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(54) **DETECTING A NEW CUTTING ELEMENT**

(57) The subject-matter of the present disclosure relates to a computer-implemented method of detecting a new cutting element installed on a personal care appliance. The computer-implemented method comprises: sensing (S200), by a sensor of the personal care appliance, data representing physical parameters associated with operating the personal care appliance; detecting (S202), using a machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data; and outputting (5204) a signal indicating that a new cutting element has been installed on the personal care appliance based on the detection.
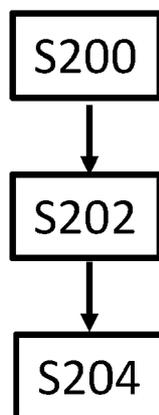
EP 4 541 530 A1



Figure 2

## Description

FIELD OF THE INVENTION

[0001]  The subject-matter of the present disclosure relates to detecting a new cutting element installed on a personal care appliance, computer-implemented methods of detecting new cutting elements installed on a personal care appliance, computer-implemented methods of training a machine learning model to detect a new cutting element installed on a personal care appliance, transitory, or non-transitory, computer-readable media, and personal care appliances.

BACKGROUND OF THE INVENTION

[0002]  Certain algorithms of personal care appliances, e.g. end-of-life cutting element predictor algorithms, require knowledge as to whether or not a cutting element is new or not new. However, it is difficult to ascertain whether or not a cutting element is new or not new.

[0003]  It is an aim of the subject-matter of the present disclosure to improve on the prior art.

SUMMARY OF THE INVENTION

[0004]  According to a first aspect of the present invention, there is provided a computer-implemented method of detecting a new cutting element installed on a personal care appliance, the computer-implemented method comprising: sensing, by a sensor of the personal care appliance, data representing physical parameters associated with operating the personal care appliance; detecting, using a machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data; and outputting a signal indicating that a new cutting element has been installed on the personal care appliance based on the detection. In this way, it is easy to detect a new cutting element. Knowledge as to whether or not the cutting element is new or not new it output by the signal which may be used by a processor processing an algorithm which requires knowledge as to whether or not the cutting element is new.

[0005]  In an embodiment, the physical parameters comprise current and/or power of a motor used to drive the cutting element.

[0006]  In an embodiment, the detecting, using the machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data comprises: calculating a plurality of predictors using the sensed data; and inputting the plurality of predictors to the machine learning model.

[0007]  In an embodiment, the plurality of predictors are selected from a list of predictors including a binned distribution of motor power for a last use, a ratio of a minimum power of a last use and a minimum power averaged over a first three uses, a difference between a maximum

power of a last use and a maximum power of a last use minus one, and a ratio of a maximum power of a last use and a maximum power of a last use minus one.

[0008]  In an embodiment, the machine learning model is a decision tree. A decision tree is more favourable than other types of machine learning models, e.g. neural networks, since they require comparatively little processing and storage resources.

[0009]  According to an aspect of the present invention, there is provided a computer-implemented method of training a machine learning model to detect a new cutting element installed on a personal care appliance, the computer-implemented method comprising: receiving a dataset including a plurality of predictors derived from data sensed from a sensor of the personal care appliance, the data representing physical parameters associated with operating the personal care appliance, and classifications of a new cutting element and a not-new cutting element; inputting the plurality of predictors to the machine learning model to predict a classification of the cutting element as being new or not-new; and optimising the machine learning model to reduce error between the predicted classification and the classification in the dataset.

[0010]  In an embodiment, the machine learning model is a decision tree.

[0011]  In an embodiment, the optimising the machine learning model is performed using a classification and regression tree algorithm.

[0012]  In an embodiment, the physical parameters include current and/or power of a motor used to drive the cutting element.

[0013]  In an embodiment, the plurality of predictors are selected from a list of predictors including a binned distribution of motor power for a last use, a ratio of a minimum power of a last use and a minimum power averaged over a first three uses, a difference between a maximum power of a last use and a maximum power of a last use minus one, and a ratio of a maximum power of a last use and a maximum power of a last use minus one.

