry such as thin film transistors to actuate pixels and one or more capacitors for energy storage.

[0087] In one or more embodiments, to be touch sensitive the flexible display layer includes a layer including one or more optically transparent electrodes. In one or more embodiments, the flexible display layer includes an organic light emitting diode layer configured to images and other information to a user. The organic light emitting diode layer can include one or more pixel structures arranged in an array, with each pixel structure comprising a plurality of electroluminescent elements such as organic light emitting diodes. These various layers can be coupled to one or more optically transparent substrates of the flexible display layer. Other layers suitable for inclusion with the flexible display layer will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0088] In one or more embodiments, the flexible display layer is coupled to the flexible substrate by a second adhesive layer. In one or more embodiments, to simplify manufacture, the second adhesive layer is identical to the first adhesive layer and comprises an optically transparent adhesive. However, since the second adhesive layer is coupled between the flexible display layer and the flexible substrate, i.e., under the flexible display layer, an optically transparent adhesive is not a requirement. The second adhesive layer could be partially optically transparent or not optically transparent at all in other embodiments.

[0089] Regardless of whether the second adhesive layer is optically transparent, in one or more embodiments the adhesive of the second adhesive layer is applied to two sides of a thin, flexible substrate. This extremely thin version of “double-sided tape” can then be spooled and applied between the flexible display layer and the flexible substrate to couple the two together.

[0090] In other embodiments, as with the first adhesive layer, the second adhesive layer will instead be applied between the flexible display layer and the foldable substrate as a liquid, gel, as a homogeneous layer, or in the form of another medium. Where so configured, the second adhesive layer can optionally be cured by heat, ultraviolet light, or other techniques. Other examples of materials suitable for use as the second adhesive layer will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0091] In one or more embodiments, the flexible display comprises a flexible substrate. In one or more embodiments the flexible substrate is coupled to the flexible display layer and defines a mechanical support for the flexible display layer due to the fact that the flexible substrate is the stiffest layer of the flexible display **404**. In one or more embodiments the flexible substrate is manufactured from stainless steel. In another embodiment, the flexible substrate is manufactured from a flexible plastic. Other materials from which the flexible substrate can be manufactured will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0092] Embodiments of the disclosure contemplate that some of the layers comprising the flexible display **404** are stiffer than others. Similarly, other layers of the flexible display **404** are softer than others. For example, where the flexible substrate is manufactured from stainless steel, this layer is stiffer than either the first adhesive layer or the second adhesive layer. In one or more embodiments, the stainless steel is stiffer than the flexible display layer as well. In one or more embodiments, the flexible substrate is the stiffest layer in the flexible display **404** while the first adhesive layer and the second adhesive layer are the softest layers of the flexible display **404**. The flexible protective cover and the flexible display layer have a stiffness that falls between that of the flexible substrate and the adhesive layers in one or more embodiments.

[0093] In one or more embodiments, the various layers of the flexible display **404** are laminated together in a substantially planar configuration. Said differently, in one or more embodiments the flexible substrate is configured as a substantially planar substrate. The second adhesive layer can be attached to this substantially planar substrate, with the flexible display layer then attached to the second adhesive layer. The first adhesive layer can be attached to the flexible display layer, with the flexible protective cover attached to the first adhesive layer. To ensure proper coupling, the resulting flexible display layer can be cured, such as in an autoclave at a predefined temperature for a predefined duration. Where employed, such curing allows any air bubbles or other imperfections in the various layers to be corrected. In one or more embodiments, since the flexible substrate is configured as a substantially planar substrate, the resulting flexible display **404** is substantially planar as well.

[0094] In one or more embodiments, the flexible display **404** wraps around a display roller mechanism when the first device housing **401** slides relative to the second device housing **402**. In this illustrative embodiment, the display roller mechanism includes a rotor **414** about which the flexible display **404** wraps when the first device housing **401** slides relative to the second device housing **402**.

[0095] Rotation of the rotor **414** causes a linear translation of the flexible display **404** across the first major surface **403** of the electronic device **400** by drawing the flexible display **404** around the rotor **414**. In one or more embodiments, the rotor **414** is positioned within a curvilinear section of the flexible display **404**, with the flexible display **404** passing around the rotor **414** when the first device housing **401** slides relative to the second device housing **402**.

[0096] The electronic device **400** is shown in a handheld configuration in FIG. **4**. Due to the pivotability of the first fastener **409** and the second fastener **410** of the strap **405** about the third fastener and the fourth fastener of the first device housing **401** and second device housing **402**, the first end **407** of the strap **405** is pivotally coupled to the first device housing **401** and the second end **408** of the strap **405** is pivotally coupled to the second device housing **402**.

