Title: FRUIT RIPENESS DETECTION AND COLLECTION SYSTEM AND METHOD THEREOF

Abstract: A fruit ripeness detection and collection system (100) at a fruit bearing tree is provided, the system (100) includes a fruit collection apparatus (103) which includes a plurality of enclosures (105) surrounding a base of the fruit bearing tree which further includes a plurality of filters (109) with decrementally sized holes towards a plurality of chambers (107) in holding detached fruits for each specific fruit bunch for a corresponding chamber, at least one weight sensor (111), wherein the weight sensor (111) is network connectible to a wireless transmitter (113) and a microcontroller (115), wherein data from weight sensor (111) is network connectible to a base station (117), such that notifications of harvest are sent and received.
FIELD OF INVENTION

The present invention relates to fruit ripeness detection and collection system at a fruit bearing tree and a method thereof.

BACKGROUND OF INVENTION

There are a number of methods developed to determine fresh fruit bunch (FFB) ripeness including measuring the moisture content of the oil palm fruit, accessing the color of the FFB using photogrammetric technique, and counting the number of detached fruits from bunches that are known.

Conventional means of determining ripening of oil palm fruit bunch is by manually counting the number of detached fruits per bunch. This ripeness detection method is very subjective as this manual human dependent task can lead to miscounting, fruit scattering, early or late harvesting which result in quality degradation of the palm oil.

Among all, the cheapest and most common practice to determine the bunch ripeness is counting the number of fallen fruits. When an oil palm FFB is ready to be harvested, the ripened fruits will detach from the bunch and fall down the tree. If the number exceeds a certain value (around 10 fruits), then this indicates that the fruit bunch can be harvested. Currently, the counting process is done manually which is prone to human errors and miscounting.
US 6276536 B1 describes a method of measuring ripeness by measuring vibrations and frequencies as well as evaluating resonance. Unfortunately, this is a more complex and costly method as it involves measurements of frequencies.

JP201 1017570A describes a light radiating and measuring output spectral data to determine ripeness of fruits. However, this is also not a cost effective method of determining fruit ripeness.

Therefore, there is a need for a solution for determining the harvest time of fruits when they are ready in a cost effective manner.
SUMMARY OF INVENTION

Accordingly, there is provided a fruit ripeness detection and collection system at a fruit bearing tree, the system includes a fruit collection apparatus which includes a plurality of enclosures surrounding a base of the fruit bearing tree which further includes a plurality of filters with decrementally sized holes towards a plurality of chambers in holding detached fruits for each specific fruit bunch for a corresponding chamber, at least one weight sensor, wherein the weight sensor is network connectible to a wireless transmitter and a microcontroller, wherein date from weight sensor is network connectible to a base station, such that notifications of ripeness are sent and received.

There is further provided a method of detecting ripeness of fruits and collecting from a fruit bearing tree, the method includes the steps of filtering out objects larger than fruit size, filtering out objects smaller than fruit size, guiding fruits towards a plurality of chambers, collecting fruits in a corresponding chamber to each fruit bunch, activating weight measurement of detached fruits and sending out notification signal when weight of collected fruits exceeds a predetermined threshold value.

The present invention consists of several novel features and a combination of parts hereinafter fully described and illustrated in the accompanying description and drawings, it being understood that various changes in the details may be made without departing from the scope of the invention or sacrificing any of the advantages of the present invention.
The present invention will be fully understood from the detailed description given herein below and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, wherein:

Figure 1 shows a cross sectional view of a filter and collection chamber in the preferred embodiment of the invention;

Figure 2 shows a sectional diagram of a plurality of chambers in an apparatus in the preferred embodiment of the invention;

Figure 3 shows a graphical representation of using variable measuring frequencies for higher efficiency in the preferred embodiment of the invention;

Figure 4 shows a side view of opening and closing the apparatus in the preferred embodiment of the invention;

Figure 5 shows an overall architecture of the system in the preferred embodiment of the invention;

Figure 6 shows a side view of collection of fruits in corresponding collection chamber;

Figure 7 shows a block diagram of successive layers in the apparatus;

Figure 8 shows a block diagram of positioning of the weight sensor in the apparatus in the preferred embodiment of the invention;

Figure 9 shows a block diagram of a wireless transmitter sending the weight data to the base station; and
Figure 10 shows a block diagram of a wireless gateway, base station, and alert device that send notifications.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to fruit ripeness detection and collection system at a fruit bearing tree and a method thereof. Hereinafter, this specification will describe the present invention according to the preferred embodiment of the present invention. However, it is to be understood that limiting the description to the preferred embodiment of the invention is merely to facilitate discussion of the present invention and it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the scope of the appended claims.

The following detailed description of the preferred embodiment will now be described in accordance with the attached drawings, either individually or in combination.

Figure 5 shows a diagram depicting fruit ripeness detection and collection system (100) at a fruit bearing tree. The system (100) includes a fruit collecting apparatus (103) which includes a plurality of enclosures (105) surrounding a base of the fruit bearing tree which further includes a plurality of filters (109) with decrementally sized holes towards a plurality of chambers (107) in holding detached fruits for each specific fruit bunch for a corresponding chamber, at least one weight sensor (111), wherein the weight sensor (111) is network connectible to a wireless transmitter (113) and a microcontroller (115), wherein data from weight sensor (111) is network connectible to a base station (117), such that notifications of ripeness are sent and received.

