Jin-yi Liu, Jing-quan Tan, En-rong Mao, Zheng-he Song, Zhong-xiang Zhu, 2016. Proportional directional valve based automatic steering system for tractors. *Frontiers of Information Technology & Electronic Engineering*, **17**(5):458-464
http://dx.doi.org/10.1631/FITEE.1500172

Proportional directional valve based automatic steering system for tractors

Key words: Automatic steering system, Hydraulic circuit, Proportional directional valve, Proportional-integral-derivative (PID) control

Contact: Jin-yi Liu
E-mail: jingyao1123@126.com
ORCID: Jin-yi Liu, http://orcid.org/0000-0001-7375-9614

Motivation

- As a key technology in farming equipment navigation, the control accuracy of an automatic steering system determines the control accuracy of the automatic navigation system.
- The traditional automatic hydraulic steering system is usually designed for oil supply systems with either constant current or constant pressure, sometimes even for a designated tractor type, making the system neither adaptable nor promotable.
- Most of the common full-hydraulic automatic steering valves lack an unloading circuit in the neutral position (Wu *et al*., 2009; Shen *et al*., 2014), which will result in high pressure, large energy consumption, temperature rise, and serious leaking problems during long-time operations.

Main idea

- In view of the abovementioned problems, here we present a proportional integrated control valve block for different steering hydraulic systems.
- The application of a 5-way-3-position proportional directional valve maintains the lowest pressure under load feedback and stays at the neutral position during unloading, thus meeting the requirements for steering.

Method

1. Considering the basic characteristics of the hydraulic steering system found in most agricultural equipment and the design principles they follow, a multifunctional automatic hydraulic steering valve circuit is developed (Fig. 2).
1. Establish a controller based on the STC90C516RD and the incremental PID control algorithm.
2. Carry out straight-line tracking and sinusoidal tracking experiments on a Foton Lovol TG1254 tractor to test the response and tracking performance of the PID control valve system.

Major results

- We set the target angle at zero, and the results of straight-line tracking are shown in Fig. 10:

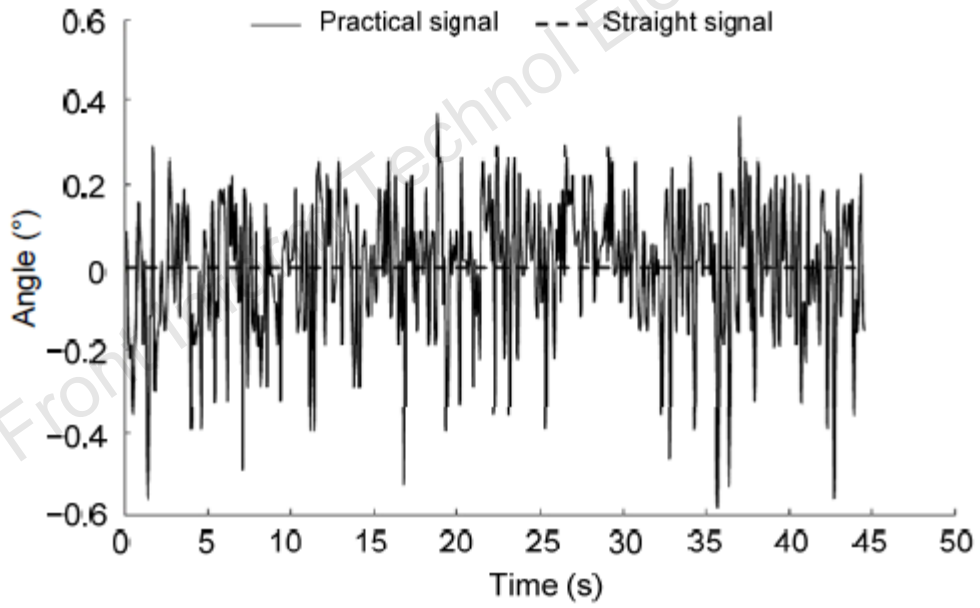

Fig. 10 Graph of straight-line tracking on the concrete way

Major results (Cont'd)

- We set a sine wave at 3.6° amplitude for sinusoidal tracking. The results are shown in Fig. 11:

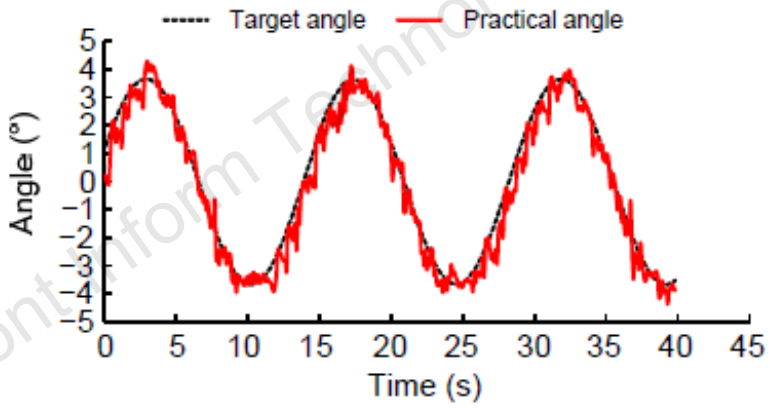

Fig. 11 Graph of sinusoidal tracking during the tractor's walking process

Conclusions

- The proportional integrated control valve block applicable to a variety of hydraulic steering systems has been developed.
- The tracking test results showed that the automatic steering control system has good tracking performance with a fast response, thus meeting the navigation control requirement of agricultural equipment to a certain extent.