[0097] Since the first device housing **401** is slid to a maximally extended position relative to the second device housing **402** in FIG. **4**, the strap **405** becomes straightened and abuts the second major surface **406** of the electronic device **400**. Said differently, the sliding operation that results in the configuration of FIG. **4** with the first device housing **401** slid away from the second device housing **402** to a maximally extended position causes the strap **405** to abut one or both of the first device housing **401** and/or the second device housing **402**. Here, the strap **405** abuts both the first device housing **401** and the second device housing **402**.

[0098] Turning now to FIG. **5**, the electronic device **400** of FIG. **4** has been transitioned to a wearable configuration. Specifically, the first device housing **401** has been slid toward the second device housing **402** to a minimally extended position. This causes slack to be introduced in the strap **405** such that the strap **405**, the first device housing **401**, and the second device housing **402** define an arm insertion aperture **501**.

[0099] In one or more embodiments, sliding the first device housing **401** relative to the second device housing **402** between the maximally extended position and the minimally extended position changes a perimeter length of the arm insertion aperture **501** defined by the strap **405**, the first device housing **401**, and the second device housing **402**. This allows a person's arm **502** to be inserted into the arm insertion aperture **501** so that the electronic device **400** can be worn as a wristwatch. When this sliding occurs, the flexible display **404** wraps around the rotor (**414**), thereby shortening the length of the flexible display **404** spanning the first major surface **403** of the electronic device **400**.

[0100] As noted above, in one or more embodiments the strap **405** is selectively detachable from the electronic device **400**. Turning now to FIG. **6**, illustrated therein is the electronic device **400** with the strap (**405**) detached therefrom. This reveals the third fastener **609** attached to the first device housing **401** and the fourth fastener **610** attached to the second device housing **402**.

[0101] In one or more embodiments, the fasteners of the strap are not only attachable to the fasteners of the first device housing **401** and the second device housing **402** but are also attachable to themselves. Said differently, in one or more embodiments the first fastener (**409**) attached to the first end (**407**) of the strap (**405**) is selectively attachable to, and detachable from, both the third fastener **609** attached to the first device housing **401** and the second fastener (**410**) attached to the second end (**408**) of the strap (**405**). Similarly, in one or more embodiments the second fastener (**410**) attached to the second end (**408**) of the strap (**405**) is selectively attachable to, and detachable from, both the fourth fastener **610** attached to the second device housing **402** and to the first fastener (**409**) attached to the first end (**407**) of the strap (**405**). As shown in FIG. 7, this allows the strap **405** to be worn as a bracelet in a jewelry configuration when the first fastener **409** attached to the first end **407** of the strap is coupled to the second fastener **410** attached to the second end **408** of the strap **405**.

[0102] Turning now to FIG. 8, illustrated therein is another electronic device **800** configured in accordance with one or more embodiments of the disclosure. In FIG. 8, the electronic device **800** is shown in a wearable configuration.

[0103] The electronic device **800** of FIG. 8 includes a device housing **801** defining a component chamber **811**. An energy storage device **107** and one or more circuit components (**108**) carried by a substrate **814** are situated within the component chamber **811**.

[0104] In this embodiment, some or all of the device housing **801** are manufactured from a bendable material. Illustrating by example, the device housing **801** can be manufactured from a malleable, bendable, or physically deformable material such as a flexible thermoplastic, flexible composite material, flexible fiber material, flexible metal, organic or inorganic textile or polymer material, or other materials.

[0105] In the illustrative embodiment of FIG. 8, the device housing **801** comprises a deformable device housing arm **802** extending distally from a side **803** of the component chamber **811**. As before, a flexible display **804** spans a major surface **806** of the electronic device **800**. The flexible display **804** also spans one side of the deformable device housing arm **802**. In this embodiment, the flexible display **804** spans the entirety of one side of the deformable device housing arm **802**.

[0106] A strap **805** is coupled to, and extends terminally away from, a terminal edge **807** of the deformable device housing arm **802**. The strap **805** of FIG. 8 includes a single coupler **809** situated at a terminal end of the strap **805**. The single coupler **809** allows the terminal end of the strap **805** to selectively attach to, and detach from, as second coupler **810** situated at a first location on the device housing **801** or a third coupler **812** situated at a second location of the device housing **801** that is different from the first location. In the illustrative embodiment of FIG. 8, the second coupler **810** and the third coupler **812** are situated on the device housing **801** in different places. The first coupler **809** is selectively attachable to, and detachable from, either the second coupler **810** or the third coupler **812** in one or more embodiments.

[0107] As shown in FIG. 8, the electronic device **800** is in a wearable configuration. This means that the component chamber **811**, the deformable device housing arm **802**, and the strap **805** define a loop when the deformable device housing arm **802** is deformed into the curvilinear shape of FIG. 8 and the first coupler **809** is attached to the second coupler **810** of the device housing **801**.

