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(54) **ESTIMATING A REMAINING AMOUNT OF A CONSUMABLE RESOURCE BASED ON A CENTER OF MASS CALCULATION**

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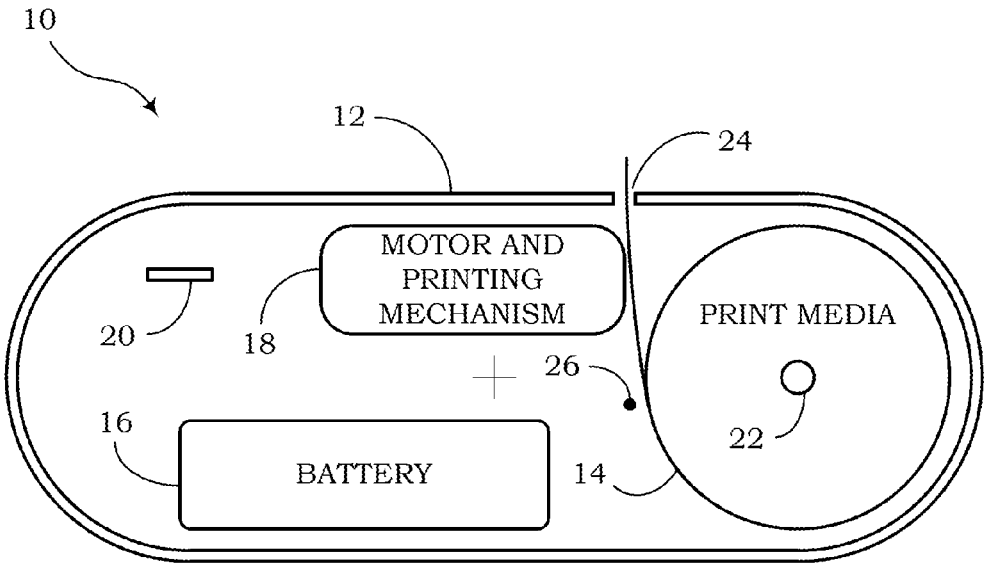
(57) **ABSTRACT**

Systems and method for estimating a remaining amount of a consumable resource are provided. According to one method, a first step of detecting the center of mass of a mobile printer is conducted, wherein the mobile printer comprises print media. The method may also include a step of determining a remaining print media level based on the detected center of mass.



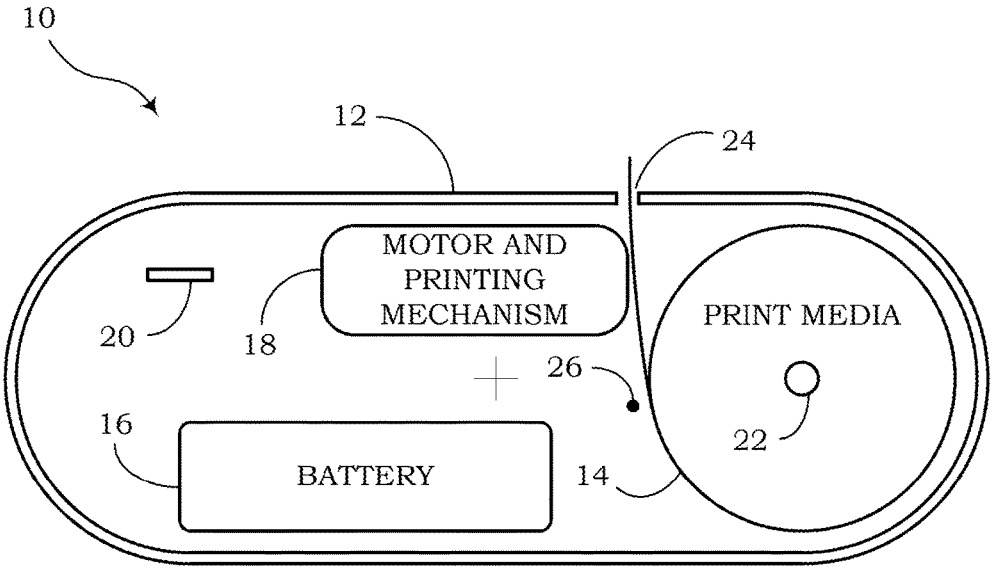
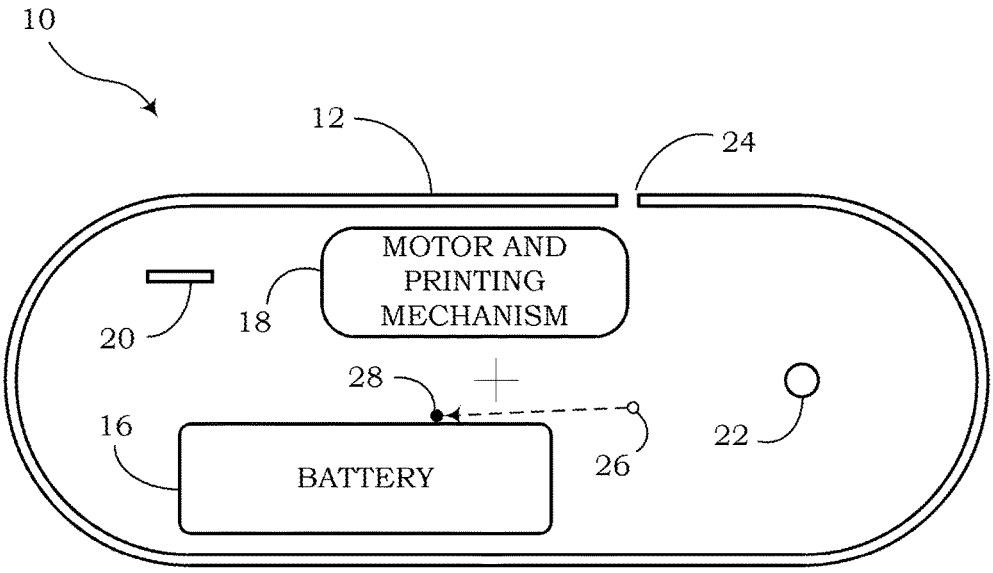

10
12
24
MOTOR AND PRINTING MECHANISM
PRINT MEDIA
20
18
26
16
BATTERY
14
22

FIG. 1


10
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MOTOR AND PRINTING MECHANISM
20
18
28
16
BATTERY
26
22

