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SENSORLESS NON-HARDSTOP BASED SERVOMOTOR POSITION REFERENCING

HP INC

Sensorless Non-Hardstop based Servomotor Position Referencing

In a printer, most of the motor drive applications are in relative motion. Often-time though, it is necessary to set a known Reference (usually re-zeroing the position), for applications such as printing (zero against paper edge), or for position limited mechanisms like the service station or carriage (zero against a reference hardstop). For high precision paper motion, zeroing against a position on the encoder disk requires an additional pattern, sensed by an additional sensor, to allow motion compensation against periodic positional errors.

For the case of newer applications, we are looking to use the servomotor to sense mechanism torque changes, to sense me mechanism state changes. These may include the presence vs non presence of media, or flexible members reaching a required position yet, or not.

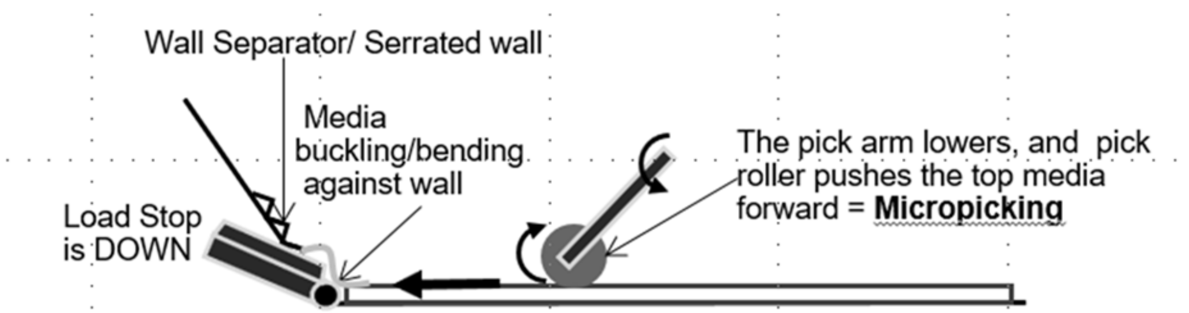

Figure 1: Example of application – Micropicking senses resistance of media against wall

This is accomplished using the servomotor's change in required voltage, as it attempts to maintain a constant speed in the face of varying loads. Simply put, higher voltage for a given fixed speed equates to higher torque/force. A common algorithm looks like this:

