Automated High-Range AFM Image Acquisition

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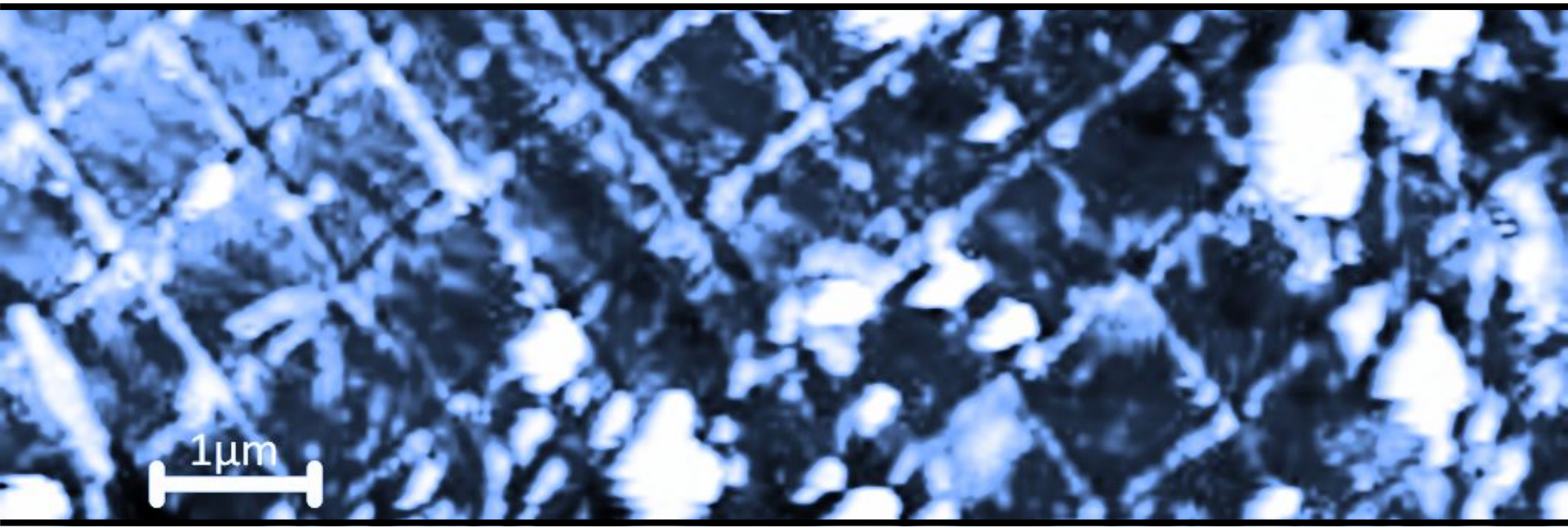

1st Cycle Integrated Project in Engineering Physics - **Scientific Project**

João Francisco Oliveira Camacho (ist1106224)
Supervisor: **Prof. Dr. Luís Humberto Viseu Melo**