FIG. 2

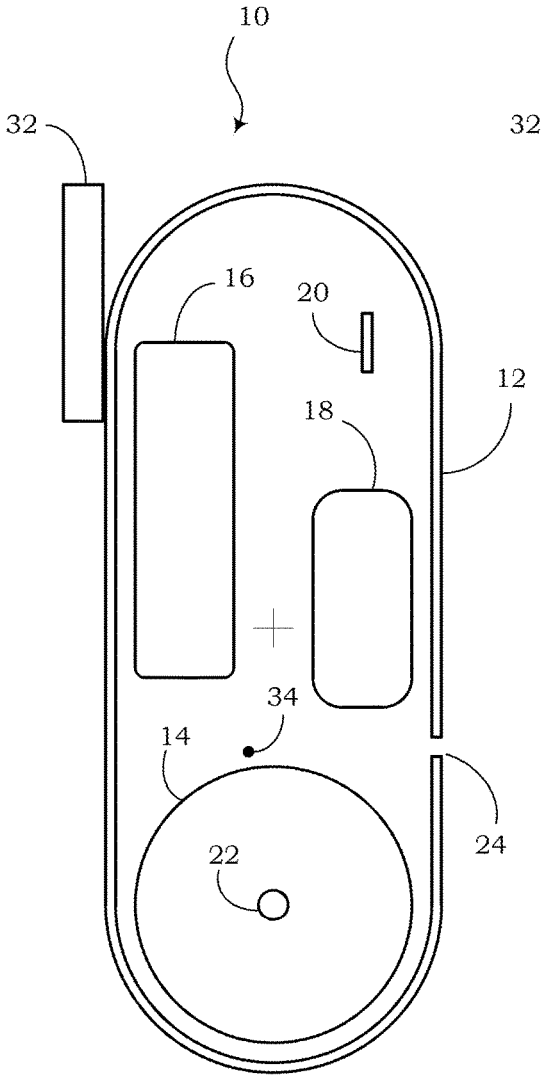

FIG. 3

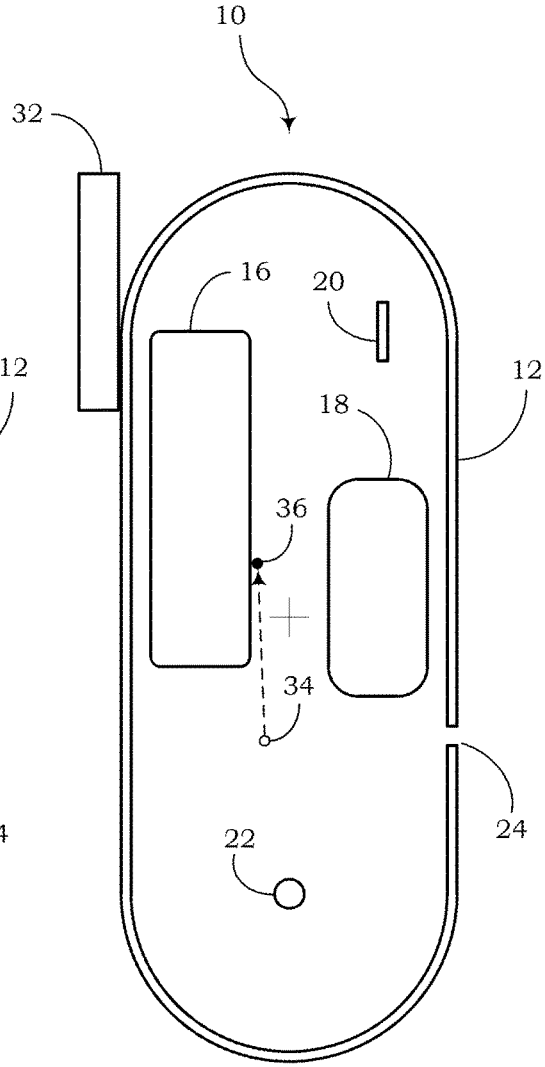

FIG. 4

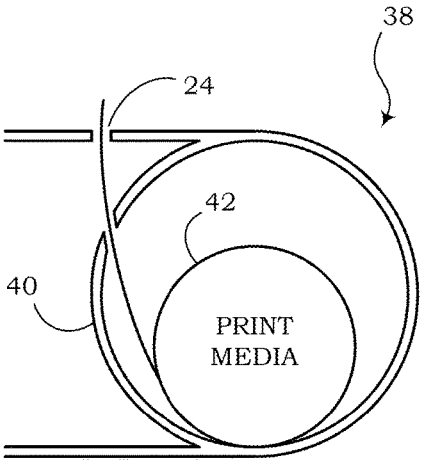

FIG. 5

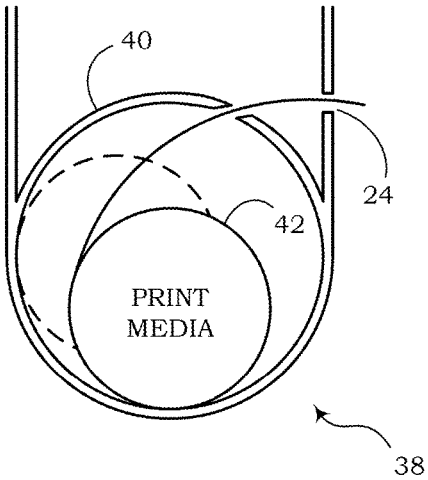

FIG. 6

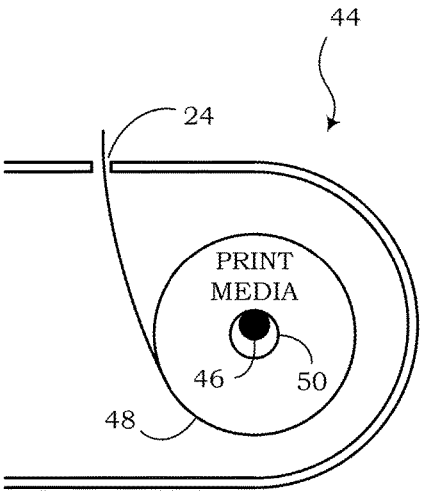

FIG. 7

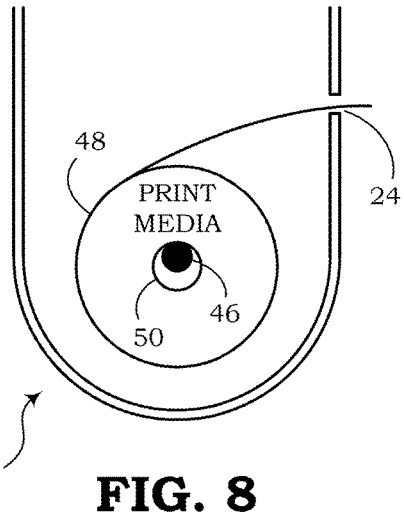

FIG. 8

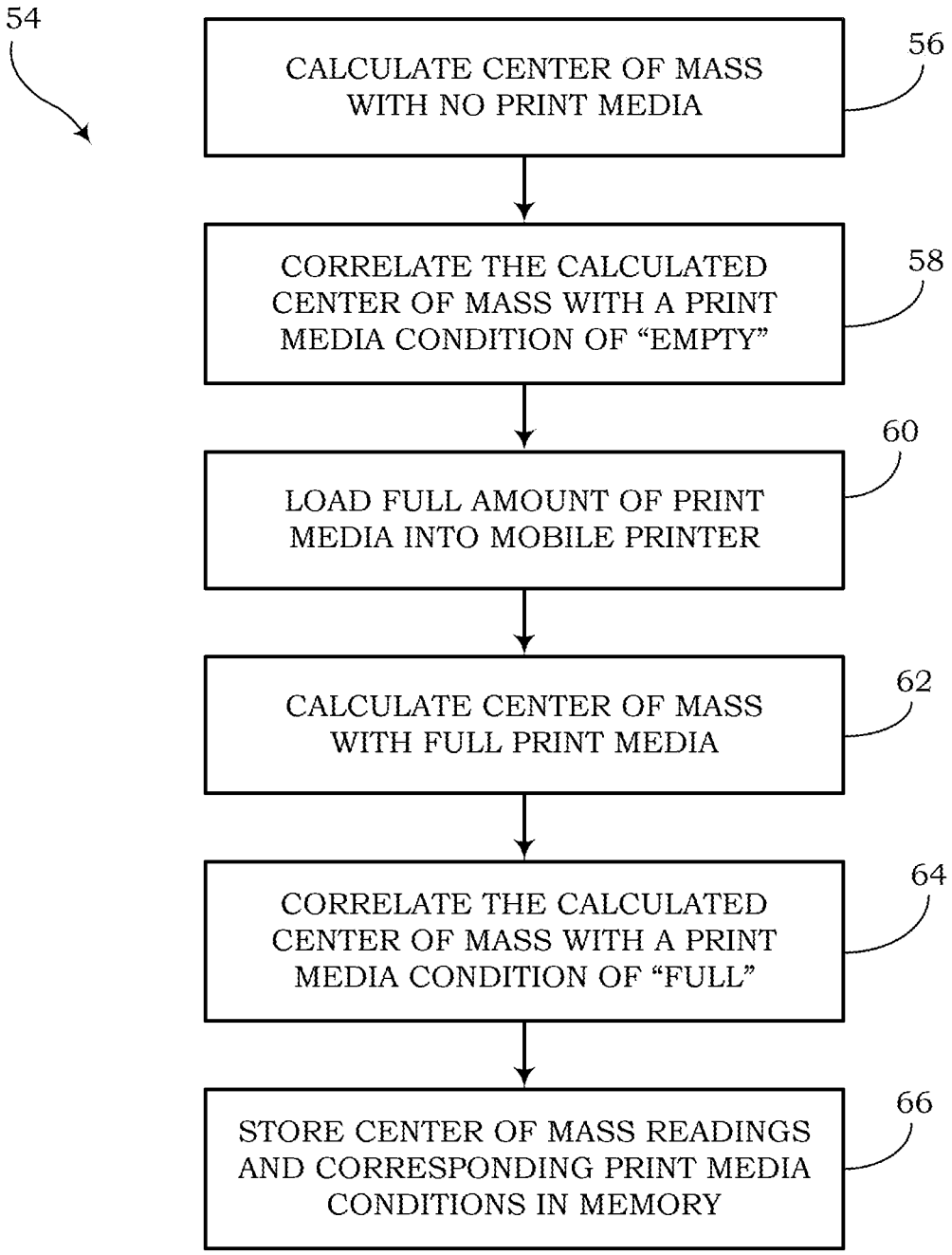
54
CALCULATE CENTER OF MASS WITH NO PRINT MEDIA
56
CORRELATE THE CALCULATED CENTER OF MASS WITH A PRINT MEDIA CONDITION OF "EMPTY"
58
LOAD FULL AMOUNT OF PRINT MEDIA INTO MOBILE PRINTER
60
CALCULATE CENTER OF MASS WITH FULL PRINT MEDIA
62
CORRELATE THE CALCULATED CENTER OF MASS WITH A PRINT MEDIA CONDITION OF "FULL"
64
STORE CENTER OF MASS READINGS AND CORRESPONDING PRINT MEDIA CONDITIONS IN MEMORY
66

