

Writing Craft Example

As a scientist, you don't just need to do good science, but you also need to communicate it well. The work we'll do with Alley's text, *The Craft of Scientific Writing*, will help you to identify and correct errors that weaken scientific communication. By way of introduction to this work, here's an example of bad scientific writing that I encountered. In it, there are many sins of poor communication: grammatical errors, needless jargon, abbreviations without definitions, inconsistent expositional strategy, inconsistent notation, pretentious word choice, needlessly passive tone, non-parallel labels, extraneous information, logical gaps, and an abstract figure with an un-informative caption. Only the brightest stars in this constellation of errors may catch your eye, but the composite effect is all too noticeable – the excerpt is far more difficult to read and understand than it needs to be. Following the original excerpt is a possible rewrite that addresses most of the flaws. I think you'll find it contains the same information, but is much easier to read and understand. The moral is, scientific writing doesn't have to be bad, and our work with Alley's text will help you to be the best writer you can.

Original Version

There are several methods for maintaining the tip-sample distance. In this paper, we only discuss amplitude modulation. This method is depicted in Fig. 3. In amplitude modulation, QTF is excited by a constant drive signal in which a_d and f_d are constants, and the tip contacts the sample intermittently. Then QTF produces signal $U_q(t)$. Controller uses the amplitude $a_q(t)$ of $U_q(t)$ to adjust the length of PCT in order to keep the tip-sample distance constant. Thus the detector output signal $S(t)$ is proportional to $a_q(t)$. In the controller, a conventional proportion-integration-differentiation (PID) control algorithm is utilized to adjust the length of PCT. This algorithm (Equ. 3 and Equ. 4) is widely used in automatic control.

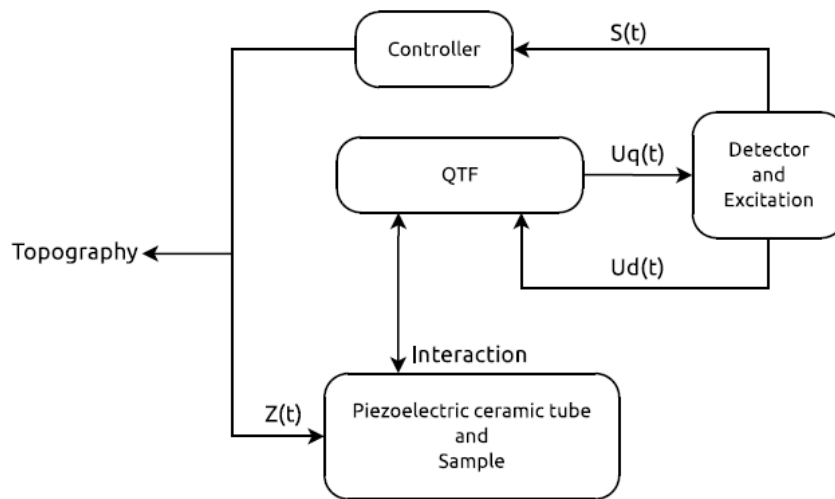


FIG. 3. Schematic of AFM operation.

$$Z(t) = K_p e(t) + K_i \int e(t) dt + K_d \frac{d}{dt} e(t) \quad (3)$$

$$e(t) = a_{setpoint} - S(t). \quad (4)$$

The PID controller calculates the error value from the difference between the signal $S(t)$ and the desired setpoint, and reduces the error by solving the Equ. 3 to generate $Z(t)$ and adjusting the tip-sample distance accordingly. The three parameters k_p , k_i and k_d in Equ. 3 are set by the teacher or by the students before the AFM scans the sample. In Equ. 4, the constant $a_{setpoint}$ is the desired value of amplitude used to maintain the tip-sample distance. Before performing the experiment, the students should become familiarize themselves with the PID algorithm. In class, the teacher could ask how the algorithm controls the tip-sample distance and how the parameters should be set for better controller performance. Generally, $Z(t)$ controls the length of the piezoelectric ceramic tube (PCT) and the length of PCT is proportional to value of $Z(t)$. Therefore, topography is obtained by sampling $Z(t)$ during scanning.

Rewritten Version

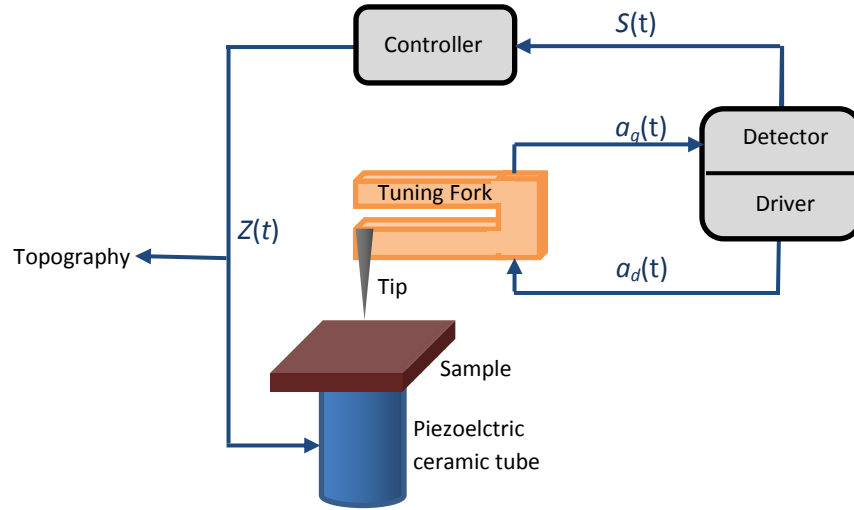


Figure 3. Schematic of AFM feedback loop. The feedback loop maintains a constant tip-sample separation.

As discussed in section A, a constant, sinusoidal signal of amplitude $a_d(t)$ drives a tuning fork with a tip attached, and variations in the tip-sample separation lead to variations in the amplitude of the tuning fork's oscillations, $a_q(t)$. By monitoring and correcting for these variations, the negative feedback loop (illustrated in Figure 3) maintains a constant tip-sample separation. To understand how the feedback loop functions, consider what happens when the tip scans across a depression in the surface. As the tip-sample separation grows, the Detector registers a change in the amplitude of tuning fork's oscillation, $a_q(t)$. The Detector's output signal, $S(t)$, is proportional to this amplitude, so it changes in response. The Controller then compares this signal with a desired signal, $S_{setpoint}$, which corresponds to a desired amplitude and, in turn, a desired tip-sample separation. The difference between the two signals defines the error signal;

$$e(t) = S(t) - S_{setpoint} . \quad (3)$$

With the tip over the depression, a significant error signal, $e(t)$, is generated. The Controller's output voltage, $Z(t)$, depends upon this error according to

$$Z(t) = k_p e(t) + k_i \int e(t) dt + k_d \frac{d}{dt} e(t), \quad (4)$$

in which the three parameters, k_p , k_i , and k_d , can be set by the user to dictate how strongly the voltage varies *proportional* to the error signal, *proportional to its integral*, and *proportional to its derivative*, respectively. The controller applies this voltage, $Z(t)$, to the piezoelectric ceramic tube that is beneath the sample. In response, the tube moves the sample toward the tip until the error signal is eliminated and the original tip-sample separation is regained. Thus the tube will have moved the tip up just as far as the surface dipped down. Similarly, if the tip had moved across a bump on the surface, the feedback loop would have generated a voltage that shrank the piezoelectric ceramic tube, and moved the sample down as far as the surface bumped up. Since the tube's extensions and contractions vary linearly with the applied voltage, recording that voltage as a function of the tip's position across the sample's surface is equivalent to mapping the surface's Topography.