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Print Bed Level Measuring in FFF Devices

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Title: Print bed level measuring in FFF devices

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Abstract: This publication relates to a bed leveling measurement which is much faster and at a higher resolution as compared to known methods. The nozzle of the printer is put into contact with the surface of the bed and is then moved between anchor points. By continuously reading the change in e.g. an accelerometer, we can measure the deformation of the bed, since if the bed is higher, it is pushed down, leading to a spike in the accelerometer.

Currently Ultimaker printers are arranged to measure a single distance to the bed at several points. This method employs a capacitive sensor to perform the measurement. As the bed can deform during the print due to the expansion when it is hot, it is needed to measure multiple times in a grid-based fashion. This is a fairly tedious process, as every point that needs to be measured can take several seconds. Improving the resolution of the grid is possible, but comes at a significant time cost. During the leveling, the nozzle must remain hot, which may degrade the material that could be still left on it.

A novel way to increase both the speed and the resolution of the measurements is suggested. For this to work, the nozzle and or bed comprises a vibration/load sensor or an accelerometer.

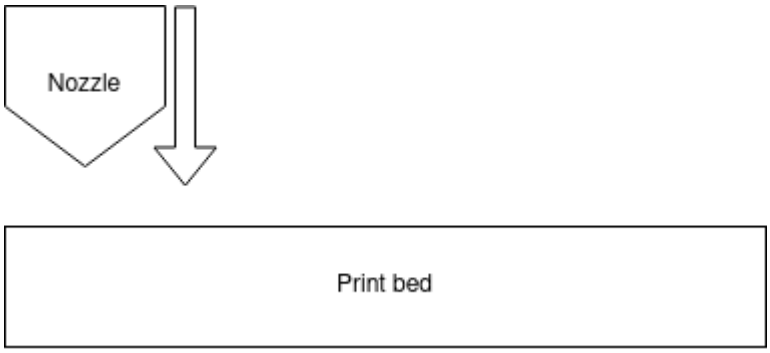
Instead of measuring a grid of points, only 3 points are measured to create some anchor points. This measurement is done with the existing method available on the machine. Once this is done, the nozzle is moved to one of these anchor points. By moving the nozzle down a bit, some tension is created (which should cause a change in the accelerometer). The nozzle is then moved (in a line) to one of the other points, dragging a line. By continuously reading the change in the accelerometer, we can measure the deformation of the bed, since if the bed is higher, it is pushed down, leading to a spike in the accelerometer. If the bed is lower, another spike should be seen in the reverse direction. Since the changes are measured every step the nozzle changes in the XY plane, the resolution of measurements is only limited by the resolution of the XY actuators.

This method only shows the change, but the anchor points have an absolute distance. By starting (and ending) on these anchor points, the distances on every point of the line can be calculated by applying the variations onto the anchor points.

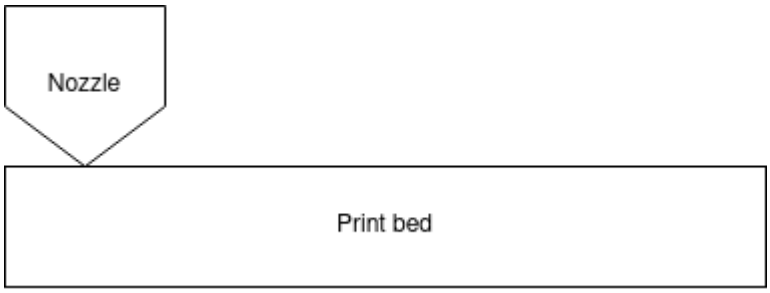
Optionally it something else than the nozzle is used, e.g. a tiny wheel that is moved down for this. Such an implementation, provided it has a spring and a way to measure the distance, would also work. The distance between the wheel and the tip of the nozzle would only need to be calibrated once.

