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(54) Title: FORCE SENSING TOUCH SYSTEM AND COMPUTING DEVICE WITH FORCE SENSING TOUCH SYSTEM

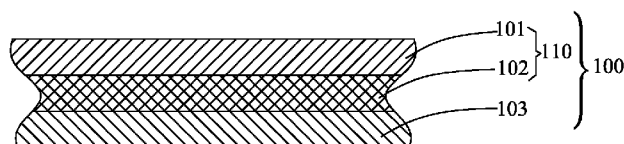


Fig. 1

(57) Abstract: A computing device configured to take action based on user touch position and force comprises a touch system and a strain amplifying force sensing structure attached to an underside of the touch system. The strain amplifying force sensing structure comprises a force sensing layer and a support plate with a strain amplifying structure.

Description

Title of Invention: FORCE SENSING TOUCH SYSTEM AND COMPUTING DEVICE WITH FORCE SENSING TOUCH SYSTEM

Technical Field

[0001] The present invention relates to a touch system, and more specifically to a computing device recognizing force applied by a user to a force sensing touch system and the computing device using the user input to take action.

Background Art

[0002] Computing device such as smartphones, tablets, e-readers, smart watches, virtual keyboards, machine panels and the like, can include a touch system in communication with a control unit configured to recognize the touch signal from the touch system and the control unit can take contextual action based on its programming. Touch system can sense a user touch that can be from one or more fingers or stylus. A user touch becomes a touch input when the touch is recognized by a computing device and may be used to take action. An action received by the user is a touch output. Touch systems such as touch screens, touch pads and touch controls and the like are well known in the art for manipulating computing devices such as portable and desktop devices, gaming systems, and industrial machines. Touch screens can have a touch sensing panel which is transparent, include a touch sensing system arranged over a display and can sense a user touch. Displayed information can not only be read by the user but the user may even interact with it by touching the touch screen on specific locations to initiate an action. Touch pads can have a touch sensing panel that may or may not be transparent and can sense a user touch. User touch over the touch pad area may become location specific action on associated but separate display. Touch controls may have a touch sensing panel with discrete arrangement of touch buttons or touch input keys or sliders. Touch controls maintain the aesthetics and integrity of the panel's material and design can still provide the necessary buttons for user input. Touch systems includes a touch sensing panel, may include protective cover layer, support frames and substrates, and may or may not include one or more displays, other buttons and the like.

[0003] Touch sensing panel can be formed by projected capacitive sensing, commonly referred to as capacitive touch. Here an array of conductive metal lines is orthogonally arranged and separated by an insulating layer creating a capacitive pixel at the cross points. Electrically activated capacitive array can then detect a user touch and its location, specifically the user touch interferes and attenuates the array's electrical signal pattern over a few pixels. Projected capacitive sensing requires the user to touch

by finger or special conductive stylus because the signal attenuating interference needed to recognize a user touch is based on electrical signal being diverted by creating a temporary conducting path to ground through the user. The user touch is recognized by the computing device; specifically the touch sensing panel communicates the user touch to the control unit where the programming determines the necessary context based action. Capacitive touch is a two-dimensional touch system that recognizes the surface location of user touch; specifically the x-y coordinates of touch. Touch sensing panels may be capable of more than single user input. They may be capable of multi-touch and gesture touch. In single user touch only one touch point on the touch sensing panel is recognized at any given instance as compared to multi-touch where more than one touch may be simultaneously be recognized by the touch system. Multi-touch may be used to develop touch patterns or gestures, for example two fingers being moved apart may be a zoom-in gesture or two fingers being brought together may be a zoom-out gesture.

[0004] Force sensing touch systems that are capable of force sensing add new capabilities to user input. Not only can the touch system know the touch location, it can also become aware of how hard the user is pushing. The additional degree of freedom can create for more innovative interactions with touch systems and make them more intuitive to the user. One handed operations are more easily implemented, for example moving the web page up or down can be dynamically adjusted based on the applied force or music volume can be turned up or down quickly based on applied force. User applied force leads to mechanical changes or strain detected by the force sensing touch system and is converted into an electrical signal for the computer system to recognize and act upon. Force sensing touch systems require integrating force sensors with touch sensing panels and incorporating signals from force sensors into the related computing device organization and operations. Special care must be taken to account for space and mechanical behavior of the physical design of the product to ensure that the user applied force and its associated strain is optimally detected by the force sensors. True force sensing touch systems may not be formed by using projected capacitive touch. Force sensing touch systems may use discrete mechanical springs, force sensing resistors (FSR), force sensing capacitors (FSC), strain gauges (SG), or piezoresistive sensors. Discrete mechanical springs and discrete strain gauges are generally large in size on the order of few millimeters or more, require tens of microns of deflection for activating the force sensors and have low sensitivity. Force sensing resistors and force sensing capacitors are very sensitive to preloading mechanical stresses introduced during the product assembly in manufacturing and can lead to yield losses, sensor variability, and reduced dynamic operating range. Semiconductor strain gauges, cantilevers and membranes have been developed as force sensors directly integrated with

the LCD display during semiconductor manufacturing, but these require special designs and can be relatively expensive. Piezoresistive sensors have the improved tolerances to manufacturing stresses and capable of useful functioning when incorporated as edge or corner sensors within the touch system but this may require redesign from material selections to assembly process to ensure optimal integration of force sensors. For larger touch systems even the edge/corner piezoresistive sensors face challenges with spatial resolution and mechanical robustness. Hence a need for sensitive and robust force sensing touch system that is low cost and capable of modular integration into existing designs.