[0108] In one or more embodiments, the first coupler **809** and the second coupler **810** comprise magnetic couplers. Thus, when the electronic device **800** is in the wearable configuration of FIG. 8, the first coupler **809** attaches to the second coupler **810** magnetically to define the loop into which a wearer's arm **813** can be inserted.

[0109] In this illustrative embodiment, the third coupler **812** allows attachment of the first coupler thereto when the electronic device **800** is transitioned to the handheld configuration. In one or more embodiments, this occurs when the deformable device housing arm **802** is extended into a linear configuration extending linearly away from the component chamber **811**. This is shown below in FIG. 9A.

[0110] In the wearable configuration of FIG. 8, the flexible display **804** extends from a first side wall of the component chamber **811** across the top of the component chamber **811**, across a second side wall of the component chamber **811**, and along the deformable device housing arm **802** to the terminal edge **807** of the deformable device housing arm **802**. In so doing, the flexible display **804** is positioned in an off-center location relative to the component chamber **811** with the component chamber situated under a right side of the flexible display **804** and the deformable device housing arm **802** situated under a left side of the first device housing **801**. By having the strap **805** extend distally not only from the terminal edge **807** of the deformable device housing arm **802** but the terminal edge of the flexible display **804** as well, this allows the strap **805** to fill the “height gap” between the terminal edge **807** of the deformable device housing arm **802** and the terminal edge of the flexible display **804** when the electronic device **800** is transitioned to the handheld configuration of FIG. 9A.

[0111] Turning now to FIG. 9A, the electronic device **800** has been transitioned from the wearable configuration of FIG. 8 to the handheld configuration by bending the deformable device housing arm **802** until it extends linearly away from the second side wall of the component chamber **811**. When this occurs, the first coupler **809** positioned at the end of the strap **805** can be attached to the third coupler **812** such that the strap **805** abuts the deformable device housing arm **802**. Said differently, when the deformable device housing arm **802** extends linearly away from the component chamber **811** in the handheld configuration, the strap **805** abuts the when the first coupler **809** is attached to the third coupler **812**. In one or more embodiments, the third coupler **812** can be moved within an adjustment chamber **901** to accommodate different strap lengths for different wrist sizes and/or user cosmetic preferences. Illustrating by example, the third coupler **812** can slide into, or out of, the device housing **801** along the adjustment chamber to allow for straps of varying lengths to still abut the device housing **801** when the electronic device **800** is in the handheld configuration.

[0112] To preclude a void being created between the flexible display **804** and the deformable device housing arm **802**, in one or more embodiments a filling element **902** can situate between the flexible display **804** and the deformable device housing arm **802** when the deformable device housing arm **802** extends linearly away from the component chamber **811** of the device housing **801**. This can be done in a variety of ways. Two explanatory embodiments are shown in FIGS. 9B and 9C.

[0113] Turning first to FIG. 9B, in this illustrative embodiment a self-organizing lattice structure **903** that is retractable into the device housing (**801**) serves as the filling element (**902**). When the deformable device housing arm **802** is extended so as to extend linearly away from the second side wall of the component chamber (**811**), the opening of a void between the flexible display **804** and the deformable device housing arm **802** allows the self-organizing lattice structure **903** to expand, thereby filling the void and providing mechanical support for the flexible display **804**.

[0114] By contrast, turning now to FIG. 9C, in this illustrative embodiment an extendable support plate **904** is retractable into, and extendable from, the device housing (**801**). This extendable support plate **904** functions as the filling element (**902**) when the electronic device **800** is transitioned to the handheld configuration. In one or more embodiments, the extendable support plate **904** extends from the second side wall of the component chamber (**811**) when the electronic device **800** is placed into the handheld configuration, thereby mechanically supporting the flexible display **804** and overall electronic device **800** when the deformable device housing arm **802** extends linearly away from the second side wall of the component chamber (**811**). Said differently, the extendable support plate **904** can eject from the device housing (**801**) when the deformable device housing arm **802** is transitioned to a flat state.

[0115] Turning now to FIG. 10, illustrated therein is yet another electronic device **1000** configured in accordance with one or more embodiments of the disclosure. In FIG. 10, the electronic device **1000** is shown in a handheld configuration.

[0116] The electronic device **1000** includes a first device housing **1001** and a second device housing **1002** that is slidable relative to the first device housing. A flexible display **1004** spans a majority of a first major surface of the electronic device **1000**. Surfaces of the first device housing **1001** and the second device housing **1002** span the second major surface **406** of the electronic device.

[0117] In the illustrative embodiment of FIG. **10**, the electronic device **1000** has a length of about 196 millimeters when the first device housing **1001** is maximally extended from the second device housing **1002**. However, the length of the electronic device **1000** can be adjusted downward by sliding the first device housing **1001** into the second device housing **1002** to a length of about 141 millimeters for smaller wrists.

