(19) DANMARK

(10) **DK/EP 3671422 T3**

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***G 06 F 3/04883 (2022.01)*** ***G 06 F 1/16 (2006.01)*** ***G 06 F 3/01 (2006.01)*** ***G 06 F 3/0354 (2013.01)*** ***G 06 F 3/038 (2013.01)*** ***G 06 F 3/044 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2025-03-24**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2025-01-08**

(86) Europæisk ansøgning nr.: **19218033.9**

(86) Europæisk indleveringsdag: **2019-12-19**

(87) Den europæiske ansøgnings publiceringsdag: **2020-06-24**

(30) Prioritet: **2018-12-20 EP 18214450**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **Sanko Tekstil Isletmeleri San. Ve Tic. A.S., Organize Sanayi Bölgesi 3. Cadde, 16400 Inegol - Bursa, Tyrkiet**

(72) Opfinder: **Cobanoglu, Özgür, c/o Sanko Tekstil Isletmeleri San. Ve Tic. A.S., Organize Sanayi Bölgesi 3. Cadde, 16400 Inegol - Bursa, Tyrkiet**
**KARAKAYA, Adil Berk, c/o Sanko Tekstil Isletmeleri San. Ve Tic. A.S., Organize Sanayi Bölgesi 3., 16400 Inegol - BURSA, Tyrkiet**
**Zengi, Leyla, c/o SANKO Tekstil Isletmeleri San. ve Tic. A.S., Organize Sanayi Bölgesi 3. Cadde, 16400 Inegol - Bursa, Tyrkiet**
**Iyidogan, Deniz, c/o Sanko Tekstil Isletmeleri San. Ve Tic. A.S., Organize Sanayi Bölgesi 3. Cadde, 16400 Inegol - BURSA, Tyrkiet**
**ERKUS, Ertug, c/o SANKO Tekstil Isletmeleri San. Ve Tic. A.S., Organize Sanayi Bölgesi 3. Cadde, 16400 Inegol - Bursa, Tyrkiet**

(74) Fuldmægtig i Danmark: **Marks & Clerk LLP, 44, rue de la Vallée , L-2661 Luxembourg, Luxembourg**

(54) Benævnelse: **BÆRBAR BERØRINGSFØLSOM BEKLÆDNINGSGENSTAND**

(56) Fremdragne publikationer:
**EP-A1- 2 895 050**
**EP-B1- 2 895 050**
**US-A1- 2005 069 695**
**US-A1- 2015 199 045**
**US-A1- 2015 301 603**
**US-A1- 2018 310 644**

# DESCRIPTION

Description

## TECHNICAL FIELD

**[0001]** The technical field of the present invention relates to a wearable touch sensitive garment, in particular, the present invention relates to a touch sensitive garment human interface.

## BACKGROUND

**[0002]** In the prior art, textile applications that use textile components such as yarns as sensing electrodes or place solid state electrodes in-between fabric layers are known. The use of fabric itself as a sensing electrode makes it hard to produce, as sensor yarns first need to be developed and woven: these operations are not easy as different materials with respect to common textile materials are used.

**[0003]** Also the materials used have to be configured and prepared, for example by multiple stripping and twisting and must be connected to the electronics with processes such as soldering and lamination. These fabric structures may have also a great number of failure paths or mechanisms compared to a robust single piece of electronics.

**[0004]** As an example of the above, document US20160048235 describes interactive textiles. The interactives textiles include a grid of conductive thread woven into the interactive textile to form a capacitive touch sensor that is configured to detect touch input. Detected touch inputs can be used to control remote devices.

**[0005]** Other prior art is represented, for example, by document US2015301603 which discloses a tactile control arrangement, including a matrix of capacitive tactile sensors, integrated in a flexible pad. The sensor matrix has a corresponding plurality of contacts for the connection with an external processing circuit module, for example, a microcontroller arranged for the acquisition and processing of the signals emitted by each sensor. Advantageously, the connection of the contacts with the processing module is implemented by means of a multipolar planar conductor strip, which is also flexible, while the processing module can be implemented by a traditional technology for hybrid circuits on rigid printed circuit support, or also on flexible supports (flex-PCB). This solution allows to place the control electronics in a remote position with respect to the sensitive part, The control electronics can possibly be

separated from the sensitive area, by decoupling the connection by means of the multipolar strip, or be permanently separated and connected via radio, provided that an antenna and associated supply and driving electronics are implemented on board of the sensor matrix.