Technical Problem

[0005] The force sensing touch structure of this invention includes a touch system; a supporting plate with strain amplifying structure; a supporting plate attached to the overlying touch system using adhesive applied solely over the strain amplifying structure; a force sensing layer; and a force sensing layer attached to the supporting plate using adhesive.

Solution to Problem

Technical Solution

[0006] According of one aspect of this invention, a force sensing touch screen detects user touch and communicates with control unit of the computing device to take action. The force sensing touch screen includes a touch sensing panel, a display, and strain amplifying force sensing structure; and the force sensing touch screen in communication with control unit determines user touch position and how hard the user pushed on the touch screen. The control unit and its programming further determine actions based on how hard the user pushed at that location.

[0007] Another aspect of this invention is a force sensing touch pad that detects user touch and communicates with control unit of computing device to take action based on force applied by the user. The force sensing touch pad includes a touch sensing panel and a strain amplifying force sensing structure attached to the underside of the touch sensing panel. The signal from the touch sensing panel determines the x-y position of user touch and the signal from the strain amplifying force sensing structure determines the user force or the x-y position and force of user touch are solely determined from signal from strain amplifying force sensing structure. The position and force signal correspond to a specific location on an associated but separate display and the control unit with its programming determines the necessary actions for the computing device.

[0008] In yet another aspect of this invention, a force sensing touch control detects if the user is applying gentle pressure or moderate pressure or hard pressure at the touch button and the computing device only takes action when pressure in a given range

value is detected. The force sensing touch control includes a metal or glass or plastic plate and a touch sensing panel with strain amplifying force sensing structure and may or may not include a capacitive or resistive touch. The metal or glass or plastic plate includes art work that identifies places where the user may touch to initiate actions. The force sensing touch system communicates user touch to the control unit and the control unit programming determines the level of user pressure and takes action corresponding to the level of pressure within the computing device.

Advantageous Effects of Invention

Advantageous Effects

[0009] Within this invention terms such as applied force or pressure or how hard a user pushes and such should all be viewed as the same and suggest a measure of touch detected by force sensors. Also use of terms such as light touch versus hard touch or moderate push versus hard push or low force versus medium force or low-, medium-, high-pressure all should be viewed the same and refer to signals detected by the force sensor that are within some range in values and these range of values are differentiable from each other.

Brief Description of Drawings

Description of Drawings

- [0010] Fig. 1 is a schematic cross section of a force sensing touch screen or system in accordance with the present invention;
- [0011] Fig. 2 is a simplified block diagram of a computing device;
- [0012] Fig. 3A~Fig. 3D are respectively a plan view of four embodiments of a strain amplifying force sensing structure;
- [0013] Fig. 4A is a simplified cross section (across A-A' in Fig. 3B) of the strain amplifying force sensing structure and its modular attachment to the touch system;
- [0014] Fig. 4B is a perspective view of the supporting plate;
- [0015] Fig. 4C shows details of another embodiment of the supporting plate;
- [0016] Fig. 4D is a simplified cross section (across B-B' in Fig. 4C) of the supporting plate; and
- [0017] Fig. 5 shows an example for calculating touch position and force in a four (4) force sensing touch system.

Mode for the Invention

Mode for Invention

[0018] To make the objectives, technical solutions and advantages of the present invention be clearer, the present invention will be further described hereinafter with reference to the accompany drawings and embodiments. It shall be understood that, the embodiments described herein are only intended to illustrate but not to limit the present

invention.

[0019] Computing devices with a force sensing touch system are common place for many applications. The structure, assembly and manufacturing of computing devices with force sensing touch systems is a highly optimized process that takes significant effort to develop, setup and mature. This process is developed to ensure the manufacturer not only provides a good product but also does so in a profitable manner. As computing devices with touch systems continue to progress it is desirable to have force sensing touch systems. It is also desirable to have force sensing touch systems that are easily introduced into existing manufacturing process and the force sensors that are highly sensitive and reliable. Force sensors that can be added to the undersurface of existing touch systems are most easily introduced into existing manufacturing processes. Attaching force sensors at the undersurface requires the force sensors to be very sensitive and have the capability to react to very small strain deflection in the overlying touch system. A strain amplifying force sensing structure of this invention is suitable for developing optimal and reliable forces sensing touch systems.

[0020] Fig. 1 is a schematic cross section of a force sensing touch system 100 that has a strain amplifying force sensing structure 103 attached to the touch system 110 that includes a touch sensing panel 101 and a display 102. The force sensing touch system 100 shown in Fig.1 is a force sensing touch screen, but it may also be a touch pad or touch control or combinations thereof where part or all of the touch sensing panel 101 may or may not be transparent and the display 102 may or may not be present. The touch sensing panel 101 may be covered by a protective sheet of glass or plastic (not shown) and may have support structures (not shown). The strain amplifying force sensing structure 103 is attached using an adhesive to an underside of the touch system 110. The strain amplifying force sensing structure 103 may cover the entire underside of the touch system 110 or may cover a part of the underside of the touch system 110. The strain amplifying force sensing structure 103 may be continuous single structure on underside of the touch system 110 or may be many structures each operating independent of the other structures or all structures operating in unison and on the underside of the touch system 110. For attachment between the touch system 110 and the strain amplifying force sensing structure 103, a sort of adhesive may be a continuous or the adhesive may be only applied to select areas.