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- Software;
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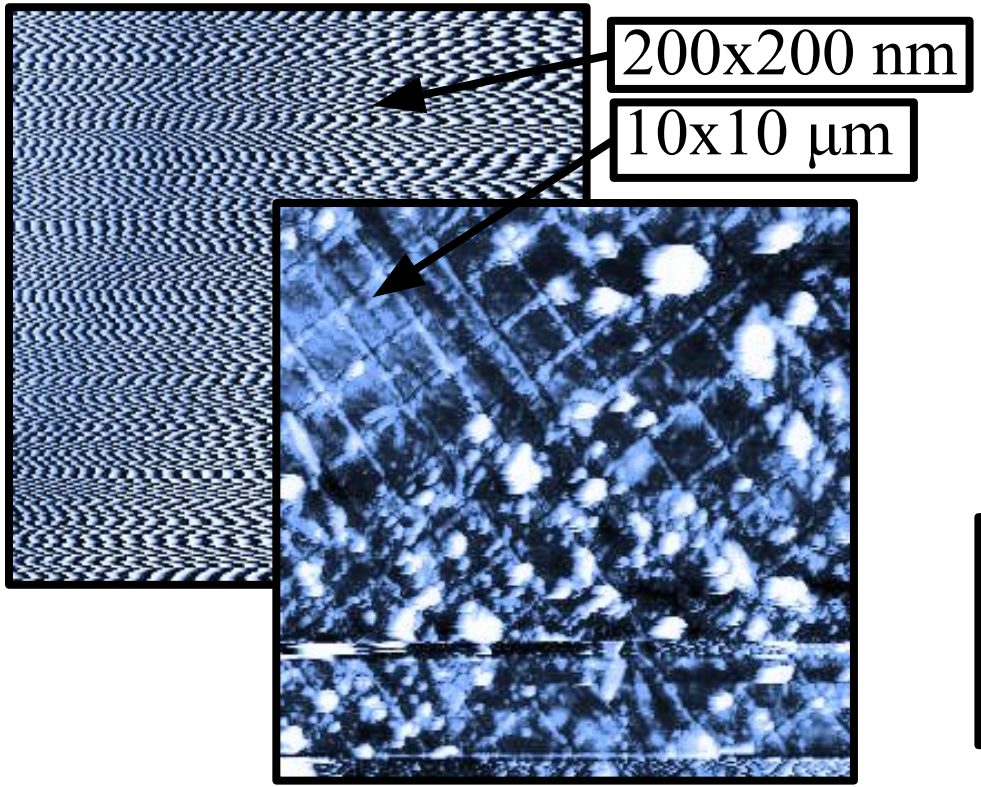
Motivation



AFM is a **local** technique!
(max ~ 100 µm)

Millimetre Range Acquisition ???

Motivation

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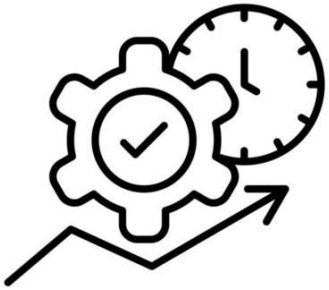
High-Range Acquisition

+Statistical Significance

+Efficiency



+Resolution for high-ranges

Introduction to AM-AFM

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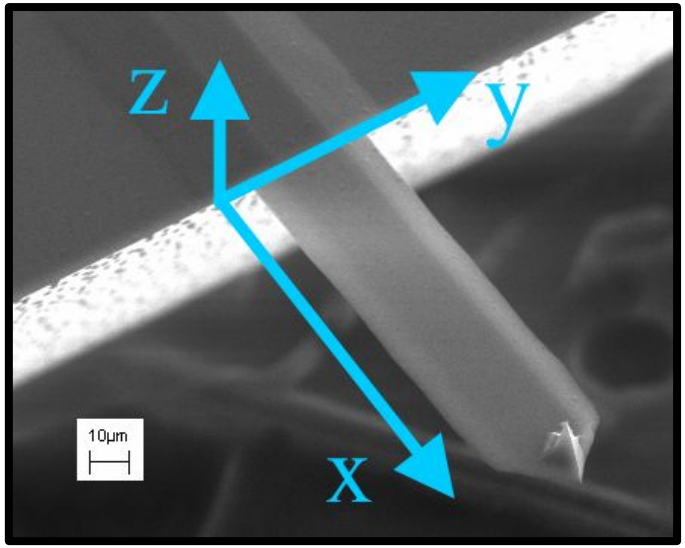


commons.wikimedia.org/wiki/File:Typical_AFM_cantilever.jpg

Euler-Bernoulli Equation

$$EI\partial_x^4 w(x,t) + \rho\partial_t^2 w(x,t) = 0$$

Generalized Euler-Bernoulli Equation

$$EI\partial_x^4[w(x,t) + \alpha_1\partial_t w(x,t)] + \rho\partial_t^2 w(x,t) + \\ + \alpha_0\rho\partial_t w(x,t) = f(x,w,t)$$