**[0006]** The conductors of the device are preferably made from conductive textiles.

**[0007]** The arrangement described in document US2015301603 can be used for the management of multiple electronic personal devices which a subject carries with him/her, tied to his/her body or kept in pockets of a jacket J, of which, a smartphone, a radar, a watch, a pair of headphones, a chest strap are illustrated from bottom to top on the left and clockwise, via the flexible control interface.

**[0008]** Furthermore, document US2015199045 describes a device comprising a sensor electronics array to be integrated into a garment, a bus that runs through the garment connecting with the sensor array and a computer having a display that shows the result of the gesture evaluation.

**[0009]** Such document discloses a proximity-based motion detection system including a capacitive sensor array (CSA) assembly and a controller, the CSA assembly including a CSA that is made up of at least two capacitor plates and conductive wires that carry signals from the capacitor plates.

**[0010]** The capacitor plates and other components of the device are preferably made from conductive textiles that can be integrated into other textiles, such as clothing, bed linens, etc., or that can be integrated into the environment (e.g., furniture, wheelchairs, car seats, etc..).

**[0011]** The conductive textile appears to make the devices of documents US2015301603 and US2015199045 bulky in addition to increase the probability of failures of the conductive textile parts.

**[0012]** An object of the invention is to create a wearable garment that implements a flexible touch array within the garment itself avoiding the above discussed problems of the prior art.

**[0013]** This and other objects are achieved by a wearable touch sensitive garment according to the independent claim 1, a method of detecting a touch event according to the independent claim 5 and a computer-implemented data structure according to the independent claim 6.

**[0014]** The dependent claims delineate preferred and/or especially advantageous aspects.

## SUMMARY

**[0015]** An embodiment of the disclosure provides a wearable touch sensitive garment according to the independent claim 1.

**[0016]** The term "parasitic capacitive coupling" is herein meant to indicate the capacitive coupling between the capacitive electrode and the parasitic capacitance of a wearer's touch. In general, when an object capable of providing parasitic capacitance (e.g. a wearer's touch) approaches the capacitive electrode of the device according the present invention, an increase of the capacitance occurs in the capacitive electrode. This fact is due to the capacitive coupling between the capacitive electrode and the parasitic capacitance of the object approaching the capacitive electrode.

**[0017]** Such increase of the capacitance and variations thereof can be transmitted to the ECU for further computations as explained thereinafter.

**[0018]** In addition to the above, the invention comprises a vibrator that provides a tactile feedback when a gesture performed on the array is detected.

**[0019]** The touch sensitive garment according to the invention can be used as user interface to control other devices such as phablets or for other application.

**[0020]** According to the invention, the electronics itself is touch-sensitive and it is placed in correspondence to the area where an user input is expected.

**[0021]** For example, the array of electronic capacitive sensors is arranged along a seam of said garment.

**[0022]** In some embodiments of the invention, the ECU can be interfaced with a Bluetooth (BT) module or a Bluetooth Low Energy (BLE) module, to connect wirelessly to a remote system such as a tablet, a smartphone or a phablet.

**[0023]** Another advantage of the present invention is that it avoids problems associated with the use of fabric itself as the sensing electrode which, as explained above, is not easy in practice because different materials with respect to textile materials are used. Also, in case of using textile materials, sensor yarns must be prepared by multiple stripping and twisting and connected to the electronics by soldering and lamination all of this being avoided by the present invention.

**[0024]** Further advantages of the present invention are that, compared to textile-based touch sensing applications, the present device is easier to mass-produce in rolls and integrate into the garment making process as a flexible "ribbon" with a stretchable bus, in order to be placed within a seam being completely invisible to the naked eye. According to an embodiment of the invention, the device of the invention can be made in such a way that the ECU is integrated into the garment.

**[0025]** As an example, the device of the invention can be either made with small dimensions or even integrated within a logo patch of the garment, making the ECU completely invisible.

**[0026]** The device of the invention is capable of acquiring gesture events with almost 100% accuracy and precision.

**[0027]** Also, the on-garment evaluation of gestures makes the energy consumption of the device lower as it decreases the amount of data to be transferred to the mobile device to be controlled.

**[0028]** The invention further comprises a method of detecting a touch event performed on a wearable touch sensitive garment, according to the independent claim 5.

