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(54) **METHOD FOR THE TEMPERATURE-DIFFERENCE-BASED SEPARATION OF FRUITS WITH STONES AND FRUITS WITHOUT STONES**

(57) The invention relates to a method for separating fruits with stones from fruits from which the stone has been removed, based on the difference in the temperature reached by the fruits when heated for the same length of time, determining whether or not a full or partial stone is present. The fruits are separated following analysis by means of computer vision with a thermal camera, or using a contact or infrared temperature sensor.

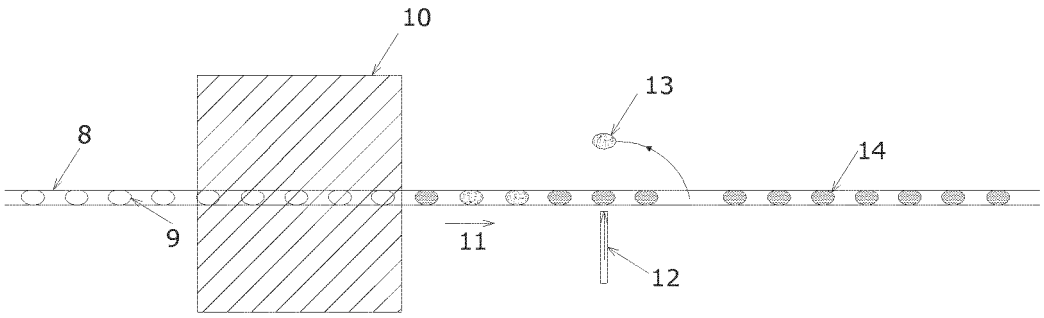

Figure 2

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Description

Object of the invention

[0001] The object of the present invention is a procedure for the separation of fruit with stones from those that have had their stones extracted, based on the temperature difference of the fruit after being heated for the same time, depending on whether the said stone is present or not. The separation is carried out after an analysis through artificial vision with thermal cameras, or through the use of infra-red contact sensors.

State of the art

[0002] The separation of fruit with and without stones from fruit without stones requires a procedure that allows the two to be distinguished. The extraction machines have an appreciable error rate, and often the whole stone or part of a stone is left inside the fruit. The separation systems habitually used depend on the type of fruit. For table olives, for example, float tanks are normally used, were the olives with stones go to the bottom of the tank and the olives without stones remain floating. This system, which is widely used in the table olive sector, has some serious drawbacks because whether the olives float or not depends on the concentration of salt in the liquid in the tank and its temperature and these are parameters that are usually uncontrolled, resulting in an appreciable error rate and the need for human operators to finish the classification task manually after using the tank.

[0003] Another existing technique, is the use of X-rays. This system can give good results, but it is expensive, the fruit has to be subjected to radiation and it requires special shielding for handling in the factory. That is why it is not used in the table olive sector. There is only one company in Spain that markets such an X-ray system: Multiscan Technologies S.L. with its model X20V B65.

[0004] The use of the thermal gradient, obtained on heating the fruit, can be a cheap, efficient alternative that has the best of both systems, its use can be generalised, for use not only with table olives, but also for a wide variety of fruit with stones.

[0005] There are no patented industrial procedures to date like the one described herein.

[0006] On reviewing the state of the art, we find a variety of inventions specific to the table olive:

Associated with separation by density:

[0007] P8700509 "Machine for washing the olive separating heavy bodies and impurities".

[0008] P8801897 "Installation and procedure for the washing of olives, including the separation of stones and accompanying foreign objects".

[0009] P200002328 "Modular kit for the cleaning and drying of olives".

[0010] U0241663 "Device for the cleaning of olives".

[0011] P9102361 "Machine for washing olives".

[0012] P200800763 "Collector of suspended solids".

[0013] A01D1/00 "Separation device by floating for fruit collectors".

Associated with the use of x-rays:

[0014] The company Multiscan Technologies S.L. markets a model (X20V B65) based on x-rays, that detects stones and possible contaminants in stoned (pitted) olives.

Description of the invention

[0015] The fruit separation process starts with fruit coming from a pitting machine that extracts the stones. As this extraction process sometimes fails, leaving whole or parts of stones in the fruit, a heat source is used to separate the fruit that still has a stone inside. The heat source raises the temperature of the fruit to values that are appreciably different in the case of fruit containing stones due to their different specific heat capacities.