[0014]  According to an aspect of the present invention, there is provided a transitory, or non-transitory, computer-readable medium, having instructions stored thereon that when executed by a processor, causes the processor to perform the computer-implemented method of any preceding aspect or embodiment.

[0015]  According to an aspect of the present invention, there is provided a personal care appliance, comprising: an attachment for attaching a cutting element thereto; a sensor for sensing physical parameters associated with operating the personal care appliance; and a controller including a processor and storage, the storage having instructions stored thereon that when executed by the processor cause the processor to perform the computer-implemented method of any preceding aspect or embodiment..

[0016]  These and other aspects of the present invention will be apparent from and elucidated with reference to

the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

**[0017]** The embodiments of the present inventions may be best understood with reference to the accompanying figures, in which:

Fig. 1 shows a schematic view of a personal care appliance according to one or more embodiments;
Fig. 2 shows a flow chart summarising a computer-implemented method of detecting a new cutting element installed on a personal care appliance, according to one or more embodiments;
Fig. 3 shows a decision tree according to one or more embodiments; and
Fig. 4 shows a flow chart summarising a computer-implemented method of training a machine learning model to detect a new cutting element installed on a personal care appliance, according to one or more embodiments.

DETAILED DESCRIPTION OF THE EMBODIMENTS

**[0018]** At least some of the example embodiments described herein may be constructed, partially or wholly, using dedicated special-purpose hardware. Terms such as 'component', 'module' or 'unit' used herein may include, but are not limited to, a hardware device, such as circuitry in the form of discrete or integrated components, a Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC), which performs certain tasks or provides the associated functionality. In some embodiments, the described elements may be configured to reside on a tangible, persistent, addressable storage medium and may be configured to execute on one or more processors. These functional elements may in some embodiments include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes, procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, databases, data structures, tables, arrays, and variables. Although the example embodiments have been described with reference to the components, modules and units discussed herein, such functional elements may be combined into fewer elements or separated into additional elements. Various combinations of optional features have been described herein, and it will be appreciated that described features may be combined in any suitable combination. In particular, the features of any one example embodiment may be combined with features of any other embodiment, as appropriate, except where such combinations are mutually exclusive. Throughout this specification, the term "comprising" or "comprises" means including the component(s) specified but not to the exclusion of the presence of others.

**[0019]** With reference to Fig. 1, a personal care appliance 10 including a cutting element 12 and a handle 14. The appliance 10 may be a personal care appliance. The personal care appliance may be a grooming appliance such as a hair cutting appliance. Hair cutting appliances generally involve hair trimmers, users, epilators, and combined devices. The personal care appliance 10 may be used for trimming and shaving.

**[0020]** The cutting element 12 comprises a stator and a moveable blade each comprising teeth. The moveable blade moves relative to the stator to cut hair between the teeth.

**[0021]** The handle 14 is elongate and has an attachment 15 for attaching to the cutting element. In other words, the attachment 15 is for attaching the cutting element 12 to the handle. The personal care appliance 10 further comprises a motor 16, a sensor 18, a controller 20, and an energy storage unit 22.

**[0022]** The motor 16 may be an electric motor 16 and may be connected to the cutting element to drive the blade. The motor 16 is powered by energy from the storage unit 22. The sensor may be a sensor 18 is configured to sense physical parameters associated with operating the personal care appliance 10. The physical parameters include current and/or power of the motor 16.

**[0023]** The controller 20 comprises a processor 24 and storage 26. The storage 26 has instructions stored thereon that, when executed by the processor 24, cause the processor to perform any of the methods described below. The storage may thus form non-transitory, computer-readable media having instructions stored thereon that when executed by the processor cause the processor to perform any of the methods described herein. The instructions may also be provided on transitory computer-readable media that can be added to the storage when, for example, an update is required.

**[0024]** With reference to Fig. 2, a computer-implemented method of detecting a new cutting element on a personal care appliance is summarised to include steps including: sensing S200, by a sensor of the personal care appliance, data representing physical parameters associated with operating the personal care appliance; detecting S202, using a machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data; and outputting S204 a signal indicating that a new cutting element has been installed on the personal care appliance based on the detection. The signal being output may be output to a processor processing an algorithm requiring knowledge of whether a cutting element is new or not new. The term new may mean that the cutting element has not been used at all before. The term not new may mean that the cutting element has been used at least once before. For instance, certain algorithms may reset a computation when a new blade has been installed.