**[0029]** Finally the invention also comprises a computer-implemented data structure codifying a gesture performed on a wearable touch sensitive garment, according to the independent claim 6.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0030]** Further aspects and advantages of the present invention will be discussed more in detail with reference to the enclosed drawings, given by way of non-limiting example, wherein:

Figure 1 shows a plane view of a front portion of an embodiment of the invention;

Figure 2 shows a plane view of a back portion of an embodiment of the invention of Figure 1;

Figure 3 shows a garment according to an embodiment of the invention;

Figure 4 shows a schematic view of an embodiment of the invention; and

Figure 5 shows a graph that exemplifies a possible mode of operation of the invention.

## DETAILED DESCRIPTION

**[0031]** Exemplary embodiments of the invention will now be described with reference to the enclosed drawings without intent to limit application and uses.

**[0032]** The invention will now be described with initial reference to Figure 1 wherein a plane view of a front portion of an embodiment of the invention is shown.

**[0033]** In particular, Figure 1 represents an array 12 of electronic capacitive sensors that can be integrated into a garment 100, the array 12 of electronic capacitive sensors comprising a plurality of electrodes E1-E5 and an Electronic Control Unit (ECU) (30), the ECU 30 being provided with a readable display 35 configured to display an indication representative of a

gesture performed on the array 12.

**[0034]** The electrodes E1-E5 of the array 12 are individually electrically connected to an Electronic Control Unit (ECU) 30 to form a system 10 that operates as touch sensitive garment reduced human interface (RHI).

**[0035]** The ECU 30 is provided with a readable display 35 configured to display an indication representative of a gesture performed on the array 12.

**[0036]** Furthermore, the array 12 of electronic capacitive sensors can be connected to a vibrator 20 configured to provide a tactile feedback to a user of the touch sensitive garment when a gesture performed on the array 12 is detected.

**[0037]** The system 10 can comprise therefore a flexible touch sensitive 1D or 2D array 12 of electrodes that can be used monitor gestures.

**[0038]** The array 12 can be encapsulated by a wash-fast encapsulant to resist laundry operations performed on the garment 100.

**[0039]** Figure 2 shows a plane view of a back portion of an embodiment of the invention of Figure 1, wherein in particular, in Figure 2 power lines 42, 44 have been schematically indicated as well as signal lines 51-55 have been schematically indicated, each signal line 51-55 connecting the respective electrode E1-E5 to the ECU 30.

**[0040]** The array 12 of electrodes E1-E5 can be connected to the Electronic Control Unit 30 via a flexible bus 25 to carry power and data to and from the flexible touch sensitive 1D or 2D array 12. Such an embodiment is disclosed in Figure 4.

**[0041]** According to an aspect of the present invention, the ECU 30 is configured to evaluate parasitic capacitive coupling by detecting an increase (or variation) of a capacitance value of the capacitive electrode.

**[0042]** Such parasitic capacitive coupling can be generated, for example, by means of a gesture or touch by the garment 100 wearer.

**[0043]** Nevertheless, it must be noted that in alternative embodiment of the invention the sensor array 12 can also be placed over the front-end electronics, an embodiment that saves space and battery power.

**[0044]** In particular, the bus and the garment computer can all be placed under the sensors array in the final product as depicted for example in Figure 3 which shows a garment according to this alternative embodiment of the invention.

**[0045]** The advantage of eliminating the bus in this embodiment can be summarized by the

fact that a bus to carry the signals from the sensing elements to the electronics may lead to issues not yet completely solved because properly routing of capacitive signals requires tedious and non-sensitized paths which are expensive.

**[0046]** The elimination of the bus does not therefore create the issue of routing capacitive signals, but on the contrary has the effect of eliminating such issue.

**[0047]** The system 10 can further comprise a Bluetooth (BT) module or, alternatively, a Bluetooth Low Energy (BLE) module, to connect wirelessly the system 10 to a remote system such as a tablet, a smartphone or a phablet.

**[0048]** Gestures performed on the wearable touch sensitive garment 100 can therefore be used to control or operate on such remote systems.

**[0049]** The sensor array 12 can be made with a flexible Printed Circuit Board (PCB) such as but not limited to double sided kapton with copper layer or digitally printed flexible boards with conducting ink on PET film or rigid islands connected to each other by flexible ribbons or alike in order to form the sensor array 12.