[0118] Unlike previous embodiments, the electronic device **1000** of FIG. **10** includes no strap. Instead, the electronic device **1000** is malleable so that it can define a strap without the need for a strap to be included. The flexible display **1004** is fabricated on a flexible plastic substrate that allows the flexible display **1004** to be flexible. When the first device housing **1001** slides relative to the second device housing **1002**, the flexible display can deform around a display roller mechanism (**105**) as previously described, thereby changing its overall length. One example of such a display roller mechanism (**105**) is a rotor **1008**, which works as does the one described above with reference to FIG. **4**.

[0119] In this embodiment, the first device housing **1001** and the second device housing **1002** are each manufactured from a bendable material, examples of which include flexible thermoplastics, flexible composite materials, flexible fiber materials, flexible metals, or organic or inorganic textile or polymer materials. Other bendable materials will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0120] As shown in FIG. **10**, a first coupler **1009** is attached to a minor face of the first device housing **1001**. Similarly, a second coupler **1010** is attached to a minor face of the second device housing **1002**. In one or more embodiments, the first coupler **1009** and the second coupler **1010** each comprise magnetic couplers. The first device housing **1001** and the second device housing **1002** can be slid relative to each other to change an overall length of the electronic device **1000** to match the circumference of a user's arm. Thereafter, the first device housing **1001** and the second device housing **1002** can be deformed sufficiently to allow the first coupler **1009** to attach to the second coupler **1010**. In one or more embodiments, as will be shown with reference to FIGS. **11-12** below, the electronic device **1000** defines a cylinder when the first coupler **1009** is attached to the second coupler **1010**.

[0121] In one or more embodiments, both of the first device housing **1001** and the second device housing **1002** define a component chamber. In the illustrative embodiment of FIG. **10**, the component chambers are situated between the couplers **1009,1010** and the flexible display **1004**. In the illustrative embodiment of FIG. **10**, one or more circuit components (**108**) are carried by a first substrate **1006** and a second substrate **1007**. Additionally, the energy storage device of the electronic device **1000** has been bifurcated into a first energy storage device **1003** and a second energy storage device **1005**, situated within the first component chamber and the second component chamber, respectively.

[0122] Accordingly, in this illustrative embodiment the electronic device **1000** includes two energy storage devices **1003,1005** and one or more circuit components (**108**) coupled to a first substrate **1006** and a second substrate **1007**. A first energy storage device **1003** and a first substrate **1006** supporting one or more circuit components (**108**) are positioned between the first coupler **1009** and the flexible display **1004**, while a second energy storage device **1005** and the second substrate **1007** supporting one or more other circuit components (**108**) are positioned between the second coupler **1010** and the flexible display **1004**. This results in the flexible display **1004** being centrally disposed between the first energy storage device **1003** and the first substrate **1006**, and the second energy storage device **1005** and the second substrate **1007**, respectively.

[0123] As with the electronic device (**100**) of FIG. **1**, features can be added to the electronic device **1000** including a charging port, speaker port, and microphone. In one or more embodiments, these features are positioned along either the first coupler **1009** or the second coupler **1010**. This positioning protects the features from environmental damage when the electronic device **1000** is transitioned into the wearable configuration with the first coupler **1009** attached to the second coupler **1010** due to the fact that the mating of the first coupler **1009** and the second coupler **1010** encases the charging port, speaker port, and microphone (or other features that may be included). [0124] Turning now to FIG. **11**, the first device housing **1001** and the second device housing **1002** can be deformed sufficiently to allow the first coupler **1009** to attach to the second coupler **1010**. As shown, the electronic device **1000** defines a cylinder **1100** when the first coupler **1009** is attached to the second coupler **1010**.

[0125] In FIG. **11**, the electronic device **1000** is deformed with the flexible display **1004** defining an exterior surface of the cylinder **1100** so that it can be seen when worn around a user's arm **1101**. By contrast, as shown in FIG. **12**, the electronic device **1000** can be deformed with the flexible display **1004** defining an interior surface of the cylinder **1100** so that it cannot be seen when worn around a user's arm **1101**. This configuration is referred to as a “jewelry configuration” due to the fact that the flexible display **1004** is hidden by the first device housing and the second device housing **1002**.

[0126] By including the “morphing” housings of FIGS. **10-12**, the electronic device **1000** provides ultimate portability in that it can be used in a handheld mode or worn in a watch configuration or jewelry configuration, all without the necessity of any strap. Advantageously, this design allows the electronic device **1000** to be worn on a wrist when not in use as a smartphone or other similar device. Additionally, the configuration of FIGS. **10-12** helps to ensure that the electronic device **1000** does not get lost when not in use in the handheld mode. By attaching the electronic device **1000** to a wrist, it is less likely to be inadvertently dropped, lost, or damaged.

