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Automatic Boom Height Control Technology for Agricultural Sprayers

Introduction

Advancements in liquid application equipment make operation of large self-propelled machines easier. Current agricultural sprayers have spray boom widths of up to 120 feet. Because of a combination of increased machinery size, technology, and growing environmental concerns, more is being demanded from chemical applicators.

One critical technology to meeting these demands is automatic boom height control (ABHC). This technology automatically maintains the boom at a target height from the top of the crop canopy; and is especially useful when operating in fields with varying terrain attributes or uneven crop canopy heights. In the case where the sprayer is traveling along uneven terrain, ABHC technology aligns left and right wings of the boom with respect to the terrain. During a typical field application, boom height of greater than the targeted plant can increase the potential for drift, loss of droplets to volatilization, and non-uniform spray coverage; whereas a boom closer than intended to the actual canopy will result in non-uniform coverage.

Consistent boom height allows control over proper spraying parameters such as spray overlap from adjacent nozzles, droplet drift, off-target application, droplet volatilization, deposition, and coverage. Applications without ABHC technology could result in product being applied at varying height depending on terrain and crop canopy, potentially reducing quality of application.

Automatic Boom Height Control Technology

ABHC technology uses boom-mounted ultrasonic sensors to continuously monitor instantaneous boom height. Ultrasonic sensors (Figure 1) emit a sound pulse that reflects off of objects within the wave field, to be received by the sensor. The sensor measures the amount of time it takes for the pulse to return. Since sound travels at almost a constant velocity, the in-cab controller calculates how high the sensor is above the sensed objects. The in-cab controller converts sensor-based information that is sent as a signal to an actuator or proportional hydraulic valve to either raise or lower the boom.



Figure 1. Ultrasonic sensor mounted on the sprayer boom.

An ultrasonic sensor's response is independent of surface color (optical reflectivity) of the reflected surface. As an example, an ultrasonic sensor will provide the same signal output for a crop canopy with varying greenness and soil surface if located at a same distance. These sensors provide linear response with distance both during daytime and night operations.

There is also another type of auto boom height system that uses rolling wheels (Figure 2) mounted to the boom. As the sprayer travels the wheels skip or stay in light contact with the ground. The sensors on these wheels measure pressure exerted on them from the ground and raise or lower the booms accordingly.



Figure 2. Gauge wheels measure pressure between the wheel and the ground to determine boom height.

Advantages

The ability to adjust the height of a sprayer boom on the go has several key advantages.

1. Maintain uniform boom height (Figure 3).
2. Increase application uniformity and thereby effectiveness.
3. Reduces wear on the sprayer boom.
4. Avoid contact between the boom or nozzles with the ground.
5. Increase field efficiency as operator does not need to make frequent stops to make more adjustments on the go to adjust to the terrain.
6. Potential to reduce drift and provide uniform droplet deposition.



Figure 3. Ultrasonic sensors on ABHC technology monitors boom height at a various locations to maintain uniform boom height.

Commercial Systems

Several large manufacturers are producing Automatic Boom Height Control systems and two of the popular commercial systems available are from NORAC and Raven industries.

NORAC Systems

NORAC currently produces two automatic boom height control systems. The two most recent models are the UC4.5 and UC5. These two systems differ in price and functionality.

The UC4.5 (Figure 4) is an entry-level standalone system. This system is less expensive when compared to the UC5, with a UC4.5 starting price beginning around \$5,000. Since this is standalone system, it has its own in cab control display and cannot be integrated into the sprayer's ISOBUS system. However, the UC4.5 interface has a fast easy setup and calibration procedure. The UC4.5 uses only two ultrasonic sensors mounted close to the end of each boom. This system can only control the vertical movement of the individual wings; the main lift is still controlled separately by the operator. The main lift height can also be automated by purchasing a main lift control option for this system. The UC4.5 kit is available with a "Severe Terrain" option. The Severe Terrain option is designed for boom lengths of 90 feet or greater traveling over very uneven ground. This option adds one more sensor on each boom about halfway between the far outside sensor and the middle of the boom to more accurately calculate the average boom height. Along with these other options, accuracy of the boom height control can be further enhanced by installing an "Active Roll" kit, which rolls to the center section of the sprayer boom.



Figure 4. UC4.5 in cab control display.

In comparison to the UC4.5, the UC5 provides all of the same functions stated above with the ability to integrate into ISOBUS compatible displays. Both of these systems include NORAC's Hybrid Mode, which combines the function provided by the two operating modes — Soil Mode and Crop Mode — by tracking

both the soil surface and crop canopy continuously. If the crop canopy is not continuous, Hybrid Mode will track the soil surface and determine a continuous “virtual” crop canopy as an operator would expect in these conditions.

Raven Systems

Ultraglides (Figure 5) is Raven’s ultrasonic boom height control system. This system provides very similar control functions when compared to NORAC, with either a standalone or ISOBUS compatible display. The Raven system has the ability to utilize up to five sensors, including a sensor for the main lift. One key feature that the Ultraglides system may include is the addition of the Powerglide technology. The Powerglide system consists of a cushioned wheel that calculates necessary boom height. The Powerglide system provides easy calibration along with ISOBUS compatibility. Since the Powerglide system does not use ultrasonic sensors, it is limited to mostly pre-emergent applications or crops that have a low canopy. For the highest boom control accuracy, the

Powerglide system should be coupled together with the Ultraglides sensors. These two systems offer the benefits of both worlds, combining both constant on-ground contact and ultrasonic sensing for accurate and precise boom height.

The Powerglide system can also be used as a standalone unit without the addition of the ultrasonic sensors. The unit by itself is a better entry-level boom height control system with a lower initial cost. Just like the NORAC system, the Raven boom control system can also be equipped with a kit that will rotate the center boom rack to compensate for rapidly changing terrain.



Figure 5. Raven Ultraglides ultrasonic sensor.

Components Needed and Functionality



Ultrasonic sensor for sensing height of the boom from the ground or top of crop.



Proportional independent hydraulic control to actuate the raising and lowering of each wing to achieve target boom height in a timely manner.



Roll sensor to predict the effects of center section and chassis roll on boom height and compensate for it.



Active Control™ technology to actively roll the center section or simulating roll in the center section and control wing lift for accurate operation on highly variable terrains.



In-cab display for easy and quick setup; adjust spray nozzle height on-the-go with the push of a button and displays the height the nozzle tips are from either the top of the crop or the soil.

Conclusion

The focus on the proper use and application of agricultural chemicals is becoming increasingly important. The risk involved with chemical misapplication and drift is high, especially with the introduction of newer stronger residual pesticides to cope with chemical resistance concerns. Input costs are significant for farmers so it is important to ensure that each application of agricultural products is done with the highest degree of care. With the challenge of operating the biggest and best application equipment on the market, advancements such as the Automatic Boom Height Control system could greatly improve nozzle overlap accuracy, reduce drift and loss of chemical due to volatilization, increasing operator efficiency while reducing fatigue, improving application uniformity, and increasing satisfaction.

More detailed information on commercially available products can be found at http://www.norac.ca/products?product_type_id=79 and <http://ravenprecision.com/products/boom-controls/autoboam/>

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