

METHOD FOR INSPECTING CONDITIONS OF PACKAGED PRODUCTS WITHIN A CARTON BOX AND SYSTEM THEREOF

FIELD OF INVENTION

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The invention relates to a packaging inspection. More particularly, the invention relates to a method and system for inspecting conditions of packaged products within a carton box.

10 BACKGROUND OF THE INVENTION

As technology advances, the role of automation has become increasingly important in the global market and our daily lives. This can be especially seen in the packaging industries where engineers strive to combine automated devices with intelligent
15 software and dedicated algorithms to create a partially or fully automated packaging system. Quality control is one of the essential processes in the packaging industries and it is most often to be blamed when a product is damaged or delayed during transit. The main objective of the quality control is to ensure the products are packaged properly prior to the delivery process and it usually involves the act of inspecting
20 conditions of the packaged products within the carton box and the carton box itself.

Conventionally, the inspection process is carried out manually by labours or automatically through image processing techniques. However, the conventional inspection process always fails due to the following reasons: (a) human errors are
25 unpreventable in any manual processes and such errors can be accumulated into a destructive error which may affect the entire production line and reputation of a company; (b) image processing techniques for the inspection of conventional packaging system usually incorporates machine learning algorithms for the detection of defects in the packages. Such techniques can only be enabled by providing large

amount of data samples resulting higher implementation cost and more time consuming as compared to manual labours. This creates a barrier that averts the transformation of manual labours into automated operations. For example, if there are 500 brands to inspect, the inspection system would require 500 recipes/programs for end users to choose specifically before the inspection. When the system encounters a new brand, the user would be required to create a new recipe for this new brand which is time and resource consuming.

Patent document US8115928B2 discloses an inspection system which employs an alternative method for inspecting the packages. The inspection system involves multiple sensors for the detection of unacceptable skew in, an item missing from and an unacceptable gap in a box. These sensors include a pairs of aligned emitters and receivers to generate a signal when an unacceptable skew is detected, at least two item present sensors corresponding to the number of items adapted to be located in a single row within the box and generating an item absent signal when an item is missing from the box, a gap detect sensor generating an unacceptable gap signal when the gap is larger than a predetermined gap size, and a box present sensor generating a box present signal when a box arrives at the inspection station. Nevertheless, the installation and maintenance of multiple sensors would be a more expensive option. Consequently, this system is less suitable to be used as compared to conventional inspection system.

Accordingly, there is a need to design a new packaging inspection system which is capable of automating the inspection process in a cost efficient manner so that the barriers of implementation can be greatly reduced. This invention provides such a method and system thereof.

SUMMARY OF INVENTION

In a first aspect of the invention, there is provided a computer-implemented method for inspecting conditions of packaged products within a carton box, the method
5 comprises the steps of: moving, by a conveying system, the carton box to an inspection station; capturing, by an image capturing device, at least one image containing the carton box from an angle where the packaged products are exposed; removing, by an image processing unit, background and the carton box from the captured image such that only the contents of the exposed package products are
10 remained; segregating, by the image processing unit, the exposed packaged products into predefined amount of image segments; and comparing, by the image processing unit, the image segments to identify for dissimilarity among the image segments based on a predetermined threshold value, whereby an occurrence of a dissimilar image segment represents a defect.

15 According to a feature of the first aspect of the invention, the method may further comprise the step of moving, by the conveying system, the carton box through the inspection station to a sealing station in the event of no defect is detected.

20 According to another feature of the first aspect of the invention, the method may further comprise the step of ejecting, by a rejection station, the carton box out from the conveying system.

According to another feature of the first aspect of the invention, the method may
25 further comprise the step of sounding a sounding alarm system upon the detection of defect.

According to another feature of the first aspect of the invention, the method may further comprising the steps of detecting, by a sensor, the carton box's position; and

triggering, by the sensor, the image capturing device to capture the at least one image when the carton box reaches the inspection station.

According to another feature of the first aspect of the invention, the background can
5 be removed from the captured image using a background segregation algorithm, the algorithm comprises the steps of: capturing, by the image capturing device, a background image of the inspection station without the carton box; and comparing, by the image processing unit, the captured image with the background image to remove the background.

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According to another feature of the first aspect of the invention, the carton box can be removed from the captured image using a hough line transform technique, the technique may comprise the steps of: determining intersection points on an outer periphery of the captured image; eliminating the outer periphery intersection points;
15 repeating the above steps until a new outer periphery has four equal sides; linking the intersection points to form a region of interest; and removing the rest of the portions within the captured image such that only the region of interest is remained, whereby the region of interest represents the exposed packaged products.