[0127] Another advantage offered by the embodiment of FIGS. **10-12** is that when the electronic device **1000** is transitioned to the jewelry configuration of the wearable mode, it can help a user “disconnect” from the electronic device **1000** by concealing the flexible display **1004**. The “jewelry” orientation of FIG. **12**, where the flexible display **1004** is not visible to the user, thereby subtly helps prevent the user from constantly checking the device for updates and notifications. Moreover, wearing the electronic device **1000** in the jewelry configuration can also be advantageous in reducing the distractions stemming from notifications by minimally lighting a portion of the flexible display **1004**, one example of which are the sides of the flexible display **1004** adjacent to the jewelry portion. In other embodiments, notifications can simply be precluded while the electronic device **1000** is worn in the jewelry orientation.

[0128] Turning now to FIG. **13**, illustrated therein is a sectional view of yet another explanatory electronic device **1300** configured in accordance with one or more embodiments of the disclosure. In FIG. **13**, the electronic device **1300** is shown in a handheld configuration.

[0129] The electronic device **1300** includes a first device housing **1301** and a second device housing **1302** that is slidable relative to the first device housing. A flexible display **1304** spans a first major surface **1303** of the electronic device **1300**. A strap **1305** spans a second major surface **1306** of the electronic device. In this illustrative embodiment, the strap **1305** comprises a first strap portion **1307** coupled to the first device housing **1301**, a second strap portion **1308** portion coupled to the second device housing **1302**, and a clasp coupling the first strap portion **1307** to the second strap portion **1308**.

[0130] In this illustrative embodiment, the first strap portion **1307** includes a first end coupled to the first device housing **1301**. The second strap portion **1308** also includes a first end coupled to the second device housing **1302**. The first end of the first strap portion **1307** and the second strap portion **1308** could be perdurably coupled to the first device housing **401** and the second device housing **402**, respectively, in some embodiments. However, in other embodiments the first end of

the first strap portion **1307** and the second strap portion **1308** are configured to be attachable to, or detachable from, the first device housing **401** and the second device housing **402**, respectively. [0131] Illustrating by example, the first strap portion **1307** of FIG. **13** includes a first fastener **1309**, while the second strap portion **1308** comprises a second fastener **1310** allowing the first ends of the first strap portion **1307** and the second strap portion **1308** to selectively attach to, and detach from, the first device housing **1301** and the second device housing **1302**, respectively. The first fastener **1309** is coupled to the first end of the first strap portion **1307**, while the second fastener **1310** is coupled to the second strap portion **1308**.

[0132] As with the electronic device (**400**) of FIG. **4** above, the first device housing **1301** includes a third fastener that is selectively attachable to, or detachable from, the first fastener **1309**. Similarly, the second device housing **1302** includes a fourth fastener that is selectively attachable to, or detachable from, the second fastener **1310**.

[0133] In one or more embodiments, these fasteners are pivotable such that the first fastener **1309** of the first strap portion **1307** can pivot about the first device housing **1301** when coupled to the third fastener of the first device housing **1301**. Similarly, the second fastener **1310** of the second strap portion **1308** can pivot about the second device housing **1302** when coupled to the fourth fastener of the second device housing **1302**.

[0134] In one or more embodiments, one or both of the first device housing **1301** and/or the second device housing **1302** defines a component chamber **1311**. In the illustrative embodiment of FIG. **13**, the component chamber **1311** is situated between sides of the first device housing **1301** and second device housing **1302**, the bottom surfaces of the first device housing **1301** and the second device housing **1302**, and the flexible display **1304**.

[0135] In the illustrative embodiment of FIG. **13**, one or more circuit components (**108**) carried by a substrate **1313** and an energy storage device **107** are situated within the component chamber **1311**. As shown in FIG. **13**, the substrate **1313** and the energy storage device **107** are situated in the second device housing **1302**, which means that they are situated in an off-center alignment relative to the flexible display **1304**.

[0136] In one or more embodiments, the flexible display **1304** comprises a flexible substrate. In one or more embodiments the flexible substrate is manufactured from stainless steel. In another embodiment, the flexible substrate is manufactured from a flexible plastic. In one or more embodiments, the flexible display **1304** wraps around a display roller mechanism when the first device housing **1301** slides relative to the second device housing **1302**. In this illustrative embodiment, the display roller mechanism includes a rotor **1314** about which the flexible display **1304** wraps when the first device housing **1301** slides relative to the second device housing **1302**.

[0137] The electronic device **1300** is shown in a handheld configuration in FIG. **13**. Due to the pivotability of the first fastener **1309** and the second fastener **1310** of the strap **1305** about the third fastener and the fourth fastener of the first device housing **1301** and second device housing **1302**, the first strap portion **1307** of the strap **1305** is pivotally coupled to the first device housing **1301** and the second strap portion **1308** of the strap **1305** is pivotally coupled to the second device housing **1302**. Since the first device housing **1301** is slid to a maximally extended position relative to the second device housing **1302** in FIG. **13**, the strap **1305** becomes straightened and abuts the second major surface **1306** of the electronic device **1300**.