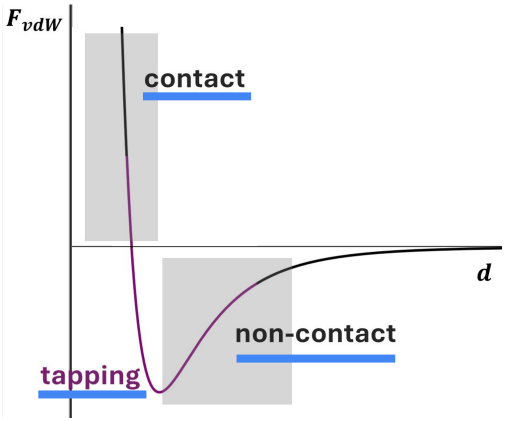
Point-mass model

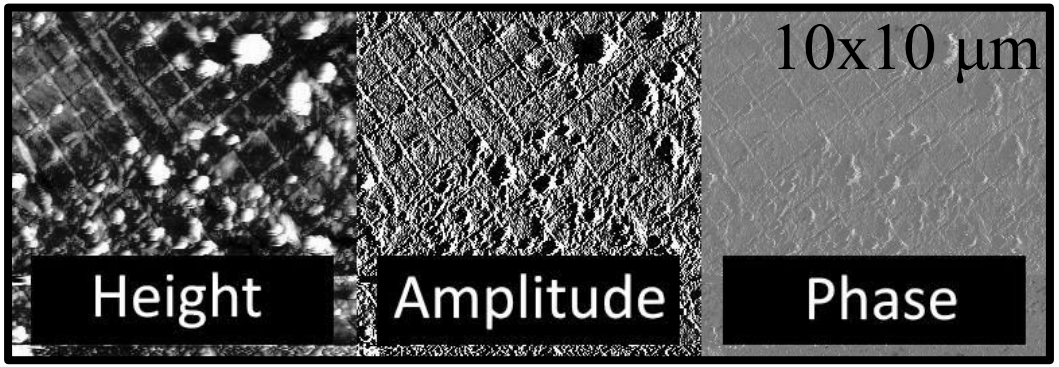
$$1 + cos(k_n L)cosh(k_n L) = 0$$

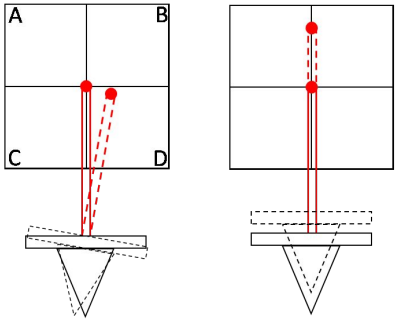
$$k_n^4 = \frac{\rho\omega_n^2}{EI}\ , \gamma_n = \frac{\alpha_0}{2m\omega_n} + \frac{\alpha_1\omega_n}{2}$$

$$\ddot{z}_n(t) + 2\gamma_n\omega_n\dot{z}_n(t) + \omega_n^2 z_n(t) = \frac{F(z,\dot{z},t)}{m}$$

