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(54) Title: GRADING MACHINE FOR GRADING OBJECTS AND METHOD THEREOF

(57) Abstract: The present disclosure relates to an electromechanical grading machine for grading objects and method thereof. The grading machine includes at least one controller with a grading comparator, an object introducing unit, an in-feed unit for feeding object in queue, a singulator for singulating objects, an object moving channel, a plurality of optical examination beds, an optic unit, a plurality of grade container and an object ejection unit. The ejector unit includes at least one channel which receives graded object from the optic unit, a plurality of channel sensors, an object directing unit and a plurality of doors. The channel sensor senses the movement of objects along the channel and cooperated with controller. The objet directing unit provides controlled movement of the objects to the doors thereby gently moving the objects. The doors are permit flow of objects in the grade container.

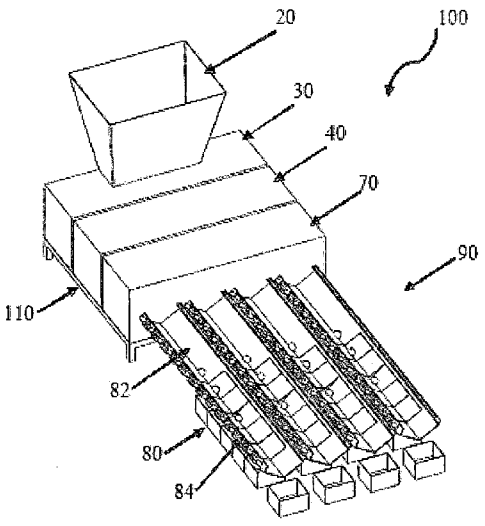

FIG. 1

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1. TITLE OF THE INVENTION:

GRADING MACHINE FOR GRADING OBJECTS AND METHOD THEREOF

FIELD OF THE INVENTION

[0001] The present invention generally relates generally to an electro-mechanical machine. Particularly, the present disclosure relates to an automated electro-mechanical grading machine and method for grading objects, typically of small size.

BACKGROUND

[0002] Determining grade of objects is a difficult task when the objects are small sized therefore graded in bulk. When small sized objects, typically pistachios are graded in bulk due to their small size and due to difficulty in handling such small sized objects, especially when these objects have skin with smooth surface and low friction, are damaged mostly on their outer skin (generally, skin of pistachios is mauvish skin with light green flesh) and such damaged objects are less preferable in the market due to their peeled off skin which deteriorates good quality of pistachios. Also, it happens that the pistachios are split into two parts, thereby damage the pistachios. Further, determining of internal characteristics along with external characteristics of such small sized objects is difficult due to their improper handling during grading, typically in case of pistachios which shows carcinogenic contamination caused by fungi highly affects the grade of the pistachios. Hence, it is important to effectively handle such small objects to prevent any damage or deterioration of quality during determination of quality based on external and/or internal characteristics of the objects.

[0003] There are some prior art documents referring to grading of small sized objects like pistachio sorting and pistachio grading based on different parameters.

[0004] Patent No. WO2012074417A1 titled "Article divider" discloses an invention which relates to a method for controlling the motion of article. More particularly, the invention relates to diverting an article moving in first trajectory by impinging with one or more fluid streams, to control or adjust the motion of article. The invention more focuses on finding the trajectory for different grade of objects but do not disclose anything on conveying on slab and then grading accordingly.

[0005] Patent No US 2010116974A titled "Seed sensor system and method for improved seed count and seed spacing" discloses a method to determine the speed and position of the seed in the conduit. The invention also discloses a method where the position in both X and Y direction is found, the sensor is able to determine multiple seeds as well providing more precision to the seed population. The invention does not disclose about harmless handling of seed while dealing with seed count and seed spacing method.

[0006] US Patent. No. 3181916 titled "Air conveyor or pneumatic conveyor for light materials, plastics etc." Claims of a designed channels that uses air to pass the objects through the channel. The invention does not disclose anything on controlling the objects speed and tracking of the objects in the channel while using air for conveying materials.

[0007] The existing grading systems or devices or methods of grading small objects are neither fully controlled during conveying nor they are effective in handling small objects, typically non-sticky with less friction while grading or in any other operation automated. Therefore, some technique need to be developed to deal gently with grading of small sized objects having smooth/non-sticky surface properties in many cases to assure their quality while grading.

[0008] The present invention obviates effectively above mentioned problems of the prior art grading machines and provides a unique system to convey objects without effecting its property.