20 According to another feature of the first aspect of the invention, the method may further comprise the steps of: applying a batch brand inspection algorithm on the image segments to identify whether the packaged products are of the same brand; applying an orientation algorithm on the image segments to identify the packaged products are of the same orientation; applying a missing inner algorithm on the image
25 segments to determine there is any missing packaged product; applying a foreign object algorithm on the image segments to detect for any non-packaged products; applying a sizing inspection algorithm on the image segments to determine if the packaged products are of the same size.

According to another feature of the first aspect of the invention, the method may further comprise the step of providing polarized lighting towards the exposed packaged products to reduce light reflection during the image capturing.

- 5 According to another feature of the first aspect of the invention, the method may further comprise the step of obtaining, by a weight measuring device, weight information of the carton box.

In a second aspect of the invention, there is provided a system for inspecting
10 conditions of packaged products within a carton box, the system comprises: a conveying system for moving the carton box to an inspection station; an image capturing device for capturing at least one image containing the carton box from an angle where the packaged products are exposed; and an image processing unit configured to capture background and the carton box from the captured image such
15 that only the contents of the exposed package products are remained, segregate the exposed packaged products into predefined amount of image segments and compare the image segments to identify for dissimilarity among the image segments based on a predetermined threshold value, whereby an occurrence of a dissimilar image segment represents a defect.

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According to a feature of the second aspect of the invention, the conveying system may move the carton box through the inspection station to a sealing station for sealing the carton box in the event of no defect is detected.

- 25 According to another feature of the second aspect of the invention, the inspection station can be coupled with a rejection station, configured to eject the carton box out from the conveying system by a rejection cylinder pusher. Preferably, the rejection station may further comprise a sounding alarm system for alerting user on the detection of defect.

According to another feature of the second aspect of the invention, the inspection station may further comprise a sensor configured to detect the carton box's position and trigger the image capturing device to capture at least one image when the carton
5 box reaches the inspection station.

According to another feature of the second aspect of the invention, the inspection station may further comprise at least one lighting unit coupled to a polarizer to provide sufficient lighting for the image capturing and to reduce light reflection from
10 the packaged products.

According to another feature of the second aspect of the invention, the inspection station may further comprise a weight measuring device for measuring the weight of the carton box.
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According to another feature of the second aspect of the invention, the inspection station may further comprise a display unit coupled with an input module to provide a graphical user interface and to receive inputs from a user.

20 According to another feature of the second aspect of the invention, the system may further comprise a control unit for managing and operating the different components of the system.

According to another feature of the second aspect of the invention, the system may
25 further comprise a power supply unit for supplying electricity to the components of the system.

One skilled in the art will readily appreciate that the invention is well adapted to carry out the objects and obtain the ends and advantages mentioned, as well as those

inherent therein. The embodiments described herein are not intended as limitations on the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

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For the purpose of facilitating an understanding of the invention, there is illustrated in the accompanying drawing the preferred embodiments from an inspection of which when considered in connection with the following description, the invention, its construction and operation and many of its advantages would be readily understood and appreciated.

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Fig. 1 is a schematic diagram illustrating a system for inspecting conditions of packaged products within a carton box which embodies therein the principle features of the invention.

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Fig. 2 is a schematic diagram illustrating an architecture of the system.

Fig. 3 is a perspective view of an inspection station of the system.

20 **Fig. 4** is a side view of the inspection station.

Fig. 5 is a block diagram illustrating a method for inspecting the conditions of the packaged products within the carton box.

25 DETAILED DESCRIPTION OF THE INVENTION

The invention will now be described in greater detail, by way of example, with reference to the drawings.

It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, that execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

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These computer program instructions may also be stored in a computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including instruction means that implement the function/act specified in the flowchart and/or block diagram block or blocks.

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The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions that execute on the computer or other programmable apparatus provide steps for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

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Referring to **Figs. 1 & 2**, a system for inspecting conditions of packaged products within a carton box is illustrated. The carton box **20** can be partially or fully filled with an array or multiple arrays of packaged products depending on the packaging requirements. In order to expose the packaged products, flaps of the carton box **20** can be in an opened condition. However, it is not a necessity for the carton box **20** to be in

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the opened condition, the carton box can also be in a closed condition if it has partial or fully transparent walls. The system generally comprises an inspection station **10**, a conveying system **30**, an image processing unit **70**, a sealing station **40** and a rejection station **80**. In operation, the carton box **20** is carried by the conveying system **30** to
 5 pass through the inspection station **10** for the detection of defect, and then enters into the sealing station **40** for sealing the carton box **20** if no defect is detected.