Introduction to AM-AFM



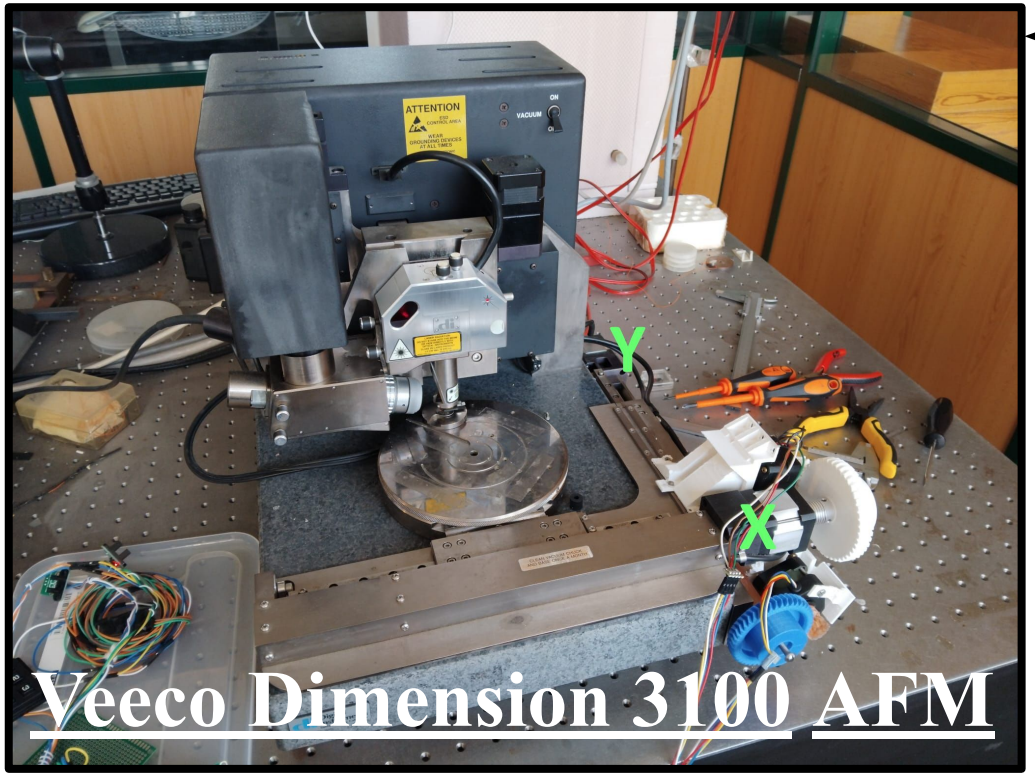




commons.wikimedia.org/wiki/File:Cantilever_movements_and_optical_deflections.png

$$F_0 cos(\omega t) \begin{cases} z_p(t) = A(\omega) cos(\omega t + \phi) \\ A(\omega) = \dfrac{F_0}{m\sqrt{(\omega_0^2 - \omega^2)^2 + 4\gamma^2\omega_0^2\omega^2}} \\ \phi = arctan\left(\dfrac{2\omega\omega_0\gamma_{eff}}{\omega^2 - \omega_0^2}\right) \end{cases}$$