SUMMARY

[0009] The present disclosure discloses a grading machine for grading objects, in accordance with one embodiment of the present disclosure, wherein objects are conveyed via air to its grading location without affecting its surface properties. The grading machine is configured with advanced handling and conveying of small objects, typically pistachios to maintain its natural property while grading as the shells of the pistachio protect the inner kernel, any harm to them will affect the pistachios. The grading machine includes at least one controller, an object introducing unit which receives objects, an in-feed unit, a singulator, a plurality of examination beds, an optic unit, a grading comparator and an ejection unit. The in-feed unit is connected to the object introducing unit and receives objects at a controlled feed rate, wherein the feed rate is determined by the controller based on the input received from feed sensors provided in the in-feed unit. The in-feed unit further directs objects in at least one queue. The singulator cooperates with the in-feed unit and singulates object(s) received from the queue. Each examination bed receives one singulated object from the singulator. The optic unit mainly includes a plurality of cameras, an image processing unit and a first storage module. The cameras are disposed proximal to the examination bed(s) and configured to capture multi-angled one/multiple real time images of each object(s) under examination in three dimensional spaces for further determining at least one internal and/or external characteristics of each object. The image processing unit

processes the captured multi-angled one/multiple real time images of each object(s) under examination in three dimensional spaces into at least one parameter. The first storage module stores each parameter. The grading comparator compares each parameter stored in the first storage module with a pre-determined parameter stored in a second storage module of the controller and provides a graded data for each object under examination. The ejection unit includes at least one channel, a plurality of channel sensors, an object directing unit and a plurality of doors. The channel receives graded objects from the optic unit. The channel sensors disposed along the length of at least one wall of the channel for sensing the movement of graded objects along the channel. The channel sensors are cooperating with the controller. The object directing unit includes a fluid chamber, a plurality of nozzles and valves. The fluid chamber is filled with fluid. The nozzles are fitted along the length of at least one side of the channel and receive fluid from the fluid chamber for moving graded objects along the channel. The valves are disposed in between the fluid chamber and the nozzles and permits and restrict flow of fluid there through as directed by the controller upon the signal received from the channel sensors for enabling controlled flow of fluid in the channel through the nozzles thereby enabling controlled movement of objects in the channel. The doors are provided on the channel, wherein each door is assigned with a per-determined grade and receives respective graded objects having defined grade parameter thereon. Each door cooperates with the controller for opening and closing of the door upon receipt of inputs received from the channel sensors. Each grade container is disposed underneath of respective grade door and configured to receive objects of a particular grade from the respective door in open configuration, thereby grading objects into multiple grades in a single pass.

[0010] The present disclosure also discloses a method for grading objects by using the grading machine. The method includes feeding a controller with object feeding rate and controlled grade parameters in a second storage module of the controller, introducing objects through object introducing unit, feeding objects, received from the object introducing unit, through an in-feed unit, at a controlled feed rate controlled by the controller, the step of feeding enables objects to move in at least one queue, singulating objects received from the in-feed unit in a singulator, disposing at least one singulated object respectively on at least one examination bed , capturing multi-angled one/multiple real time images of each object under examination in three dimensional spaces of each object by a plurality of cameras and light sources of an optic unit, processing the image in a image processing unit of an optic unit, wherein the image is processed into at least one parameter, storing each parameter in a first storage module of the optic unit, comparing each parameter stored in the first storage module with a pre-determined parameter stored in a second storage module by using a grading comparator, wherein the second storage module and the grading comparator are configured in said controller and determining grade of object(s) by the controller, locating grade container(s) based on the determined grade of object(s) by the controller, receiving graded object(s) on channel(s) from examination bed(s), sensing position of object(s) on the channel(s) such that the sensed position is forwarded to the controller, actuating a valve of an object directing unit such that fluid from a fluid chamber is directed to nozzle(s) and thereby the channel(s)for directing graded objects(s) of a particular parameter/grade to respective door of pre-determined grade, wherein actuation of the valve is controlled by the controller upon the inputs received from channel sensors, opening of door(s) such that

graded object(s) received on the door(s)falls in respected grade container, thereby grading object(s) into multiple grades in a single pass.

OBJECT

[0011] The proposed disclosure recognizes and addresses various disadvantages and drawbacks of the existing object sorting and grading systems and related methods and provide an improved multi-vision object grading system and a method for grading objects into multiple grades in a single pass based on external or internal parameters. The disclosure is very specific for object grading considering different characteristics of objects. Accordingly, few objects of the present invention are listed below:

- A main object of the present disclosure is to provide an object grading machine and the method of grading object in which the objects are gently handled to prevent any damage or quality deterioration/degradation of the objects during grading.
- It is another object of the present disclosure is to provide an object grading system which does not include any moving part while conveying the object, wherein the system includes stationary/stable conveying channel which makes the system highly energy efficient and simple.
- It is still another object of the present disclosure is to provide an object grading system which uses fluid or air carrying of objects while tracking of objects to the grading points, thereby imparting delicate and accurate grading of objects into multiple grades based on internal and/or external features, wherein the analysis and grading of each object is performed with higher precision.