[0016] After an appropriate interval of time, a difference of up to several degrees Celsius can be observed. To define the time required, previous laboratory adjustments are made to calibrate the heat source according to the type of fruit to be classified and its variety, always taking care that this heating does not affect the texture or organoleptic features. The empirical values that are obtained depend on each type of fruit and/or their variety, and are added as configuration parameters to the sorting machine that performs the separation according to this thermal gradient so as to make the process efficient from a commercial standpoint, The fruit is transported on a multiple track conveyor belt which allows a large number of items to be passed in front of a thermal analysis system. The means of discernment can be through an image, obtained by a thermal camera, that is processed using an artificial vision system, which determines from its image whether a fruit has a stone inside or not, according to its temperature. Another method is to analyse the surface temperature of each piece of fruit using in infrared system or by physical contact with a thermocouple type sensor, e.g. PT100 or similar.

[0017] In both cases, once the decision has been made, an actuator system extracts the fruit with stones from the conveyor belt.

Description of the figures

[0018] *Figure 1,* block diagram of procedure function blocks.

[0019] The diagrams show the different blocks involved in the application of this method: *(1)* fruit to be classified that may contain a whole stone or part of a stone, *(2) the* heating of the fruit by means of a heat source for a time that will depend on the nature of the

fruit: (size, variety, condition, etc.), *(3)* an image capture and digitalization system based on a thermal imaging camera, infrared temperature sensors or contact temperature sensors, *(4)* analysis of the thermal image of the fruit or *(5) of the* value obtained from the infrared or contact temperature sensor, *(4)* and *(5)* PC based or autonomous system with FPGA, DSP or microcontroller, *(6)* a segmentation of the image in colour planes to quantitatively determine the temperature in each zone, allowing the discernment of fruit without stone, fruit with complete stone or fruit with part of a stone (splinters), *(7)* separation in real time of the fruit with and without stones.

[0020] Figure 2, outline of the physical implementation of the machine that separates fruit by temperature difference. *(8)* single track conveyor belt, *(9)* fruit at room temperature, *(10)* heat source, *(11)* direction of movement of fruit-carrying conveyor belt, *(12)* actuator that extracts the heated fruit with stones from the conveyor belt, *(13)* heated fruit with stones extracted from the conveyor belt, *(14)* heated fruit without stone.

Preferred embodiment of the invention for the particular case of the table olive

a) Fruit:

[0021] The olives arriving from a conventional pitting machine, circulate on a conveyor belt that takes them through an (electrical or microwave) oven, applying heat for several seconds raising the temperature by different amounts for the olives that contain a stone or part of a stone and those that do not.

b) Temperature system:

[0022]

b1) If the temperature of each olive is acquired by infrared, or contact, sensors, the decision-making system (PC, FPGA or microcontroller) resolves the separation, normally acting on a pneumatic system that eliminates the olives with stones from the conveyor belt.

b2) If the temperature is acquired by a thermal imaging camera, it will use an image processing system that will allow the elimination of the olives with stones using a, preferably pneumatic, actuator. The decision-making system again will be a PC, FPGA or microcontroller.

[0023] As a non-limiting illustrative example, with a conveyor belt speed of 1 cm/s, a power of 1000 W in microwaves and an exposition of 5 seconds, variations of 4 °C are found in the manzani variety of olive measuring 18-20 mm. The temperatures achieved are no more than 40 °C so the olive does not suffer deterioration in quality at any time.

[0024] With a 20 line conveyor belt and pneumatic separation, a performance of 1,200 olives/minute is achieved.

Claims

1. Process for separation by temperature difference between fruits with a stone and fruits without a stone **characterized in that** it comprises:

   a) use of fruits to classify, which may not contain a stone or contain it either whole or partially.
   b) a heating of the fruits with a source of heat during a time which will depend on their nature: (size, variety, condition, etc.) and which does not affect the organoleptic characteristics of the fruit nor generate deterioration or losses in quality.
   c) a temperature measurement system based on infrared temperature sensors, contact temperature sensors or by a thermographic camera.
   d) the processing of temperature values of the thermal image sensors of the olives with a P.C. or in an autonomous system with FPGA, DSP or Microcontroller.
   e) in the case of a thermal image, a segmentation of the image in colour plans, to quantitatively determine the temperature in each area making it possible to distinguish between fruits without a stone, fruits with a stone or fruits with a piece of stone (splinters).
   f) a non-linear adjustment of a trained neuronal network to perform the selection in real time as it makes the fruits pass at a certain speed through the temperature measurement part.

2. Process for separation by temperature difference between fruits with a stone and fruits without a stone according to claim 1, **characterised in that** it avoids the typical errors of the standard density-separation systems in flotation tanks, (influence of the temperature, variation in salt concentration, incapacity to differentiate those fruits with pieces of stone).