FIG. 9

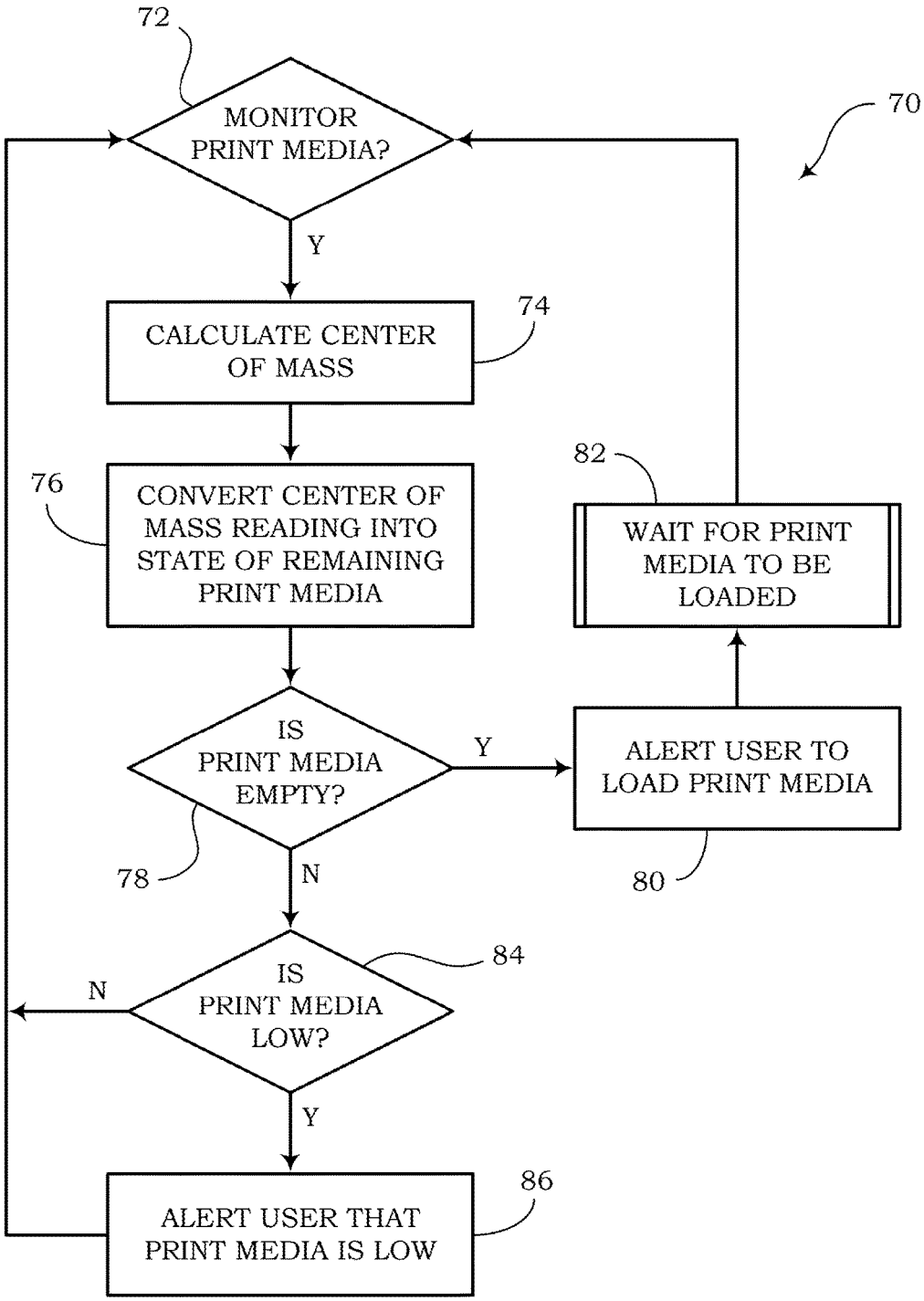
72
MONITOR PRINT MEDIA?
70
Y
CALCULATE CENTER OF MASS
74
76
CONVERT CENTER OF MASS READING INTO STATE OF REMAINING PRINT MEDIA
82
WAIT FOR PRINT MEDIA TO BE LOADED
IS PRINT MEDIA EMPTY?
Y
ALERT USER TO LOAD PRINT MEDIA
78
N
80
84
IS PRINT MEDIA LOW?
N
Y
86
ALERT USER THAT PRINT MEDIA IS LOW

FIG. 10

ESTIMATING A REMAINING AMOUNT OF A CONSUMABLE RESOURCE BASED ON A CENTER OF MASS CALCULATION

FIELD OF THE INVENTION

[0001] The present invention relates to systems and methods for determining a remaining amount of a consumable resource, such as print media, and more particularly relates to determining the remaining amount based on a center of mass calculation.

BACKGROUND

[0002] Generally, mobile printers allow a user to print labels and other print media while on the move. For instance, mobile printers may be used in a warehouse environment, in a retail setting, in the transportation industry, and in other environments where users might not be confined to an office but may instead be required to perform activities, including printing, in many different locations.

[0003] When a user is moving around within an area and performing multiple printing jobs, the user may be unaware that the mobile printer may be running out of paper, labels, or other print media on which the mobile printer may be designed to print. When the print media is used up, the user may be required to reload more print media into the mobile printer. However, it can be time-consuming and/or inconvenient for the user if the print media runs out when the user is far from a supply of replacement media. Therefore, a need exists for communicating to the user of a mobile printer when the print media is empty, almost empty, or below a certain threshold.

SUMMARY

[0004] Accordingly, in one aspect, the present invention embraces systems and methods for calculating center of mass of a device (e.g., mobile printer). From the center of mass calculations, a remaining amount of a consumable resource (e.g., paper) can be calculated. The remaining amount of the consumable resource can be calculated by comparing the center of mass reading with pre-established reference points that represent center of mass points when the device is full or empty.

[0005] In an exemplary embodiment, a method is provided for estimating the remaining amount of consumable resource. The method includes detecting the center of mass of a mobile printer, where the mobile printer comprises print media. The method also includes determining a remaining print media level based on the detected center of mass.

[0006] In another exemplary embodiment, a printer is described. The printer includes a housing and a printing mechanism mounted within the housing. The printing mechanism is configured to print onto a print media. The printer further includes a media level detection module mounted with the housing. The media level detection module is configured to detect the center of mass of the printer. The media level detection module is further configured to determine a remaining print media level based on the detected center of mass of the printer.

[0007] In yet another exemplary embodiment, a device configured to use a consumable resource is provided. The device includes a housing that includes a containment area where the consumable resource is to be stored. The device further includes a detection module configured to detect the center of mass of the device and determine a remaining level of the consumable resource based on the detected center of mass.

[0008] The foregoing illustrative summary, as well as other exemplary objectives and/or advantages of the invention, and the manner in which the same are accomplished, are further explained within the following detailed description and its accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** schematically depicts a cross-sectional side view of a first mobile printer arranged in a horizontal orientation when the print media is full, according to one embodiment of the present invention.

[0010] FIG. **2** schematically depicts a cross-sectional side view of the first mobile printer of FIG. **1** when the print media is empty, according to one embodiment of the present invention.

[0011] FIG. **3** schematically depicts a cross-sectional side view of the first mobile printer of FIG. **1** arranged in a vertical orientation when the print media is full, according to one embodiment of the present invention.

[0012] FIG. **4** schematically depicts a cross-sectional side view of the first mobile printer of FIG. **3** when the print media is empty, according to one embodiment of the present invention.

[0013] FIG. **5** schematically depicts a cross-sectional side view of a portion of a second mobile printer arranged in a horizontal orientation when the print media is between full and empty, according to one embodiment of the present invention.

[0014] FIG. **6** schematically depicts a cross-sectional side view of the portion of the second mobile printer of FIG. **5** arranged in a vertical orientation, according to one embodiment of the present invention.

[0015] FIG. **7** schematically depicts a cross-sectional side view of a portion of a third mobile printer arranged in a horizontal orientation when the print media is between full and empty, according to one embodiment of the present invention.

[0016] FIG. **8** schematically depicts a cross-sectional side view of the portion of the third mobile printer of FIG. **7** arranged in a vertical orientation, according to one embodiment of the present invention.

[0017] FIG. **9** schematically depicts a flow diagram of a method for establishing a correlation between center of mass points and full and empty conditions of the print media, according to one embodiment of the present invention.