[0021] Fig. 2 is a simplified block diagram of the computing device 200 showing a control unit 210, and a force sensing touch system 100. The force sensing touch system 100 connects to the control unit 210 through an electrical signal transmitting setup 216. The force sensing touch system 100 includes the strain amplifying force sensing structure 103. Specifically, the force sensing touch system 100 may have a single electrical connection 216 to the control unit 210 or may have many electrical connectors to the

control unit 210. More specifically, the strain amplifying force sensing structure 103 may connect to the control unit 210 through its own independent electrical transmitting setup (not shown). Common electrical connector may be a flexible printed circuit, one or more, that sends signals, one or more, between the force sensing touch system 100 and the control unit 210. The computing device 200 may have other features not shown in Fig. 2 such as motion sensors, a power button, an antenna, speakers, microphones, keypads, light indicators and so on. The control unit 210 may include a touch system controller 212 and a force sensor controller 214 therein. The control unit 210 may also include, but not shown, a processor, a display controller, a memory, a firmware and other software, an input-output interface and so on. The firmware and any software within the control unit 210 are referred to as its programming. Even though in Fig. 2 the control unit 210 is shown as a single block, in practice the various components of the control unit 210 may be distributed. Specifically, the force sensor controller 214 may be a separate unit. The force sensing touch system 100 may further include a touch sensing panel and a display. The touch sensing panel may be capacitive or resistive touch or such. The display may be an LCD or OLED display. All of these are described for purposes of explanation only. Those well versed in the art of computing devices know the possible variations and details necessary beyond what is described here. For purposes of the present invention it should be stated that the descriptions of these figures should not be limiting. When a user pushes on the force sensing touch system 100, for example, the touch screen, the touch sensing panel will send a signal to the control unit 210. The control unit 210 along with its programming will process the signal and identify the position of the user touch. Also, when the user pushes on the force sensing touch system 100, the force sensing touch system 100 will undergo some deflection and this deflection will be detected by the strain amplifying force sensing structure 103 that will send a signal to the control unit 210. The control unit 210 along with its programming may determine position and how hard the user has pushed on the force sensing touch system 100. The available information about the position of touch and how hard the user touched the touch screen is combined together and called a touch input. The touch input is used by the control unit 210 and its programming to take necessary action called a touch output. US Patent 4550384, US Patent 7196694 B2, US Patent 7746352 B2, US Patent and Application and Publication US 2007/0052690 A1 describe methods to determine the x-y position of force sensing touch using moment and vector based calculations. The applied force in a calibrated force sensing touch system is distributed across all the force sensors and can be calculated to get the user touch force. To those well versed in the art of force sensing touch systems it is well known how to calibrate force sensors and use the control unit 210 and its programming to calculate user touch position and force.

[0022] Fig. 3A to Fig. 3D are respectively a plan view of four embodiments of the strain amplifying force sensing structure 103. The strain amplifying structure 103 is designed to provide optimal operation of the included force sensors. The strain amplifying force sensing structure 103 includes a first region (a strain amplifying region) 1032 and a second region 1030. The first region 1032 is a force sensing region. The second region 1030 is not a force sensing region. The force sensors of the first region 1032 are labeled as 1032a, 1032b, 1032c, 1032d, 1032e and so on and may be distributed at different locations within the strain amplifying force sensing structure 103. The force sensor such as 1032a of the first region 1032 includes a strain amplifying structure and associated the force sensor and the second region 1030 does not include a strain amplifying structure. The force sensors such as 1032a may be placed anywhere within the strain amplifying force sensing structure 103, for example in four corners (as shown in Fig. 3A); in four corners and center (as shown in Fig. 3B); as a border (as shown in Fig. 3C); or as an array (as shown in Fig. 3D). The strain amplifying region 1032 is specially designed to take small deflections in the overlying touch system and to amplify its strain. The amplified strain is imparted to the underlying force sensor. The force sensor then has an improved response due to the strain amplifying region. Fig. 4A is a simplified cross section (across A-A' in Fig. 3B) of the strain amplifying force sensing structure 103 and its modular attachment to the touch system 110. The strain amplifying force sensing structure 103 includes a force sensor layer 1035 attached with an adhesive 1036 to the supporting plate 1037 that is then attached with an adhesive 104 to the underside of the touch system 110. The force sensor layer 1035 may include one or more force sensors. The strain amplifying force sensing structure 103 connects to the control panel of the control unit through an electrical signal transmitting setup that is not shown. The force sensor layer 1035 may be a screen printed multilayer stack that includes a substrate, active force sensing material, insulating layers, layer with conductive metal traces, passivation layer and so on. The conductive traces may include a power and ground traces and electrical signal traces for measurement and reference sensor outputs. The printed force sensor layer uses a glass or flexible plastic or polyimide substrate. The thickness of the force sensor layer 1035 can be between 25 to 350 microns, specifically between 50 to 200 microns. The force sensing material changes its intrinsic material property with applied force allowing the force sensing layer to output an electrical signal that changes as user changes the applied force. The force sensing material may be structural composite that may be based in polymer or ceramic or semiconducting material and may contain one or more metallic particle or one or more insulating particle or combination thereof along with other fillers. The adhesives 1036, 104 used within the strain amplifying force sensing structure 103 must not only provide excellent adhesion but must be robust to mechanical movements and

