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AN APPARATUS AND METHOD FOR MAINTAINING CONSISTENT TENSION OF A ROLL OF MEDIA UNDERGOING UN-WINDING OR RE-WINDING

5 FIELD OF INVENTION

The present invention relates to an apparatus and a method for maintaining consistent tension of a roll of media undergoing un-winding or re-winding.

10 BACKGROUND

Currently, there are devices which enable the un-winding and re-winding of a roll of media. These device employ analog controls and utilise a potentiometer to determine speed of roll rotation and direction of movement in some instances.

15 However, variation of resistance value of the potentiometer over time leads to inaccuracies for such devices when controlling the speed of roll rotation. This unfortunately causes damage to the roll of media.

Furthermore, some of these devices employ a switch to change the direction of roll movement or an additional control to adjust the speed/direction of roll movement in order function as either as an unwinder or rewinder for varying print speeds and loads. This is inconvenient for a user as these devices require manual intervention to function in their intended manner, the process is slower/jerky and fine-tuning of the movement is dependent on a resolution enabled by the provided controls.

In view of the aforementioned, it is evident that there are improvements which can be implemented to the devices which enable the un-winding and re-winding of a roll of media.

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SUMMARY



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In a first aspect, there is provided an apparatus for maintaining consistent tension of a roll of media undergoing un-winding or re-winding. The apparatus includes a drive mechanism configured for causing movement of the roll of media with a speed and a direction; an extender arm; an extender arm position monitoring system configured for determining a position of the extender arm; and a controller configured for receiving the position of the extender arm and for providing instructions to the drive mechanism. The position includes an angular deviation of the extender arm from a neutral axis. Furthermore, the position may be received at intervals of a pre-determined time, such as, for example, between 1ms to 5ms.

It is advantageous that the controller is configured to process the position and to provide the instructions to vary at least one of the speed and the direction of the roll of media to maintain consistent tension of the roll of media.

Preferably, the drive mechanism includes a spindle for mounting the roll of media; a transmission system coupled to the spindle for providing movement to the spindle; and a DC motor with an encoder, the DC motor being coupled to the transmission system to drive the transmission system.

The extender arm position monitoring system preferably also includes a potentiometer for providing a reference position of the extender arm; an encoder disc for providing position data for the extender arm; an encoder sensor to obtain the position data; and a gear couple between an extender arm pivot and the potentiometer, the gear couple being for coupling a potentiometer gear to the an extender arm gear. The extender arm position monitoring system may also include an extender arm home sensor.

It is also preferable that the instructions further include at least one of a power width modulation, pulse width modulation, and direction of movement for the DC motor, the instructions being derived from a closed loop PID control algorithm.

The extender arm may further include a sub-roller which is configured to advantageously clean a surface of the media.

In a second aspect, there is provided a method for maintaining consistent tension of a roll of media undergoing un-winding or re-winding in a holder of the roll with a motor-powered spindle and an extender arm. The method includes determining a position of the extender arm; varying at least one of a power width modulation, pulse width modulation, and direction of movement of the motor; and moving the extender arm to a neutral position. It is preferable that the movement of the extender arm is due to the variation of the at least one of the power width modulation, pulse width modulation and direction of movement of the motor, the movement of the extender arm being to maintain consistent tension of the roll of media.

The position of the extender arm is preferably provided by an extender arm position monitoring system, whereby the extender arm position monitoring system includes a potentiometer for providing a reference position of the extender arm an encoder disc for providing position data for the extender arm; an encoder sensor to obtain the position data; and a gear couple between an extender arm pivot and the potentiometer, the gear couple being for coupling a potentiometer gear to the an extender arm gear.

The variation of at least one of a power width modulation, pulse width modulation, and direction of movement of the motor is preferably determined by a controller, the controller carrying out a closed loop PID control algorithm.

The method may be carried out at intervals of a pre-determined time such as, for example, between 1ms to 5ms.

DESCRIPTION OF FIGURES

In order that the present invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative figures.

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Figure 1 is a perspective view of a preferred embodiment of the apparatus of the present invention.