**[0025]** The physical parameters comprise current and/or power of the motor 16 used to drive the cutting element. The detecting whether a new cutting element

has been installed on the personal care appliance based on the sensed data comprises two steps. In a first step, a plurality of predictors are calculated using the sensed data. In a second steps, the plurality of predictors are input to the machine learning model.

**[0026]** The plurality of predictors may include one or more of a binned distribution of motor power for a last use, a ratio of a minimum power of a last use and a minimum power averaged over a first three uses, a difference between a maximum power of a last use and a maximum power of a last use minus one, and a ratio of a maximum power of a last use and a maximum power of a last use minus one. The term use may refer to a shave.

**[0027]** With reference to Fig. 3, the machine learning model may be a decision tree 30. The decision tree includes a plurality of nodes 32. Each node 32 is either a branch node or a leaf node. The branch node provides a split leading to two new nodes. The leaf nodes are output nodes outputting that the cutting element is new 34 or not new 36, for example. The splits are different for each level of the tree. The splits may be numeric values and may be decided by training the machine learning model as explained below. One of the predictors 38 is applied after each branch node. The value of the predictor is compared to the split and if the predictor is less than or equal to the split, a first branch is taken. If the predictor is greater than the split, a second branch is taken. In Fig. 3, the first branch is a left branch, and the second branch is a right branch. This convention may be altered in other embodiments.

**[0028]** With reference to Fig. 4, a computer-implemented method of training a machine learning model to detect a new cutting element installed on a personal care appliance is summarised as having steps including: receiving S400 a dataset including a plurality of predictors derived from data sensed from a sensor of the personal care appliance, the data representing physical parameters associated with operating the personal care appliance, and classifications of a new cutting element and a not-new cutting element; inputting S402 the plurality of predictors to the machine learning model to predict a classification of the cutting element as being new or not-new; and optimising S404 the machine learning model to reduce error between the predicted classification and the classification in the dataset.

The optimising the machine learning model may be performed using a classification and regression tree, CART, algorithm. The CART algorithm helps identify the splits to use at each level, the number of nodes, number of leaf nodes, etc.

**[0029]** While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments.

**[0030]** Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfil the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

**Claims**

1. A computer-implemented method of detecting a new cutting element (12) installed on a personal care appliance (10), the computer-implemented method comprising:

   sensing (S200), by a sensor (18) of the personal care appliance, data representing physical parameters associated with operating the personal care appliance;
   detecting (S202), using a machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data; and
   outputting (S204) a signal indicating that a new cutting element has been installed on the personal care appliance based on the detection.

2. The computer-implemented method of Claim 1, wherein the physical parameters comprise current and/or power of a motor (16) used to drive the cutting element.

3. The computer-implemented method of Claim 2, wherein the detecting, using the machine learning model, whether a new cutting element has been installed on the personal care appliance based on the sensed data comprises:

   calculating a plurality of predictors (38) using the sensed data; and
   inputting the plurality of predictors to the machine learning model.

4. The computer-implemented method of Claim 3, wherein the plurality of predictors are selected from a list of predictors including a binned distribution of motor power for a last use, a ratio of a minimum power of a last use and a minimum power averaged over a first three uses, a difference between a maximum power of a last use and a maximum power of a last use minus one, and a ratio of a maximum power of a last use and a maximum power of a last use minus one.

**5.** The computer-implemented method of any preceding claim, wherein the machine learning model is a decision tree (30).

**6.** A computer-implemented method of training a machine learning model to detect a new cutting element (12) installed on a personal care appliance (10), the computer-implemented method comprising:

receiving (S400) a dataset including a plurality of predictors (38) derived from data sensed from a sensor of the personal care appliance, the data representing physical parameters associated with operating the personal care appliance, and classifications of a new (34) cutting element and a not-new (36) cutting element;
inputting (S402) the plurality of predictors to the machine learning model to predict a classification of the cutting element as being new or not-new; and
optimising (S404) the machine learning model to reduce error between the predicted classification and the classification in the dataset.

