EVERYTHING YOU WANTED TO KNOW ABOUT MICROSTEPPING BUT DIDN'T KNOW WHO TO ASK!

Microstepping? What the heck is that? Good question and I even know what your next question is, why microstepping? Firstly let's look at a basic stepper motor driven in full step mode.

Full step mode is when each coil is switched on sequentially and the rotor will move from each discreet detent position to the next. This is what most people will think of when someone mentions stepping motors. Sounds logical doesn't it? Most motors are offered with 200 steps per revolution, i.e. 1.8 degrees per step, if you flip through product brochures this is what you will see for all the motors that we are likely to deal with. Small stepper motors are often 7.5 deg. per step, this is because it is difficult to manufacture them any other way. "But!" you cry, "Why don't we make motors with 400 steps per revolution, or even more, then the resolution of our system will be better!" Yes indeed, why not? The answer at it's simplest level is that we don't need to make motors with more than 200 steps per revolution, we can make the motor think it has 400 or even more steps per revolution electronically (don't you wish sometimes there were other things we could change just as easily?).

Now, that's great but how do we make the motor think it is something that it isn't? "Einstein, take one step forward please!", no, it really isn't that difficult, we know that if we switch each coil on sequentially then the motor will move from one step to the next, what if we were to switch two adjacent coils on at the same time? Surely then the rotor will move halfway in between the two coils? Correct! Now I see, we switch one coil on, then the next and it moves half a step, then switch off the first coil and it moves the full step, "Great!"

This is great if all you want to do is move at half the resolution and many simple drives (mostly unipolar) offer this half stepping technique for free. Remember though that there are times when two coils are switched on and so your current used and the heat generated is double.

Now this is good but what if we require more than 400 steps per revolution? We use a similar technique, but instead of switching the coil completely on or off we switch it a little bit on or off! Understand? No I didn't think so! The magnetic field strength is proportional to the amount of current flowing through the coil, if we vary the amount of current we can control the field strength, if we vary the field strength between the two adjacent step positions we are able to drive this rotor anywhere between the two, this would give us an infinite number of steps but in practice however we usually settle for a number of discreet positions. The common microstepping ratios are 1/2, 1/4 and 1/8 of a full step, these are common and the reason is that the counting is usually implemented with digital electronics and it is easy to count digitally in multiples of two. The newer drives having more modern and compact electronics allow for 1/10 of a full step to be implemented. This makes the math very easy when deciding the leadscrew ratios. (Remember we count in multiples of 10 but computers count in multiples of 2!)

The technique that I have just described holds well for both unipolar and bipolar drives, the difference between the two is that the bipolar drive doesn't switch the next coil on, there is only two to begin with but reverses the direction of the current in the other and so tends to 'push' the rotor to it's next position rather than 'pull' it. There are drives available that offer up to 1000 microsteps per full step but to be honest this is completely impractical unless you have an encoder fitted as the mechanical friction and hysteresis in the system will prevent the motor from actually moving from one position to the next.

Good, now that we know what microstepping is, why do we want microstepping? Simply put, we can improve the resolution of our system with out having to gear the output shaft, and we can position more accurately without loosing the speed that a reduction unit will penalize us with. The other reason and one that is not immediately apparent is the reduction is resonance that the full stepping imposes on our system. All mechanical systems will have a frequency at which they will vibrate naturally, should we be so unlucky that this natural frequency is close to the frequency that the steps of the stepper motor driving it are, then the whole system will resonate and in the worst case mechanical damage may result, at best we can expect the stepper motor to loose synchronization with the driven signal and we won't know where we really are. The natural frequency of vibration is usually quite low for the mechanical systems that we are likely to encounter, driving the stepper motor with microstepping increases this apparent frequency that we drive it with and hopefully we will move further away from this natural frequency and have less likelihood of resonance.

This does come at a small price however, to maintain the same output speed we need to drive the step signal faster, if we have 10 microsteps per full step then we need to increase the speed of the step signal by 10 times. If we have a dedicated controller that can offer these increased step rates then we are fine but if we are driving the system from the PC printer port (like so many low cost or hobby systems) then it is unlikely that we can achieve the increased step rate. Printer ports can seldom manage over 25 KHz, 50 KHz seems to be about the limit on ISA bus printer cards, despite what some programs say they are capable of.

Usually you have to pay extra for a drive that offers microstepping but Geckodrives offer this feature for free! Tell your friends about this! (Remember, head high, shoulders back, "My Geckodrive…."

However if you want full stepping or half stepping then you pay the extra, odd isn't it. The reason for this is that all Geckodrives are inherently 10 microsteps per full step. You cannot get them any other way. To get the full and half step ratios, a clever little board that plugs into the drive takes your incoming steps and multiplies them by a factor of 10 (full steps) or 5 (half steps) or 2 (5 micro steps). This may seems odd but really it is quite clever and very useful.

Firstly it means that the resonance problems we looked at earlier are reduced because your system is always driven in microstepping mode even if you think you are full stepping.

Secondly, because the drive's timing requirements are quite strict i.e. how long the step pulse must last for and how long to leave between steps this little board sorts all that out for you. It has a counter on the incoming side that keep's track of how many steps are received and how many have been made, it makes sure that your motor is never far from where it should be.

The third and possibly more subtle but even more important advantage to this, is when the step stream from the computer is irregular or inconsistent, as many Windows based systems are, this clever little board 'smoothes' out these uneven pulse and makes sure that your motor will operate smoothly. This sounds nice until you realize that what we mean by smooth is reduced noise from the motor and a machine that won't jerk or oscillate when you don't want it to, remember the resonance issues we spoke about earlier? Well this is the slam dunk to your resonance issues.

We have seen how advantageous microstepping is to our systems and really everyone should use it to minimize the problems you are likely to encounter when operating your machine. Remember-keep it smooth for best results.

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