Interconnected motor technology – decentralized and centralized

The diligent bees simulate it to us: Every bee performs small tasks autonomously by itself. With smart and little communication, it is possible to organize themselves and compensate errors in the whole organization. Is the decentralized intelligence an example for the interconnected motor technology or rather the centralized nerve system of the living organisms among us, were all information converge at one point, get handled and cause actions? We try to illuminate this questions from the point of view of a motor technology manufacturer.

For the motor, it seems to be clear at first sight: A servo motor just obeys orders. It drives with defined speed, satisfies defined torques and positions as per specification. The superior control working as centralized nerve system looks after everything. Disturbance values are recognized and compensated by the centralized control.

Many current, interconnected systems e.g. production machineries work according to the principle of the centralized system. The advantages are obvious: the programming takes place via a centralized system and the debugging is also at a centralized place. Also, when a superior entity e.g. an ERP system needs data from the latest production or needs to transfer information, there’s a centralized place where information gets exchanged.

Mirrored to the centralized nerve system of a living organism e.g. of a mouse it means: Organs are centrally controlled, muscles for movement are activated, eyes, ears and skin monitor the environment. The brain looks after subordinated tasks as breathing and the heart beat but also after more complex tasks as e.g. the escape from an enemy.
A beehive would not work according to this principle. Hundred different decisions as e.g. ‘Should I either fly to the red flower field or to the yellow one?’ or ‘Are we 20 bees able to chase away the hornet?’ would need to be decided from a remote brain. Therefore, the communication lines are too long and the tasks are too complex to transfer them with simple communication tools to the bees.

Did we already find the answer that decides if a decentralized or a centralized system is the right one? So, the following would apply: Stationary systems – centralized; versatile systems – decentralized?

It is worth taking a closer look. Would the bees have a 5G mobile connection to a centralized ‘brain’, they could pass decisions and need less intelligence. Conversely, the heart, stomach, lungs and muscles of a mouse would have their own intelligence. So, the centralized nerve system could have taken the pressure of for simple tasks. The nerve system could focus on more complex tasks ask e.g. to search for food.

In nature as well as in motor technology the following applies: With an effective communication between centralized intelligence and components, the components need less intelligence. But if the components are intelligent, the communication can be easier and the centralized intelligence is relived or can be completely omitted.

If you look at the motor technology market, you will recognize that there is a choice: there are powerful centralized systems with an effective communication to the motor components. On the other hand, there are intelligent and powerful decentralized drive systems available. Both solutions can easily be implemented and put into operation. The following criteria are important when deciding a centralized or decentralized system:
Complexity of the task:
The low cost of processor power allows simple decentralized drive systems to become intelligent systems, so that a variety of little to medium complex tasks can be performed without a superior control. They read analog and digital data from sensors and communicate with each other. Tasks are distributed among the motors. Settings are done with a human-machine-interface (HMI). Many packaging machines, test equipment and special machines meanwhile works without a superior control. Every component of the machinery monitors itself. The communication can be reduced to a minimum. Economic classic fieldbuses are enough for communicating among each other.

For more complex tasks, e.g. in case of many machinery parts are interconnected, and there are high requirements to synchronize – the inventory to centralized machinery control is worth it in most of the cases. But also in these cases it can make sense to implement decentralized components for autonomously performed processes. One example is a solar thermal energy machinery: the permanent adjustment of single mirrors can take place completely decentralized.

What is used up to now?
Pragmatic reasons often decide if a machinery is constructed centralized or decentralized. A system is well-known and the design is oriented towards the existing one. So, the new system will be constructed similarly. An engineer understandably doesn’t like to study the communication types and system architectures for every new machinery concept. Especially in times of full order books companies are more focused on a quick implementation than on the perfect solution. This is clear. Nevertheless, it can be worth it because the total costs are not always obvious.
System cost:
The system costs are hard to define, because some of the costs are not visible or economic solutions can bring high follow-up costs with it. Here are two less obvious but nevertheless relevant cost factors:

- Electric cabinet: How much space is needed inside the electric cabinet? Which dimensions are needed for it? Here a decentralized solution can be the right one. In decentralized solutions, heat loss is also distributed and therefore does not require forced cooling.
- What seems to be the most reasonable solution at first sight, can turn into a bottomless pit if the entire system isn't taken into consideration from the beginning. Are all the components for the planned system available? Are the components needed which cannot be implemented directly into the network? Depending on this it is possible that expensive gateways need to be sourced or to do sophisticated special programming.

How is Dunkermotoren as a motor technology manufacturer prepared?

Prepared for both parts

With regards to the connection, Dunkermotoren is prepared for both parts. Motors of Dunkermotoren can be implemented in centralized architectures as simple slaves and can also perform decentralized tasks. In both cases a monitoring of motor functions and the protection against permanent damage takes place in each motor. That makes sense. Every motor knows its characteristic and knows how overload situations can be tolerated. Hardware and software protection mechanisms which are directly mounted in the motor can enable the motors to be used to their physical capacity, without being damaged.

Dunker motors speak several of the most important communication languages. At the moment are included, CANopen, Profibus, Profinet and EtherCAT. As with the most of the component manufacturers, Dunkermotoren needs to face the babble of diverse fieldbus and industrial
Ethernet communication. To join in the centrally steered communication systems, Dunkermotoren needs to implement the respective interfaces. Dunkermotoren is the same as many other component manufacturers, we are looking forward to having manufacturer-independent standards.

**Interconnection of the future**

Dunkermotoren asked themselves how motors need to be interconnected in the future, both in decentralized and centralized solutions. It is not enough just to say that all common fieldbus, industrial Ethernet and all wireless standards need to be covered. The question is which data to which place and how quick must be transmitted. Topics like predictive maintenance, cloud-based application analysis, remote service and pay-per-use will be very important. In these cases, data needs to find its way from the machinery to a cloud or directly to the manufacturer. It remains exciting, if Ethernet-based systems without the accompanied safety risks come to the top, or mobile-communication-based systems without the associated problems of network coverage and cost. In fact, the customer benefit of the so called “IoT” features are very high if these problems can be solved.

**Interconnection and intelligence**

With the launch of the BG 65 CI, almost 20 years ago, Dunkermotoren laid the foundation of today’s wide product portfolio of decentralized motors. Since then, not only the product portfolio, but has also grown massively the market for decentralized solutions. The market requires more and more complete drives, not only with gearboxes, brakes and high-resolution encoders but also with preferably integrated intelligence. It should be able to recreate the main processes or to perform tasks completely autonomously. With the lower cost and smaller construction per processor power decentralized motors can meet the expectations of more intelligence.
This trend will move on. Decentralized motors will not only perform tasks autonomously, they will also collect data from the applications, directly analyze them or forward them to external analyzing tools which are stored at the final customer, the OEM or at the manufacturer. Collecting data currently has negative connotations in the press. But regarding motor data, the end-customer, OEM and the component manufacturer can take advantage because the application becomes transparent due to its use. Thereby, processes can be optimized, new machineries can be designed better and bugs can be found quicker.

No matter if a centralized or decentralized system is implemented, interconnection and intelligence must never be considered isolated. Both the more powerful communication systems and the more intelligent components provide more possibilities in the future. These will move centralized, decentralized as well as hybrid solutions going forward.

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