**[0050]** In general, the invention provides a reduced version of a human interface (RHI) that can be integrated into a seam of a garment, for example to detect one-dimensional gesture events such as i) tap-only, ii) swipe-up, and iii) swipe-down.

**[0051]** With the word "seam" a side seam of a jeans or of any trousers or a seam of any garment in general or any portion of a garment that comprises at least two superimposed parts of the garment is intended in the present description.

**[0052]** As a non limitative example, the sensor electronics can be limited to 1.5 cm in width and garment computer to $6\times3\times1.5$ $cm^3$.

**[0053]** The width of the sensor electronics advantageously allows the same extends along a seam 65 in the garment 100, for example seam 65 of pocket 60 or other seam (Figure 3).

**[0054]** After populating the array 12 with electrodes E1-E5, the whole circuit is resin coated and then silicon coated.

**[0055]** An alternative embodiment does not have silicon coating. Silicon coated circuit has lower sensitivity with respect to the one without silicon coating.

**[0056]** Every time a decision is made, a tactile feedback is provided via the vibrator 20 which vibrates for a predefined amount of time, for example 50 ms, to signal a gesture acquisition or an invocation of the decision making algorithm.

**[0057]** A minimum of two or three sensor electrodes are needed or are enough for

implementing the functionalities of the present invention, however, to obtain precision and robustness, some redundancy is considered to be needed, hence the embodiment described herein has 5 sensors, namely electrodes E1-E5.

**[0058]** Operation of the system is reliable and the decisions are almost 100% correct. The algorithm suppresses non-intentional taps as well.

**[0059]** Figure 5 shows a graph that exemplifies a possible mode of operation of the invention. In particular, in Figure 5, raw data produced by the sensor array 12, showing intentional "down" and "up" swipe gestures as well as non-intentional touch instances are represented.

**[0060]** Non-intentional touch instances or noise depicted can be successfully suppressed without affecting the correctness of the decision making algorithm in identifying the intentional "down" and "up" swipe gestures.

**[0061]** A corresponding indication may be displayed on the display 35.

# REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

**Patent documents cited in the description**


- US20160048235A [0004]
- US2015301603A [0005] [0007] [0011]
- US2015199045A [0008] [0011]

# BÆRBAR BERØRINGSFØLSOM BEKLÆDNINGSGENSTAND

PATENTKRAV

1. Bærbar berøringsfølsom beklædningsgenstand (100), der omfatter et arrangement (12) af elektroniske kapacitive sensorer, som er integreret i beklædningsgenstanden (100), hvor arrangementet (12) af elektroniske kapacitive sensorer omfatter en flerhed af elektroder (E1-E5), hvor hver elektrode (E1-E5) individuelt er elektrisk forbundet med en elektronisk styreenhed, ECU (30), hvor arrangementet (12) er placeret over ECU'en (30) og er forbundet med ECU'en (30) ved hjælp af en flerhed af signalledninger (51-55), hvor hver signalledning forbinder den tilhørende elektrode (E1-E5) med ECU'en (30) med henblik på til ECU'en (30) at overføre et parasitært kapacitivt koblingssignal, hvor ECU'en (30) er konfigureret til at evaluere en parasitær kapacitiv kobling mellem hver af elektroderne (E1-E5) og en bærers berøring, hvor ECU'en (30) er forsynet med et læsbart display (35), der er konfigureret til at vise en angivelse, som repræsenterer en gestus, som udføres på arrangementet (12), og hvor arrangementet (12) af elektroniske kapacitive sensorer (12) er forbundet med en vibrator (20), hvor vibratoren (20) er konfigureret til at tilvejebringe en taktil tilbagemelding ved vibrering i et foruddefineret tidsrum til signalering af en gestusregistrering, og hvor arrangementet (12) er anbragt langs og integreret i en søm i beklædningsgenstanden (10), hvor arrangementet (12) er indkapslet af et vaskeindkapslingselement, og hvor ECU'en er integreret i beklædningsgenstanden (100).

2. Berøringsfølsom beklædningsgenstand (100) ifølge krav 1, hvor arrangementet (12) er konfigureret som en fleksibel printplade, PCB, der omfatter et dobbeltsidet kaptonlag, der er forsynet med et kobberlag, eller som en digitalt printet fleksibel plade, der er forsynet med ledende blæk på PET-folie, eller som stive øer, der er forbundet med hinanden ved hjælp af fleksible bånd.