Figure 2 is a perspective view of a preferred embodiment of the apparatus of Figure 1 showing a transmission system and an extender arm position
10 monitoring system.

Figure 3 is a frontal view of the transmission system and the extender arm position monitoring system.

Figure 4 is a close up perspective view of an extender arm position monitoring system portion of Figure 3.

15 Figure 5 is a close up perspective view of an extender arm position monitoring system portion of Figure 3 with some gears hidden from view.

Figure 6 shows a first usage scenario of the apparatus.

Figure 7 shows a second usage scenario of the apparatus.

Figure 8 shows a third usage scenario of the apparatus.

20 Figure 9 shows a process flow of a preferred embodiment of a method of the present invention.

Figure 10 shows a visual representation of a closed loop PID control algorithm used in the present invention.

25 **DESCRIPTION OF PREFERRED EMBODIMENTS**

Embodiments of the present invention, as described hereinafter, relate to an apparatus and a method for maintaining consistent tension of a media roll during un-winding and re-winding. Maintaining consistent tension of the media
30 roll aids in minimising disruption during use of the media roll as a printing surface of the media roll remains flat so that printing is able to be carried out on the media roll. Another advantage of the invention which will be evident from the

disclosure of the subsequent paragraphs include eliminating a need for manual intervention to maintain the tension of the media roll. In addition, the invention enables issues like wide dynamic loading, media diameter and media width to be resolved without manual intervention.

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Referring to Figures 1 and 2, there is shown a preferred embodiment of an apparatus 20 for maintaining consistent tension of a roll of media undergoing un-winding or re-winding. Figure 2 shows the apparatus 20 without a central covering plate 22 which cover some internal parts of the apparatus 20. Media guides 24 for a roll of media are shown mounted on a spindle 26 of the apparatus 20. The spindle 26 is for the mounting of the roll of media.

The apparatus 20 includes a drive mechanism 28 configured for causing movement of the roll of media when the roll of media is mounted on the spindle 26. The drive mechanism 28 includes the spindle 26, a transmission system 30 coupled to the spindle 26 for providing movement to the spindle 26, and a DC motor 32 with an encoder, the DC motor 32 being coupled to the transmission system 30 to drive the transmission system 30.

There is also an extender arm 34, the extender arm 34 being for guiding and maintaining tension of the roll of media. The extender arm 34 includes a sub-roller 36, and the sub-roller 36 may be configured to clean a surface of the media. Cleaning the surface of the media may ensure that particles which may adversely affect printing on the surface are removed. The sub-roller 36 may be covered by a dust capturing material such as, for example, felted fabric, interwoven fabric and the like.

The apparatus 20 also includes an extender arm position monitoring system 38 configured for obtaining data for a position of the extender arm 34, specifically, an angular deviation of the extender arm 34 from a neutral axis. The angular deviation of the extender arm 34 may be a pre-determined angle, for example,

+20⁰ and -20⁰. Thus, when the extender arm 34 moves beyond the pre-determined angles, it is out of range and the apparatus 20 will halt operations.

Referring to Figures 3, 4 and 5, the extender arm position monitoring system 38 includes a potentiometer 40 for providing a reference position of the extender arm 34. There is also an encoder disc 42 for providing position data for the extender arm 34, the encoder disc 42 being coupled to the extender arm 34. There is also an encoder sensor 44 to obtain the position data, and a gear couple 46 between an extender arm pivot 48 and the potentiometer 40, the gear couple 46 being for coupling a potentiometer gear 46(a) to the an extender arm gear 46(b). The use of the potentiometer 40 in the extender arm position monitoring system 38 also enables a provision of a position of the extender arm 34 on an instantaneous basis in view of the gear couple 46. In addition, the extender arm position monitoring system 38 may further include an extender arm home sensor 48.