remain reliable over time. Further the adhesives must ensure that the touch system deflections initiated by user touch are optimally transmitted with minimum loss within the adhesives. Adhesives may be epoxy resins, commercial glues, two sided tapes and so on. The supporting plate 1037 as shown in Fig. 4B may be plastic or metal or glass and typically less than 3mm in thickness and select parts of the plate are patterned with openings that may extend the entire thickness of the plate. It is possible to use greater thickness of support plate 1037 but is usually not necessary. Within the strain amplifying force sensing structure 103, the supporting plate 1037 may include a plurality of patterned regions 1037b which are patterned and amplify strain, and the other unpatterned region 1037a which is not patterned and does not amplify strain. The patterned region 1037b of the supporting plate 1037 overlays the active sensor areas and adhesive 104 may be only applied over patterned regions 1037b of the supporting plate 1037 or may be applied over both the unpatterned region 1037a and patterned region 1037b of the supporting plate 1037. Projection of the strain amplifying regions 1037b and associated force sensors is labeled 1032 and in a region where there is no strain amplification is labeled 1030 at the bottom of Fig 4A. When two force sensors are paired together in close proximity and one force sensor is centrally located under the patterned region 1037b and the second force sensor is also placed in the patterned region 1037b but near its edge, the force sensing operates more reliably against external temperature variation because paired sensors experience similar temperature driven material property changes and therefore compensate for this change; any signal from the sensor pair is then mainly due to user applied touch and associated force.

[0023] Fig. 4C and Fig. 4D show details of the supporting plate 1037 with a patterned region 1037b being patterned for strain amplification and an unpatterned region 1037a is not patterned and does not amplify strain. The patterned region 1037b consists of a shaped opening 1037b2 that extends through the entire thickness of the supporting plate 1037 and an unpatterned inner region 1037b1 that is not patterned. The unpatterned inner region 1037b1 and unpatterned region 1037a must always be fully connected to ensure mechanically stable patterned structure 1037b. The overall shape of the patterned structure 1037b can be circular or square or any geometrical shape with openings that extends through the entire thickness of supporting plate 1037. The supporting plate 1037 is attached to the overlying touch system with an adhesive 104 such as an epoxy or glue or double side tape or such, and preferably attached using double sided tape. The adhesive 104 may only be applied over the patterned region 1037b or may be applied to both the patterned region 1037b and the unpatterned region 1037a, preferable it is only applied over region 1037b.

[0024] Fig 5 shows an example for calculating touch position and force in a four (4) force sensing touch system. The four force sensors are labeled 1032a, 1032b, 1032c, and

1032d. The x-distance between sensors 1032b and 1032c is (r+s). The y-distance between sensors 1032c and 1032d is (u+v). Let us assume the user touches at 300 and applied a force of F grams. Let the computing device measure the force calculated at force sensors 1032a as F_a ; at 1032b as F_b ; at 1032c as F_c ; at 1032d as F_d . Then the total force F is calculated from the equation $F = F_a + F_b + F_c + F_d$. Using the sensor 1032c as the origin for x-y coordinates, the touch x-position is calculated as $x = r = (r+s)(F_b/[F_c+F_b])$ and the y-touch position is calculated as $y = v = (u+v)(F_d/[F_c+F_d])$. Fig. 5 calculations assume that the adhesive 104 is only applied over the patterned regions 1037b of the supporting plate 1037 and the attached touch system is in contact with the underlying strain amplifying force sensing structure; the user applied force being transmitted through region labeled 1032 in Fig. 4A and in this situation the applied force in a force sensing touch system is distributed only across the force sensors and can be summed up to get the user touch force.

[0025] According to one aspect of this invention, a force sensing touch system 100 detects user touch and communicates with control unit 210 of the computing device 200 to take action. The force sensing touch screen includes a touch sensing panel 101, a display 102, and strain amplifying force sensing structure 103; the force sensing touch screen is in communication with control unit to detect user touch position and how hard the user pushed on the touch screen. The strain amplifying force sensing structure has four (4) force sensors such as 1032a, 1032b, 1032c, 1032d at corners of the touch screen. The strain amplifying force sensing structure may have fewer, but at least three (3), or larger number of force sensors and these may be placed in any geometrical arrangement. The control unit and its programming further determine actions based on position and how hard the user pushed at that location. Within this invention, the user touch position may be determined not only by the touch sensing panel but may also be determined by the strain amplifying force sensing structure. The control unit and its programming may use the position information from touch sensing panel or strain amplifying force sensing structure or combination of both. The strain amplifying force sensing structure signal that is communicated to the control unit may solely be used to determine the user touch position and how hard the user pushed. As an example, the user is viewing a document on a touch screen and the user pushes hard with bare finger at a specific word within this document. The user touch is detected by the touch sensing panel and the user force is recognized by the strain amplifying force sensing structure. The electrical signal from touch sensing panel is communicated to the control unit and the user touch position is recorded and correlated to the content within the document by the control units programming. A second electrical signal from the strain amplifying force sensing structure is communicated to the control unit and the programming determines that how hard the user touched the screen by adding the force