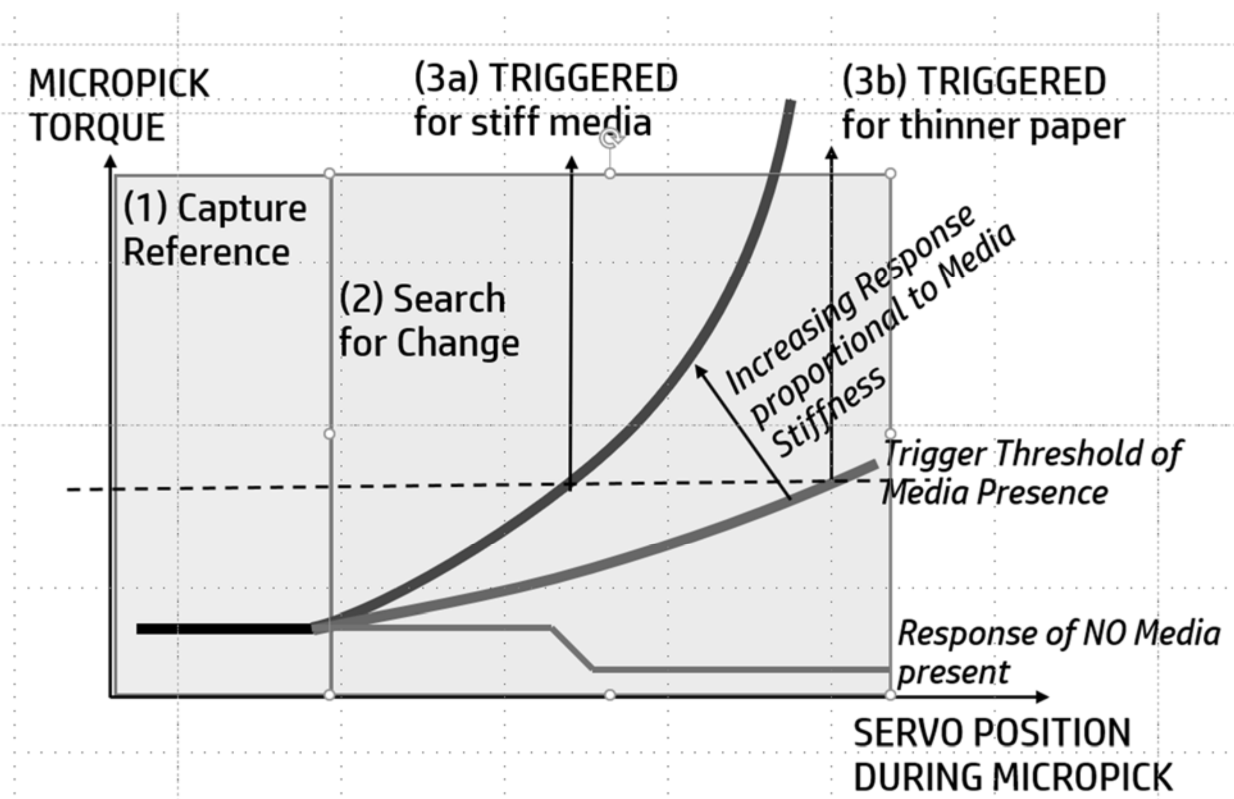

Figure 2: Step by Step description of SENSE algorithm using Torque Change, Step by step from (1) to (3)

The challenge faced in a very recent application, was that due to certain hardware limitations, the drive used for sensing has to also concurrently drive other (parasitic) loads, which induce a very low spatial frequency (relative to size of sensing move). Say, a move that takes say, 10 revolutions, unfortunately is 'polluted' with a parasitic load that has a spatial period of say, 7 revolutions, with an amplitude of comparable torque to the signal that we are using to signify a state change. We run into a problem, because as we attempt to take the reference torque at the first revolution of the move, the servo will have a varying reference at any possible phase angle of that periodic parasitic load. An example of one such load, is a Peristaltic pump, which continues to be driven (though in a lower-torque disengaged state) whenever a Paper Pick move is done, as shown below.

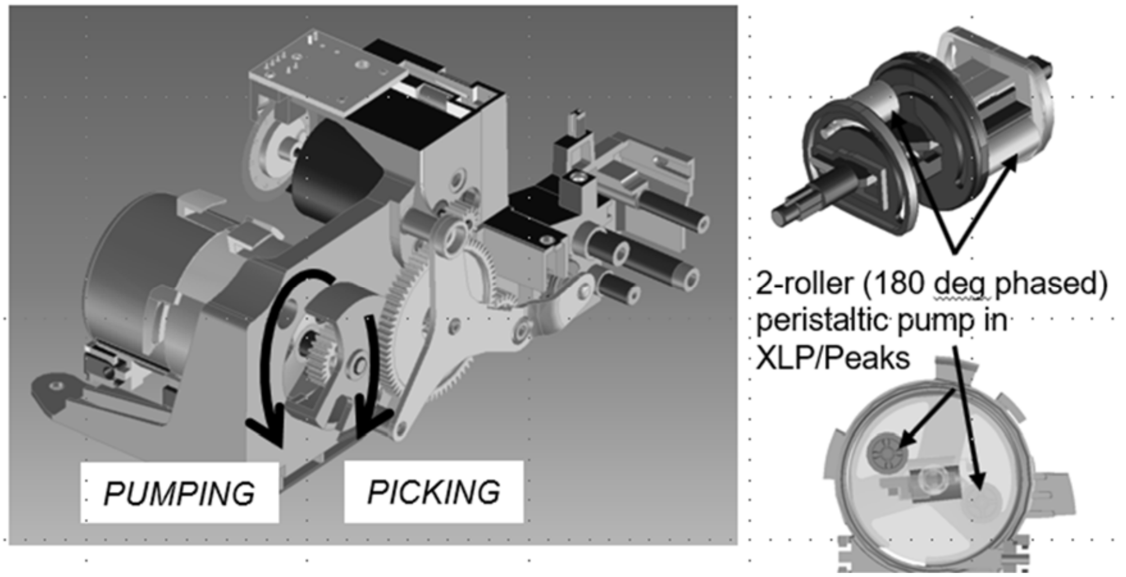

Figure 3: Shared Pick/Pump Drive system, with Pump creating a 2/rev parasitic periodic noise onto torque during picking