**7.** The computer-implemented method of Claim 6, wherein the machine learning model is a decision tree (30).

**8.** The computer-implemented method of Claim 7, wherein the optimising the machine learning model is performed using a classification and regression tree algorithm.

**9.** The computer-implemented method of any of Claims 6 to 8, wherein the physical parameters include current and/or power of a motor (16) used to drive the cutting element.

**10.** The computer-implemented method of Claim 9, wherein the plurality of predictors are selected from a list of predictors including a binned distribution of motor power for a last use, a ratio of a minimum power of a last use and a minimum power averaged over a first three uses, a difference between a maximum power of a last use and a maximum power of a last use minus one, and a ratio of a maximum power of a last use and a maximum power of a last use minus one.

**11.** A transitory, or non-transitory, computer-readable medium, having instructions stored thereon that when executed by a processor, causes the processor to perform the computer-implemented method of any preceding claim.

**12.** A personal care appliance (10), comprising:

an attachment for attaching a cutting element

(12) thereto;
a sensor (18) for sensing physical parameters associated with operating the personal care appliance; and
a controller (20) including a processor (22) and storage (24), the storage having instructions stored thereon that when executed by the processor cause the processor to perform the computer-implemented method of any of Claims 1 to 5.
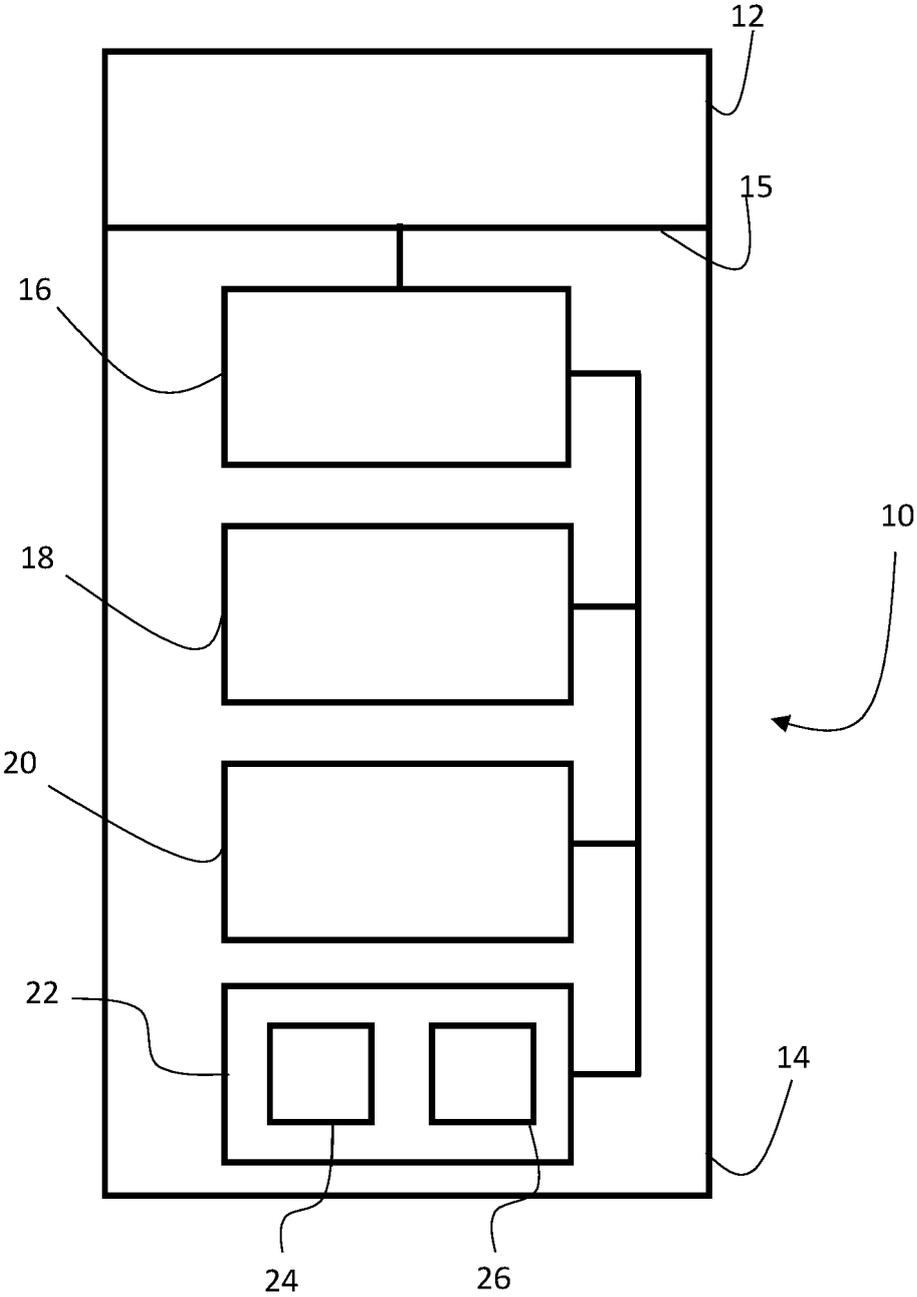
Figure 1