- It is a further object of the present disclosure which operates by using embedded intelligence, having a multi-vision system aided with multi-wavelength lighting for grading statistically distributed objects very much effectively based upon their natural properties and requirements.
- It is still further another object of the present disclosure to provide an object grading system which includes an advanced channel comprising of sensors and multiple nozzles, where sensor is of any type such as Infra Red sensor, Ultra Sonic sensor, or proximity sensing sensors not limiting to the invention that accurately track the object during its movement, and where valves are controlled in each air ejectors of channels to control the flow of the fluid/air for controlling the speed of the objects on the channel.
- It is a further object of the present disclosure to provide an object grading system which includes the channel with a good surface finish and having a very low frictional co efficient for easy conveying of objects along with multiple partitions at the grading location where each of these partition are called doors, where each door is one grading location and below each grading location is at least one grade collector for collecting the graded pistachios.
- It is still further object of the present disclosure to keep the design of doors in such that it has a pivoted joint on one end and can be opened on the other end.
- It is another object of the present disclosure to provide an on-line method for analyzing individual each object on object by object basis, typically small objects with low friction surface, grading objects and to grade objects into multiple grades in a single pass based on their different pre-determined internal and/or external

parameters which enable in significantly improving the performance of the improved multi-vision grading system where the method is capable of grading small sized, objects into multiple ('n' number) grades in a single pass unlike the conventional grading methods in an automated, programmed and hence in an easy and reliable manner.

- It is still another object of the present invention to provide an accurate and efficient method which is an on-line, a rapid and time-efficient method for grading objects into multiple grades in a single pass based on predefined external/morphological or internal parameters after analyzing each object at least three dimensionally unlike conventional grading.
- It is a further object of the present invention to provide an improved multi-vision pistachio grading system for a single or individual pistachio analysis at a time to increase accuracy of analysis of pistachios three dimensionally for efficient pistachio grading.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present disclosure refers few exemplary drawings to refer to few embodiments of the disclosure, which are not construed to be limited.

FIG. 1 is a schematic perspective view of the grading machine for grading objects;

FIG. 2a and FIG. 2b are schematic perspective views of the ejection unit of the grading machine of FIG. 1; and

FIG. 3 illustrates the flowchart of the method for grading objects.

DETAILED DESCRIPTION

[0013] The present invention will now be described in brief with reference to the accompanying drawings. Now, refer in more detail to the exemplary drawings for the purposes of illustrating non-limiting embodiments of the present invention.

- As used herein the term 'object' shall refer to any natural or synthetic objects which are generally small in size (weight range), wherein the natural or synthetic objects can be agricultural or non agricultural objects. The term 'object' refers to objects weighing from 1gm to 100gm, has good surface finish or non-sticky surface.
- As used herein, the term 'pistachio' or 'pistachios' refer to a feed for the purposes of the invention and the feed may be 'hulled' or 'un-hulled' or 'de-shelled' or 'split' or 'un-split' or 'kernel' or combination or mixtures of different forms of pistachio and similar objects with a good surface finish.
- As used herein, the term 'external parameters' shall refer to any morphological, extrinsic characteristics related to object which may include but not limited to size, shape, color, surface properties, profile, or alike any other properties, defects, mechanical injuries, or any other possible characteristics.
- As used herein, the term 'internal parameters' shall refer to any internal or biochemical characteristics related to object which may include but not limited to hull thickness, shell thickness, size, kernel thickness, moisture content within object, any microbial infection or any microbial activity or biochemical activity inside object which make object rotten, rancid, infected or diseased, or any other possible characteristics by which the object can be graded into a category.

[0014] According to one embodiment of the present disclosure, the proposed disclosure discloses a grading machine and a method of grading objects in multiple grades in a single pass based mainly on external and internal parameters/characteristics.

[0015] Referring to FIG. 1, it is a schematic perspective view illustrating a grading machine (100) according to one embodiment of the present subject matter. Typically, the objects are small sized objects such as nuts (like pistachio), pulses and the like and the objects weighing from 1gm to 100gm are non-sticky in nature having good surface finish. The components of the grading machine (100) for grading objects (not illustrated in Figures) mainly are at least one controller (10) (typically a master controller) configured with a grading comparator (120), an object introducing unit (20), an in-feed unit (30), a singulator (40), at least one object moving channel (50), a plurality of optical examination beds (60), an optic unit (70), a plurality of grade containers (80) and an ejection unit (90). In one embodiment, some of the components of the grading machine (100) are disposed on a frame (110).

[0016] In one embodiment, the controller (10) is one master controller. In another embodiment, the controller (10) may be more than one controller. In one embodiment, the object introducing unit (20) is a hopper arrangement. The object introducing unit (20) receives objects either in whole, half, or quarter size. Typically, the object is small and light weight (weight ranging in between 1gm to 100 gms) having non-sticky and good surface finish such as pistachio which can be semi-shelled, separated pistachios or shelled pistachios. The hopper distributes the load uniformly to enable controlled moving of objects without having any moving parts.