[0018] FIG. **10** schematically depicts a flow diagram of a method for indicating when print media needs to be replaced during operation of a mobile printer, according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0019] The present invention embraces systems and methods for sensing the amount of a consumable resource (e.g., print media) that remains within a device (e.g., a mobile printer). The remaining amount of the resource can be measured using an accelerometer and/or gyroscopic sensor to determine the center of mass of the mobile printer at different times during the use of the mobile printer. As the print media is consumed, the mobile printer not only loses overall mass but also experiences a change in its center of

mass or center of gravity. Since the print media by itself is usually not centered within a housing of the mobile printer, the change in mass of the print media as it is consumed thereby changes the center of mass of the mobile printer.

[0020] Furthermore, the mobile printer may be configured to store reference points that define the extremes of the locations of the center of mass with respect to a housing in which the print media is contained. The stored reference points may include an initial location of the center of mass when the mobile printer contains a new full roll of print media. This initial location can be regarded as being the location of the center of mass when the print media is "full." Also, the mobile printer may also be configured to store an ending location, which represents the location of the center of mass of the mobile printer when the print media has been completely used up. This ending location can be regarded as being the location of the center of mass when the print media is "empty."

[0021] Some mobile printers may already include an accelerometer and/or gyroscopic sensor for determining orientation and dynamic positional states of the device. The present invention may also utilize these elements for making center of mass calculations. The accelerometer and/or gyroscopic sensor can measure approximate weight of the mobile printer, which may also be used to estimate the amount of print media left in the mobile printer. In addition to mobile printers, some embodiments may include incorporating an accelerometer and/or gyroscopic sensor in a stationary printer that may be moved occasionally. In this respect, for stationary printers that may be moved for printing at different locations, the embodiments disclosed herein may also to these printers as well.

[0022] The main contributors to the weight of a mobile printer are typically the battery and the print media. As the print media is consumed due to printing operations, the concentration of the weight or center of mass is shifted. The accelerometer and/or gyroscopic sensor readings will vary with the changes in the center of mass. Furthermore, the center of mass calculations can be correlated with the amount of print media remaining in the mobile printer. Thus, as the print media is consumed, the center of mass gradually moves from a first point (when the print media is full) to a second point (when the print media is empty).

[0023] FIG. **1** is a cross-sectional side view of an embodiment of a mobile printer **10** having a housing **12**. It should be noted that the shape and size of the housing **12** may differ based on the specific design. Consequently, center of mass calculations are affected by the characteristics of the housing **12**. As described herein for the purpose of determining the amount of the remaining consumable resource, the center of mass measurements may be conducted for each particular design of the housing **12** or other various housings.

[0024] The mobile printer **10** is illustrated in a condition when print media **14** within the housing **12** of the mobile printer **10** is full. In addition to the print media **14**, one or more batteries **16**, a motor and printing mechanism **18**, and a media level detection module **20** are contained within the housing **12** of the mobile printer **10**.

[0025] The media level detection module **20** may include a microelectromechanical system (MEMS) or other suitable detecting elements for detecting center of mass. In some embodiments, the media level detection module **20** may further include or have access to memory for storing reference points corresponding to full and empty conditions of the consumable resource. For example, the MEMS or media level detection module **20** may include an accelerometer and/or a gyroscopic sensor. The media level detection module **20** may also be configured for determining whether the mobile printer **10** is in a horizontal orientation or a vertical orientation. As illustrated in FIGS. **1** and **2**, the mobile printer **10** is oriented in a horizontal configuration, and in FIGS. **3** and **4**, the mobile printer **10** is shown as being oriented in a vertical position, which may be a common orientation when attached to a belt of a user.

[0026] The housing **12** and each of the internal components of the mobile printer **10** naturally includes a certain mass. It should be recognized, however, that the mass of most of the components does not change significantly over time. However, during use, the print media **14** is consumed until the print media **14** eventually runs out and must be replaced with a new roll. Therefore, the overall mass of the mobile printer **10** gradually declines with use of the print media **14**.

[0027] The various masses of the different components of the mobile printer **10** contribute to a point representing the center of mass (or center of gravity) that may not necessarily be consistent with the center of mass of the housing **12**. For instance, certain components, such as the print media **14** and battery **16** may have a greater mass that contributes more significantly to the overall center of mass of the mobile printer **10** than other components of the mobile printer **10**. And, as mentioned above, the print media **14** is gradually consumed, which consequently results in a shift of the center of mass of the mobile device **10** from one extreme point (i.e., when the print media **14** is "full") to another extreme point (i.e., when the print media **14** is "empty").

[0028] As shown in FIG. **1**, the print media **14** is in a full state. The print media **14** is contained within an area of the housing **12** by a peg **22** or shaft, pin, spool, or other means for maintaining the print media **14** within the designated area. An end of the print media **14** is led through an output slot **24** in the housing **12**.

[0029] During a manufacturing process, reference points that serve to represent the locations of the center of mass points in at least the two extreme conditions can be calculated. The first extreme condition is the full condition when the print media is completely full. For example, using the media level detection module **20**, the center of mass of the mobile printer **10** can be calculated to determine the "full" point **26**. As an example, the center of mass may be determined to be at the point **26**, which is shown slightly off center of the geometrical center of the housing **12**. The contribution of the mass of the print media **14** may shift the center of mass of the housing **12** and its contents in the direction of the print media **14**.

[0030] FIG. **2** is a cross-sectional side view showing an embodiment of the mobile printer **10** of FIG. **1** when the print media **14** is empty. When the print media **14** is completely consumed, the empty spool **22** or other various media distribution elements may be left. During manufacture, the media level detection module **20** may be used to obtain a center of mass measurement at a time when the print media **14** is absent. In this example, it may be determined that the center of mass of the mobile printer **10** has been shifted to a final point **28**. Without the presence of the print media **14**, the contributions of the battery **16** and motor and printing mechanism **18** to the overall mass may provide a center of mass more closely located near these components.

Again, this final center of mass point **26** may be slightly off center from the geographical center of the housing **12**.

[0031] Theoretically, the center of mass point changes from the initial point **26** to the final point **28** in a linear manner. However, in some circumstances, the change in the center of mass may follow a non-linear, curved path. Also, the amount of change of the center of mass per unit of print media consumed may increase or decrease based on various factors and/or unknowns in the device.

[0032] FIG. **3** is a cross-sectional side view showing an embodiment of the mobile printer **10** arranged in a vertical orientation when the print media is full. FIG. **4** is a cross-sectional side view showing an embodiment of the mobile printer of FIG. **3** when the print media is empty. In the embodiment of FIGS. **3** and **4**, however, the mobile printer **10** may further include a belt clip **32**, which may be configured to be attached to a belt worn by the user of the mobile printer **10**.

