Saving Time with Auto-Tuning Drives

Auto-tuning drive software is becoming more sophisticated than ever, making it easier than ever to save time in the face of talent shortages.

Alex Cannella, News Editor

Many of Yaskawa's products, such as the Sigma-7 servomotors (pictured here), come with 24-bit encoders, which are pushing the boundaries of what Yaskawa can do in the realm of auto-tuning.

If there are two things that are in tight supply in the industry, it's time and talent. Manufacturers are always pressured to do more faster, and the industry is producing fewer experts to help them do it, so the industry's had to get crafty and find what time-cutting procedures they can.

In such an environment, an auto-tuning drive's appeal is self-evident: instead of tinkering around with a drive for a few days to get it whipped into shape, just let the drive do it itself in a matter of hours. It not only takes less time, but also requires significantly less expertise than tuning a motor manually does. No muss, no fuss; just hit a button and the drive will take care of it for you. It's a straightforward and sensible pitch for manufacturers strapped for time and/or expertise.

"You don't need to be a seasoned motion control engineer that has been dealing with these things for 10 or 15 years," Scott Carlberg, Yaskawa's product marketing manager, said. "It's very simple to apply."

Auto-tuning drives themselves are nothing new. According to Joaquin Ocampo, Bosch Rexroth's product manager for electric drives and controls, the company's been utilizing them since before he started working at the company 17 years ago.

"This is something I really take for granted…" Ocampo said. "I just hit the enter button and everything's good to go."

But depending on how precise you need your drive to be, auto-tuning drives may not have historically been sophisticated enough to follow through on their promise. According to some, such as B&R Industrial Automation's Solutions Engineer, Derrick Stacey, they still aren't enough for high-end applications that require extreme precision. He sees auto-tuning's benefits differently, as a quality assurance tool that pays dividends down the road.

"It only knows what you tell it at the start," Stacey said. "You have to give it the best possible start position, and then as it sees how it's operating and changes in operation, it can make intelligent decisions to adapt its tuning loops and increase or decrease the forward parameters."

If it isn't apparent yet, the auto-tuning drive's place in the industry is something everyone has a different opinion on. While they may be a regular presence in the industry that some use without giving much thought, everyone seems to disagree on their exact function, and so that begs the question: when will you benefit from using an auto-tuning drive?

According to Ocampo, auto-tuning drives can save you an hour of labor here or there during setup, but they're sometimes not even necessary. While third-party motors can still necessitate some setup, Ocampo noted that many of Bosch Rexroth's systems already work together well enough that auto-tuning often isn't required.

"With [Bosch Rexroth's] systems, auto-tuning is not necessary," Ocampo said. "Hard to believe in some cases, but I would say, if you want a number, like 99 percent of all the applications work straight out of the box when you put the motor and the drive together as long as it's sized correctly."

Carlberg, on the other hand, has seen Yaskawa's auto-tuning algorithms pay out great dividends in saved time with some of the company's customers.

"We get customers giving us feedback that 'hey, you know, we did everything that used to take us two weeks, we're doing it now in two days,'" Carlberg said.

Auto-tuning's effectiveness largely comes down to how

precise your application requires your drive to be. Auto-tuning drives are by no means infallible, and the more precision you require, the less benefit you're going to see from them. The highest end applications can still benefit from auto-tuning drives to get in the ballpark of where they need to be, but an expert is still going to have to go in and fine tune the drive further.

"In most applications, that level of tuning is not the most you can get out of these servo systems," Carlberg said. "But in the majority of applications, it's good enough. It's so easy to just leave it in that adaptive mode. A lot of our customers are really leveraging that and using it as a selling factor."

"With the use of three or four different auto-tune methods, you can get yourself in a pretty good spot," Stacey said. "And then only sort of really rigorous requirements would require you to do a lot of hands on work...You have to define where you are...Do you need sub-micron position accuracy? Are we talking sub-millimeter? Are we talking within a few millimeters?"

But like everything else automation-related in the industry, auto-tuning drives are getting more sophisticated by the year, and they've come far enough along that it may be worth taking a second look. According to Carlberg, advances in processing speed have opened up new avenues for Yaskawa to develop more and increasingly complex auto-tuning software that is not only more accurate than past iterations, but can also maintain and preemptively adjust a drive's performance as it works.

"The main thing that's allowing us to create some of this new technology is processing speed," Carlberg said. "As all the servo companies are developing new products, the microchips get faster and faster, the processors get faster and faster and smaller. So really, the motion control industry's kind of been able to leverage that additional power and throughput to create some really cool stuff."