[0017] The in-feed unit (30) is fitted proximal to the object introducing unit (20) and receives objects from the object introducing unit (20). The in-feed unit (30) receives objects at a controlled feed rate, wherein the feed rate is determined by the controller (10) based on the input received from feed sensors (29) provided in the in-feed unit (30). The in-feed unit (30) further directs objects in at least one queue. In accordance with one embodiment of the present disclosure, the in-feed unit (30) includes a slider (not illustrated in Figures) which receives objects from the hopper arrangement and cooperates with the slider for receiving object at the controlled feed rate. The in-feed unit (30) also includes at least one pair of set of reverse rotating rollers (not illustrated in Figures) which moves the objects towards the singulator (40) and because of vibration the objects align in a queue. In one embodiment, there is plurality of the set of reverse rotating rollers which enables forming plurality of queues of objects. The controller (10) directs the in-feed unit (30)to increase the feed rate, decrease the feed rate or maintain the feed rate based on the real-time input received from the feed sensors.

[0018] The singulator unit (40), in one embodiment, includes a pick and place mechanism configured to pick each object from the queue and place each picked object on each examination bed (50) such that one examination bed is filled with one object, thus singulating the object such as pistachios. In an exemplary embodiment, the pick and place mechanism includes a rotating drum (not illustrated in Figures). The rotating drum is configured with a plurality of holes or wrapped with a suction pad. During rotation the rotating drum singularly picks at least one object and places on at least one examination bed (50) such that one examination bed (50) has one object. Although, the singulator unit (40) of the present disclosure describes singulating objects by the pick and place mechanism,

however, the present disclosure is not limited to the pick and place mechanism and any mechanism that can singulate the objects can be used.

[0019] The object moving channel (50), which is adjacent to the singulator (40), in which objects move at a second controlled speed which is synchronous with the first controlled speed of the rotating drum of the pick and place mechanism of the singulator (40). The second pre-determined speed is determined by the controller (10). The object moving channel (50) is stationary and the objects automatically move by themselves without having any moving capacity in the object moving channel (50) when the fluid is impinged in a controlled manner.

[0020] The optical examination beds (60), also known as examination beds, receive released object(s), from the pick and place mechanism of the singulator (40) such that one optical examination bed (60) receives one object. Typically, the released object(s) fall on the optical examination beds (60) due to gravity. Typically, the optical examination beds (60) are made of optical material. Typically, one examination bed (60) is configured to accommodate one object. Alternatively, one examination bed (60) is configured with a plurality of compartments (not illustrated in Figures) wherein each compartment receives one object. The number of compartments can be equal to the number of objects falling from the singulator (40) at a particular time. Typically, each examination bed (60) is a cup like arrangement.

[0021] The optic unit (70) is disposed in proximity with the examination bed (60). In embodiment, the optic unit (70) includes a plurality of cameras (72), a multiple light sources (74), an image processing unit (76) and a first storage module (78). The cameras (72), in presence of the light sources (74) capture multi-angled one/multiple real time images of each

object under examination in three dimensional spaces for amounting to complete three dimensional analysis of the object under examination. The captured image is without reconstructing the plurality of images of object, this feature helps in accurate and quick analysis of the object under examination. The images are captured to determine at least one internal and/or external features of each object under examination.

[0022] The image processing unit (76) processes each of the captured multi-angled (different view) one/multiple real time images of each object and converts the images into at least one parameter. Typically, the external parameters are the external characteristics like at least one of size, shape, color, surface properties and object profile and internal parameter are internal characteristics like moisture content, biochemical changes and/or microbial infections. However, the present subject matter is not limited to the above mentioned parameters and any other parameters can also be considered for examination. The first storage module (78) stores each parameter generated in the image processing unit (76).

[0023] The controller (10) includes a grading comparator (120) and a second storage module (130). The grading comparator (120) compares each parameter stored in the first storage module (78) with pre-determined parameter stored in a second storage module (130), wherein the pre-determined parameter is a standard parameter set by a regulatory authority which determines the grade of the object, and provides a graded data for each object under examination. Typically, the grade containers (80) are pre-determined and categorized into multiple grades according to the object grade.

[0024] The ejection unit (90), as illustrated in FIGS. 2a and 2b, is operated by the controller (10) and directs the graded objects in a particular grade container of the grade containers (80).In one embodiment, the ejection unit includes at least one channel (82), a plurality of

channel sensors (84), an object directing unit and a plurality of doors (86). The channel(s) (82) receives graded object(s) from the optic unit (70). In one embodiment, the channel (82) is a V-shaped channel. Typically, a plurality of channels (82) is provided to receive plurality of objects from the optic unit (70) thereby enabling grading of multiple grading of each object. The channels (82) have surfaces with very less co-efficient of friction and helps in maintaining a queue of the graded objects at the center of the channel without much force, hence the channel (82) reduces the excess energy which is needed for maintaining the graded object(s) at the center of the channel (82) while conveying.