Below some drawings are shown to explain the steps of the proposed method. The long arrows indicate the movement of the nozzle relative to the bed. The shorter arrows indicate the location of the anchor points on the bed. In this example only two anchor point are shown to simplify the explanation.

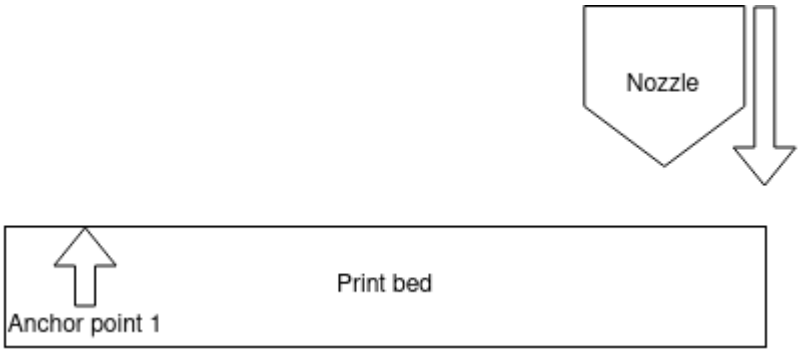
Step 1: Position nozzle above a primary anchor point



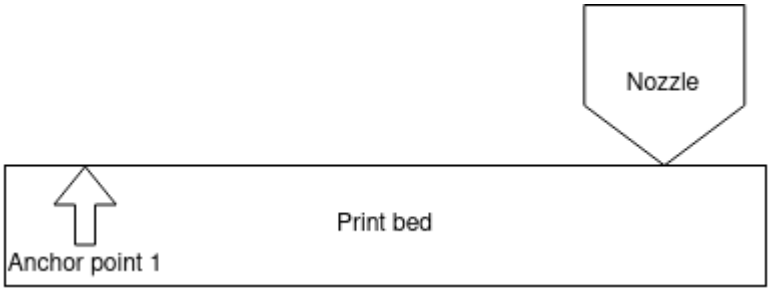
Step 2: Perform the measurement for the primary anchor point



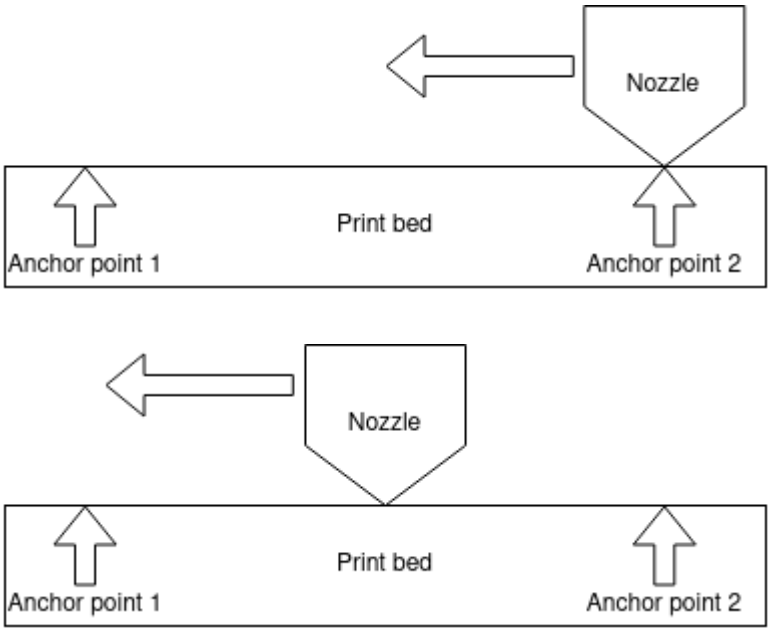
Step 3: Position nozzle above the desired secondary anchor point



Step 4: Measure the secondary anchor point



Step 5: Move the nozzle from one anchor point towards the other while keeping contact between the build plate and the nozzle / measurement tool



Step 6: Keep moving until the anchor point is reached. One could continue moving a bit further to increase the measured area.