Hardware - AFM



Veeco Dimension 3100 AFM

AFM Computer Unit

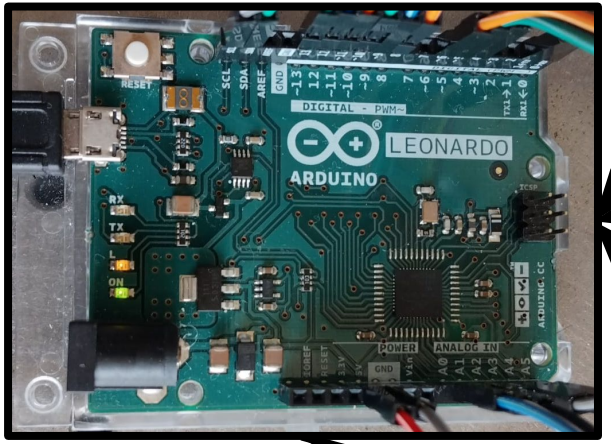
Nanoscope V614R1

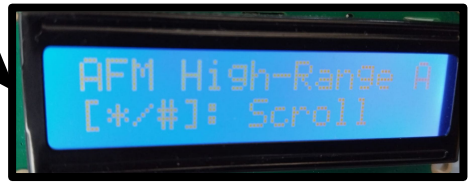
USB

Buzzer

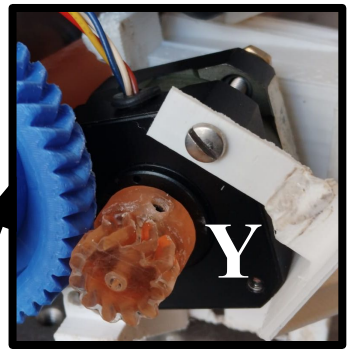
Automation System

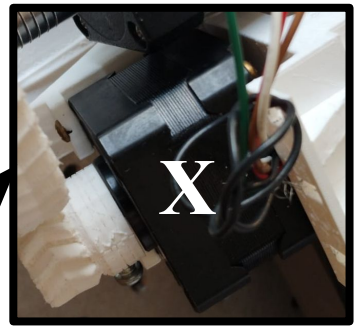
Hardware - Components





I2C





20 D I/O.
12 A I/O.
I2C.
Output 5V, 10mA.
2.5Kb SRAM.
32Kb Flash Memory.
1Kb EEPROM.

Driver Y

Driver X

9V Power Supply

Hardware - Supports

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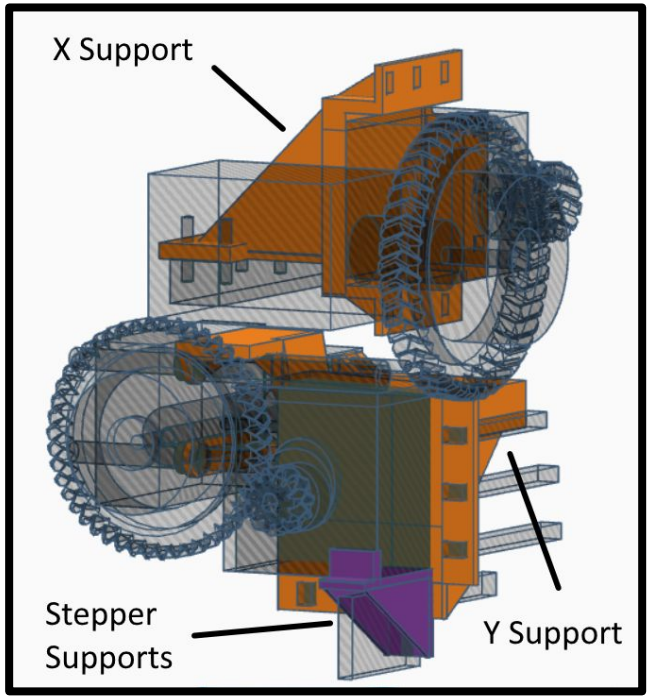

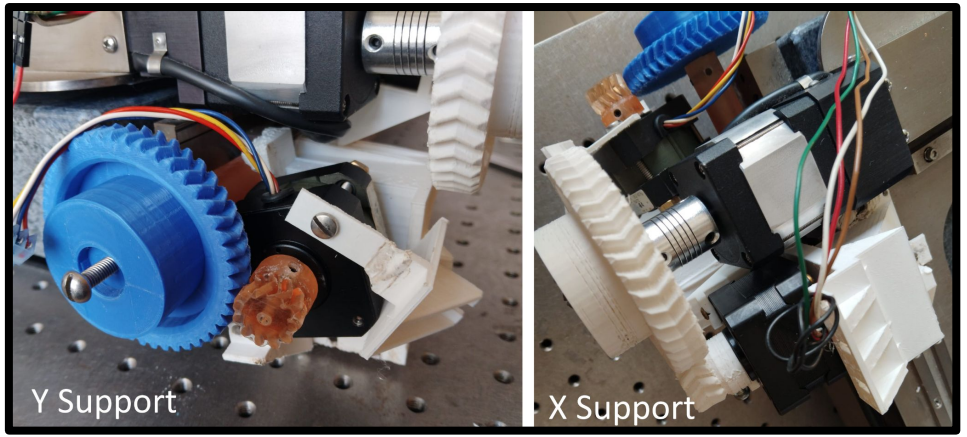

Printed in PLA/resin.