There is also a controller 50 configured for receiving the position data of the extender arm 34 from the extender arm position monitoring system 38 and for providing instructions to the drive mechanism 28. The controller is configured to process the data and to provide the instructions in accordance with the processed data. The position data is received at intervals of a pre-determined time, such as, for example, from 1ms to 5ms. The instructions include at least one of a power width modulation, pulse width modulation, and a direction of rotation for the DC motor 32. It should be appreciated that the controller 50 carries out a closed loop PID control algorithm as depicted in Figure 10. In addition, the use of the closed loop PID control algorithm also enables issues like wide dynamic loading, media diameter and media width to be resolved.

Referring to Figures 6 to 8, there is shown three usage scenarios for the apparatus 20 which would provide a clear description for the operation of the apparatus 20. It should be appreciated that the numerical labels used in Figures 1 to 5 are also used in Figures 6 to 8 to maintain consistency in the description.

Referring to Figure 6, there is shown the media 100 moving forward from rest or undergoing an increase in forward moving speed. Correspondingly, the extender arm 34 undergoes an incremental rise in position (Figure 6(a)), and the controller 50 will provide instructions to rotate the spindle 26 forward or faster forward to adjust to the incremental rise of the extender arm 34. Subsequently, the extender arm 34 is maintained at the neutral position (Figure 6(b)).

Referring to Figure 7, there is shown the media 100 slowing down in forward moving speed. Correspondingly, the extender arm 34 undergoes an incremental lowering in position (Figure 7(a)), and the controller 50 will provide instructions to slow down the spindle 26 forward speed to adjust to the incremental lowering of the extender arm 34. Subsequently, the extender arm 34 is maintained at the neutral position (Figure 7(b)).

Referring to Figure 8, there is shown the media 100 moving in a reverse direction (in relation to a direction of media 100 movement in Figures 6 and 7) while the spindle 26 is still rotating in a forward direction. Correspondingly, the extender arm 34 undergoes an incremental lowering in position (Figure 8(e)), and the controller 50 will provide instructions to reverse direction of rotation for the spindle 26 at a speed to take up the slack in the media 100 due to the change in direction of the media 100 and to maintain the extender arm 34 at the neutral position (Figure 8(f)).

Based on the descriptions of Figures 6 to 8, it should be appreciated that user intervention is not required whenever there are variations in the movement speed or direction of the media 100 during use of the apparatus 20. This is clearly very convenient for users of the apparatus 20 as there is no necessity to activate a switch(es) to vary operation modes or adjust spindle speed. Furthermore, the apparatus 20 utilises digital control (use of the encoder) which eradicates issues pertaining to analog methods. The use of digital controls is

typically faster compared to analog methods which require conversion of analog signals to digital format. In addition, response of the apparatus 20 to variations in the movement speed or direction of the media 100 is fast (controller received position data of the extender arm 34 at short intervals) and this correspondingly
5 reduces jerkiness in the movement of the media 100. Finally, the use of the potentiometer 40 in the extender arm position monitoring system 38 also enables a provision of a position of the extender arm 34 on an instantaneous basis in view of the gear couple 46.

10 Referring to Figure 9, there is shown a preferred embodiment of a method 150 for maintaining consistent tension of a roll of media undergoing un-winding or re-winding in a holder of the roll with a motor-powered spindle 26 and an extender arm 34. The method 150 includes determining a position of the extender arm 34 (152). The position of the extender arm 34 is provided by an
15 extender arm position monitoring system 38 as described earlier in the preceding paragraphs.

The method 150 also includes varying at least one of a power width modulation, pulse width modulation, and a direction of rotation of the motor powering the
20 spindle 26, whereby an appropriate power width modulation of the motor is determined by a controller using a closed loop PID control algorithm, an example which is depicted in Figure 10. In addition, the use of the closed loop PID control algorithm also enables issues like wide dynamic loading, media diameter and media width to be resolved.

25 Subsequently, the method 150 also includes moving the extender arm 34 to a neutral position. The extender arm 34 is moved to the neutral position as a result of the variation of a speed and direction of rotation of the spindle 26. The method 150 is carried out at intervals of a pre-determined time from 1ms to 5ms.

30 It should be appreciated that most of the advantages brought about from the use of the method 150 are similar to those from the use of the apparatus 20.