3. Berøringsfølsom beklædningsgenstand (100) ifølge krav 1, hvor arrangementet (12) er harpiksbelagt og/eller siliciumbelagt.

4. Berøringsfølsom beklædningsgenstand (100) ifølge krav 1, hvor ECU'en (30) kan sammenkobles med et Bluetooth-(BT)-modul eller et Bluetooth-lavenergi-(BLE)-modul med henblik på trådløs forbindelse med et remote-system såsom en tablet, en smartphone eller en phablet.

5. Fremgangsmåde til detektering af en berøringsbegivenhed, der udføres på en bærbar berøringsfølsom beklædningsgenstand (100) ifølge krav 1 til 4, hvilken fremgangsmåde omfatter:

- tilvejebringelse af en bærbar berøringsfølsom beklædningsgenstand (100);
- tilvejebringelse af et arrangement (12) af elektroniske kapacitive sensorer, der er integreret i beklædningsgenstanden (100) og anbragt langs og integreret i en søm deraf, hvor arrangementet (12) af elektroniske kapacitive sensorer omfatter en flerhed af elektroder (E1-E5),
- hvor arrangementet er placeret over en elektronisk styreenhed, ECU (30), og er forbundet med ECU'en (30) ved hjælp af en flerhed af signalledninger (51-55), hvor hver signalledning forbinder den tilhørende elektrode (E1-E5) med ECU'en (30) med henblik på til ECU'en (30) at overføre et parasitært kapacitivt koblingssignal, hvor ECU'en (30) er konfigureret til at evaluere en parasitær kapacitiv kobling mellem hver af elektroderne (E1-E5) og en bærers berøring, hvor ECU'en (30) er forsynet med et læsbart display (35), der er konfigureret til at vise en angivelse, som repræsenterer en gestus, som udføres på arrangementet (12), og hvor arrangementet (12) af elektroniske kapacitive sensorer (12) er forbundet med

en vibrator (20), og hvor arrangementet (12) er indkapslet af et vaskeindkapslingselement, og hvor ECU'en er integreret i beklædningsgenstanden (100);

- evaluering af kapacitansvariationer, der tilvejebringes af flerheden af elektroder (E1-E5);
- bestemmelse af en berøringsbegivenhed, der udføres på den berøringsfølsomme beklædningsgenstand (100), som en funktion af kapacitansvariationer, der tilvejebringes af flerheden af elektroder (E1-E5);
- aktivering af vibratoren (20), der er associeret med den berøringsfølsomme beklædningsgenstand (100) og konfigureret til at tilvejebringe en taktil tilbagemelding, når den gestus, som udføres på arrangementet (12), detekteres.

6. Computerimplementeret datastruktur, der koder en gestus, som udføres på den bærbare berøringsfølsomme beklædningsgenstand (100) ifølge krav 1-4, hvor datastrukturen omfatter berørings-rådata, der genereres af flerheden af elektroder (E1-E5) i løbet af et foruddefineret tidsinterval, i hvilket der udføres en gestusbegivenhed på den bærbare berøringsfølsomme beklædningsgenstand (100), hvor datastrukturen er egnet til at blive fortolket af den elektroniske styreenhed (30) ifølge fremgangsmåden ifølge krav 5.