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┌──────────┐
│   S200   │
└──────────┘
      │
      ▼
┌──────────┐
│   S202   │        Figure 2
└──────────┘
      │
      ▼
┌──────────┐
│   S204   │
└──────────┘
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┌──────────┐
│   S400   │
└──────────┘
      │
      ▼
┌──────────┐
│   S402   │        Figure 4
└──────────┘
      │
      ▼
┌──────────┐
│   S404   │
└──────────┘
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Figure 3

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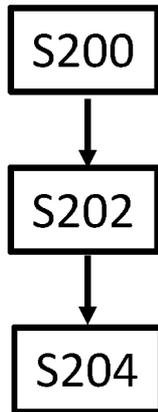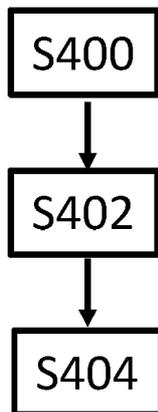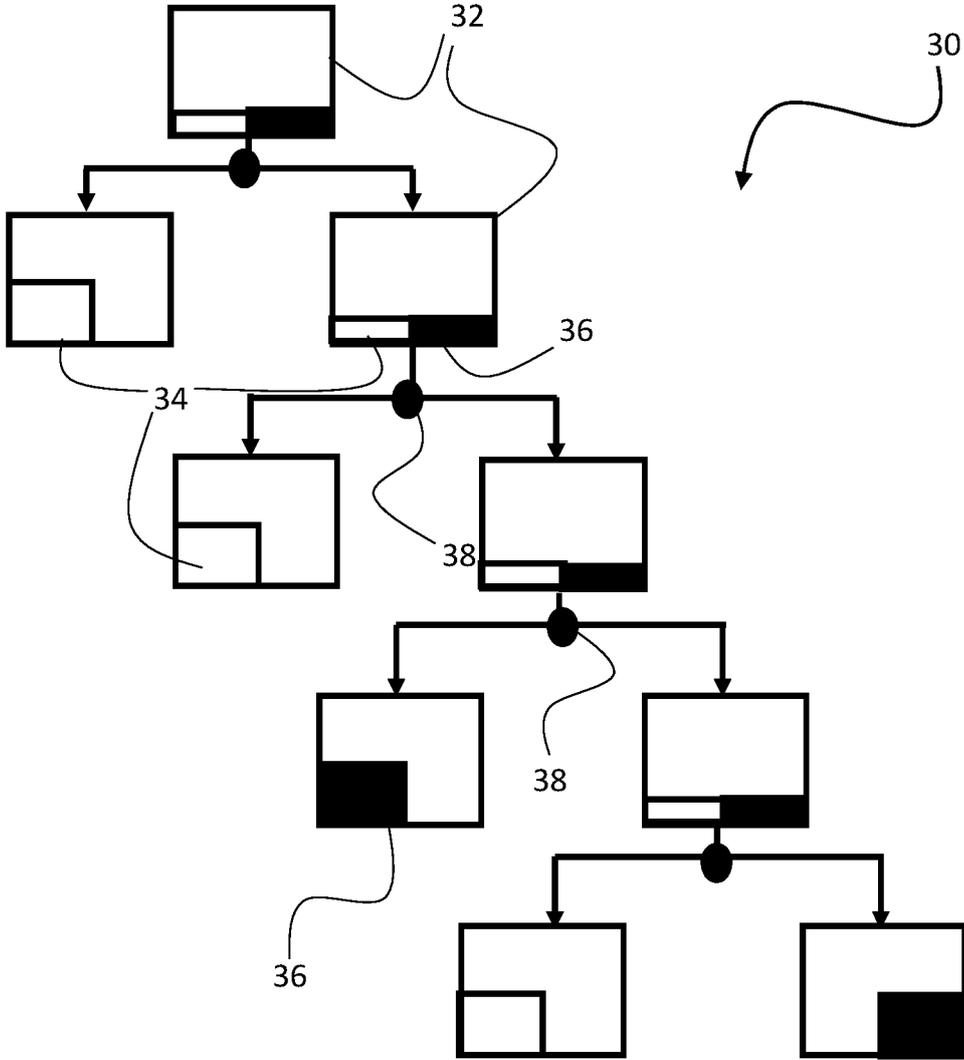
# EUROPEAN SEARCH REPORT