In the face of this parasitic load, we can show in Figure 4, that despite having no paper actually in the input tray; however, in 2 different trials, 2 different outcomes appear.

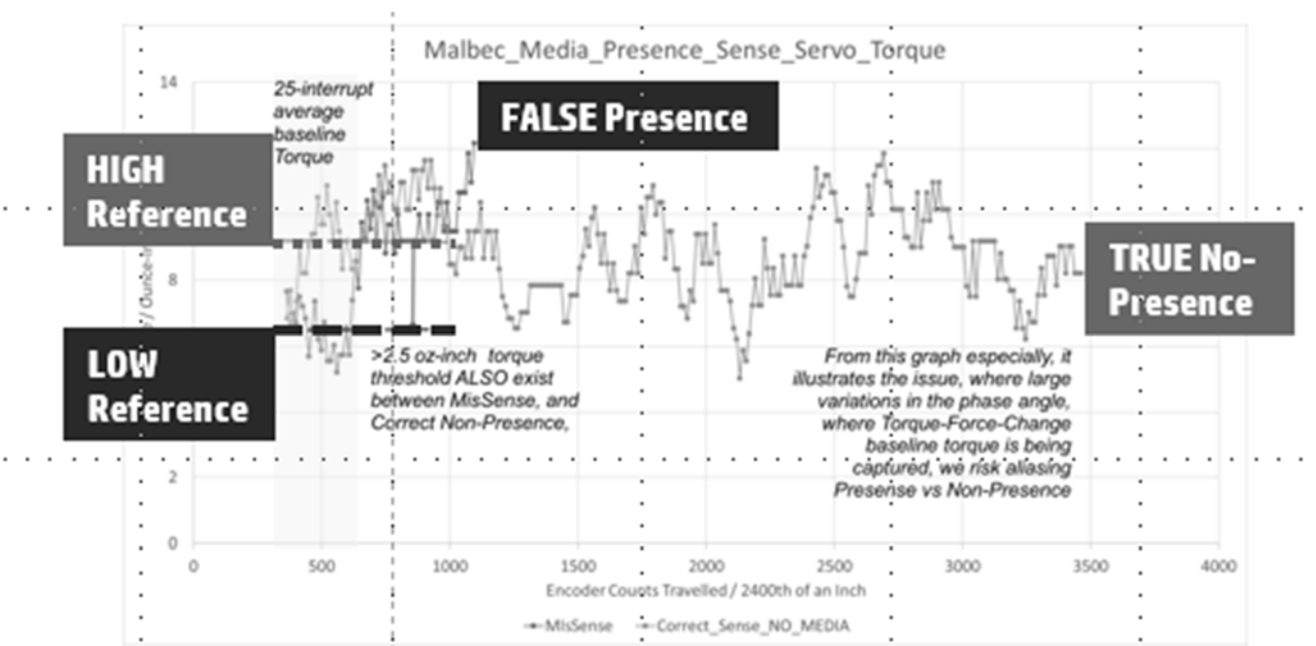

Figure 4: Difference in Capture Reference results in a very different response to trigger

Commonly used software filters are very good in removing high spatial frequency noise. One example is that of a moving average filter. The challenge here however, is to handle low frequency noise – the danger to that approach is that this same filter can also filter out the aperiodic signal, since as far as the (often short) sensing move is concerned, this signal is low frequency.