3. Process for separation by temperature difference between fruits with a stone and fruits without a stone according to claim 1, **characterised in that** x-rays are not used for the classification, which allows greater safety in the use and the non-exposure of food to radiation.

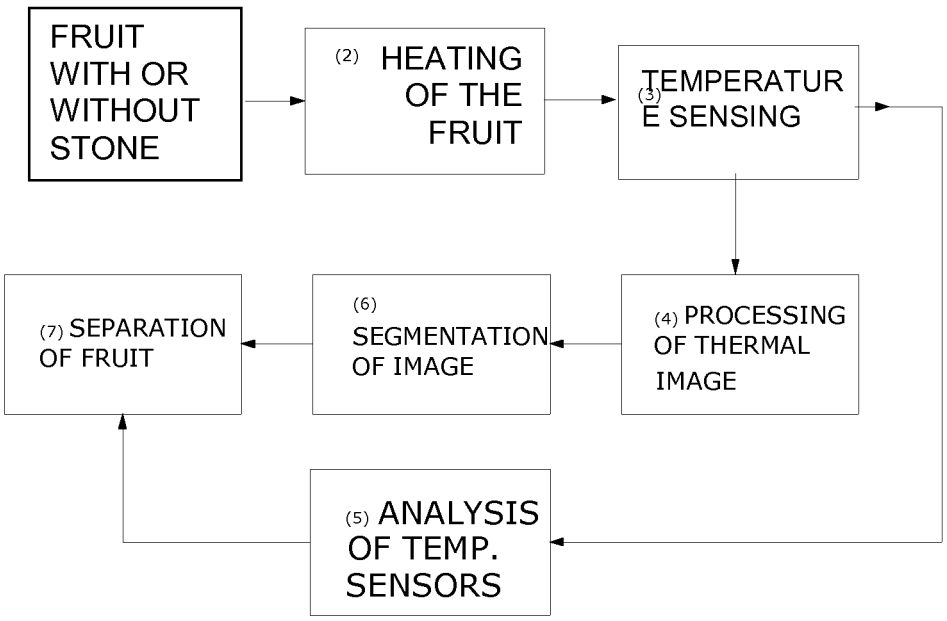

Figure 1

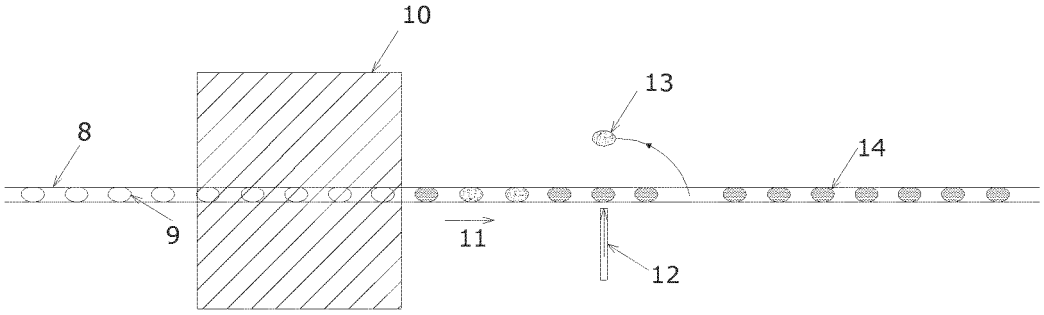

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES2013/000040

A. CLASSIFICATION OF SUBJECT MATTER

B07C5/34 (2006.01)
G06K9/66 (2006.01)
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)
B07C, G06K, A23N

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)

EPODOC, INVENES, WPI, TXTEN

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 2697450 A1 (FELTER, C. ET AL.) 06/05/1994, abstract; page 1, lines 11 - 35; page 3, line 11 - page 4, line 15; page 6, line 35 - page 9, line 8; page 9, line 36 - page 11, line 25; figures 1, 3 and 4.	1-3
Y	US 5659624 A (FAZZARI ET AL.) 19/08/1997, abstract; column 1, lines 5 - 35; column 4, line 11 - column 7, line 11; column 11, line 27 - column 13, line 2; figures 1, 2, 4 - 7.	1-3

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance.
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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 documents , such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
12/07/2013	**(16/07/2013)**
Name and mailing address of the ISA/ OFICINA ESPAÑOLA DE PATENTES Y MARCAS Paseo de la Castellana, 75 - 28071 Madrid (España) Facsimile No.: +34 91 349 53 04	Authorized officer A. Figuera González Telephone No. +34 91 3495516

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
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Patent document cited in the search report	Publication date	Patent family member(s)	Publication date
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Form PCT/ISA/210 (patent family annex) (July 2009)