**Application Number**

EP 23 20 5036

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| X | US 2019/224870 A1 (ROBINSON SUSAN CLARE [GB] ET AL) 25 July 2019 (2019-07-25) | 1,5,11, 12 | INV. B26B19/38 B26B21/40 |
| Y | * paragraphs [0005] - [0127] * | 2,3 | |
| A | * figures 1-20 * | 4 | |
| Y | US 2019/299435 A1 (FUELLGRABE MARTIN [DE] ET AL) 3 October 2019 (2019-10-03) * paragraphs [0107] - [0114] * | 2,3 | |
| A | US 11 219 978 B2 (LANDWEHR THOMAS JAY [US]; RITESAFETY PRODUCTS INTL LLC [US]) 11 January 2022 (2022-01-11) * the whole document * | 1-5,11, 12 | |

**TECHNICAL FIELDS SEARCHED (IPC)**

B26B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 18 January 2024 | Calabrese, Nunziante |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another
document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or
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D : document cited in the application
L : document cited for other reasons

......................................................................
& : member of the same patent family, corresponding
document

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## CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

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## LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

    see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

    1-5, 11, 12

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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**LACK OF UNITY OF INVENTION**
**SHEET B**

**Application Number**

**EP 23 20 5036**

The Search Division considers that the present European patent application does not comply with the
requirements of unity of invention and relates to several inventions or groups of inventions, namely:

    1. claims: 1-5, 11, 12

        A computer-implemented method of detecting a new cutting
        element installed on a personal care appliance using a
        machine learning method.
                          ---

    2. claims: 6-10

        a computer-implemented method of training a machine learning
        model to detect a new cutting element installed on a
        personal care appliance.
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## ANNEX TO THE EUROPEAN SEARCH REPORT
## ON EUROPEAN PATENT APPLICATION NO.

**EP 23 20 5036**

This annex lists the patent family members relating to the patent documents cited in  the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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**18-01-2024**

| Patent document cited in search report | | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|---|
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| | | | US | 2019224870 A1 | 25-07-2019 |
| US 2019299435 | A1 | 03-10-2019 | CN | 110303533 A | 08-10-2019 |
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| | | | JP | 6835897 B2 | 24-02-2021 |
| | | | JP | 2019171051 A | 10-10-2019 |
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| | | | EP | 4110564 A2 | 04-01-2023 |
| | | | US | 2021260777 A1 | 26-08-2021 |
| | | | WO | 2021171197 A2 | 02-09-2021 |

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82