The inspection station **10** may comprise an image capturing device **12** for capturing at least one image containing the carton box **20** from an angle where the packaged
 10 products are exposed, a plurality of lighting units **13** to provide sufficient lighting for the image capturing, at least one polarizer coupled to the lighting units **13** to prevent light reflection from the packaged products, a weight measuring device **14** for measuring the weight of the carton box **20**, a display unit **53** for providing a graphical user interface as well as easy troubleshooting if there is any problem, an input module
 15 for receiving setting input or parameters from a user, a control unit **52** for managing and operating the different components of the system, and a power supply unit **51** for supplying electricity to the components of the system. The image capturing device **12** can be further coupled with a sensor **82** for detecting the position of the carton box **20** and further triggers the image capturing device **12** to capture the image when the
 20 carton box **20** reaches the inspection station **10**.

In addition, an electrical panel box **50** can be provided for containing the control unit **52** and the power supply unit **51**. The display unit **53** together with the input module can be in the form of a touch screen monitor and mounted on an external surface the
 25 electrical panel box **50**. Preferably, the display unit **53** is disposed at eye level to provide easy access for the user. The power supply unit **51** may be coupled with a safety kill switch for providing an emergency stop to the entire operations of the system.

In one specific embodiment of the invention, the inspection station **10** may comprise a portable rectangular stand **11** which the components of the inspection station **10** can be mounted thereon. As shown in **Figs. 3 & 4**, an upper section of the portable rectangular stand **11** includes a bracket **16** for receiving the image capturing device **12** and a calibration set **15** for adjusting the position and angle of the bracket **16**. The image capturing device **12** can be an industrial camera which is capable of operating in an extreme environment for an extensive duration of time, being adaptive to the implementation of new software and the integration into existing packaging system. The lighting units **13** can be in the form of light bars coupled with polarizer film, and being installed beneath the image capturing device **12**.

The conveying system **30** can be extended into a lower section of the portable rectangular stand **11** to deliver the carton box **20** onto the weight measuring device **14** for obtaining the weight measurement of the carton box **20**.

The image processing unit **70** can be one or more heavy duty computers which are connected to the control unit **52** via a communication network **60** for receiving and processing the captured images from the image capturing device **12** to determine if there is any defect. The image processing unit **70** can be further provided with any known devices or group of devices to provide sufficient capacity for data storage and pre-installed with a plurality of software modules to carry out different algorithms for the image processing and defect detection. The communication network **60** can be a wireless network connection established via a wireless protocol cloud such as Long-Term Evolution (LTE) cloud, Code Division Multiple Access (CDMA) and its derivatives, Enhanced Data Rates for GSM Evolution (EDGE), 3G protocol, High Speed Packet Access (HSPA), 4G protocol, 5G protocol and the like, in accordance to the advancement of wireless technology with time. The communication network **60** can also be a wired network in which the image processing unit **70** is connected to the control unit **52** through a local network port.

Upon the detection of defect, the image processing unit **70** will notify the control unit **52** to activate operations of the rejection station **80**. The rejection station **80** may comprise a rejection cylinder pusher **81** for ejecting the carton box **20** out from the conveying system **30** to prevent the carton box **20** from entering the sealing station **40**, a sounding alarm system **83** for alerting user on the detection of defect and a sensor **82** for detecting the presence of the carton box **20**.

Referring to **Fig. 5**, an image processing method for the detection of defect is illustrated. In step **100**, the user selects parameter for the inspection through the graphical user interface provided by the display unit **53** and the input module. The parameter may include the total number of packaged products within the carton box **20** and a threshold value for dissimilarity detection.

In step **110**, the background within the captured image is removed by applying a background segregation algorithm. Preferably, the background segregation algorithm comprises the steps of capturing a background image without the carton box **20** and comparing the captured image with the background image to remove the background. The background image capturing step only needs to be conducted once but it should be understood that this step can be repeated to maintain the accuracy of the defect detection.