# DRAWINGS

Drawing

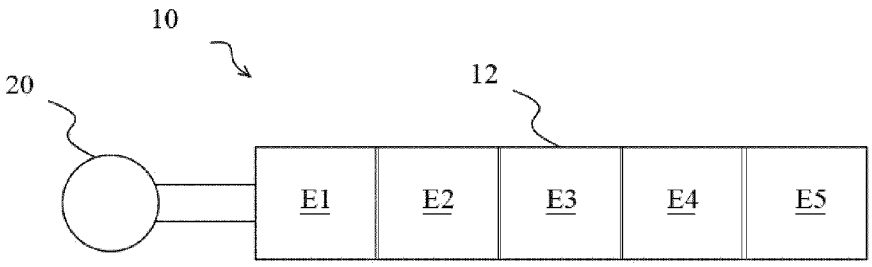


FIG.1

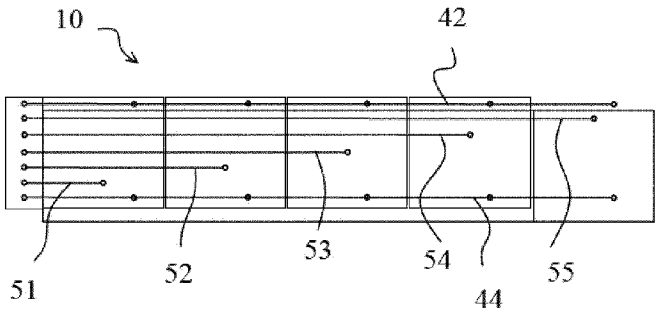


FIG.2