[0138] The embodiment of FIG. **13** differs from the embodiment of FIG. **1** in that the strap **1305** includes a clasp **1315**. The clasp **1315** couples the first strap portion **1307** coupled to the first device housing **1301** to the second strap portion **1308** coupled to the second device housing **1302**. Details of the clasp **1315** will be shown in more detail below with reference to FIG. **15**.

[0139] Turning now to FIG. **14**, the electronic device **1300** of FIG. **13** has been transitioned to a wearable configuration. Specifically, the first device housing **1301** has been slid toward the second device housing **1302** to a position between the maximally extended position of FIG. **13** and the minimally extended position. This causes slack to be introduced in the strap **1305** such that the

strap **1305**, the first device housing **1301**, and the second device housing **1302** define a arm insertion aperture **1401**.

[0140] In one or more embodiments, sliding the first device housing **1301** relative to the second device housing **1302** between the maximally extended position and the minimally extended position changes a perimeter length of the arm insertion aperture **1401** defined by the strap **1305**, the first device housing **1301**, and the second device housing **1302**. This allows a person's arm to be inserted into the arm insertion aperture **1401** so that the electronic device **1300** can be worn as a wristwatch. When this sliding occurs, the flexible display **1304** wraps around the rotor (**1314**), thereby shortening the length of the flexible display **1304** spanning the first major surface **1303** of the electronic device **1300**.

[0141] In one or more embodiments the strap **1305** is selectively detachable from the electronic device **1300**. Turning now to FIG. **15**, illustrated therein is the strap **1305** after being detached from the electronic device (**1300**). This detachment allows the strap **1305** to be worn as a bracelet in a jewelry configuration when the first fastener **1309** attached to the first strap portion **1307** of the strap **1305** is coupled to the second fastener **1310** attached to the second strap portion **1308** of the strap **1305**.

[0142] Also shown in FIG. **15** are details of the clasp **1315** extending from the end **1502** of the first strap portion **1307**. While not shown in FIG. **15**, in one or more embodiments a complementary clasp that is a mirror image of the clasp **1315** shown in FIG. **15** extends from the second strap portion **1308**.

[0143] In one or more embodiments, so as to be adjustable, the clasp **1315** comprises a plurality of stair-stepped sliding clasp members **1501** that can be slid together, or apart, to change the overall length of the clasp **1315**. The complementary clasp extending from the second strap portion **1308** can include another plurality of stair-stepped sliding clasp members that function in a similar manner.

[0144] In one or more embodiments, the plurality of stair-stepped sliding clasp members **1501** extends from an end **1502** of the first strap portion **1307**, while the other plurality of stair-stepped sliding clasp members extends from an end of the second strap portion **1308**. The clasp **1315** of FIG. **15** includes a clasp element **1503** as well. In one or more embodiments, the clasp element **1503** couples to a complementary clasp element attached to the other plurality of stair-stepped sliding clasp members of the complementary clasp extending from the end of the second strap portion **1308**.

[0145] In one or more embodiments, to support the plurality of stair-stepped sliding clasp members **1501**, the clasp **1315** further comprises an elastic material **1504** extending from the end **1502** of the first strap portion **1307** to the clasp element **1503**, which is decorative in one or more embodiments. The complementary clasp extending from the second strap portion **1308** can include a similar piece of elastic material.

[0146] Embodiments of the disclosure contemplate that the overall length of the strap **1305** can vary as a function of the lengths of the first strap portion **1307**, the second strap portion **1308**, the number and length of stair-stepped sliding clasp members, and the size of the clasp element **1503**. Embodiments of the disclosure also contemplate that lengths of between 141 millimeters and 196 millimeters will typically accommodate the majority of adult wrist sizes. Accordingly, the number, length, extension capability, and other characteristics of each stair-stepped sliding clasp members can be selected by the manufacturer, as needed, to ensure that one or both of the strap **1305** and/or strap **1305** attached to the electronic device (**1300**) of FIG. **13** will be able to adequately fit a broad range of wearer's wrists.

[0147] In one or more embodiments, the plurality of stair-stepped sliding clasp members **1501** may include up to thirteen clasp members that each extend up to six millimeters relative to their next clasp member neighbor. Other configurations for the strap **1305** and its extendable components will be obvious to those of ordinary skill in the art having the benefit of this disclosure.

[0148] The electronic device **1300** of FIG. **13** is shown in the handheld configuration, with the first device housing **1301** maximally inserted into the second device housing **1302**, in FIG. **16**. By contrast, the electronic device **1300** is shown in the handheld configuration with the first device housing **1301** maximally extended from the second device housing **1302** in FIG. **17**.

[0149] Turning now to FIG. **18**, illustrated therein are various embodiments of the disclosure.

