CANopen-connectable DC micro-drives are deployed in many industrial, medical, transportation, aerospace, and other applications. But what are the benefits of deploying them in smart farming and agriculture?

The agricultural industry faces a major challenge regarding the feeding of growing world’s population: Crop cultivation and livestock farming must produce more without endangering the life-sustaining resources. Smart farming concepts are critical to enable it in an ecologically feasible manner over the long term. The increasingly automated agricultural industry relies on micro-drives deployed e.g. in robotic equipment. These drives are compact, high-torque, and dynamic. Networked via CANopen in agriculture environments, they can be precisely actuated and meet the reliability and long-service-life requirements.

Smart farming for efficiency

Most work steps in arable farming such as sowing, fertilizing, and crop protection have so far been carried out over entire areas, meaning the machines distribute the substances with a corresponding throughput. Thus, instead of fertilizer working right on the plant, it partially ends up in the groundwater. Also, tasks such as pruning of fruit trees or harvesting of vegetables require costly manual labor, while more and more companies suffer from a personnel shortage.

Smart farming (also precision, digital, or e-farming) concepts use modern technologies to increase efficiency, spare resources, relieve people from monotonous work, and to produce higher yields. With computer-aided, networked processes, machine learning, and tailor-made robot functions, it is possible to focus the measures on individual plants instead of on the entire area (see Figure 1). For example, use of herbicides could be significantly reduced, fruits and vegetables could be harvested by robots in continuous passes, always at the optimum ripeness (see Figure 2).

Field robots instead of large machines

Large agricultural machines weigh up to ten tons and compact the soil, so it can barely absorb any additional water and air. The growth and health of the crop plants in the areas near travel paths are also impacted. Lightweight, autonomous field robots can help contribute to healthier soil and increased biodiversity.

Many of these applications currently only exist as studies or prototypes. A practical example is precision planting, originally developed for research and seed breeding. Applied machines can plant individual seeds at precisely defined intervals. Each plant receives enough space to grow, and the acreage is optimally utilized. At the same time, the seeds are used efficiently. The machines use a separating module with an electric drive for each row. A motor drives a slotted or toothed disk that transports the individual seeds to the outlet. The control precisely sets the optimal distance depending on the type of seed. The different radii of the individual rows can be compensated when driving along curves. The feeding of the seeds to the disks is controlled using closures that are also motorized.

Robotics in greenhouse

With vegetable and flower cultivation in greenhouses, many plants are first sprouted in small pots and later replanted in larger pots or in beds. In modern horticultural enterprises, machines perform the sorting and handling of plants and pots. Their machinery is similar to that used in industrial production and logistics (see Figure 3). There are conveyor...
belts and roller conveyors, on which trays with products in various stages are transported, sorted, and repotted. The grippers used in other industries differ only in terms of shape. Driven by micro-motors, they perform automatic handling of the individual pots and root balls.

These micro-motor types will also play a key role in self-propelled fruit and vegetable harvesters, which have not yet reached series maturity. Here, camera-assisted sensors detect the ripeness degree of strawberries or peppers on basis of color and shape, and record their exact position. The on-board computer uses these data to control a robot arm, which is equipped with a type of shears and a collection device. The prototypes of this technology are full of electric motors, from the single-wheel drive and the robot arm to the cutting apparatus and the collection system for the harvested produce.

Requirements for small electric drives

Unlike the traditional large agricultural devices, the machines and components used in smart farming are more compact and lighter with little space available for motors. Nevertheless, as drives of sowing disks, flaps, grippers, robot arms or shears, they must supply sufficient power to reliably perform the respective task over countless cycles. At the same time, they should operate efficiently, as autonomous units usually draw their energy from batteries. It is also important to integrate the drive electronics into the

Company background

Faulhaber is specialized in the development, production, and deployment of high-precision, miniature drive systems, servo components, and drive electronics with up to 200 W of output power. This includes customer-specific packaged solutions as well as an extensive range of standard products, such as brushless motors, DC-micro-motors, encoders, and motion controllers. The motion control solutions are used in such application areas as medical technology, factory automation, precision optics, telecommunications, aviation, aerospace, robotics, and others.

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networked structures and enable smart control. Moreover, the drives must be robust to function reliably and for long term under demanding conditions such as large temperature fluctuations and high mechanical loads. And, last but not least, the costs must remain reasonable.

The drive specialist Faulhaber provides various motor and drive device series to address these issues. For example, the BXT brushless and compact DC flat motors enabling short designs in the axial direction. The motors are 14 mm, 16 mm, and 21 mm in length, but deliver torques up to 134 mNm, within a diameter of 22 mm, 32 mm, and 42 mm respectively. For precise speed control and high positioning accuracy, diameter-compliant magnetic encoders or speed controllers are fully integrated into the housed motor variants, whereby the drive length is increased by just 6.2 mm. The matching metal planetary gearheads of the GPT series are characterized by a robust, short design, high torque, and fine graduations of the numerous reduction ratios. Another suitable drive solution is the copper-graphite CXR motor line along with the matching gears. Their commutation system is durable and is suited to dynamic, high-performance applications with fast start/stop operation, as is required for automatic sorting. Optional incremental encoders enable precise positioning. Various controllers, e.g. with a CANopen interface, are available for the networking of the company’s drive systems.

**CANopen communication**

CANopen is a higher-layer protocol for Classical CAN. It is pre-destined for networking of micro-drives. Because of its size, a CAN interface can be integrated in small electronic modules. Further CAN benefits include real-time and multi-drop capabilities, robustness regarding EMC (electromagnetic compatibility) disturbances, and reliable communication due to very low residual error probability. Each year, more than two billion CAN nodes are sold e.g. for use in automotive and heavy-duty transportation applications. Thus, CAN is well-proven and the price for CAN protocol controllers is very reasonable.

The CiA 402 CANopen device profile specifies the configuration parameters, process parameters, and diagnostic information for drives and motion controllers in a standardized manner. CiA 402 series is a de-facto standard for motion control applications and is also internationally standardized in IEC 61800-7-201/-301.

Faulhaber’s CANopen-connectable device versions provide the common operating modes as defined in CiA 402. All parameters are stored directly in the CANopen object dictionary. Thus, configuration of the drives can take place both via the Faulhaber Motion Manager tool or via off-the-shelf CANopen configuration tools from other providers. The CANopen version is particularly suitable for users who already use different CANopen devices or who want to operate the motion controller on a PLC (programmable logic controller). The dynamic PDO (process data object) mapping enables efficient networking with the connected devices. Many of CANopen systems are already in use today in smart farming applications and will continue to contribute to advancing technology in this area, which is essential to feeding the world’s population.

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Figure 4: Drive technology used in agriculture must work reliably, even in tough environmental conditions (Source: Adobe Stock)

Figure 5: The CANopen-connectable BXT compact flat DC-micro-motors, the robust CXR copper-graphite motors, and the GPT gearheads are well-suited for smart farming applications (Source: Faulhaber)
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