Therefore, the countermeasure that was put into place for this application in a printer design, was to change the sensing algorithm slightly, as shown below:

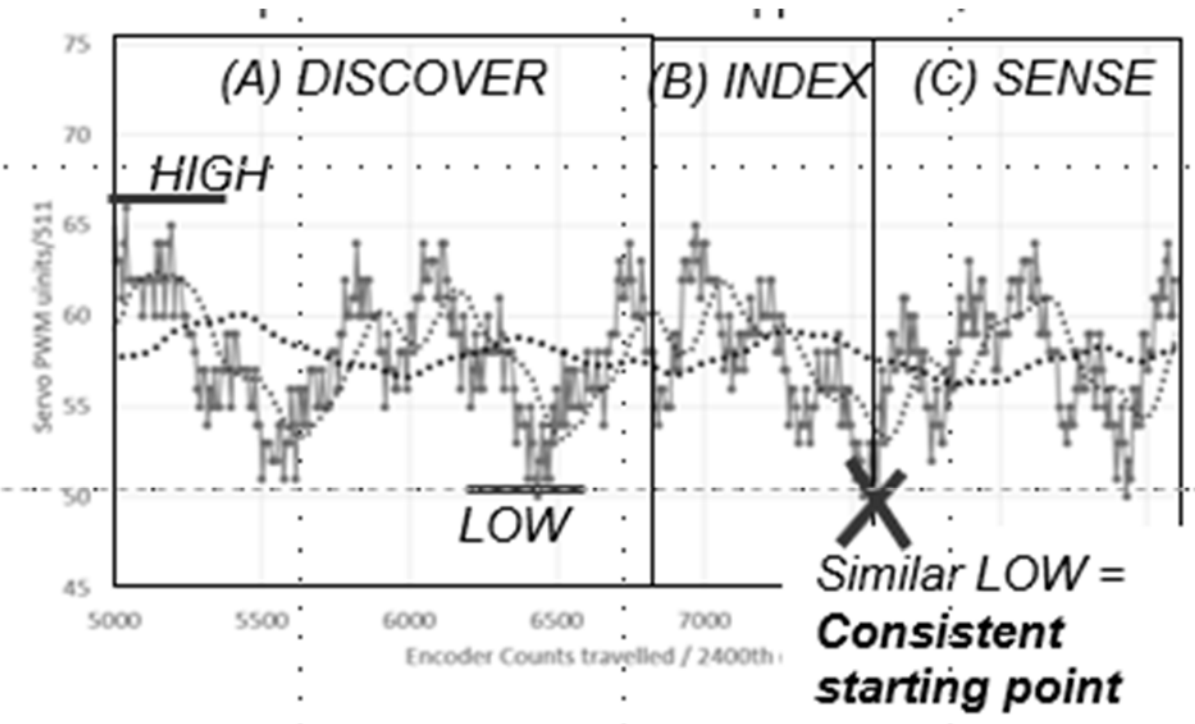

Figure 5: Adding additional Indexing actions (DISCOVER-> INDEX), before the basic SENSEmove

Given that the goal was to be able to handle generic periodic errors, as opposed to assuming a particular form (say a pure sine; or using sine/wavelet signal processing), the indexing algorithm instead, searches for the Maximum and/or Minimum of the periodic disturbance, within say, >2 periods of the parasitic load that causes the largest error. From there, we are able to then start the Torque/Force Referencing phase, at either the Maximum/Minimum points. Since we are now able to perform Referencing at a much more consistent phase angle compared to previously, we can be certain that when sensing is done, it will be more accurate as the signal seen will now be more consistent with respect the reference used.

As shown in Figure 5, we can assume that the entire (DISCOVER->INDEX->SENSE) could be done within a single move; or broken up into separate moves. At the same time, the current embodiment that uses this in an HP design, requires that Indexing is done when mechanism is in a Disengaged State. This is possible, because the parasitic load remains that same there, while being in Disengaged state, the Indexing Sampling move can be made longer (we used x3 spatial periods) to better capture signal Max/Min. Therefore, how this additional 2 actions of DISCOVER and SENSE can be added as per the requirements of the mechanism being worked upon.

Disclosed by Wei Lit Teoh, HP Inc.