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AUTOMATIC CALIBRATION OF WIPERS TO ENSURE THAT AN OPTIMAL FORCE IS APPLIED TO THE PRINTHEADS

HP INC

Automatic calibration of wipers to ensure that an optimal force is applied to the printheads

1. Abstract

The procedure herein disclosed allows the printer to automatically detect with high precision the point where a non-rigid moving element (for example, the wiper such as a rubber wipe or a web wipe subsystem) starts interfering with the nozzle plate as to ensure that the force applied during the wiping routines stays at the optimal value, avoiding disturbances coming from:

- The geometric tolerances of the machine and subsystems. These tolerances cause that the machines have different distances between the wiper subsystems and the nozzle plate in each particular machine and wiper.
- The geometric tolerances of the consumable. Bare rubber wipes are frequently replaced due to wear and every consumable has some deviation in their datum-to-rubber-tip distance.
- The wear of the rubber part. Vertical position of the tip changes with use (specially in the bare rubber wipers), so it is important to position the wiper taking this change into account.

The above-mentioned high precision is necessary to avoid image quality problems that can come from excessive wiping force (streakiness or ink drops) or from insufficient wiping force (crusting).

The procedure compares the free movement of the motor that is responsible for the vertical positioning of the wiper with its movement when the carriage is positioned above. An algorithm compares read position, voltage input and its derivative for the two cases (with several repetitions for each case), filters the data and is able to predict with high accuracy where the beginning of the interference between the wiper and the nozzle plate is taking place.

This procedure will be applied at the beginning of the life of each consumable and automatically throughout its use in the machine, with some regularity.

Description of invention

2. Problems solved

TIJ printheads performance is highly sensitive to wiping force. Insufficient force can leave residues on the printhead such as, e.g., ink puddling not being removed on time which may then become dry on the surface of the die and block a number of nozzles. Such defect causes image quality issues such as microbanding or white lines . Excessive force, on the other hand, can cause that fibers are removed from the web wipe and may adhere to the nozzle plate thereby absorbing ink until at least one blob of ink is formed and falls to the media. Also, such excessive force may lead to streakiness due to other substances such as water getting inside the nozzles and preventing the printhead from properly firing at the beginning of the pass.

Moreover, the elements that are used for cleaning the printheads are consumables and suffer non-negligible wear throughout their life. Therefore, to guarantee a nominal interference between these elements and the nozzle plate, it is not enough to perform a z-calibration at the beginning of the use of the machine. On the contrary, it is necessary that such cleaning can be repeated regularly and the process is executed as fast as possible, in order to reduce maintenance times for the customer.

3. Prior solutions

Previous solutions that have being used to apply a specified interference between wiper and nozzle plate include:

- Assuming a nominal separation between nozzle plate and the wiping element. This assumption implies high deviation with respect to real distance (not taking into account tolerances or wear).
- In the web wipe, using an algorithm that applying several vertical positions creates lines of ink in the cloth and, through visual inspection accepts an input to increase or reduce the calibrated value. This is a tiresome process for the user, with low precision, and can create noise coming from an incorrect user interpretation of a visual inspection process or a variable calibration frequency.

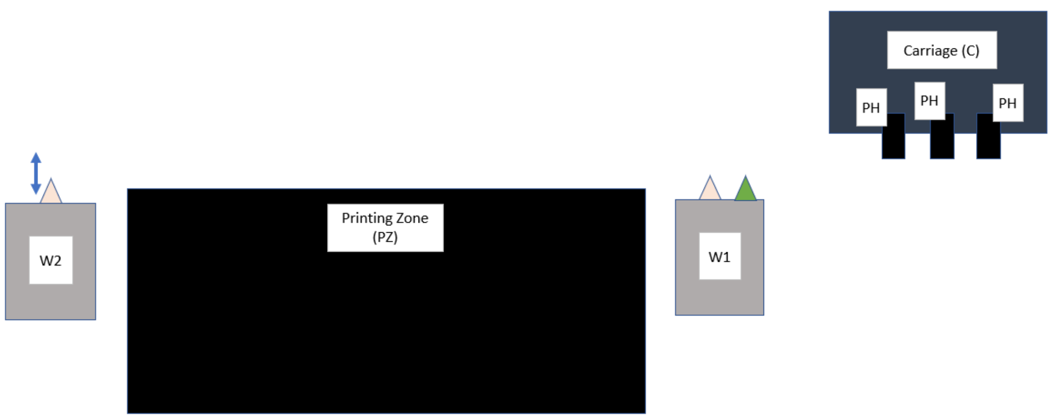
4. Description

The process of automatic calibration for the wiper elements in the printer is executed:

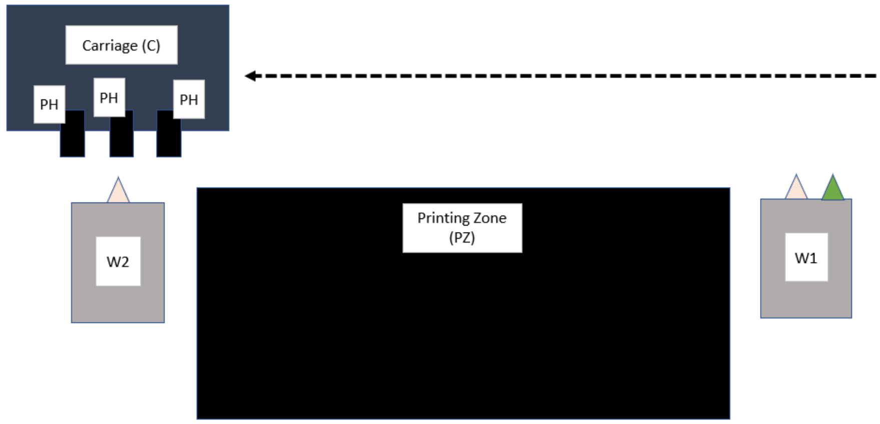
- At the beginning of the life of the consumable.
- Every determined amount of printing passes. The amount is defined based on the evolution of the wear throughout the life and the minimum wear that causes a noticeable reduction in the wiping force, and can vary for different wiping elements.

The execution of the procedure includes the following steps, which are illustrated below in figures 1, 2 and 3 taking as an example the calibration of wiper W2:

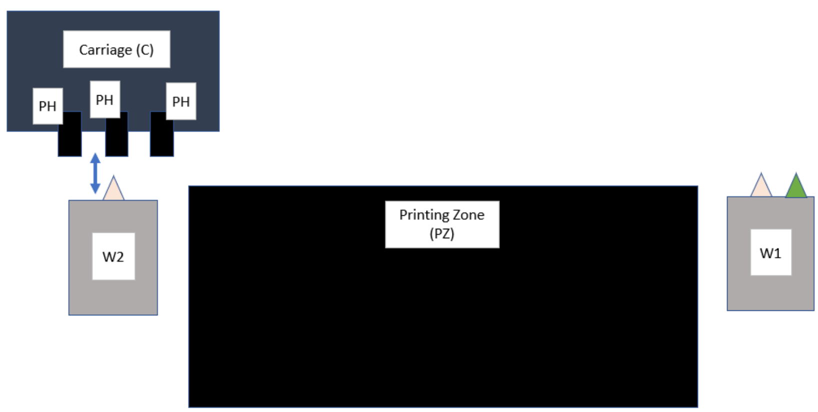
- Performance of a set of free movements (without anything above, Figure 1) of the wiper. In this step, data from the movement of the servo controlling the motor (position and voltage applied) is recorded.



- Movement of the carriage to a position where a printhead stays above the wiper element (Figure 2).



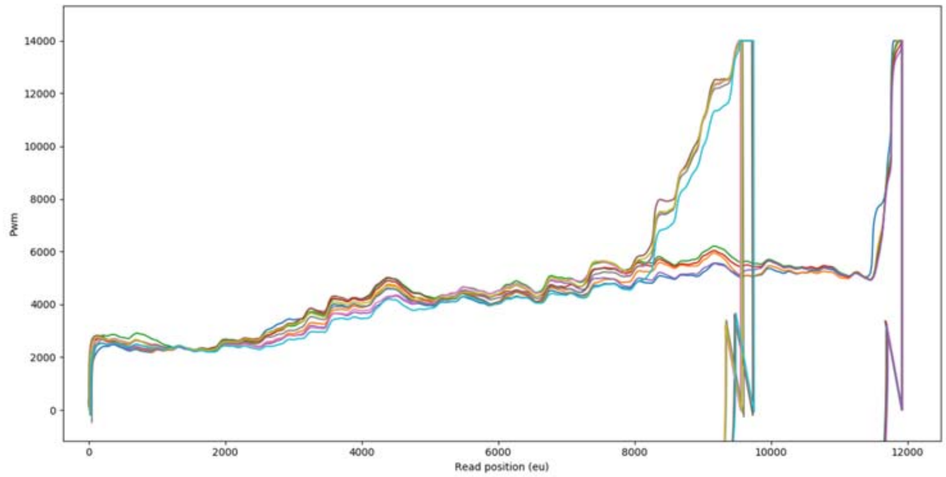
- Performance of a set of movements of the wiper with the carriage in this position (Figure 3), causing interference and a difference in the behaviour of the servo.