In step **120**, the carton box **20** is removed from the captured image by applying a hough line transform technique. Preferably, the hough line transform technique comprises the steps of determining intersection points on an outer periphery of the captured image, eliminating the outer periphery intersection points, repeating the above steps until a new outer periphery has four equal sides, linking the intersection points to form a region of interest, and removing the rest of the portions within the captured image such that only the region of interest is remained, whereby the region

of interest represents the exposed packaged products. This algorithm enables the user to crop out the region of interest without the need of applying pre-training set and to point out the region of interest to the system.

- 5 In step **130**, the processed image which now only contains the packaged products will be segregated into a predefined amount of image segments using an inner segregation algorithm, whereby each image segment represents a packaged product. The benefits of this step is it will scale accordingly and thereby allowing accurate segmentation of the packaged products without the need of knowing the package size. Preferably, the
- 10 inner segregation algorithm comprises the step of determining combinations of factors which multiplication of the factors within each combination is equal to the predefined number of packaged products, defining each factor within each combination as a value for row and column respectively; segregating the processed image based on the different combinations of row and column to obtain different combinations of image
- 15 segments; applying inner inspection algorithms to obtain a plurality of values representing the similarity of the packaged products for the different combinations of image segments; and comparing the highest value to a predetermined threshold value to determining if there is any dissimilarity.
- 20 In step **140**, the image segments are compared among each other by the inner inspection algorithms to identify for dissimilarity among the image segments based on the predetermined threshold value. Preferably, the inner inspection algorithms include a sizing inspection algorithm **141**, a batch brand inspection algorithm **142**, a foreign object algorithm **143**, an orientation algorithm **144**, and a missing inner algorithm
- 25 **145**.

The main task for the sizing inspection algorithm **141** is to inspect whether the size of the packaged product within the packages are all the same. The size can be determined by the label on each packaged product. The algorithm may apply optical

character recognition to identify for the characters of the size such as “XS”, “S”, “M”, “L”, “XL” or any other characters which represent the size and the recognition model can also utilise a machine learning application to conduct data training.

- 5 The main task for the batch brand inspection algorithm **142** is to identify if there is any different brand in the carton box. The algorithm may apply adaptive threshold, edge detection, morphology and pattern matching by calculating white pixels to carry out the objective.
- 10 The main task for the foreign object algorithm **143** is to detect for any anomaly or non-packaged products related object in the carton box **20**. The algorithm may work hand in hand with the batch brand inspection algorithm **142** and the missing inner algorithm **145**, using the results from batch brand inspection algorithm **142** to compare it to the missing inner algorithm’s **145** image subtraction to identify the
- 15 foreign object.

- 20 The main task for the orientation algorithm **144** is to identify whether the packaged products within the carton box **20** are all arranged in a same orientation. The algorithm may further include the step of splitting each packaged product image into smaller image segments and then apply morphology and pattern matching method to compare the smaller image segments with each other of the different packaged product images.

- 25 The main task for the missing inner algorithm **145** is to detect for any gaps or empty slots within the carton box **20**. The algorithm may apply image subtraction to obtain a value which can be further compared with a threshold value for the detection of gaps or empty slots.

In step **150**, the results of the inner inspection algorithms will be compared with 5-

point logic to determine if there is any defect. If a defect is identified, the image processing unit **70** will notify the control unit **52** to activate operations of the rejection station **80** in step **170**. If no defect is identified, then the carton box **20** will be conveyed to the sealing station **40** via the conveying system **30** and the inspection
5 details will be recorded in step **160**.

The present disclosure includes as contained in the appended claims, as well as that of the foregoing description. Although this invention has been described in its preferred form with a degree of particularity, it is understood that the present disclosure of the
10 preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangements of parts may be resorted to without departing from the scope of the invention.

CLAIMS

1. A computer-implemented method for inspecting conditions of packaged products within a carton box (20), the method comprising the steps of:
 - 5 moving, by a conveying system (30), the carton box (20) to an inspection station (10); capturing, by an image capturing device (12), at least one image containing the carton box (20) from an angle where the packaged products are exposed; removing, by an image processing unit (70), background and the carton box (20) from the captured image such that only the contents of the exposed package products are
10 remained; segregating, by the image processing unit (70), the exposed packaged products into predefined amount of image segments; and comparing, by the image processing unit (70), the image segments to identify for dissimilarity among the image segments based on a predetermined threshold value,
15 whereby an occurrence of a dissimilar image segment represents a defect.
2. The method according to claim 1, further comprising the step of moving, by the conveying system (30), the carton box (20) through the inspection station (10) to a sealing station (40) in the event of no defect is detected.
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3. The method according to claim 2, further comprising the step of ejecting, by a rejection station (80), the carton box (20) out from the conveying system (30).
4. The method according to claim 3, further comprising the step of sounding an alarm
25 system (83) upon the detection of defect.
5. The method according to any one of claims 1 to 4, further comprising the steps of detecting, by a sensor (82), the carton box's (20) position; and triggering, by the sensor (82), the image capturing device (12) to capture the at least

one image when the carton box (20) reaches the inspection station (10).