PLA - Creality Ender 3.

Gears from prev. works: GR=11/45

https://www.hardware-x.com/article/S2468-0672(23)00054-8/fulltext

Hardware - Box

~110,63€

Not accounting for screws, drills, solder, …

Software - Features

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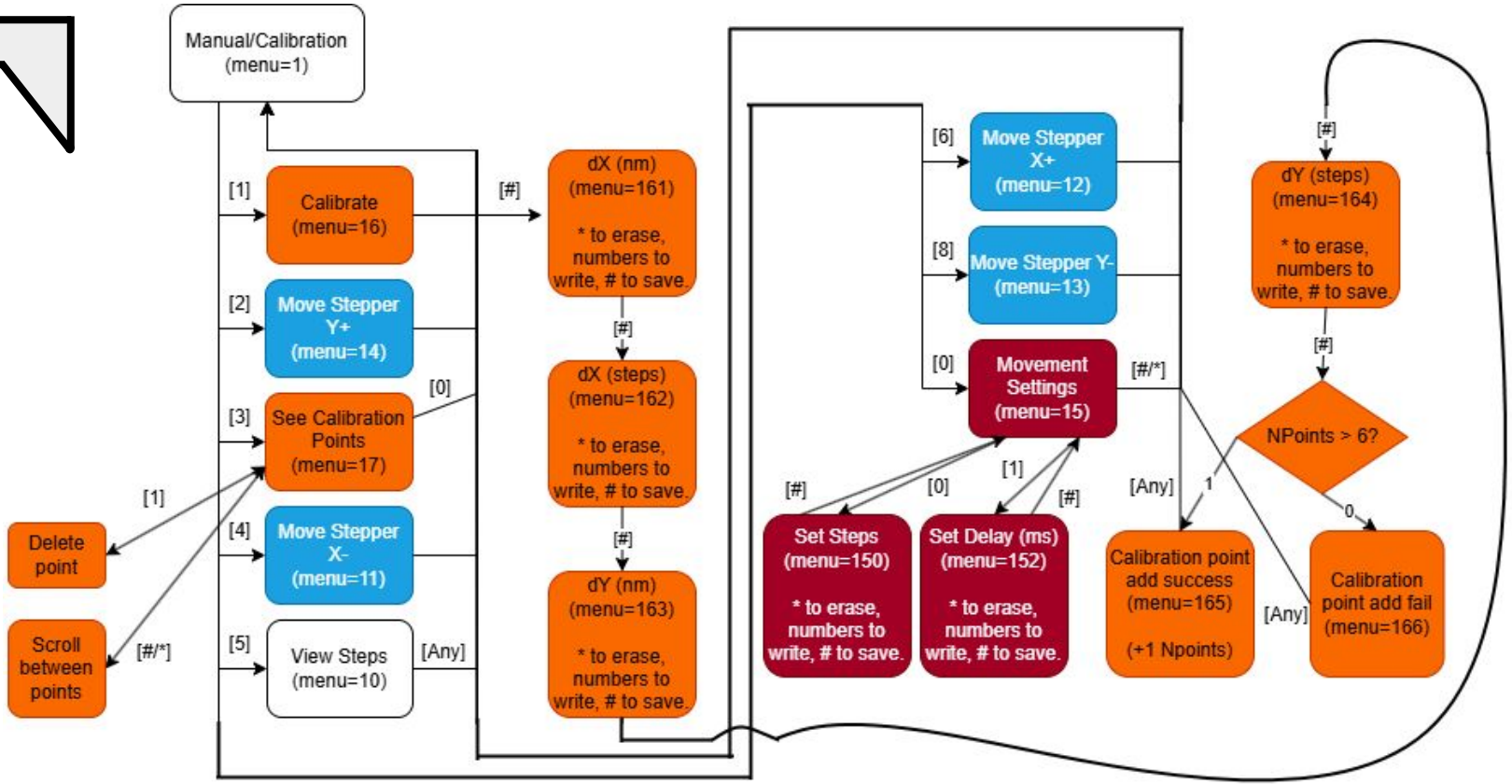
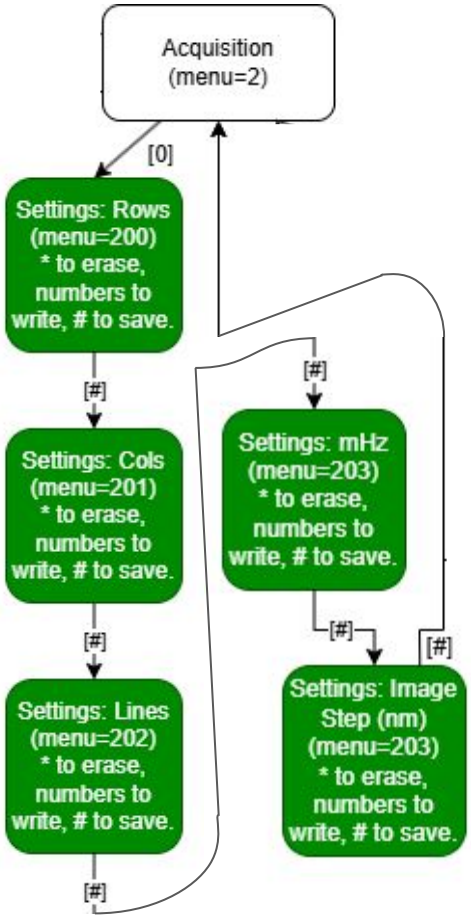
- Manual Control
- Calibration
- Automated Acquisition
- Text Scrolling
- EEPROM