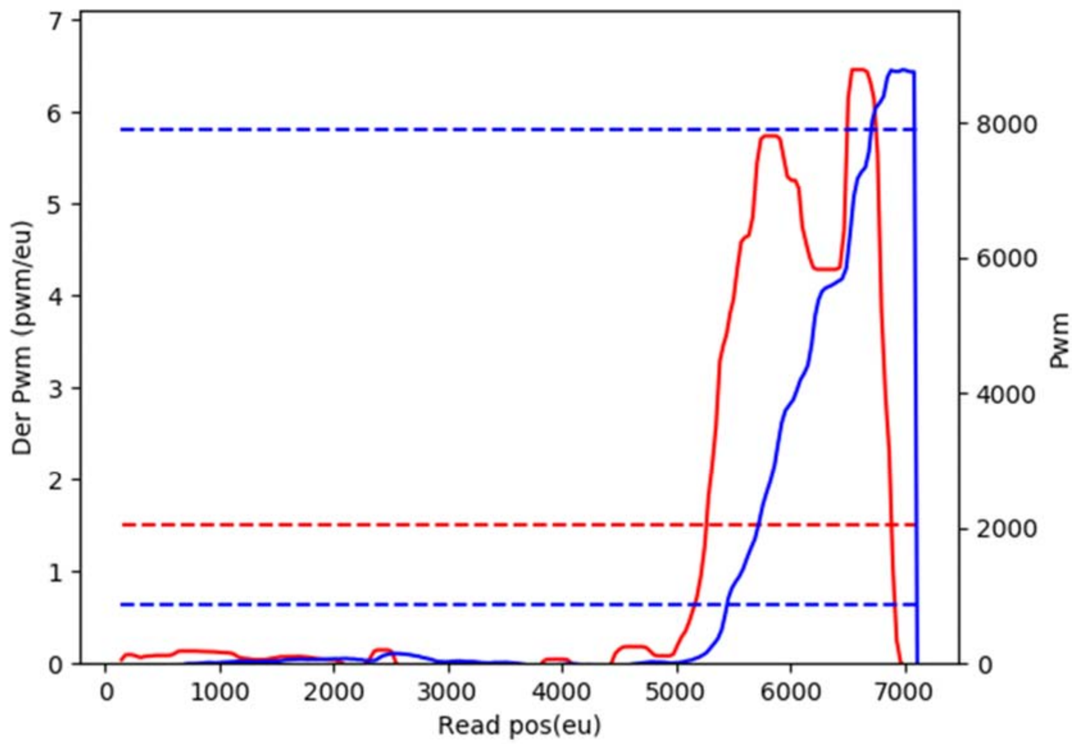
- Execution of an algorithm that, receiving the input of the two sets of data (with and without the carriage above) is able to detect at which point the contact begins.

The steps this algorithm performs are:

- Receive as inputs the two sets of data (wiper movements with and without carriage above). Each set of data contains Read Position – PWM pairs. A sample input data is represented in Figure 4.



- Process the input data in order to (if necessary, depending the particular wiper that is being calibrated) remove the known offset and/or the sign.
- Obtain the mean of each set of values (at this step we have two curves of PWM as a function of Read Position, one for the case without carriage, and the other for the case with carriage).
- Interpolate and subtract the mean of the two sets (at this step we have a curve of Difference of PWM as a function of Read Position, for which a sample is represented in the blue curve of Figure 5).
- Obtain the derivative of the difference.
- Apply filters to reduce noise in the final derivative we will use to compute the point where it begins making contact with the nozzle plate (at this step we have also a curve of Derivative of the Difference of PWM as a function of Read Position, for which a sample is represented in the red curve of Figure 5).



- The point of contact will be computed (Figure 5) as the value of Read Position where the Derivative of the Difference of PWM reaches a certain threshold (red dotted line). This point is searched beginning at the value of Read Position where Difference of PWM reaches a percentage of its maximum (lower blue dotted line) and going backwards or forward depending if at that point the Derivative of the Difference of PWM is above or below its threshold (red dotted line).

This algorithm ensures robustness to noise and friction or motor temperature disturbances, allows to avoid local maximums, adapts well to different curves and rubber stiffness values and has been proven to perform with high repeatability in several different machines.

5. Advantages

The proposed solution isolates the system from disturbances coming from geometrical tolerances of the subsystems or the consumable, the wear of the rubber throughout the life of the consumable, or the human error inherent to a calibration that relies on visual inspection. This way, it ensures that the wiping force applied is always the optimal and minimizes the image quality defects coming from an excessive or insufficient force.

In addition, it achieves this through a process that causes very little pain to the customer, as the automatic calibrations trigger automatically every certain number of printing passes and do not require any input from the user.

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