calculated at the four force sensors and if the user push was beyond the programmed force threshold the control units takes the action to show the meaning of the word on the display. At another time the user pushed with a gloved finger at a word in the document being read on the touch screen and this user touch is only detected by the strain amplifying force sensing structure. The touch sensing panel that is capacitive touch may not reliably detect a glove finger touch. In this situation only the signal from the force sensors is communicated to the control unit and both the user touch position and applied force is determined solely based on force sensing signal information. The control unit takes action based on its programming and in this case, based on the applied force, takes the user to a correlated location within the document to find next occurrence of the selected word. The control panel and its programming is setup to recognize two ranges of force, at one range of force the meaning of the word is shown and the second range of force the next occurrence of the word is activated and in both cases the user touch position is used to identify and select the correct word within the document.

[0026] Another aspect of this invention is a force sensing touch pad that detects user touch and communicates with control unit of computing device to take action based on how hard the user has pushed based. Fig. 1 may be used to explain a force sensing touch pad. The force sensing touch pad includes a touch sensing panel 101 and a strain amplifying force sensing structure 103 attached to the underside of the touch sensing panel. The touch pad does not contain a display 102. The signal from the touch sensing panel determines the x-y position of user touch and the signal from the strain amplifying force sensing structure determines how hard the user pushed or in another situation the x-y position and force of user touch are solely determined from signal from strain amplifying force sensing structure. The position and force signal correspond to a specific location of an associated display and the control unit with its programming determines the necessary actions for the computing device. As an example, the user is looking at a map on a display of a laptop that has a force sensing touch pad. Two fingers touch the force sensing touch pad and with a hard sliding action the fingers are moved away from each other. The touch sensing panel detects the touch from two fingers and their movement and the electrical signal is communicated to the control unit. The control unit and its associated programming determine the gesture as a zoom-in. The strain amplifying force sensing structure detects the position and how hard the two fingers are pushing and the electrical signal is communicated to the control unit. The control unit and its associated programming determine the user touch position within the displayed map based on combined information from the touch panel and the force sensors and determines solely from the force sensors that the two fingers are pushing harder than the threshold force. The

control unit and its programming combine the information of high force and zoom-in gesture and takes action of 5X zoom-in of the map region touched and gestured by the user. All of the details discussed for touch screen and in Fig. 1 through Fig. 5 are equally applicable to force sensing touch pads with necessary modifications as is well understood by those well versed in the art of computing devices and touch systems.

[0027] In yet another aspect of this invention, a force sensing touch control detects if the user is applying gentle pressure or moderate pressure or hard pressure at the touch button and the computing device only takes action when pressure in specific range value is detected. The force sensing touch control includes an exterior panel that may be a painted glass or plastic or metal plate that overlies the touch sensing panel with strain amplifying force sensing structure attached to its underside; the touch sensing panel may or may not include a capacitive or resistive touch. The force sensing touch control may or may not have a display under the touch sensing panel. In another embodiment both the touch panel and the display may not be present and a metal plate directly overlies the strain amplifying force sensing structure. The metal plate includes art work that identifies places where the user may touch to initiate actions. The metal plate may also be plastic or glass plate. The force sensing touch control communicates user touch to the control unit and the control unit programming determines if the user has pushed hard enough to warrant taking an action within the computing device. All of the details discussed for touch screen or touch pad and in Fig. 1 through Fig. 5 are equally applicable to force sensing touch controls with necessary modification as is well understood by those well versed in the art of computing devices and touch systems. As an example, the force sensing touch control has discrete keys arranged as a keypad and at least numeric ten (10) keys are identified by numeric zero (0) to nine (9). Each key is identified by its preset position and communicates with the control unit as such. Further all keys can be pushed by the user with light or heavy push and this signal is sent by the strain amplifying force sensing structure to the control unit. The control unit and its programming determines the if the signal is a low push versus a heavy push and takes action based on the numeric key pushed as well as the how hard the key was pushed. A force control keypad may be used for security applications and more specifically as a password entry device. One advantage of a force control keypad device in security applications may be to make it difficult to record the user entered password. Video recorders may record the keystrokes applied by the user when entering a password but since they cannot discern the amount of applied force; the exact password is therefore not disclosed to the recording device.

[0028] The forgoing descriptions and discussions and examples disclosed in this invention are meant only to be exemplary and are not meant to be limiting. Those well versed in the art of computing devices, touch systems, and force sensors well understand that the

concepts disclosed herein are extendable well beyond the embodiments discussed.