For example, user intervention is not required whenever there are variations in the movement speed or direction of the media 100. Furthermore, the method 150 utilises digital control which eradicates issues pertaining to analog methods. In addition, response of the method 150 to variations in the movement speed or direction of the media 100 is fast (controller received position data of the extender arm 34 at short intervals) and this correspondingly reduces jerkiness in the movement of the media 100. It should be appreciated that the "fast" response for the method 150 is in comparison to analog methods such as, for example, use of potentiometer only, as the step pertaining to conversion of analog signals to digital format is removed.

Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications in details of design or construction may be made without departing from the present invention.

CLAIMS

1. An apparatus for maintaining consistent tension of a roll of media undergoing un-winding or re-winding, the apparatus including:

5 a drive mechanism configured for causing movement of the roll of media with a speed and a direction;

an extender arm;

an extender arm position monitoring system configured for determining a position of the extender arm; and

10 a controller configured for receiving the position of the extender arm and for providing instructions to the drive mechanism,

wherein the controller is configured to process the position and to provide the instructions to vary at least one of the speed and the direction of the roll of media to maintain consistent tension of the roll of media.

15 2. The apparatus of claim 1, wherein the drive mechanism includes:

a spindle for mounting the roll of media;

a transmission system coupled to the spindle for providing movement to the spindle; and

20 a DC motor with an encoder, the DC motor being coupled to the transmission system to drive the transmission system.

3. The apparatus of either claim 1 or 2, wherein the extender arm position monitoring system includes:

25 a potentiometer for providing a reference position of the extender arm;

an encoder disc for providing position data for the extender arm;

an encoder sensor to obtain the position data; and

a gear couple between an extender arm pivot and the potentiometer, the gear couple being for coupling a potentiometer gear to the an extender arm

30 gear.

4. The apparatus of any one of claims 1 to 3, wherein the extender arm position monitoring system further includes an extender arm home sensor.
5. The apparatus of any one of claims 1 to 4, wherein the position includes an angular deviation of the extender arm from a neutral axis.
6. The apparatus of any one of claims 1 to 5, wherein the position is received at intervals of a pre-determined time.
7. The apparatus of claim 6, wherein the pre-determined time is between 1ms to 5ms.
8. The apparatus of claim 2, wherein the instructions further include at least one of a power width modulation, pulse width modulation, and direction of movement for the DC motor, the instructions being derived from a closed loop PID control algorithm.
9. The apparatus of any one of claims 1 to 8, wherein the extender arm further includes a sub-roller.
10. The apparatus of claim 10, wherein the sub-roller is configured to clean a surface of the media.
11. A method for maintaining consistent tension of a roll of media undergoing un-winding or re-winding in a holder of the roll with a motor-powered spindle and an extender arm, the method including:
determining a position of the extender arm;
varying at least one of a power width modulation, pulse width modulation, and direction of movement of the motor; and
moving the extender arm to a neutral position,
wherein the movement of the extender arm is due to the variation of the at least one of the power width modulation, pulse width modulation, and

direction of movement of the motor, the movement of the extender arm being to maintain consistent tension of the roll of media.

12. The method as claimed in claim 11, wherein the position of the extender arm is provided by an extender arm position monitoring system.

13. The method as claimed in claim 12, wherein the extender arm position monitoring system includes:

a potentiometer for providing a reference position of the extender arm;
an encoder disc for providing position data for the extender arm;
an encoder sensor to obtain the position data; and
a gear couple between an extender arm pivot and the potentiometer, the gear couple being for coupling a potentiometer gear to the an extender arm gear.

14. The method as claimed in any one of claims 11 to 13, wherein the variation of at least one of a power width modulation, pulse width modulation, and direction of movement of the motor is determined by a controller, the controller carrying out a closed loop PID control algorithm.

15. The method as claimed in any one of claims 11 to 14, wherein the method is carried out at intervals of a pre-determined time.

16. The method as claimed in claim 15, wherein the pre-determined time is between 1ms to 5ms.