6. The method according to any one of claims 1 to 5, wherein the background is removed from the captured image using a background segregation algorithm, the algorithm comprises the steps of:
- capturing, by the image capturing device (12), a background image of the inspection station (10) without the carton box (20); and
- comparing, by the image processing unit (70), the captured image with the background image to remove the background.

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7. The method according to any one of claims 1 to 6, wherein the carton box (20) is removed from the captured image using a hough line transform technique, the technique comprises the steps of:
- determining intersection points on an outer periphery of the captured image;
- eliminating the outer periphery intersection points;
- repeating the above steps until a new outer periphery has four equal sides;
- linking the intersection points to form a region of interest; and
- removing the rest of the portions within the captured image such that only the region of interest is remained, whereby the region of interest represents the exposed packaged products.

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8. The method according to any one of claims 1 to 7, further comprising the steps of:
- applying a batch brand inspection algorithm (142) on the image segments to identify whether the packaged products are of the same brand;
- applying an orientation algorithm (144) on the image segments to identify the packaged products are of the same orientation;
- applying a missing inner algorithm (145) on the image segments to determine there is any missing packaged product;
- applying a foreign object algorithm (143) on the image segments to detect any non-

packaged products related object;

applying a sizing inspection algorithm (141) on the image segments to determine if the packaged products are of the same size;

- 5 9. The method according to any one of claims 1 to 8, further comprising the step of providing polarized lighting towards the exposed packaged products to reduce light reflection during the image capturing.

- 10 10. The method according to any one of claims 1 to 9, further comprising the step of obtaining, by a weighting measuring device (14), weight information of the carton box.

11. A system for inspecting conditions of packaged products within a carton box (20), the system comprising:

- 15 a conveying system (30) for moving the carton box (20) to an inspection station (10);
an image capturing device (12) for capturing at least one image containing the carton box (20) from an angle where the packaged products are exposed; and
an image processing unit (70) configured to capture background and the carton box (20) from the captured image such that only the contents of the exposed package
20 products are remained, segregate the exposed packaged products into predefined amount of image segments, and compare the image segments to identify for dissimilarity among the image segments based on a predetermined threshold value, whereby an occurrence of a dissimilar image segment represents a defect.

- 25 12. The system according to claim 11, wherein the conveying system (30) moves the carton box (20) through the inspection station (10) to a sealing station (40) for sealing the carton box (20) in the event of no defect is detected.

13. The system according to claim 12, wherein the inspection station (10) is coupled

to a rejection station (80), configured to eject the carton box (20) out from the conveying system (30) by a rejection cylinder pusher (81).

14. The system according to claim 13, wherein the rejection station (80) further
5 comprises a sounding alarm system (83) for alerting user on the detection of defect.

15. The system according to any one of claims 11 to 14, wherein the inspection station
(10) is further coupled to a sensor (82) configured to detect the carton box's (20)
position and trigger the image capturing device (12) to capture the at least one image
10 when the carton box (20) reaches the inspection station (10).

16. The system according to any one of claims 11 to 15, wherein the inspection station
(10) further comprises at least one lighting unit (13) coupled to a polarizer to provide
sufficient lighting for the image capturing and to reduce light reflection from the
15 packaged products.

17. The system according to any one of claims 11 to 16, wherein the inspection station
(10) further comprises a weight measuring device (14) for measuring the weight of
the carton box (20).
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18. The system according to any one of claims 11 to 17, wherein the inspection station
(10) further comprises a display unit (53) coupled with an input module to provide a
graphical user interface and to receive inputs from a user.

25 19. The system according to any one of claims 11 to 18, further comprising a control
unit (52) for managing and operating the different components of the system.

20. The system according to any one of claims 11 to 19, further comprising a power

supply unit (51) for supplying electricity to the components of the system.