[0150] The embodiments of FIG. **18** are shown as labeled boxes in FIG. **18** due to the fact that the individual components of these embodiments have been illustrated in detail in FIGS. **1-17**, which precede FIG. **18**. Accordingly, since these items have previously been illustrated and described, their repeated illustration is no longer essential for a proper understanding of these embodiments. Thus, the embodiments are shown as labeled boxes.

[0151] Beginning at **1801**, an electronic device comprises a first device housing and a second device housing that is slidable relative to the first device housing. At **1801**, the electronic device comprises a flexible display spanning a first major surface of the electronic device.

[0152] At **1801**, the electronic device comprises a strap spanning a second major surface of the electronic device with a first end coupled to the first device housing and a second end coupled to the second device housing. At **1801**, sliding the first device housing relative to the second device housing changes a perimeter of an arm insertion aperture defined by the strap, the first device housing, and the second device housing.

[0153] At **1802**, the electronic device of **1801** further comprises a clasp coupling a first portion of the strap coupled to the first device housing to a second portion of the strap coupled to the second device housing. At **1803**, the clasp of **1802** comprises a plurality of stair-stepped sliding clasp members extending from an end of one of the first portion of the strap or the second portion of the strap to a clasp element. At **1804**, the clasp of **1803** further comprises an elastic material extending from the end of one of the first portion of the strap or the second portion of the strap to the clasp element.

[0154] At **1805**, the first end of the strap of **1801** is pivotally coupled to the first device housing. At **1805**, the second end of the strap is pivotally coupled to the second device housing.

[0155] At **1806**, sliding the first device housing of **1805** away from the second device housing to a maximally extended position straightens the strap. At **1807**, sliding the first device housing of **1805** away from the second device housing to a maximally extended position causes the strap to abut one or both of the first device housing or the second device housing. At **1808**, the strap of **1805** is selectively detachable from the electronic device.

[0156] At **1809**, the electronic device of **1808** further comprises a first fastener coupled to the first end of the strap, a second fastener coupled to the first device housing, a third fastener coupled to the second end of the strap, and a fourth fastener coupled to the second device housing. At **1809**, the first fastener is selectively attachable to, and detachable from, the second fastener and the third fastener, and the third fastener is selectively attachable to, and detachable from, the first fastener and the fourth fastener.

[0157] At **1810**, the electronic device of **1801** further comprises an energy storage device and one or more circuit components carried by a substrate and configured to operate the flexible display. At **1810**, the energy storage device and the substrate are situated in an off-center alignment relative to the flexible display.

[0158] At **1811**, the electronic device of **1801** further comprises a rotor positioned within a curvilinear section of the flexible display. At **1811**, the flexible display passes around the rotor when the first device housing slides relative to the second device housing.

[0159] At **1812**, an electronic device comprises a first device housing and a second device housing that is slidable relative to the first device housing. At **1812**, the electronic device comprises a flexible display spanning a first major surface of the electronic device.

[0160] At **1812**, the electronic device comprises a first coupler attached to a first device housing minor face and a second coupler attached to a second device housing minor face. At **1812**, the first

device housing and the second device housing are manufactured from a flexible material such that each can be deformed sufficiently to allow the first coupler to attach to the second coupler.

[0161] At **1813**, the electronic device of **1812** defines a cylinder when the first coupler is attached to the second coupler. At **1814**, the flexible display of **1813** is positioned on an exterior surface of the cylinder when the first coupler is attached to the second coupler.

[0162] At **1815**, the electronic device of **1814** further comprises a first energy storage device, one or more circuit components carried by a first substrate, a second energy storage device, and one or more other circuit components carried by a second substrate. At **1815**, the first energy storage device and the first substrate are positioned between the first coupler and the flexible display and the second energy storage device and the second substrate are positioned between the second coupler and the flexible display.

[0163] At **1816**, an electronic device comprises a device housing defining a component chamber having one or more of an energy storage device or one or more circuit components carried by a substrate situated therein. At **1816**, the electronic device comprises a deformable device housing arm extending distally from a side of the component chamber.

[0164] At **1816**, the electronic device comprises a strap coupled to, and extending distally away from, a terminal edge of the deformable device housing arm. At **1816**, the electronic device comprises a first coupler coupled to an end of the strap. At **1816**, the electronic device comprises a second coupler and a third coupler situated on the device housing in different places. At **1816**, the first coupler is selectively attachable to, and detachable from, either the second coupler or the third coupler.

[0165] At **1817**, the component chamber, the deformable device housing arm, and the strap of **1816** define a loop when the deformable device housing arm is deformed into a curvilinear shape and the first coupler is attached to the second coupler. At **1818**, the strap of **1817** abuts the deformable device housing arm when the deformable device housing arm extends linearly away from the component chamber and the first coupler is attached to the third coupler.