[0025] The channel sensors (84) are disposed along the length of at least one wall of the channel (82). The channel sensor (84) senses the movement of objects along the channel (82). The channel sensor (84) senses the graded object(s) moving on the channel (82) and provided the real-time information of the location of each graded object to the controller (10). The controller (10) upon receipt of the information from the channel sensor (84) signals the object directing unit to either move the graded object under consideration towards respective door (86) or enable the graded object to remain at desired location. The objet directing unit includes a fluid chamber (92), a plurality of nozzles (94) and a valve (96). The fluid chamber (92) is filled with fluid or air. The fluid is selected such that it does not damage of deteriorate the properties of the graded objects and only facilitates controlled movement of graded object in the channel (82). The nozzles (94) are fitted along the length of at least one side of the channel (82).The nozzles (94) are connected to the fluid chamber (92) and receive fluid from the fluid chamber (92). The nozzles (94) eject fluid at a controlled pressure such that the pressure is adequate to gently move, at a controlled speed, the graded objects along the channel (82) towards the doors (86). The orientation of nozzle

(94) is such that it can direct the fluid in a direction by which the object moves towards the door (86). Typically, the nozzles (94) are connected to the fluid chamber (92) by pipes (not illustrated in Figures). The valve (96) is disposed in between the fluid chamber (92) and the nozzles (94). The operation of the valve (96) is controlled by the controller (10) based upon the input received from the channel sensor (82). The valve (96) permits and restricts the flow of the fluid in the channel (82) for enabling controlled flow of fluid in the channel (82) through the nozzles (94) thereby enabling controlled movement of graded objects in the channel (82). Each channel (82) has a plurality of doors (86). The valve (96) is actuated till graded object reaches on a pre-determined door (86) and once the graded object(s) reaches the pre-determined door (86) the valve (96) is de-actuated. Each door (86), in an open configuration, permits the graded object(s) to move to the respected grade containers (80), disposed underneath, due to gravity, wherein each grade container (80) is assigned with a per-determined grade and configured to receive respective graded objects having defined grade parameter thereon, each door (86) cooperates with the controller (10) for opening and closing of the door (86) upon receipt of real-time inputs received from the channel sensors (82). Although, the present disclosure is described with the ejection unit (90) as mentioned above, the present disclosure is not limited to the ejection unit (90) as mentioned above and modifications can be made by the person skilled in the art to direct the objects to the grading containers (80). The channel (82) is a V-shaped channel or similar arrangement for supporting the free movement of the object under the influence of fluid which exerts an external force on the object for directing the object to move ahead for analysis and getting graded into the corresponding category decided by the cameras while the machine has no moving parts for conveying the object.

[0026] Thus, in an operative configuration, the grading comparator (120) analyzes and grades electronically each physical object and directs each objects of a particular parameter in a pre-determined grade container of the plurality of grade containers (80), thereby grading multiple objects in a single pass. Thus, each object is graded in multiple-grade in the grading machine (100) in a single pass without affecting their natural grade or deteriorating its grade or damaging the object(s). Further, the grading machine (100) does not have any moving components/elements and the object is driven by the fluid flow controlled by the controller (10) while the objective specifically is to have objects being graded into multiple categories based on the internal and external parameters decided by the optic unit (70).

[0027] However, the present disclosure grading machine is not limited to grading of pistachio only but similar objects having non sticky surfaces and low friction can be efficiently graded.

[0028] The present disclosure also discloses the method of grading objects, typically of small size by using the grading machine (100). FIG. 3 illustrates the flow chart of the method for determining the grade of the objects. Initially, the controller (10) is fed with object feed rate for the in-feed unit (30) and controlled grade parameters in a second storage module (130) of the controller. (10). The object moving channel (10) is actuated. The objects are introduced through the object introducing unit (20) of the grading machine (100). The object(s) are feed through the in-feed unit (30) at the controlled feed rate wherein the feed rate of objects is controlled by the controller (10) fed in the controller based upon the inputs received from feed sensors. In the in-feed unit the objects are directed to move in at least one queue. In one embodiment, the steps followed in the in-feed unit are receiving objects on the slider of the in-feed unit (30) which is co-operating with the object

introducing unit (20) and receiving at the controlled feed rate the objects from the slider and which further moves to a pair of set of reverse rotating rollers for sequencing objects in queue. The objects received, in the queue, from the in-feed unit (30) are then singulated.

The singulator (40) singulating objects received from the in-feed unit (30). Typically, the pick and place mechanism is used for singulating. The pick and place mechanism is actuated for picking single object and placing the at least one picked object on at least one examination beds (60) such that one examination bed (60) or one compartment of the examination bed has one object. In one embodiment the pick and place mechanism includes rotating a rotating drum (not illustrated in Figures) with a plurality of holes configured thereon, and proximal to the object(s) in the queue(s) such that each hole picks one object and rotating further the rotating drum such that the rotation causes the picked object(s) to fall therefrom and get placed in the examination bed (60). In another embodiment, the rotating of the rotating drum is configured with a suction pad, in which the suction is actuated proximal to the object(s) in the queue(s) such that each object is picked and further the rotating drum is rotated followed by de-actuating suction such that the picked object(s) fall from the suction pad and get placed in the examination bed (60) which are further moved to the optic unit (70).