Figure 1 shows the fruit collecting apparatus (103) in the preferred embodiment of the invention. As there might be other objects that fall from the tree other than oil palm fruits such as leaves, stones, twigs and rain drops, the apparatus (103) includes the plurality of filters (109) with at least two layers to separate the fruits from other objects (Figure 1). A first
layer of the plurality of filters (109) filters out all objects that are bigger than fruits and a second layer filters objects smaller than the fruits. The first layer conducts the relatively bigger objects to fall outside the apparatus (103) and the second layer guides the fruits towards the fruit chamber and allows the relatively smaller object fall to the ground. Since the dimensions of oil palm fruits for various species are known as seen in Table 1, pore size of the filters are accurately determinable.

Table 1: Summary of some properties of palm fruit with standard deviation

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<th>Property</th>
<th>Mean value (+/- standard deviation)</th>
<th>Dura variety</th>
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<tr>
<td>Length, mm</td>
<td>30.25 (+/- 5.07)</td>
<td>35.96 (+/- 4.08)</td>
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<td>Width, mm</td>
<td>19.94 (+/- 2.64)</td>
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<td>Thickness, mm</td>
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<td>Sphericity, %</td>
<td>70.67 (+/- 9.27)</td>
<td>64.23 (+/- 6.58)</td>
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<tr>
<td>Aspect ratio, %</td>
<td>67.78 (+/- 15.29)</td>
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<td>Fruit mass, g</td>
<td>7.66 (+/- 2.04)</td>
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<tr>
<td>True density, kg/m³</td>
<td>1112.50 (+/- 52.60)</td>
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<tr>
<td>Bulk density, kg/m³</td>
<td>659.40 (+/- 21.74)</td>
<td>611.04 (+/- 27.79)</td>
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<td>Density ration, %</td>
<td>59.33 (+/- 2.21)</td>
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<tr>
<td>Porosity, %</td>
<td>40.67 (+/- 2.21)</td>
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Source: Journal of Food Engineering 78 (2007) 1228-1232

An oil palm tree can have more than one fruit bunch simultaneously, therefore collected fruits should be related to a specific bunch where they originated. To overcome this issue, the apparatus (103) further includes a plurality of chambers (107). It is then determinable that the fruits collected in each chamber belong to which particular fruit bunch as seen in Figure 2.
Each collecting chamber includes a porous tray connectible to a weight sensor (111). A plurality of pores on the tray allows rain water entering the chamber to be channeled out and allows for accurate measurements. The weight sensor (111) is not required to be on all the time. Whenever necessary, a control circuit activates the weight sensors (111) and collected fruits weight is measurable. Frequency of measurements can be varied to optimize the electric power consumption of the system (100). A result of this may be seen graphically in Figure 3.

The apparatus (103) is installable by a ring attachable to trunk of the fruit bearing tree. The ring further includes at least two members that are connectible during installation. Further, the plurality of filters (109) are foldable. During time of harvest, the apparatus may be leaned to the fruit bearing tree trunk for easy harvest as seen in Figure 4.

If weight of collected fruits exceeds a predefined threshold value which will depend on the type of oil palm, the system (100) will send out a notification signal. The notification signal can be as sophisticated as a phone call or a text message or as simple as a blinking light emitting diode (LED). Data analysis and notification generation are fully or partially done by the micro controller (115). There is further included a coordinate detection system such as GPS which senses coordinates of the tree. The wireless transmitter (113) sends coordinates or inventory of trees apart from the weight of the fruits. The wireless transmitter (113) not only transmits data to the base station (117) but also receives commands from the base station (117).

The system (100) is set up by choosing number of segments on the apparatus (103) and size of each segment. The preferred embodiment of the invention uses 6 segments for the apparatus (103) which resulted in accurate results. Further, the set up is continued by selecting the pore size of filter layers based on the type of oil palm, installing the apparatus (103) around the tree trunk and unfolding the filter, installing the weight sensors (111) and
the control circuit as well as adjusting the threshold values for weight measurement frequency and final notification alarm. It is to be appreciated that while it is preferrable to control the system (100) remotely via a wireless link, there is an option of having the control circuit on the apparatus (103) itself.

A method of detecting ripeness of fruits and collecting from a fruit bearing tree is described herein. The method includes the steps of filtering out objects larger than fruit size, filtering out objects smaller than fruit size, guiding fruits towards a plurality of chambers (107), collecting fruits in a corresponding chamber to each fruit bunch, activating weight measurement of detached fruits and sending out notification signal when weight of collected fruits exceeds a predetermined threshold value.

