Apparatus and methods for minimizing waste during web splicing

An apparatus and methods are disclosed to reliably utilise material as close as possible to the end of the primary supply wheel (14) so to minimize the roll waste. An indicator material (16), such as tape, is positioned on the primary and standby supply wheels at a distance from the end of the roll so that a reader, such as a machine vision system (12), can detect the presence or absence of the indicator material (16) on the rolls. If the indicator material (16) is present, the machine vision system (12) will initiate a minimal waste splice logic. If the indicator material (16) is absent, the machine vision system (12) will initiate a standard splice logic.

Figure 1
Description

Related Application

[0001] This application claims the benefit of United States Provisional application serial No. 60/880,143 filed 12 January 2007.

Background of the Invention

[0002] The invention disclosed herein relates to an apparatus and method for decreasing the amount of roll waste present in many web based operations, such as diaper manufacturing or printing.

[0003] Roll waste occurs when the material on an expiring roll, such as a paper roll (the expiring roll) into the system, leaving raw material remaining on the core of the expiring roll. In present methods using standard web splicing techniques, material in a radius of as much as ¼" to ½" of raw material remains on the core of the expiring roll, and this material is generally wasted. During the course of time, the roll waste can become quite considerable in terms of both cost and waste of natural resources.

[0004] During web processing operations, a web is fed from a primary supply wheel (the expiring roll) into the manufacturing process. As the material from the expiring roll is paid out, it is necessary to splice the leading edge of a web from a standby roll to the trailing edge of the material on the expiring roll in a manner that will not cause interruption of the web supply to a web consuming or utilizing device.

[0005] In modern splicing systems, a web accumulation dancer system may be employed, in which an accumulator accumulates a substantial length of a running web. By using an accumulator, the material being fed into the process can continue, yet the trailing end of the material can be stopped or slowed for a short interval so that it can be spliced to leading edge of the new supply roll. The leading portion of the expiring roll remains being paid out continuously to the web-utilizing device. The accumulator continues to feed the web utilization process while the expiring roll is stopped so the new material roll can be spliced to the end of the expiring roll.

[0006] In this manner, the device has a constant web supply being paid out from the accumulator, while the stopped web material in the accumulator can be spliced to the standby roll. Examples of web accumulators include that disclosed in U.S. Patent Application Serial No. 11/110, 616, which is commonly owned by the assignee of the present application, and incorporated herein by reference.

[0007] A zero speed splice unit is an air-operated clamping and cutting mechanism. The purpose of the splice unit is first to join an expiring material roll with the leading edge of a standby roll, then to cut the expiring roll from the process. The splice unit uses two clamp bars, one on each side. The clamp bar nearest to the expiring web advances to make the splice. A knife located in the center of the unit captures the expiring web on the drive side and cuts the web as it advances to the operator side. The clamp releases, and the knife returns.

[0008] An electrical sensor monitors the RPM of the active web spindle. A diameter is calculated for the expiring roll using the backing motor speed and the RPM of the spindle. When the expiring roll diameter reaches a preset size, the machine control system initiates an automatic splice. The spindle motor stops the expiring roll and the accumulation is paid out.

[0009] The splice unit joins the expiring web with the standby web while the two webs are at rest. The machine continues to run during the splice because of web material stored in the accumulator. The splice knife then cuts the expiring material web before accelerating new material from the standby roll. The spindle motor accelerates the new material roll to the proper speed before the web is used up in the accumulator.


[0011] A typical machine vision system will consist of several among the following components:

- One or more digital or analog camera (black-and-white or colour) with suitable optics for acquiring images
- Lighting
- Camera interface for digitizing images (widely known as a "frame grabber")
- A processor (often a PC or embedded processor, such as a DSP)
- Computer software to process images and detect relevant features.
- A synchronizing sensor for part detection (often an optical or magnetic sensor) to trigger image acquisition and processing.
- Input/Output hardware (e.g. digital I/O) or communication links (e.g. network connection or RS-232) to report results
- Some form of actuators used to sort or reject defective parts.

[0012] The sync sensor determines when a part (often moving on a conveyor) is in position to be inspected. The sensor triggers the camera to take a picture of the part as it passes by the camera and often synchronizes a lighting pulse. The lighting used to illuminate the part is designed to highlight features of interest and obscure or minimize the appearance of features that are not of interest (such as shadows or reflections).

[0013] The camera's image can be captured by the framegrabber. A framegrabber is a digitizing device (within a smart camera or as a separate computer card) that converts the output of the camera to digital format (typi-
cally a two dimensional array of numbers, corresponding to the luminous intensity level of the corresponding point in the field of view, called pixel) and places the image in computer memory so that it may be processed by the machine vision software.

[0014] The software will typically take several steps to process an image. In this case, the image processing will result in either detection of the indicator material, or non-detection of the indicator material.