[0029] In the optic unit (70), the cameras (72) capture real-time images from different angles of each object in presence of the light sources (74). The image processing unit (76)processes the image into at least one parameter. The parameter(s) are stored in the first storage module (78). Each parameter, stored in the first storage module (78) is compared by the grading comparator (120) with a pre-determined parameter stored in the second storage module (130), wherein the second storage module (130) and the grading comparator (120) are

configured in the controller (10). The grade of the object(s) is determined by the controller (10). The controller (10) then determines the location of the grade containers (80) in which the object needs to be ejected based on the grade of the object. Once the location of the grade container (80) is determined the location of the respective door (86) is determined. The valve (96) is then operated to permit flow of fluid, typically air, through the channel (82) which in turn moves the object to the determined door (86), at a controlled speed. The movement of the object is tracked by the channel sensors (82) which are provided to the controller (10). The controller (10) accordingly operates the valve (96) to either increase the flow of fluid so that the speed of the object is increased or decrease the flow of fluid so that the speed of the object is decreased or maintained the flow of fluid to maintain the speed the object or stops the flow of fluid to stop movement of the object. The above process is followed till the object reaches on determined door (86). Once the object reaches the determined door (86), the controller (10) opens the door (86) so that the object falls in the determined grade container (80). The controller (10) then directs for closing the opened door (86). Thus, each object is graded in multiple-grade in the grading machine (100) in a single pass without affecting their natural grade or deteriorating its grade or damaging the object(s).

[0030] In accordance with another embodiment of the disclosure, the multi-vision grading machine (100) includes at least one controller (10) (typically a master controller) configured with a grading comparator (120), an object introducing unit (20), an in-feed unit (30), a singulator (40), at least one object moving channel (50), a plurality of optical examination beds (60), an optic unit (70), a plurality of grade container (80) and an ejection unit (90). The optic unit includes one of an ultra-violet unit, an infra-red unit, an x-ray unit or a laser

ray unit that releases appropriate rays for examining at least one internal or external characteristics and a processing unit that processes the appropriate rays for determining grade of the object under examination and not limiting the scope of examination to the use of the cameras (72) and the image processing unit (76) as described in this disclosure. Any examination unit or processes that can determine at least one internal or external characteristics of the object under examination shall be considered within the scope of the present disclosure.

We Claim:

1) A grading machine (100) for grading objects, said machine comprising:

- at least one controller (10);
- an object introducing unit (20) configured to receive objects;
- an in-feed unit (30) connected with said object introducing unit (20) and configured to receive objects at a controlled feed rate, wherein the feed rate is determined by said controller (10) based on the input received from feed sensors (29) provided in said in-feed unit (30), said in-feed unit further configured to direct objects in at least one queue;
- a singulator (40) cooperating with said in-feed unit (30) and configured to singulate object(s) received from the queue;
- a plurality of examination beds (60), wherein each examination bed (60) is configured to receive one singulated object from the singulator;
- an optic unit (70) comprises:
    - a plurality of cameras (72) disposed proximal to examination bed(s) (60) to capture one/multiple real time images of each object in three dimensional space, for further determining at least one internal and/or external parameters of each object under examination;
    - an image processing unit (76) for processing said captured three dimensional image of each object into at least one parameter; and
    - a first storage module (78) configured to store each parameter;
- a grading comparator (120), configured in said controller (10) to compare said each parameter stored in said first storage module (78) with a pre-

determined parameter stored in a second storage module (130) of said controller (10) and provide a graded data for each object under examination;

- an ejection unit (90) comprises:
  - at least one channel (82) configured to receive graded objects from said optic unit (70);
  - a plurality of channel sensors (84) disposed along the length of at least one wall of said channel (82) for sensing the movement of graded objects along the channel (82), said channel sensors (84) are cooperating with said controller (10);
  - an object directing unit, said unit includes:
    - a fluid chamber (98) filled with fluid;
    - a plurality of nozzles (94) fitted along the length of at least one side of said channel (82) and configured to receive fluid from said fluid chamber (98) for moving graded objects along the channel (82); and
    - a valve (96) disposed in between said fluid chamber (98) and said nozzles (94) and configured to permit and restrict flow of fluid therethrough as directed by said controller (10) upon the signal received from said channel sensors (84) for enabling controlled flow of fluid in the channel (82) through the nozzles (94) thereby enabling controlled movement of objects in the channel (82); and

- a plurality of doors (86) configured on said channel (82), wherein each door (86) is assigned with a pre-determined grade and configured to receive respective graded objects having defined grade parameter thereon, each door (86) cooperating with said controller (10) for opening and closing of said door (86) upon receipt of inputs received from said channel sensors (84); and

- a plurality of grade containers (80), wherein each grade container is disposed underneath of respective grade door (86) and configured to receive objects of a particular grade from said respective door (86) in open configuration, thereby grading objects into multiple grades in a single pass.

2) The grading machine (100) as claimed in claim 1, wherein said controller (10), said object introducing unit (20), said in-feed unit (30), said singulator (40), said examination beds (60) and said optic unit (70) are disposed on a frame (110).