[0033] When positioned in the vertical orientation, the mobile printer **10** may include a first reference point **34** related to the center of mass of the mobile printer **10** when the print media **14** is full. Also, the mobile printer **10** may include a second reference point **36** related to the center of mass of the mobile printer **10** when the print media **14** is empty.

[0034] As mentioned above, the print media **14** is confined by the peg **22**. Although the peg **22** may be configured to substantially maintain the print media **14** in the designated area within the housing **12**, the effect of gravity may slightly alter the center of mass readings. Therefore, during manufacture, the reference points for indicating the positions of the center of mass at the extreme conditions of the print media **14** can be calculated when the mobile printer **10** is also configured in the vertical position. Another component that may slightly alter the center of mass readings is the belt clip **32**.

[0035] For these reasons, it may be advantageous to determine at least four center of mass points for each specific mobile printer design. The first center of mass point **26** may be calculated to represent the condition when the print media **14** is full and the mobile printer **10** is oriented horizontally (FIG. **1**). The second center of mass point **28** may be calculated to represent the condition when the print media **14** is empty and the mobile printer **10** is oriented horizontally (FIG. **2**). The third center of mass point **34** may be calculated to represent the condition when the print media **14** is full and the mobile printer **10** is oriented vertically (FIG. **3**). And the fourth center of mass point **36** may be calculated to represent the condition when the print media **14** is empty and the mobile printer **10** is oriented vertically (FIG. **4**). Again, these points may be calculated before the mobile printer **10** is put into use, such as during a time when the mobile printer **10** is being manufactured or during a calibration process.

[0036] When the mobile printer **10** is put into use, the media level detection module **20** may be configured to determine the center of mass of the mobile printer **10**. The media level detection module **20** may also detect the orientation of the mobile printer **10**. Based on these factors, the media level detection module **20** can compare the current center of mass point with the pre-stored reference points (i.e., **26**, **28**, **34**, **36**). By comparing with these and/or other additional reference points, the media level detection module **20** can estimate how much of the print media **14** remains. In some embodiments, the media level detection module **20** can provide an indication to the user when the print media **14** drops below a certain threshold.

[0037] According to some embodiments, the media level detection module **20** may alternatively be installed in the housing of another type of device that contains a consumable resource other than print media. For example, some devices may use various types of consumable resources, such as paper, labels, solid or liquid fuels, ammunition, or other resources that when used will essentially alter the center of mass of the respective device. The respective housing of the various devices may include chambers, tanks, or other designated areas where the consumable resource is stored. Throughout the use of the device, the consumable resource is consumed. As the consumable resource is consumed, the overall mass of that resource will naturally decrease from an initial mass representing a full condition to a final mass representing an empty condition.

[0038] According to some embodiments, the mobile printer **10** may include various types of components for indicating a remaining amount of the print media **14** and/or for indicating when the amount of the print media **14** falls below certain thresholds. In some embodiments, a graduated gauge may be used for indicating an amount of print media **14** remaining in the mobile printer **10**. The media level detection module **20** may utilize a processing device, such as a microprocessor, for comparing a current center of mass measurement with pre-stored reference points. For example, if a center of mass measurement is determined to be halfway between full and empty conditions, the processing device may be configured to conclude that the consumable resource is about half full.

[0039] According to various embodiments, the center of mass calculations may be used to indicate fractions or percentages of the remaining resource. For example, if the center of mass is calculated as being ⅞ths of the distance from a "full" center of mass location (e.g., point **26**) to an "empty" center of mass location (e.g., point **28**), then the processing device may determine that the consumable resource is approximately ⅛ths full. If it is determined that the consumable resource drops below a certain threshold (e.g., below ⅛ full, below 10%, below 5%, etc.), then an alert indication can be provided to the user. The alert indication may include, for example, the illumination of a light emitting diode (LED) or other visual indicator, an audio output, a display message on a user screen, and/or other various types of indications. In some embodiments, a wireless signal may be transmitted from the mobile printer **10** to a remote device or server to provide an indication of the amount of print media remaining.

[0040] For example, some indications may include a first LED that is illuminated to show that the consumable resource is below a certain threshold. The LED, for example, may be a specific color, such as yellow. Additionally, another LED may be used to indicate a more urgent condition, such as when the consumable resource drops below an even lower threshold. This second LED, for example, may be another color, such as red.

[0041] In other embodiments, an indication device may be used to show a more gradual decrease in the amount of consumable resource remaining. For instance, a graduated gauge may be used. A needle or other marking or indicating

device (mechanical and/or electrical) may be used for indicating an amount ranging from "E" to "F" or from 0% to 100%.

[0042] It should be noted that the use of an accelerometer and/or gyroscopic sensor may require that the mobile printer **10** be in motion, at least around the time that the measurements are made. Otherwise, the media level detection module **20** may not be able to calculate parameters that rely on a mechanical force (e.g., gravitational force).

[0043] FIG. **5** is a cross-sectional side view showing a portion of a second mobile printer **38** arranged in a horizontal orientation. The second mobile printer **38** may include many of the same features as described with respect to FIGS. **1-4**. However, instead of containing the peg **22** shown in FIGS. **1-4**, the second mobile printer **38** includes a cylindrical compartment **40**. The cylindrical compartment **40** is configured to contain the print media **42**, which in this embodiment does not necessarily include a center spool around which the media is wrapped.

[0044] Without means for centering the print media **42** within the cylindrical compartment **40**, the print media **42** may be allowed to move freely within the cylindrical compartment **40**. It should be noted that as the print media **42** is consumed, the center of mass of the print media **42** will also shift within the cylindrical compartment **40**, particularly based on the orientation of the mobile device **38**. FIG. **5** shows a condition when the print media **42** is between full and empty. Because of gravity, when the mobile printer **38** is oriented in the horizontal orientation as shown in FIG. **5**, the print media **42** will settle on the bottom, thereby adjusting the center of mass of the mobile printer **38** downward.

[0045] FIG. **6** is a cross-sectional side view of the portion of the second mobile printer **38** of FIG. **5** arranged in a vertical orientation. The print media **42** again is shown in a state between full and empty. As the print media **42** is consumed, the center of mass calculations for the mobile printer **38** will be slightly different from those calculations made when the mobile printer **38** is oriented horizontally. The difference between the center of mass calculations from the horizontal orientation (FIG. **5**) to the vertical orientation (FIG. **6**) may be due to the positioning of the print media **42** within the cylindrical compartment **40**.