Amongst that "cool stuff" are several motion control algorithms that come standard on Yaskawa's amplifiers. Some of their algorithms, such as their Tuning-less Mode, fill fairly standard auto-tuning roles. When a drive is connected with Tuning-less Mode activated, it is constantly communicating with one of Yaskawa's 24-bit encoders to detect the drive's load inertia, then automatically adjusts the drive's tuning gains to optimize it for that level of inertia.

"A lot of our customers are leaning towards that instead of going in and kind of fine-tuning the system," Carlberg said. "It makes it so much easier for a machine builder because every machine that a machine builder makes, they're going to have variances in the mechanics. This essentially just kind of takes care of that. You don't have to spend a week commissioning the whole machine before you ship it out. You just set this up in the Tuning-less Mode, and then it kind of just works. You don't have to spend a bunch of time with it."

Many of Yaskawa's motion control algorithms are available across most of their products.

Tuning-less Mode also accounts for the inevitable wear and tear of a machine's continued use, adjusting drives over time to allow them to continue operating as well as they did when they were first installed, and can track sudden changes in load. If, for example, a robotics arm in a production line were to pick something up, Tuning-less Mode can notice the change in the load and automatically compensate.

Stacey has noticed similar offerings to Yaskawa's Tuning-less Mode appearing on the market in recent years, and pointed it out as one of the primary and most noticeable ways auto-tuning drives have advanced in recent years.

"The drives are smart enough to adjust their filters," Stacey said.

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"So as systems wear, or the system response changes, you can actually adjust where a filter would exist…Something like that was nonexistent five years ago."

Some of Yaskawa's other algorithms fill more niche roles. The vibration suppression algorithm, for example, hammers out a machine's resonance points in real time. When working manually, engineers need to test and plot out where a drive's resonance points are, then apply a number of filters in the software to try and diminish them as much as possible. Yaskawa's vibration suppression system takes the entire process and automates it, gathering the data and setting filters as it locates vibrations without ever having to even turn the drive off.

"As your machine's moving, it detects exactly where these disturbances are, and it's setting notch filters, anti-resonance filters, anti-vibration filters at different frequencies," Carlberg said. "It's setting these filters up automatically to do all that for you. What traditionally could take a few days in the past, it's doing all that automatically."

Yaskawa has also developed an algorithm for recording errors. When all else fails and an error occurs in a drive, Yaskawa has an algorithm that records what state the drive was both prior to and immediately after the error occurred. This prevents technicians from having to replicate an error to see what caused it, saving both time and sanity when trying to pin down the source of the error.

"We're constantly recording the state the product's in for a certain amount of time that's user definable…" Carlberg said. "Whenever an alarm occurs, the amplifier has a snapshot of some amount of time previous to the alarm and just after the alarm occurred, and you can pull that up after the fact."

B&R has developed their auto-tuning software in other directions. One primary difference between them and other companies is that they've put the tuning information in the PLC instead of the drive itself. That way, if a drive is replaced for whatever reason, a new drive can take its place, upload the old drive's tuning information from the PLC, then pick up exactly where its predecessor left off.

"Some other manufacturers may require you to plug into your ethernet port or serial port directly on the drive and then set up each individual drive," Stacey said. "We wanted that to be a thing of the past, and we actually focus on everything being managed by the main controller."

One other additional benefit Stacey has seen recently has been developed thanks to the increasingly prevalent technologies that fall under the Industrial Internet's umbrella. In particular, strides forward in machine self-analysis that are a major facet of the Industrial Internet go hand in hand with the concept of auto-tuning drives. As drives continue to become more self-analytical, one natural route of development is preemptive maintenance. With increasing amounts of data being studied more frequently by the drive, potentially fatal breakdowns or errors can be caught more easily.

"You're really spending money when you don't have to just to ensure that you never have unplanned downtime, and as systems can be made smarter, you can actually predict when downtime will occur and shift when it will occur by allowing a PC or PLC to learn about how it's working. So I think that will be the future step: giving drives the ability to adapt themselves to get the most out of the mechanical components they're plugged into."

According to Stacey, the future of auto-tuning drives largely rests with the Industrial Internet. It's a theory that makes sense, as automation, the auto-tuning drive's raison d'être, is one of the major cornerstones of the Industrial Internet, and will doubtless see many advances in the foreseeable future.

"As our PLCs get smarter and smarter, I have a feeling things are going to really take off as far as more advanced auto-tuning," Stacey said.

However, Stacey also believes that there will always be a place for the motion control technician. No matter how smart a drive might become, there will always be high-end applications that will require that human touch to calibrate just right.

"I don't think [an auto-tuning drive] will ever replace a knowledgeable motion control expert," Stacey said. "But what it will be able to do is after that expert gets their hands on a system and starts it up and gets it running as expected, then over time, it will be able to make intelligent adjustments from what that expert did."

For more information

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