[0015] Commercial and open source machine vision software packages typically include a number of different image processing techniques such as the following:

- Pixel counting: counts the number of light or dark pixels
- Thresholding: converts an image with gray tones to simply black and white
- Segmentation: used to locate and/or count parts
- Blob discovery & manipulation: inspecting an image for discrete blobs of connected pixels (e.g. a black hole in a grey object) as image landmarks. These blobs frequently represent optical targets for machining, robotic capture, or manufacturing failure.
- Recognition-by-components: extracting geons from visual input
- Robust pattern recognition: location of an object that may be rotated, partially hidden by another object, or varying in size
- Barcode reading: decoding of 1D and 2D codes designed to be read or scanned by machines
- Optical character recognition: automated reading of text such as serial numbers
- Gauging: measurement of object dimensions in inches or millimeters
- Edge detection: finding object edges
- Template matching: Finding, matching, and/or counting specific patterns.

[0016] In most cases, a machine vision system will use a sequential combination of these processing techniques to perform a complete inspection. A system that reads a barcode may also check a surface for scratches or tampering and measure the length and width of a machined component.

Summary of the Invention

[0017] An apparatus and methods are disclosed to reliably utilize material as close as possible to the end of the primary supply wheel so to minimize the roll waste.

[0018] An indicator material, such as tape, is positioned on the primary and standby supply wheels at a distance from the end of the roll so that a reader, such as a machine vision system, can detect the presence or absence of the indicator material on the rolls. If the indicator material is present, the machine vision system will initiate a minimal waste splice logic. If the indicator material is absent, the machine vision system will initiate a standard splice logic.

Brief Description of the Drawings

[0019]

Fig. 1 is a perspective and schematic view of an apparatus for detecting an indicator material present on a supply roll;

Fig. 2 is a logic flowchart for an apparatus for detecting an indicator material present on a supply roll;

Fig. 3 is a side view of apparatus for detecting an indicator material present on a supply roll including a splicer.

Description of the Preferred Embodiment

[0020] Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structures. While the preferred embodiment has been described, the details may be changed without departing from the invention, which is defined by the claims.

[0021] Referring now to Fig. 1 is a perspective and schematic view of an apparatus for detecting an indicator material present on a supply roll is disclosed. In this system, vision system 12 is supplied to detect the presence or absence of indicator material 16. As shown, it is preferred that indicator material 16 be positioned extending externally of the material roll 14, which is rotatably held in the system by spindle 18. The web 20 is paid out to a splicer as shown. In an alternate embodiment, the indicator material need not extend externally of the material roll 14, but instead could be either applied to the side or interior of the roll 14, either radially or longitudinally. The positioning of the indicator material 16, although preferred to extend externally from the roll 14, is based on a preference of the material supplier of the roll 14, and detection of the indicator material 16 is adjusted by adjusting the field of vision of the vision system 12.

[0022] One preferred indicator material 16 is simply tape that extends out from the roll 14. However, any identifiable feature that either the material supplier or the user adds at a predetermined distance from the end of the roll suffices.

[0023] In an alternate embodiment, the indicator material 16 could be coded with information to tell the vision system 12 the exact distance to the end of the roll, if the indicator material 16 is not set at a predetermined distance.

[0024] The vision system 12 is coupled to a programmable logic controller, which controls the splicer through the logic provided in Fig. 2; either standard or minimal waste splice logic.

[0025] Referring now to Fig. 2, a logic flowchart for an apparatus for detecting an indicator material present on
a supply roll is shown. In this logic, if the vision system 12 detects the indicator material 16, minimal waste splice logic is employed. If the vision system 12 does not detect the indicator material 16, standard splice logic is employed.

[0026] In the standard splice logic, a user measures the diameter of the new supply roll and enters the diameter into the splice controller. An electrical sensor monitors the RPM of the web spindle carrying the new supply roll as the roll is paid out. A diameter is calculated for the expiring material roll using the machine web speed and the RPM of the web. When the roll reaches a preset size, the machine control system initiates an automatic splice. The spindle motor stops the active roll. The splice unit joins the expiring web with the new web while the two webs are at rest. The machine continues to run during the splice because of web material stored in the accumulator. The splice knife then cuts the old material web before accelerating new material. The spindle motor accelerates the new material roll to the proper speed before the web is used up in the accumulator.

[0027] In the minimal waste splice logic, it is preferred that the indicator material 16 is set at a predetermined distance from the end of the roll, for instance 3 to 6 feet of material remaining. In this manner, early detection of the presence of the indicator material 16 will trigger the splice based on the known distance to the end of the roll. Then, by computing the time until the end of the roll is reached by using the RPM of the spindle, the machine control system can initiate the automatic splice routine based on time, and the time to initiate the splice can be calculated and activated to take place just prior to reaching the end of the roll.

[0028] One purpose of the indicator material is to allow the vision system 16 to recognize ahead of time what type of roll is in the expiring position, and also to calculate how much material remains on the roll 14, in order to calculate the time/distance left relationship, and to trigger the splice routine at just the right time to eliminate the possibility that the roll 14 will expire without being spliced to the new roll, which can lead to machine down time. In this manner, the splice triggered by the machine PLC will initiate at a time when the roll is almost, but not yet fully, expired. For instance, if the vision system recognizes that the roll contains indicator material 16, and the machine PLC is informed that the roll 14 will have exactly 3 feet left, and further is informed at what rate the material is being paid out, the machine PLC would then calculate the amount of time remaining until initiating a splice with nearly zero material remaining on the roll.