[0046] As mentioned above with respect to FIGS. **1-4**, initial readings can be conducted before the mobile printer **38** is put into use. These initial readings can be used to establish reference points that later readings can be compared to. Also, the initial measurements can be conducted and then stored for a mobile printer positioned both in a horizontal orientation and a vertical orientation. Then, during use, the media level detection module **20** (not shown in FIGS. **5** and **6**) may be configured to determine the current center of mass and compare this measurement to the reference points to estimate the remaining amount of print media **42**.

[0047] FIG. **7** is a cross-sectional side view of a portion of a third mobile printer **44** arranged in a horizontal orientation. The third mobile printer **44** includes a post **46** around which the print media **48** can rotate. In this embodiment, print media **48** includes an inner tube **50** that fits around the post **46**. The inner tube **50** in this embodiment may have an inner diameter that is larger than the outer diameter of the post **46**, thereby allowing the print media **48** to rotate freely. In FIG. **7**, the print media **48** is shown when it is between a completely full condition and a completely empty condition.

[0048] FIG. **8** schematically depicts a cross-sectional side view of the portion of the third mobile printer **44** of FIG. **7** arranged in a vertical orientation. Because of the way gravity acts on the print media **48** when the mobile printer **44** is oriented in the horizontal orientation (FIG. **7**) and in the vertical orientation (FIG. **8**), the center of mass measurements will differ slightly. Therefore, initial reference points may be obtained when the mobile printer **44** is oriented horizontally and vertically. Then, based on center of mass calculations during use of the mobile device **44** and based on the calculated orientation, a current center of mass point can be compared with the reference points to estimate the remaining amount of print media **48**.

[0049] FIG. **9** is a flow diagram showing an embodiment of a method **54** for establishing a correlation between center of mass points and full and empty conditions of the print media. For example, the method **54** may be conducted during a manufacturing process or a calibration or recalibration process after the mobile printer has been constructed. Therefore, the method **54** may be executed before the mobile printer is put into use.

[0050] It should be noted that the method **54** of FIG. **9** may represent the correlation of center of mass points with remaining amounts when a mobile printer is oriented in one particular manner (e.g., horizontally). The method **54** may also be repeated for determining additional correlations when the mobile printer is in a different orientation (e.g., vertically).

[0051] Method **54** includes a first step of calculating the center of mass of the mobile printer with no print media included, as indicated in block **56**. This center of mass point is correlated with a condition of the print media being "empty," as indicated in block **58**.

[0052] The method **54** also includes a step of properly loading a full amount (e.g., full roll) of the print media into the mobile printer, as indicated in block **60**. In some embodiments, the method **54** may alternatively include adding a weight other than an actual roll of print media to the interior of the mobile printer. For example, the weight may be configured to mimic the size, mass, and weight distribution of an actual full roll of print media.

[0053] With a full amount of print media (or substitute weight), the method **54** includes the step of calculating, according to block **62**, the center of mass of the mobile printer a second time. Also, the method **54** includes correlating the calculated center of mass of the full mobile printer with a print media condition of "full," as indicated in block **64**.

[0054] In addition, the method **54** includes storing the center of mass readings (i.e., obtained in blocks **56** and **62**) and the corresponding print media conditions (i.e., obtained in blocks **58** and **64**). The center of mass and corresponding media conditions can be stored in memory, which may preferably be contained within the housing of the mobile printer.

[0055] In some embodiments, the method **54** may also include calculating one or more additional center of mass points corresponding to conditions in which the print media may be in state between a full amount and an empty amount. By establishing additional points, the mobile printer, during use, may be configured to more easily indicate multiple threshold levels that may fall between the two extremes of full and empty.

[0056] The method **54** may also include steps to account for differences in various types of print media that may be installed in the printer **10**, **38**, **44**. For example, print media types may differ with respect to mass or density. If this is the case, the center of mass calculations can be made for each type of media. Then, the user can inform the printer what type of media is installed and the parameters for that type of media can be used for correlating center of mass with remaining print media. Therefore, the steps related to blocks **60**, **62**, and **64** may include repeating the processes of determining center of mass when full for each type of print media that may be installed in the printer.

[0057] FIG. **10** is a flow diagram illustrating an embodiment of a method **70** for indicating when print media needs to be replaced during operation of a mobile printer. The method **70** relies on the pre-established reference points calculated in the method **54** of FIG. **9**.

[0058] The method **70** includes a first decision block **72**, which determines when certain conditions are met for monitoring the print media. The print media may be monitored at certain predetermined times or under certain conditions. For example, the print media may be monitored when the mobile printer is first powered on, booted up, or when a user closes the media door. Or the print media may be monitored after a certain number of print jobs have been done. In some cases, the print media may be monitored periodically (e.g., once every one-, five-, ten-minute interval or other suitable time periods). Block **72** may also include determining what type of print media has been installed in the printer

[0059] Also, decision block **72** may include determining the angular orientation of the mobile printer to determine which set of algorithms and/or reference points to use to monitor the print media. For instance, method **70** may need to compare current calculations with certain reference points that were specifically obtained when the mobile printer was oriented in a horizontal manner or specifically obtained when the mobile printer was oriented in a vertical manner.

[0060] It should be noted that, during use, a user of the mobile printer **10** may position the mobile printer **10** at any angle, not just a zero degree horizontal configuration and a 90 degree vertical configuration. Hence, the gyroscopic sensor may be configured to detect any orientation angle. Also, the processing device may be configured to use interpolation or other suitable algorithm if an angle falls between angles at which the initial reference points were obtained. Then, an intermediate reference point (between reference point **26** shown in FIG. **1** and reference point **34** shown in FIG. **3**) may be used for monitoring the amount of print media remaining. Therefore, the present invention may use a suitable combination of reference points to monitor the print media.

[0061] Furthermore, it should be noted that the mobile printer **10** may be tilted in more than just a pitching angle as illustrated. Instead, the mobile printer **10** may be oriented at any angle with reference to three dimensions. Therefore, the gyroscopic sensor of the present invention may be configured to calculate pitch, roll, and yaw angles of the mobile printer **10**. Therefore, the original detection of reference points as described herein may include detection of various print media amounts at multiple sets of angles in three dimensions.

[0062] In order for the gyroscopic sensor to operate properly, the mobile printer **10** should be in motion at least for a certain amount of time before the mobile printer **10** is configured to print. Therefore, the media level detection module **20** can detect the pitch, roll, and yaw angles, which can be used for detecting the proper reference points or for calculating (e.g., interpolating) intermediate reference points derived from predetermined reference points.