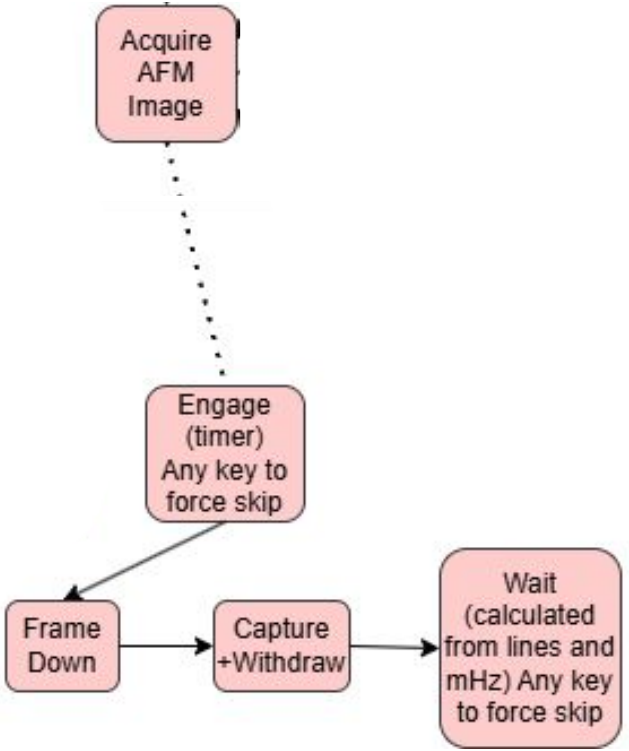
lannisraurus/afm-tools
@ GitHub

Software - Flowchart Diagram

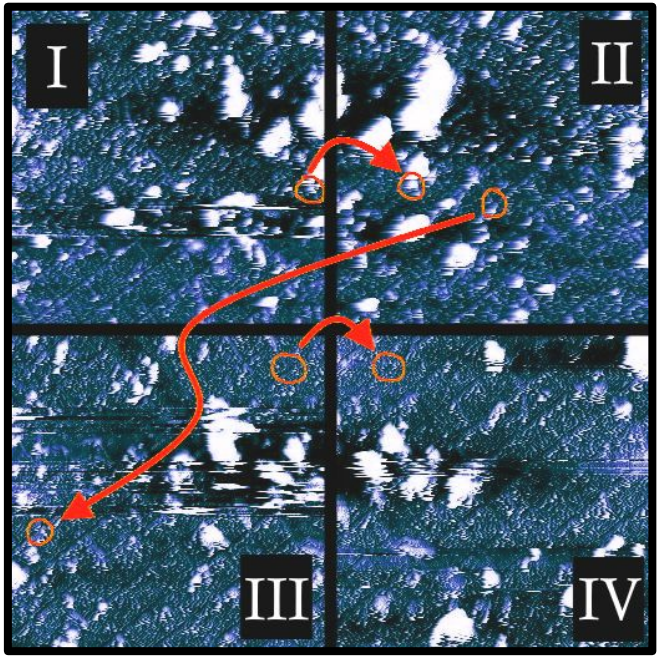


Software - Flowchart Diagram





Issues and Suggestions



$3.04 \pm 0.93\ \mu m/\text{full-step}$