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Claims

- [Claim 1] A computing device configured to take action based on user touch position and force, comprising:
a touch system; and
a strain amplifying force sensing structure attached to an underside of the touch system;
wherein the strain amplifying force sensing structure comprises a force sensing layer and a support plate with a strain amplifying structure.
- [Claim 2] The computing device of claim 1, wherein the strain amplifying force sensing structure comprises a first region that amplifies strain and a second region that does not amplify strain.
- [Claim 3] The computing device of claim 1, further comprising:
a control unit communicating with the touch system and a strain amplifying force sensing structure.
- [Claim 4] The computing device of claim 1, wherein the touch system is a touch screen or touch pad or touch control or combinations thereof.
- [Claim 5] The computing device of claim 1, wherein the touch system comprises at least a touch sensing panel and any of the following: a display or a substrates or a protective cover or a support frame or a printed circuit boards or any combination thereof.
- [Claim 6] The computing device of claim 1, wherein the strain amplifying force sensing structure comprises two force sensors in close proximity, one force sensor located centrally in a region that amplifies strain and a second force sensor located near the edge in a region that amplify strain.
- [Claim 7] The computing device of claim 1, wherein the support plate with strain amplifying structure is attached to the touch system underside using an adhesive and the force sensing layer is attached using an adhesive to the support plate with strain amplifying structure.
- [Claim 8] The computing device of claim 1, wherein the support plate with strain amplifying structure is attached to the touch system underside using an adhesive applied only over the strain amplifying structure and the force sensing layer is attached using an adhesive to the support plate with strain amplifying structure.
- [Claim 9] The computing device of claim 1, wherein the force sensing layer is printed on a substrate and includes active force sensing material or insulating layer or layer with conductive metal traces or passivation layer

- or combinations thereof.
- [Claim 10] computing device of claim 1, wherein the force sensing layer includes one or more force sensor.
- [Claim 11] computing device of claim 1, wherein the support plate comprises an unpatterned region that is not patterned and a patterned region having a pattern that is an opening that extends through the thickness of the support plate.
- [Claim 12] The computing device of claim 3, wherein the control unit and its programming takes action based on user touch position determined from signal from touch panel or user touch force determined from signal from force sensors or combination thereof.
- [Claim 13] computing device of claim 3, wherein the control unit and its programming takes action based on user touch position or force or combinations thereof determined solely from signal from force sensors.
- [Claim 14] method to take action based on user touch position or force or combinations thereof, the method comprising:
determining a position from signal communicated from a touch system or strain amplifying force sensing structure or combinations thereof,
determining a force from signal communicated from the strain amplifying force sensing structure,
wherein a control unit programming makes a decision based on combined position or force or combinations thereof.
- [Claim 15] structure of a force sensing touch system comprising,
a touch system,
a supporting plate with strain amplifying structure, wherein the supporting plate attached to the overlying touch system using an adhesive,
a force sensing layer attached to the supporting plate using an adhesive.
- [Claim 16] The structure of claim 15, wherein the supporting plate is attached to the overlying touch system using the adhesive that is applied solely over the strain amplifying structure on the supporting plate.
- [Claim 17] structure of claim 15, wherein the adhesive that attaches the supporting plate to the touch system is a double side tape and the adhesive that attaches the force sensing layer to the supporting plate is epoxy.
- [Claim 18] structure of claim 15, wherein the touch system is a touch screen, or a touch pad, or a touch control or combinations thereof.
- [Claim 19] structure of claim 15, wherein the force sensing layer comprises one or more force sensors.

- [Claim 20] The structure of claim 15, wherein the supporting plate with a strain amplifying structure comprises an unpatterned region that is not patterned and a patterned region having a pattern; and the pattern of the patterned region is an opening that extends through the thickness of the supporting plate.
- [Claim 21] The structure of claim 15, wherein the force sensing layer is printed on a substrate and includes active force sensing material or insulating layer or layer with conductive metal traces or passivation layer or combinations thereof.