3) The grading machine (100) as claimed in claim 1, wherein said in-feed unit comprises:

- a slider configured to receive objects from said object receiving unit (20); and
- a feeding unit cooperating with said slider for receiving object at said pre-determined feed rate, wherein said feeding unit comprises at least one pair of set of reverse rotating rollers, said reverse rotating rollers configured to direct objects in said queue for controlled feeding of the objects in a synchronized manner.

4) The grading machine (100) as claimed in claim 1, wherein said singulator (40) comprises a pick and place mechanism comprises one of a rotating drum,

configured with a plurality of holes or a suction pad, wherein during rotation said rotating drum singularly picks object(s) and places on an examination bed such that one examination bed has one object.

5) The grading machine (100) as claimed in claim 1, wherein said external parameter are at least one of size, shape, color, surface properties and object profile and internal parameter are at least one of moisture content, biochemical changes and microbial infections.

6) The grading machine (100) as claimed in claim 1, wherein said feed sensors (29) are controlled by a feed controller cooperating with said controller (10).

7) The grading machine (100) as claimed in claim 1, wherein said nozzles (94) and said fluid chamber (98) are connected through pipes.

8) The grading machine (100) as claimed in claim 1, wherein said channel (82) is a V-shaped channel or similar arrangement that aides the free movement of the object under the influence of fluid that exerts an external force on the object thus directing the object to move ahead for analysis and getting graded into the corresponding category decided by said cameras while the machine has no moving parts for conveying the object.

9) A method for grading objects by using a grading machine (100), said method comprising:

- feeding a controller (10) with object feeding rate and grade parameters in a second storage module (130) of said controller (10);
- introducing objects through object introducing unit (20);

- feeding objects, received from said object introducing unit (20), through an in-feed unit (30), at a controlled feed rate controlled by said controller (10), said feeding enables objects to move in at least one queue;
- singulating objects received from said in-feed unit (30) in a singulator (40);
- disposing at least one singulated object respectively on at least one examination bed (60);
- capturing real-time one/multiple multi-angled images of each object in three dimensional space from different views by a plurality of cameras (72) and light sources (74) of an optic unit (70);
- processing said image in a image processing unit (76) of an optic unit (70), wherein said image is processed into at least one parameter;
- storing each parameter in a first storage module (78) of said optic unit (70);
- comparing said each parameter stored in said first storage module (78) with a pre-determined parameter stored in a second storage module (130) by using a grading comparator (120), wherein said second storage module (130) and said grading comparator (120) are configured in said controller (10); and
- determining grade of object(s) by said controller (10);
- locating position of grade container(s) (80) based on said determined grade of object(s) by said controller (10);
- receiving graded object(s) on channel(s) from examination bed(s) (60);

- sensing position of object(s) on said channel(s) (82) such that said sensed position is forwarded to said controller (10);
- actuating a valve (96) of an object directing unit such that fluid from a fluid chamber (98) is directed to nozzle(s) (94) and thereby the channel(s) (82) for directing graded objects(s) of a particular parameter/grade to respective door (86) of pre-determined grade, wherein actuation of said valve (96) is controlled by said controller (10) upon the inputs received from channel sensors (84);
- opening of door(s) (86) such that graded object(s) received on the door(s) (86) falls in respected grade container (80), thereby grading object(s) into multiple grades in a single pass.

10) The method as claimed in claim 9, wherein the step of feeding objects through in-feed unit (30) includes:

- receiving objects on a slider of the in-feed unit which is cooperating with the object introducing unit; and
- receiving at said pre-determined feed rate said objects from said slider and directing to set of vibrators for sequencing objects in queue.

11) The method as claimed in claim 10, wherein the step of singulating comprises picking and placing at least one object by:

- rotating a rotating drum, with a plurality of holes configured thereon, proximal to the object(s) such that each hole picks object(s); and

- rotating further said rotating drum such that the rotation causes the picked object(s) to fall therefrom and get placed on said examination bed.

12) The method as claimed in claim 9, wherein the step of singulating comprises picking and placing at least one object by:

- rotating a rotating drum configured with a suction pad;
- actuating suction, proximal to the object(s), of suction pad such that one object(s) is picked;
- rotating further said rotating drum; and
- de-actuating suction such that the picked object(s) fall from the suction pad and get placed in said examination bed.

