

PRECISION FARMING TECHNOLOGY: Embedded Control Software



US Department of Agriculture estimates that in year 2022 the farmers increased their yield by 48% by the use precision farming technology. This is an amazing productivity improvement in food production. Imagine a Farmer is walking around in a farm inspecting each plant, and spraying some liquid on each plant as needed. Precision farming technology does the same thing, except it does it at least 1000 times faster and more accurately with autonomous farming equipment.

Precision farming technology refers to the use of state of art sensors such as cameras, Lidar, Radar, GPS and embedded edge plus cloud computers to plan-measure-control the individual plant condition and deliver the correct spray material or operation that is optimal for that plant in real time. For example, a spraying machine (driven remotely or autonomously), equipped with cameras (i.e. 24 cameras, 5000 frames/sec mounted on a 80 feet long boom), utilize the vision system data to assess the condition of plants as it is passing over, and decide on **what** and **how much** and **where** to spray the necessary fertilizer or water in an optimal manner. When this concept is applied to the soil preparation, planting and spraying equipment, it leads to a very precisely controlled farming, hence increased productivity. Precision farming technology is about precision delivery of liquid spray or product by determining “what” and “how much” and “where” to deliver in real time with millisecond accuracy.

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There are three main subsystems in precision farming technology: sensors (cameras, GPS, Lidar, radar), electrically controlled actuators (valves for spraying or tilling actuator control), and embedded computers (i.e. 12 GPUs) to process the data and take action in real time within a few milliseconds as the machine is moving over the field at 20 miles per hour speed. Offline planning using GPS surveys is often used to plan the operation for the whole farm, whereas the Online system is used to do the necessary work in millimeter accuracy.

The application of the precision farming technology includes the following phases of farming

- ✔ Soil preparation: tilling, fertilizing, irrigating.
- ✔ Planting: seed spray by volume, individual baby plant placement in soil.
- ✔ Spraying at different times during a growth season against pesticides, additional fertilizing and/or irrigation.
- ✔ Harvesting: collection of the product and storage for transportation.

Vision cameras, LIDAR, Radar, GPS are well developed technologies. Solenoid controlled valves used in spray equipment are also rather well developed.

The “brains” of the operation is the embedded software that runs on the CPUs/GPUs of the embedded controller on the machine. The embedded software must process all the sensor data reliably and on-time so that precision delivery can be made at the right location (where), right amount (how much) and the right spray liquid (what). The success of the system depends on the reliable, accurate and real-time operation of the system, all of which depends on how well the embedded control software works with the hardware.

System components: All integrated over CAN bus technology using CANopen or J1939 protocol

HMI: Human Machine Interface device for setup and configuration for application.

ECU: Electronic Control Units with CPUs/GPUs, the brain hardware.

SENSORS: Camera, LIDAR, GPS, Radar.

ACTUATORS: Solenoids for various valves and electric motor actuators for spraying and motion.

SOFTWARE: Using CODESYS, Matlab/Simulink, C/C++, Python. Embedded software to implement the “brains” and connect all these devices to work together.

Servotech has decades long expertise and experience in embedded control software development for many industries.