[0029] Referring now to Fig. 3, a side view of apparatus for detecting an indicator material present on a supply roll including a splice is shown.

[0030] As can be seen, two vision systems 12 may be employed such that each system is directed at an indicator material 16 on both the expiring roll 14a and the new supply roll 14b. It is noted that only one of the two visions systems 12 would be reading the expiring roll (14a as shown in Fig. 3), and thus communicating with the machine PLC and splicer, at any given time. The other vision system 12 would not activate until the new supply roll (14b as shown in the sequence in Fig. 3) became the expiring roll (14b as shown in the sequence in Fig. 3) only the vision system 12 watching the expiring roll need be involved in the splice logic selection process described with reference to Fig. 2.

[0031] Both the expiring roll 14a and the new supply roll 14b feed webs 20 into the splicer for splicing, which is controlled by the machine PLC coupled to the vision systems 12. The web 20 is paid out into the accumulator 22, which can be of any type used to facilitate constant supply of the web 20 to the process, while allowing zero speed splicing at the splice unit.

[0032] It is only necessary for the indicator material 16 to be present on the expiring material roll 14a in order to select the minimal waste splice logic, because the splice logic is initiated based on the marker-tape on the expiring roll. If the new roll that is spliced into the process is a standard roll, lacking indicator material 16, then the subsequent splice would be a standard splice based on the splice logic.

[0033] The foregoing is considered as illustrative only of the principles of the invention. Furthermore, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction, and operation shown and described. While the preferred embodiment has been described, the details may be changed without departing from the invention, which is defined by the claims.

Claims

1. A method for minimizing waste during web splicing, the method comprising:

- providing an indicator material on a primary supply roll, said indicator material placed at a distance from the end of said primary supply roll;
- providing a standby supply roll;
- providing an indicator material reader;
- detecting the presence or absence of the indicator material on said primary supply roll;
- initiating a minimal waste splice logic in the presence of said indicator material on said primary supply roll, said minimal waste splice logic thereby employed to splice said primary and standby supply rolls;
- initiating a standard waste splice logic in the absence of said indicator material on said primary supply roll, said standard waste splice logic thereby employed to splice said primary and standby supply rolls.

2. The method according to claim 1, said minimal waste splice logic comprising;
ascertaining distance of said primary supply roll remaining between said indicator material and the end of said primary supply roll; measuring the revolution speed of a spindle, carrying said primary supply roll as said primary roll is expiring; calculating time remaining until the expiration of said primary supply roll would be reached; initiating a splice sequence through a web accumulator at a time immediately prior to said calculated time remaining until the expiration of said primary supply roll would be reached, thereby joining said expiring primary supply roll and said standby supply roll.

3. The method according to claim 1, said standard waste splice logic comprising:

- measuring an initial diameter of said primary supply roll;
- communicating said diameter to a splice controller;
- measuring the revolution speed of a spindle carrying said primary supply roll as it expires;
- calculating a remaining diameter on said expiring primary supply roll using a predetermined machine web speed and the measured revolution speed of a spindle;
- initiating a splice sequence through a web accumulator when said expiring primary supply roll remaining diameter reaches a preset point, thereby joining said expiring primary supply roll and said standby supply roll.

4. The method according to claim 1, said standby roll carrying an indicator material.

5. The method according to claim 1, wherein the indicator material is placed at a known distance from the end of said primary supply roll.

6. A method for minimizing waste during web splicing, the method comprising:

- providing an indicator material on a primary supply roll, said indicator material placed at a distance from the end of said primary supply roll;
- providing a standby supply roll;
- providing an indicator material reader;
- detecting the presence or absence of the indicator material on said primary supply roll;
- initiating a minimal waste splice logic in the presence of said indicator material on said primary supply roll, said minimal waste splice logic comprising:

  ascertaining a distance of said primary supply roll remaining between said indicator material and the end of said primary supply roll;
  measuring the revolution speed of a spindle carrying said primary supply roll as said primary roll is expiring;
  calculating time remaining until the expiration of said primary supply roll would be reached;
  initiating a splice sequence through a web accumulator at a time immediately prior to said calculated time remaining until the expiration of said primary supply roll would be reached, thereby joining said expiring primary supply roll and said standby supply roll;

- initiating a standard waste splice logic in the absence of said indicator material on said primary supply roll, said standard waste splice logic comprising:

  - measuring an initial diameter of said primary supply roll;
  - communicating said diameter to a splice controller;
  - measuring the revolution speed of a spindle carrying said primary supply roll as it expires;
  - calculating a remaining diameter on said expiring primary supply roll using a predetermined machine web speed and the measured revolution speed of a spindle;
  - initiating a splice sequence through a web accumulator when said expiring primary supply roll remaining diameter reaches a preset point, thereby joining said expiring primary supply roll and said standby supply roll.
Figure 2

Vision System

Indicator Material Detected on Roll?

Yes

Employ Minimal Splice Logic

No

Employ Standard Splice Logic

Splice primary and standby supply rolls

To Process
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6088014 B [0001]
- US 110616 A [0006]