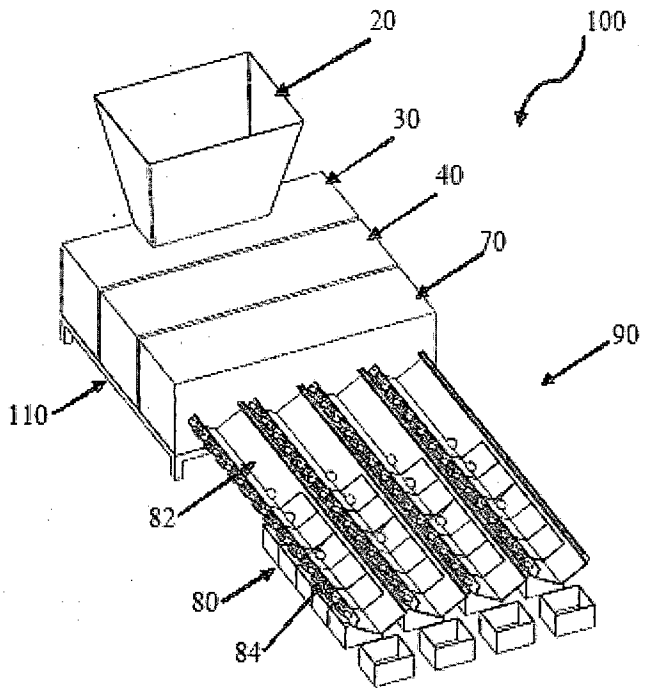

FIG. 1

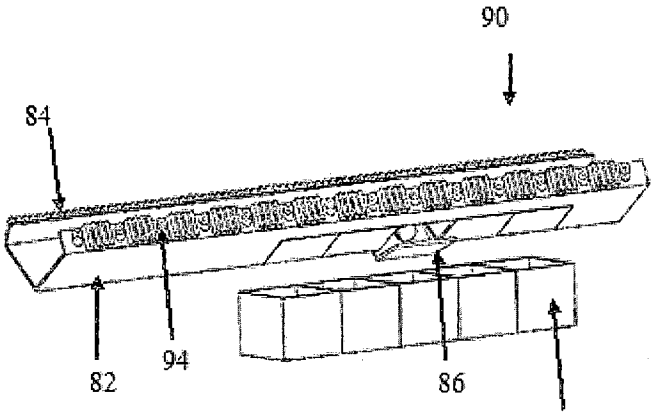

FIG. 2a

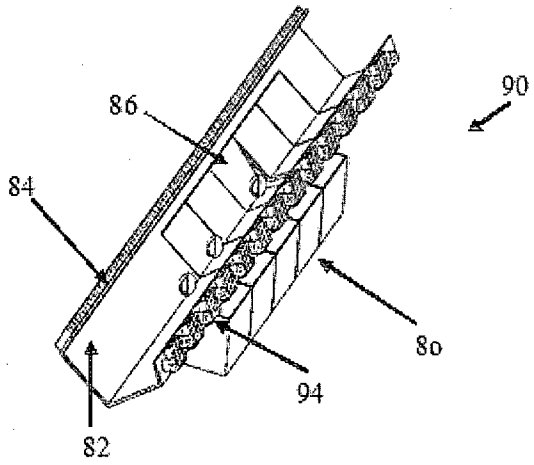

FIG. 2b

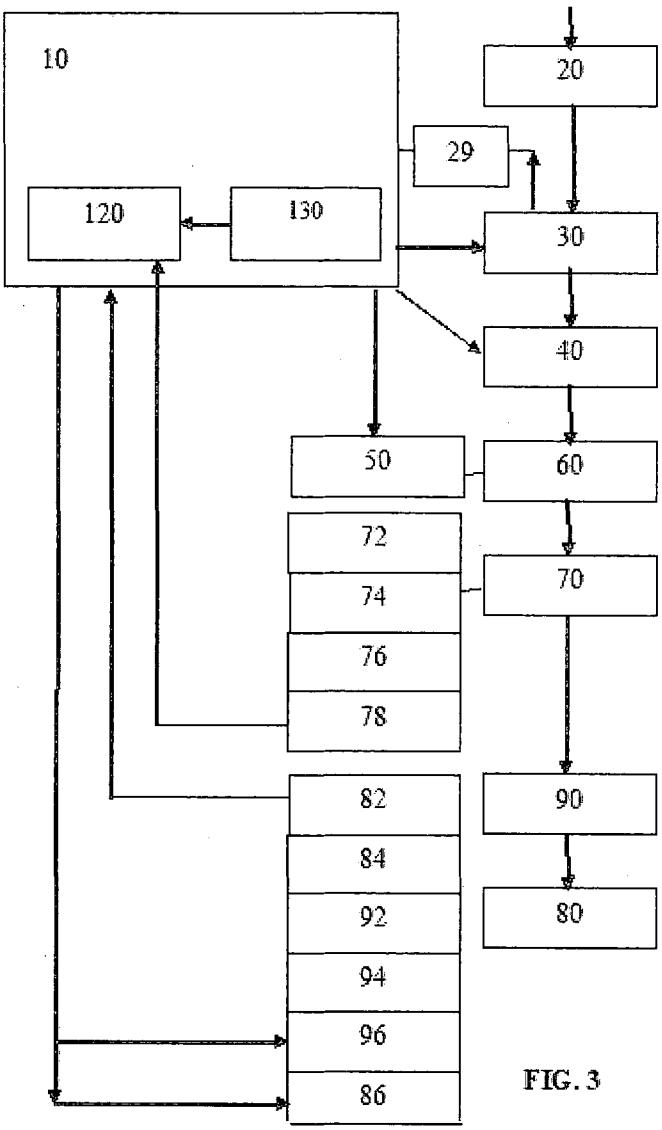

FIG. 3