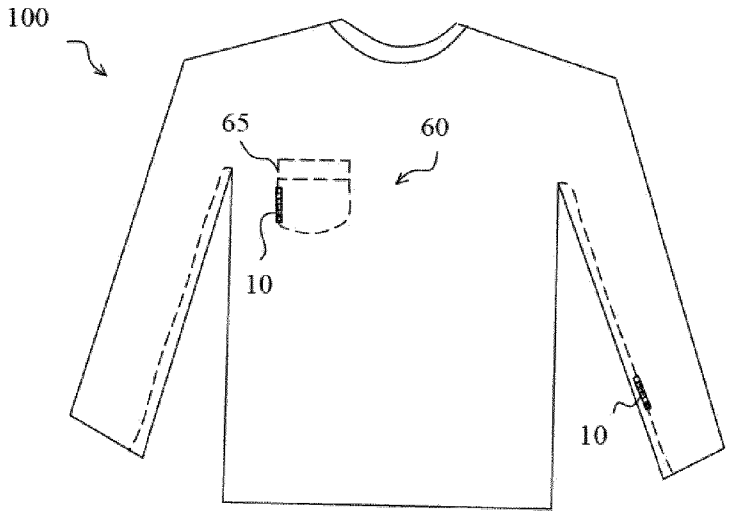


FIG.3

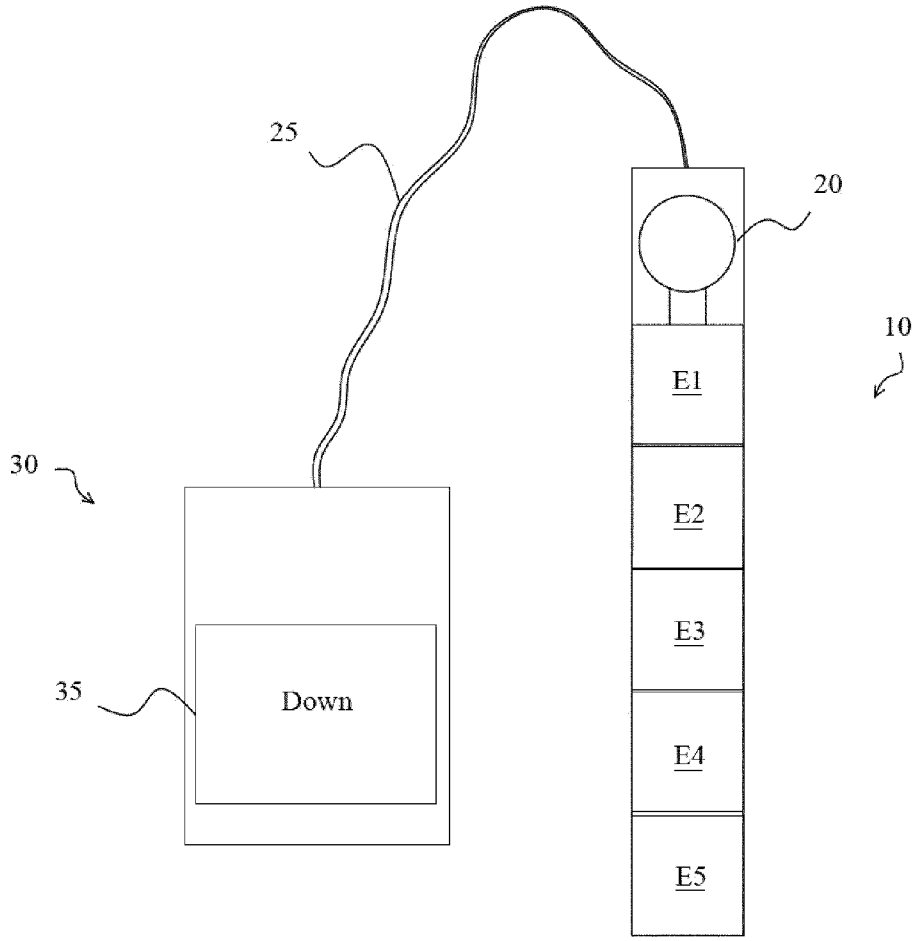


FIG.4

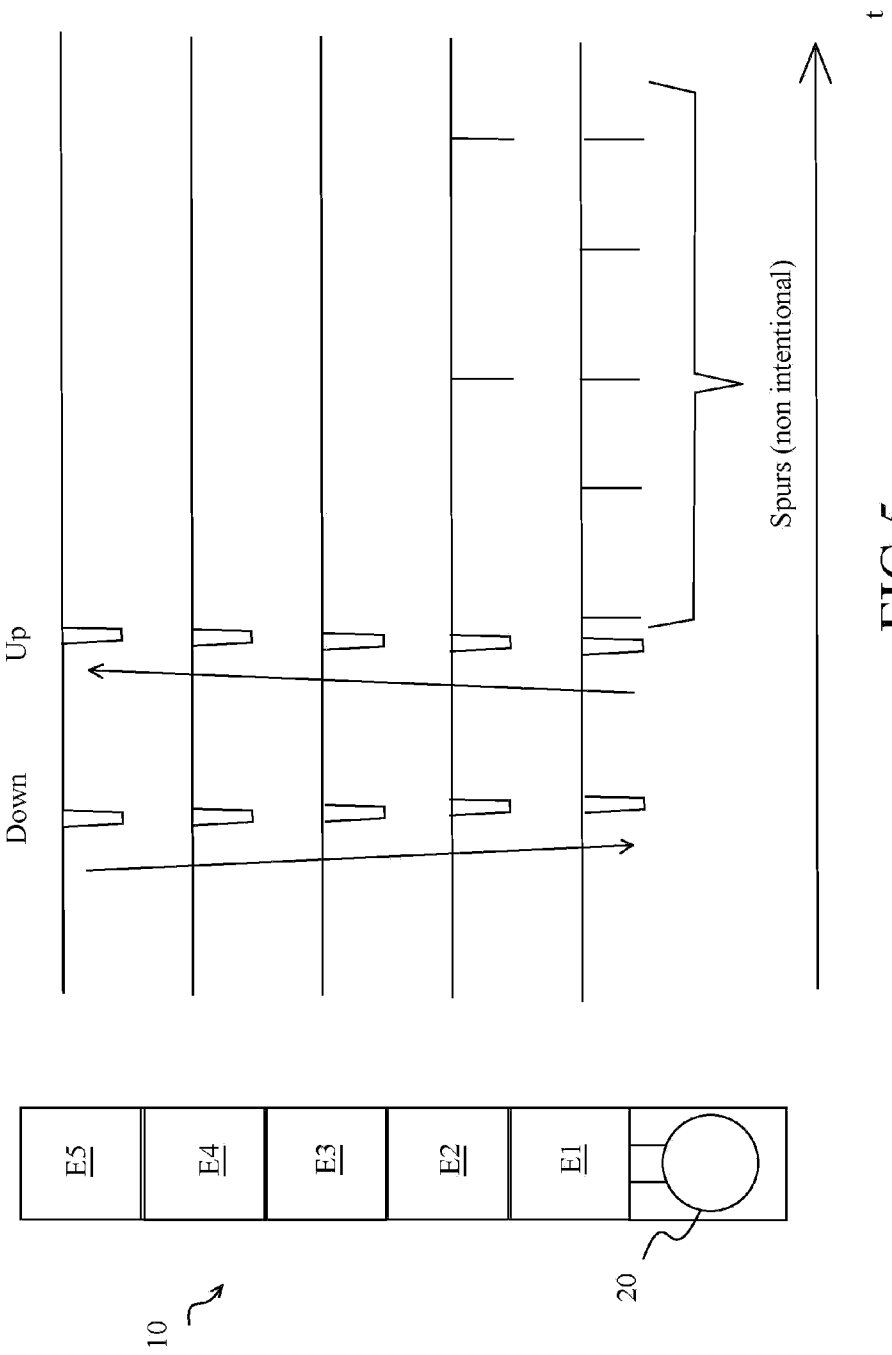


FIG.5