$\Delta d = \Delta\theta_d G_{ratio} R_{linkage}$ | $\Delta x = 1.76\ \mu m$

~~Y Motor~~

~~X Microstepping~~

Use Engage Buzz

Kickback Compensation

Rotary Encoders

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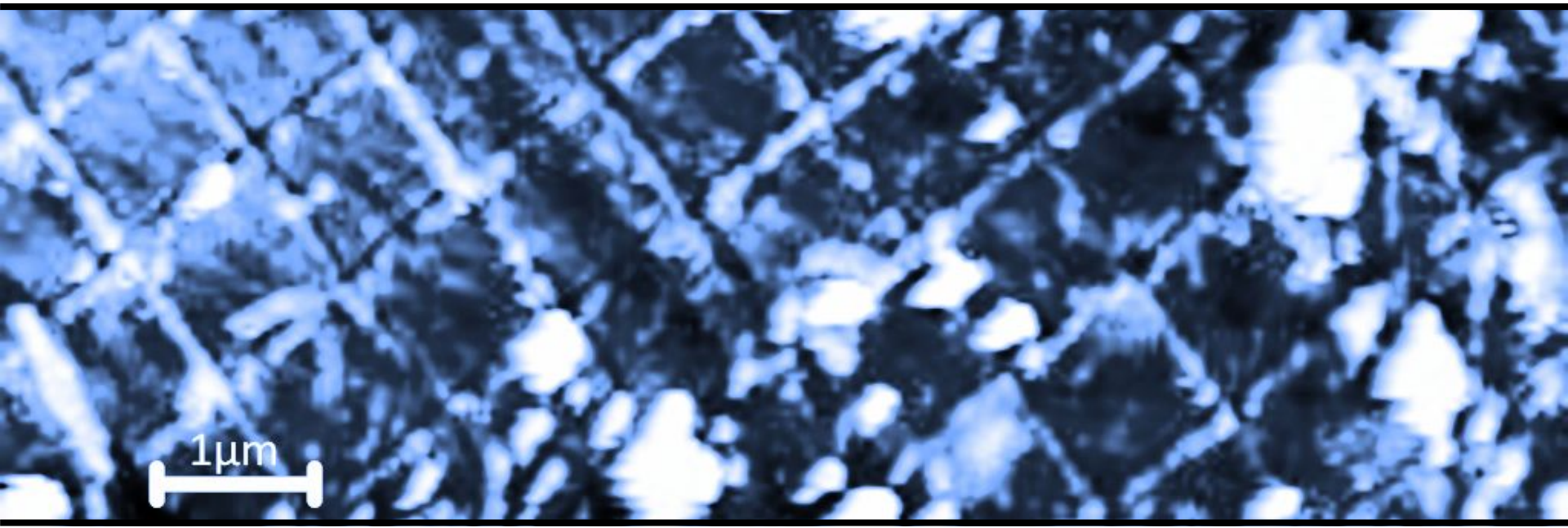

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