All fruits detached from the fruit bearing tree go through the filter before the fruits are stored in the corresponding fruit chamber. The fruits fall onto an impact resistant plastic as seen in Figure 6. The impact resistant plastic is a shock-absorbing material to protect bouncing of fruits. The fruits are isolated from relatively bigger and smaller objects including leaves and rainwater (Figure 6 and 7). Initially, the system (100) is in sleeping mode. After a predefined time, the system (100) wakes up and the control circuit activates the weight sensors (111) according to a preferred frequency and measures the weight of collected fruits as seen in Figure 8. Then, total weight of collected fruits is compared with the predefined threshold value. If the total weight is higher than the threshold value, the notification signal is activated. Otherwise the frequency of measurements will be adjusted and system goes back to sleep mode. It is to be noted that in case of wireless remote monitoring, the wireless transmitter (113) sends weight data to the base station (117) directly or through wireless gateways and/or repeaters as seen in Figure 9. The base station (117) analyzes the weight data in accordance with set of notification preferences as seen in Figure 10. An optional notification message is sent to appropriate personnel such as a planter or a manager to harvest ripened fruits.
The key advantage of using this system and method is instant ripeness indication to the planter for optimal harvesting. This system and method automates current manual human dependent fruit bunch ripeness detection, efficiently collects loose fruits and reduces the total harvesting time. Furthermore, detection circuitry used in this system is a low power consumption device compared to other technologies.

This invention is adapted for use in collection of detached ripened fruits. The disclosed invention is suitable, but not restricted to, for use in oil palm fruit ripeness detection.
CLAIMS

1. A fruit ripeness detection and collection system (100) at a fruit bearing tree, the system (100) includes:
   a fruit collection apparatus (103) which includes a plurality of enclosures (105) surrounding a base of the fruit bearing tree which further includes a plurality of filters (109) with decrementally sized holes towards a plurality of chambers (107) in holding detached fruits for each specific fruit bunch for a corresponding chamber;
   at least one weight sensor (111), wherein the weight sensor (111) is network connectible to a wireless transmitter (113) and a microcontroller (115), wherein data from weight sensor (111) is network connectible to a base station (117), such that notifications of ripeness are sent and received.

2. The system (100) as claimed in claim 1, wherein a first layer of the plurality of filters (109) filters out all objects that are bigger than fruits and a second layer filters objects smaller than the fruits.

3. The system (100) as claimed in claim 1, wherein a control circuit activates the weight sensors (111) and collected fruits weight is measurable.

4. The system (100) as claimed in claim 1, wherein frequency of measurements can be varied to optimize the electric power consumption of the system (100).

5. The system (100) as claimed in claim 1, wherein the apparatus (103) is installable by a ring attachable to trunk of the fruit bearing tree.

6. The system (100) as claimed in claim 1, wherein the ring further includes at least two members that are connectible during installation.
7. The system (100) as claimed in claim 1, wherein the plurality of filters (109) are foldable.

8. The system (100) as claimed in claim 1, wherein when weight of collected fruits exceeds a predefined threshold value, the system (100) will send out a notification signal.

9. The system (100) as claimed in claim 1, wherein the wireless transmitter (113) transmits data to the base station (117) and receives commands from the base station (117).

10. A method of detecting ripeness of fruits and collecting from a fruit bearing tree, the method includes the steps of:
   i. filtering out objects larger than fruit size;
   ii. filtering out objects smaller than fruit size;
   iii. guiding fruits towards a plurality of chambers (107);
   iv. collecting fruits in a corresponding chamber to each fruit bunch;
   v. activating weight measurement of detached fruits; and
   vi. sending out notification signal when weight of collected fruits exceeds a predetermined threshold value.

11. The method as claimed in claim 10, wherein the fruits are isolated from relatively bigger and smaller objects.

12. The method as claimed in claim 10, wherein weight sensors (111) are activated after a predetermined time.

13. The method as claimed in claim 10, wherein weight data is sent to the base station (117).
14. The method as claimed in claim 10, wherein a notification message is sent to appropriate personnel.
Figure 2

Figure 3

3. Frequency of reading vaned by time to minimize power consumption, maximize accuracy

2. Weight > L1, frequency of reading increases

1. Weight < L1, systems wakes up 1/day
Figure 4

Apparatus in operation
OPEN

Apparatus side view when closing opening

Apparatus lean with tree trunk CLOSE

Figure 5

Farmer & Handheld Device
Wireless Gateway
Base Station

Collection Zones
Control Circuit
Weight Sensor

Successive Layers
Apparatus installed on tree trunk beneath FFBs

Fruit drops on the apparatus top layer.

Collection zones cover fruit dropping area.
Fruits are collected in the chamber.

Figure 6
Figure 7

Figure 8
Figure 9
**INTERNATIONAL SEARCH REPORT**

**International application No**

PCT/MY2012/00151

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. G01N33/02 A0  
ADD.

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)

G01N A01D

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)

EPO-Internal , WPI Data, INSPEC, COMPENDEX

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of Box C.

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<td>&quot;Z&quot; document member of the same patent family</td>
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Date of the actual completion of the international search: 25 October 2012

Date of mailing of the international search report: 06/ 11/2012

Name and mailing address of the ISA/Authorized officer

European Patent Office, P.B. 5818 Patentlaan 2
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Joyce , David

Form PCT/ISA/210 (second sheet) (April 2005)
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