[0063] When it is determined in decision block **72** that the print media is to be monitored, the method **70** proceeds to block **74**, which indicates that the center of mass of the mobile printer is calculated. As indicated in block **76**, the method **70** includes converting the center of mass reading into a state of remaining print media. For example, the center of mass reading may be compared with the two extreme points obtained with respect to a full state and an empty state. Additionally, if multiple intermediate points are determined in the method **54** of FIG. **9**, the center of mass reading may be compared with and/or interpolated with the extreme points and/or intermediate points to determine the remaining amount of the print media. The conversion of center of mass into remaining media amount may be based on the type of print media that is installed in the printer to thereby account for differences in the various masses or densities of different print media that could be used.

[0064] The method **70** includes the decision block **78**, which determines whether the print media is empty. If empty, the method **70** proceeds to block **80**, which indicates that the user is alerted that the print media needs to be loaded into the mobile printer. The method then includes the step of waiting for the print media to be loaded, as indicated in block **82**. In some embodiments, waiting for the print media to be loaded may include waiting for the media cover to be opened to allow the print media to be loaded and waiting for the media cover to be closed. The method **70** then returns back to decision block **72** in order that it can be determined whether the print media is to be monitored again.

[0065] If it is determined in decision block **78** that the print media is not empty, then the method **70** proceeds to decision block **84**, which determines if the print media is low. A low print media state may be determined based on threshold comparisons, which may be part of the step of block **76**. If the print media is not low, the method loops back to decision block **72**. However, if the media is low, the method proceeds to block **86**, which indicates that the user is alerted that the print media is low. The alert may include a visual and/or audible indication for communicating the state of print media.

[0066] The step of block **86** may include providing an estimation of the level of print media remaining. For example, one indication may include an alert that the print media is below a certain percentage of full (e.g., below 5%) or may include an alert that the print media can conduct an estimated number of print jobs before running out (e.g., "less than 10 labels remaining" or other indication). In some embodiments, several levels may be detected in a similar manner as diamond **84** and several corresponding alerts can be provided to the user in a similar manner as block **86**.

[0067] To supplement the present disclosure, this application incorporates entirely by reference the following commonly assigned patents, patent application publications, and patent applications:

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U.S. Patent Application Publication No. 2017/0199266;

U.S. Patent Application Publication No. 2017/0200108; and

U.S. Patent Application Publication No. 2017/0200275.

[0068] In the specification and/or figures, typical embodiments of the invention have been disclosed. The present invention is not limited to such exemplary embodiments. The use of the term "and/or" includes any and all combinations of one or more of the associated listed items. The figures are schematic representations and so are not neces-

sarily drawn to scale. Unless otherwise noted, specific terms have been used in a generic and descriptive sense and not for purposes of limitation.

1. A method comprising the steps of:

detecting, by a media level detection module within a housing of a mobile printer, the center of mass of the mobile printer based on a first signal from a sensor, the mobile printer comprising print media; and

determining, by the media level detection module, a remaining print media level based on comparing the first sensor signal indicating a first center of mass to a second sensor signal indicating a second center of mass associated with empty print media level and a third sensor signal indicating a third center of mass associated with a full print media level.

2. The method of claim **1**, further comprising the step of determining, by the media level detection module, consumption of the print media based on a change of the center of mass of the mobile printer, wherein the change of center of mass of the mobile printer results from a redistribution of weight of the mobile printer due to consumption of the print media.

3. The method of claim **2**, further comprising the step of determining, by the media level detection module, the change in the center of mass of the mobile printer from a first point to a second point, wherein the first point corresponds to a condition in which the mobile printer contains a maximum amount of print media and the second point corresponds to a condition in which the mobile printer contains a minimum amount of print media.

4. The method of claim **1**, further comprising the step of detecting, by a gyroscope and/or an accelerometer housed within the mobile printer, the center of mass of the mobile printer.

5. The method of claim **4**, further comprising the step of determining, by the gyroscope and/or the accelerometer, an orientation of the mobile printer.

6. The method of claim **1**, further comprising the steps of:

detecting, by the media level detection module, an orientation of the mobile printer; and

determining, by the media level detection module, the remaining print media level based on the detected center of mass and the orientation.

7. The method of claim **1**, further comprising the step of providing, by the media level detection module, an indication of the remaining print media level.

8. The method of claim **7**, further comprising the step of providing, by the media level detection module, a warning if the remaining print media level falls below a predetermined threshold.

9. A printer comprising:

a housing;

a printing mechanism mounted within the housing, the printing mechanism configured to print onto a print media; and

a media level detection module mounted within the housing, the media level detection module configured to:

detect the center of mass of the printer based on a first signal from a sensor; and

determine a remaining print media level by comparing the first sensor signal indicating a first center of mass to a second sensor signal indicating a second center of mass associated with empty print media level and a third sensor signal indicating a third center of mass associated with a full print media level.

10. The printer of claim **9**, wherein the media level detection module is further configured to determine consumption of the print media based on a change of center of mass of the printer resulting from a redistribution of weight of the mobile printer based on consumption of the print media.

11. The printer of claim **10**, wherein the media level detection module is further configured to determine the change in the center of mass of the printer from a first point to a second point, wherein the first point corresponds to a condition in which the printer contains a maximum amount of print media and the second point corresponds to a condition in which the printer contains a minimum amount of print media.

12. The printer of claim **9**, wherein the media level detection module comprises a gyroscope and/or an accelerometer.

13. The printer of claim **12**, wherein the gyroscope and/or accelerometer are configured to determine an orientation of the printer, and wherein the media level detection module is configured to determine the remaining print media level based on the detected center of mass and the orientation.

14. The printer of claim **9**, wherein the printer is a mobile printer.

15. The printer of claim **9**, further comprising an interface configured to provide an indication of the remaining print media level.

16. The printer of claim **9**, wherein the center of mass of the print media is offset from the center of mass of the printer.

17. A device configured to use a consumable resource, the device comprising:

a housing that includes a containment area where the consumable resource is to be stored; and

a detection module configured to:

detect the center of mass of the device based on a first signal from a sensor; and

determine a remaining level of the consumable resource by comparing the first sensor signal indicating a first center of mass to a second sensor signal indicating a second center of mass associated with empty consumable resource level and a third sensor signal indicating a third center of mass associated with a full consumable resource level.

18. The device of claim **17**, wherein the first sensor comprises a gyroscope and/or an accelerometer configured to detect the center of mass of the device.

19. The device of claim **18**, wherein the gyroscope and/or accelerometer are configured to detect an orientation of the device and determine the remaining level based on the detected center of mass and the orientation.

20. The device of claim **17**, wherein the device is a mobile printer and the consumable resource is paper or labels.

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