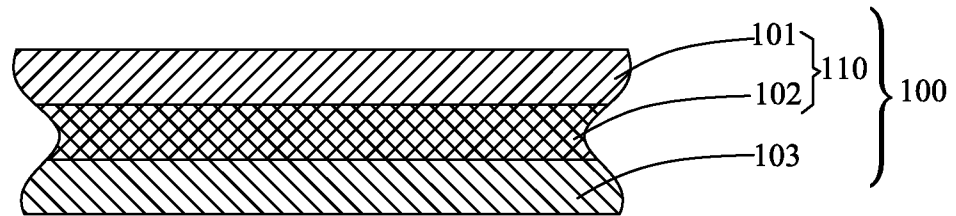


Fig. 1

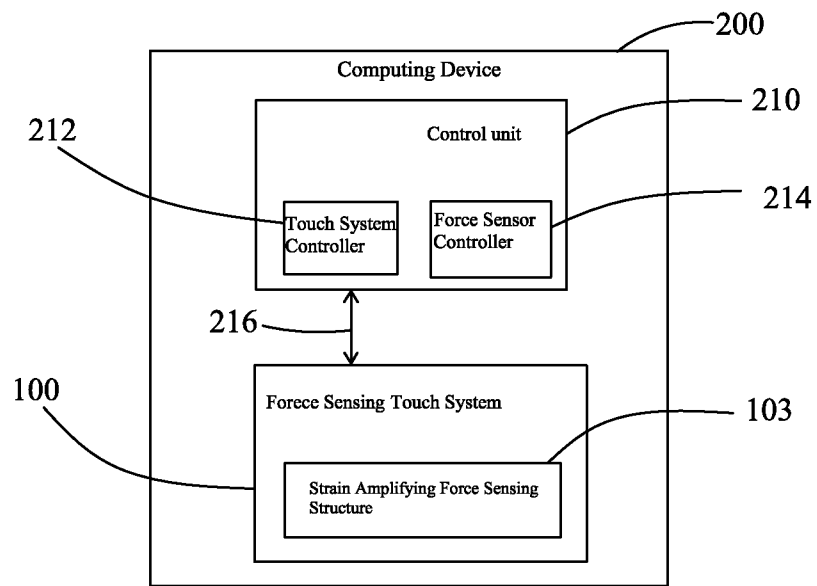


Fig. 2

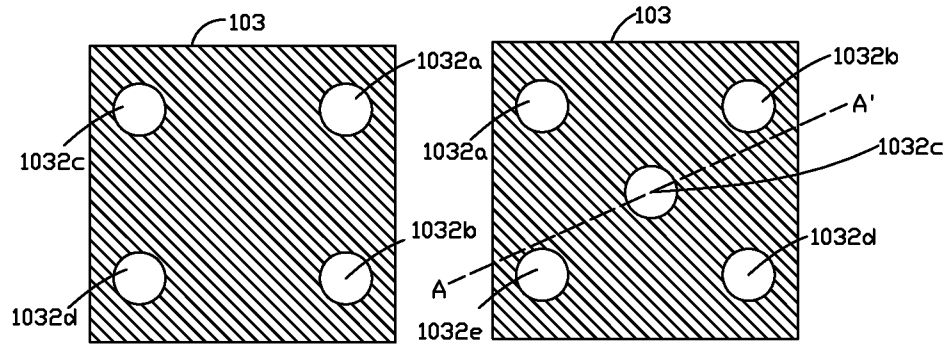


Fig. 3A

Fig. 3B

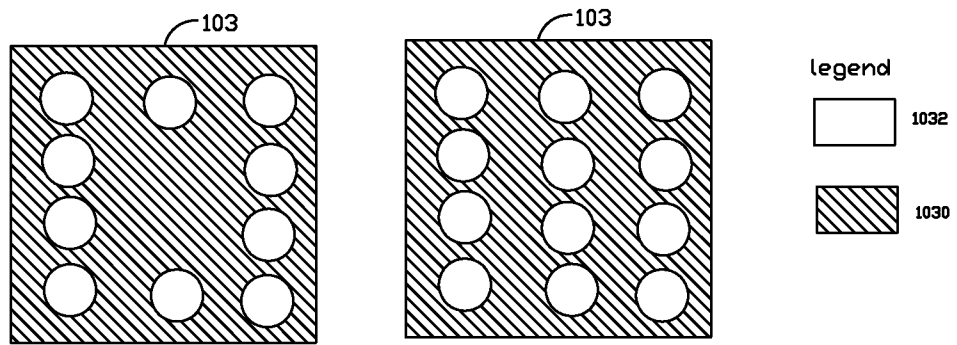


Fig. 3C

Fig. 3D

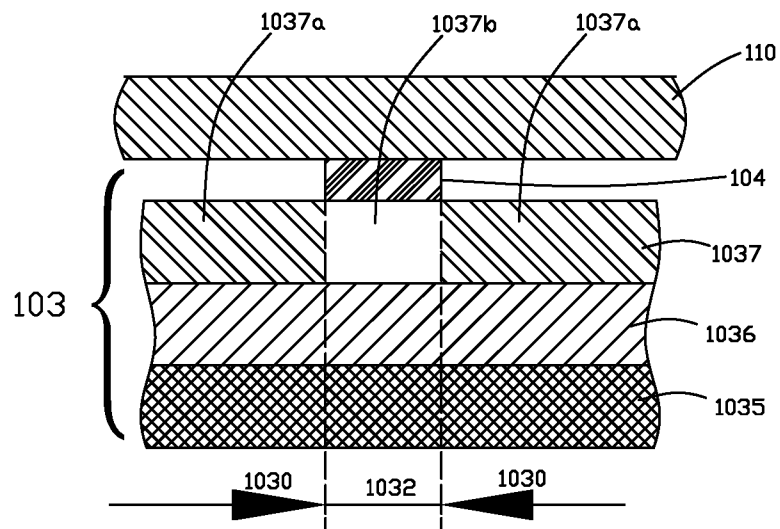


Fig. 4A

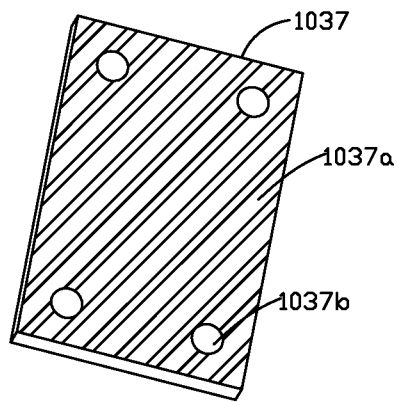


Fig. 4B

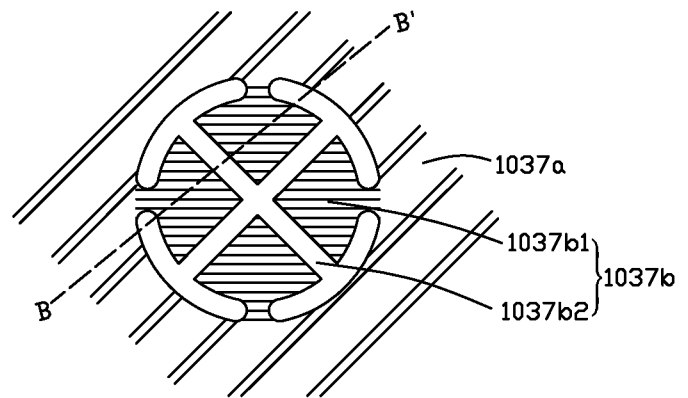


Fig. 4C

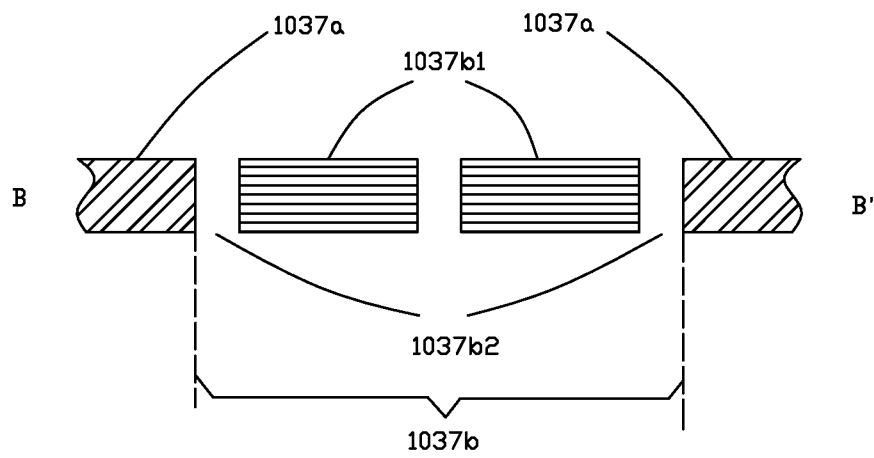


Fig. 4D

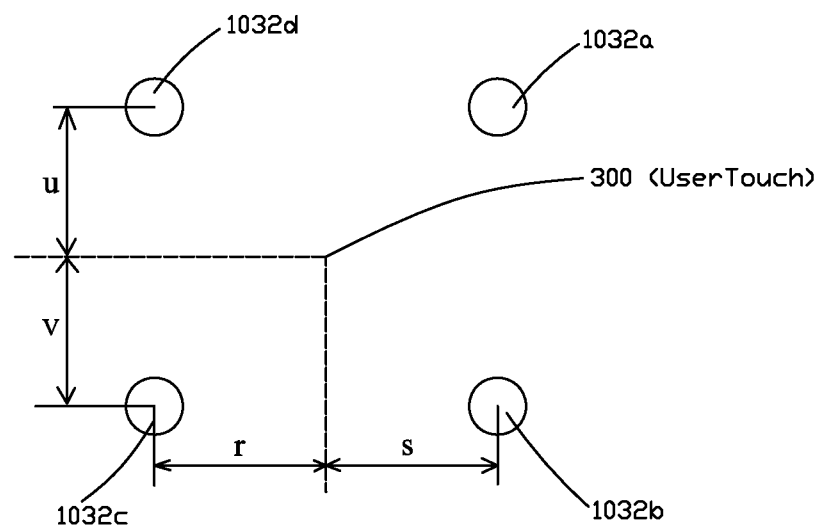


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/083681

A. CLASSIFICATION OF SUBJECT MATTER

G06F 3/041(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, EPODOC, WPI, IEEE: SHENZHEN NEW DEGREE, touch+, panel?, display+, press+, stress+, strain, forc+, measur+, detect+, sens+, position+, amplify+, magnify+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102053750 A (SONY CORP.) 11 May 2011 (2011-05-11) description, paragraphs [0008]-[0048], [0096]-[0098], [0191]-[0195], figures 14, 20	1, 3-10, 12-19, 21
X	CN 103076930 A (LIANSHENGCHINA TECHNOLOGY CO., LTD. ET AL.) 01 May 2013 (2013-05-01) description, paragraphs [0030]-[0044], figures 1-2	1, 3-10, 12-19, 21
X	CN 102339179 A (ELAN MICROELECTRONICS CORP.) 01 February 2012 (2012-02-01) description, paragraphs [0036]-[0038], figure 1	1, 3-10, 12-19, 21
X	CN 104423740 A (TIANJIN FUNA YUANCHUANG TECHNOLOGY CO., LTD.) 18 March 2015 (2015-03-18) description, paragraphs [0018]-[0028], figures 1-5	1, 3-10, 12-19, 21
A	CN 102804116 A (NISSHA PRINTING CO., LTD.) 28 November 2012 (2012-11-28) the whole document	1-21
A	CN 1794336 A (SAMSUNG ELECTRONICS CO., LTD.) 28 June 2006 (2006-06-28) the whole document	1-21

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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“O” document referring to an oral disclosure, use, exhibition or other means

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“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

08 October 2015

Date of mailing of the international search report

29 February 2016

Name and mailing address of the ISA/CN

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Telephone No. (86-10)82245504

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/083681

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2015/083681

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