[0166] At **1819**, the first coupler, the second coupler, and the third coupler of **1818** comprise magnetic couplers. At **1820**, the electronic device of **1819** further comprises an extendable support plate that extends from the side of the component chamber. At **1820**, the extendable support plate mechanically supports the electronic device when the deformable device housing arm extends linearly away from the component chamber.

[0167] In the foregoing specification, specific embodiments of the present disclosure have been described. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the present disclosure as set forth in the claims below. Thus, while preferred embodiments of the disclosure have been illustrated and described, it is clear that the disclosure is not so limited. Numerous modifications, changes, variations, substitutions, and equivalents will occur to those skilled in the art without departing from the spirit and scope of the present disclosure as defined by the following claims.

[0168] Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present disclosure. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims.

Claims

1. An electronic device, comprising: a device housing defining a component chamber having one or more of an energy storage device or one or more circuit components carried by a substrate situated therein and a deformable device housing arm extending distally from a side of the component chamber; a strap coupled to, and extending distally away from, a terminal edge of the deformable

device housing arm; a first coupler coupled to an end of the strap; and a second coupler and a third coupler situated on the device housing in different locations; wherein the first coupler is selectively attachable to, and detachable from, either the second coupler or the third coupler.

2. The electronic device of claim 1, wherein the component chamber, the deformable device housing arm, and the strap define a loop when the deformable device housing arm is deformed into a curvilinear shape and the first coupler is attached to the second coupler.

3. The electronic device of claim 2, wherein the strap abuts the deformable device housing arm when the deformable device housing arm extends linearly away from the component chamber and the first coupler is attached to the third coupler.

4. The electronic device of claim 3, wherein the first coupler, the second coupler, and the third coupler comprise magnetic couplers.

5. The electronic device of claim 4, further comprising an extendable support plate that extends from the side of the component chamber, thereby mechanically supporting the electronic device when the deformable device housing arm extends linearly away from the component chamber.

6. The electronic device of claim 1, wherein the device housing is manufactured from a bendable material.

7. The electronic device of claim 6, wherein the device housing is manufactured from one or more of a flexible thermoplastic, a flexible composite material, a flexible fiber material, a flexible metal, and/or an organic or inorganic textile or polymer material.

8. The electronic device of claim 1, further comprising a flexible display spanning a major surface of the electronic device.

9. The electronic device of claim 8, wherein the flexible display spans an entirety of one side of the deformable device housing arm.

10. The electronic device of claim 1, wherein the strap defines a loop when the deformable device housing arm is deformed into a curvilinear shape and the first coupler is attached to the second coupler.

11. The electronic device of claim 1, wherein the first coupler and the second coupler each define magnetic couplers.

12. The electronic device of claim 1, further comprising a flexible display, wherein the flexible display is positioned in an off-center location relative to the component chamber.

13. The electronic device of claim 12, wherein the flexible display extends from a first side wall of the component chamber across a top of the component chamber, across a second side wall of the component chamber, and along the deformable device housing arm to the terminal edge of the deformable device housing arm.

14. The electronic device of claim 12, further comprising a flexible display, wherein the component chamber is situated under a right side of the flexible display.

15. The electronic device of claim 14, wherein the deformable device housing arm is situated under a left side of the device housing.

16. The electronic device of claim 1, wherein the electronic device transitions from a wearable configuration to a handheld configuration when the deformable device housing arm is bent until the deformable device housing arm extends linearly away from a second side wall of the component chamber.

17. The electronic device of claim 1, wherein the third coupler is movable within an adjustment chamber.

18. The electronic device of claim 1, further comprising a flexible display and a filling element that situates between the flexible display and the deformable device housing arm when the deformable device housing arm extends linearly away from the component chamber of the device housing.

19. An electronic device, comprising: a device housing defining a component chamber and a deformable device housing arm extending distally from a side of the component chamber; a flexible display supported by the device housing; a filling element; a strap coupled to, and

extending distally away from, a terminal edge of the deformable device housing arm; a first coupler coupled to an end of the strap; and a second coupler and a third coupler situated on the device housing in different locations; wherein: the first coupler is selectively attachable to, and detachable from, either the second coupler or the third coupler; and the filling element situates between the flexible display and the deformable device housing arm when the deformable device housing arm extends linearly away from the component chamber of the device housing.

20. An electronic device, comprising: a device housing defining a component chamber and a deformable device housing arm extending distally from a side of the component chamber; a strap coupled to, and extending distally away from, a terminal edge of the deformable device housing arm; a first coupler coupled to an end of the strap; and a second coupler and a third coupler situated on the device housing in different locations; wherein: the first coupler is selectively attachable to, and detachable from, either the second coupler or the third coupler; and the electronic device is transitions from a wearable configuration to a handheld configuration when the deformable device housing arm is bent until the deformable device housing arm extends linearly away from a second side wall of the component chamber.
