Development of Farmland-Terrain Simulation System for Consistency of Seeding Depth

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Abstract. *A farmland-terrain simulation system suitable for rugged topography was designed to study the irregularities of farmland surface morphology led by both topographic fluctuation and terrain tilt. The system consists of terrain simulation mechanism, hydraulic system, control system, etc. The terrain simulation mechanism is connected to the rack through hydraulic cylinder to simulate farmland surface fluctuation. The hydraulic system controls the hydraulic cylinder to drive the terrain simulation mechanism through the electro-hydraulic proportional directional valve. The control system controls hydraulic system and drives the terrain simulation mechanism according to the topographic data. The physical parameters of the terrain simulation mechanism were achieved by mathematic modeling of the profiling mechanism and building the geometrical relationship between the telescopic gradient angle and the expansion or contraction of the hydraulic cylinders. Based on the force analysis of hydraulic cylinder, the parameters of the hydraulic system were determined by theoretical calculation. In the simulation at 2.0 m/s operating speed, the average elevation error was 1.61 mm and the average slope error was 0.56 °. The test results show that the rapid and accurate performance of terrain elevation and slope simulation can meet the requirement of farmland terrain simulation, to provide a test platform for sowing and sowing deep control system test.*

Keywords. *Farmland topography, Terrain simulation system, Hydraulic system, Control system,*

Force analysis

Introduction

As one of the important indexes in the sowing of corn precision seeder, the sowing depth has a great influence on the yield of corn. The research and test of depth control technology is mainly carried out in fields. The workload is great, the testing cycle is long, it is difficult to control a single variable, and it is greatly affected by the season, which brings great inconvenience to the scientific research. In addition, some scholars have only conducted digital simulation and device design because of the experimental conditions. At present, the laboratory simulation of the deep consistency control system is mostly parallel, four linkage mechanism or surface fluctuation movement, while the surface morphology of the actual farmland varies irregularly in elevation and slope. In view of this, a corn seeding single body test bench with profiling mechanism research was carried out, and a suitable terrain on farmland terrain simulation system terrain fluctuation and tilt was designed for further study to provide experimental platform of sowing depth control technology.

Design of System

The farmland-terrain simulation system consists of terrain simulation mechanism, hydraulic system, and control system and so on. The terrain simulation mechanism is connected to the rack by hydraulic cylinder installation to simulate the farmland surface fluctuation. The hydraulic system controls the hydraulic cylinder action to drive the terrain simulation mechanism through the electro-hydraulic proportional directional valve. The control system real-time control hydraulic system driven the terrain simulation mechanism according to the topographic data.

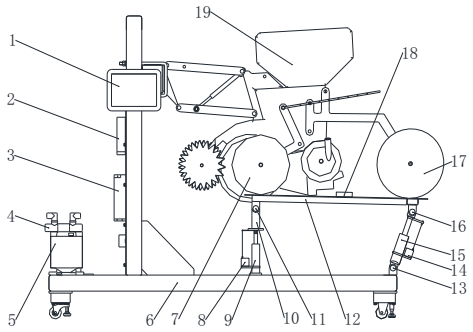

Fig 1. Sketch of terrain simulation system

1.field computer, 2.controller, 3.power supply module, 4. hydraulic valve unit, 5.hydraulic pump station, 6.pedestal, 7.depth wheel, 8. displacement sensor (F), 9.hydraulic cylinder (F), 10.U-frame, 11.hinges (F), 12. terrain simulation board, 13. hinges (B) 14. displacement sensor (R), 15. hydraulic cylinder (R), 16.hinges (R), 17.suppress wheal, 18.inclinometer sensor, 19.corn sowing unit

Based on the analysis of the geometry relationship between the terrain simulation board and the hydraulic cylinder, the geometric relation equation between the topographic dip angle and the hydraulic cylinder expansion was deduced. According to the suitable range of large mechanized operation and the physical size of the seeding unit and the mechanical dimensions of the terrain simulation mechanism, the minimum length of the hydraulic cylinder and the range of the stroke were calculated. The force analysis of the hydraulic cylinder was carried out and the load range of the hydraulic cylinder was calculated. On this basis, the hydraulic system of profiling mechanism was designed. According to the conditions of general sowing speed and terrain slope, the parameters of each part of the hydraulic system were preliminarily determined by theoretical calculation. Then the main components of the hydraulic system were selected. The vehicle terminal, the controller and displacement sensor, tilt sensor and other sensors were selected, the electric control system was constructed, and finally, a farmland terrain simulation system was

formed.

Testing and Data Analysis

The terrain simulation device, simulation slope range and hydraulic cylinder piston speed are tested and verified, and the step response test of the electronic control system was carried out. The terrain simulation tests were performed for three kinds of speeds of 0.5 m/s, 1.0 m/s, and 2.0 m/s respectively. The test results for speed 2.0 m/s were given in the following figures From the following figures, it can be concluded that the mean value of the elevation simulation error was 1.61 mm and the mean value of the slope simulation error was 0.56 °.

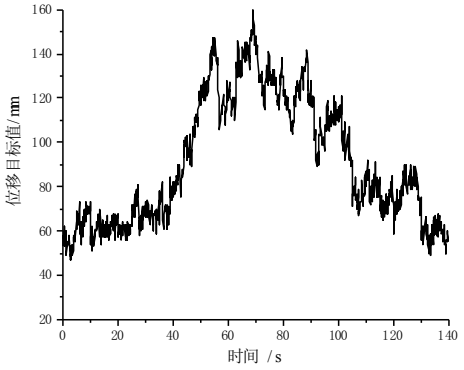

Fig.2 Target terrain elevation curve

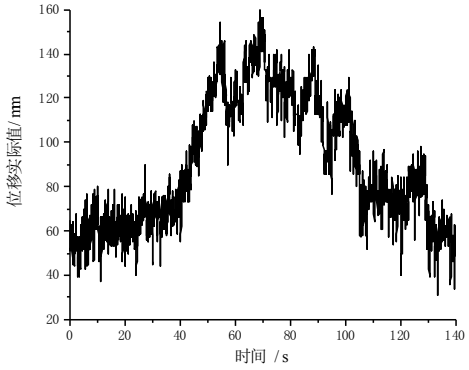

Fig.3 Simulation of terrain elevation curve

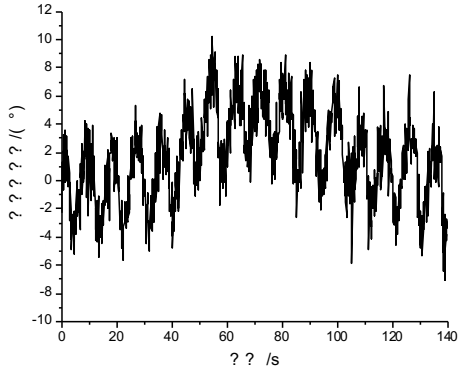

Fig.4 Target terrain slope curve

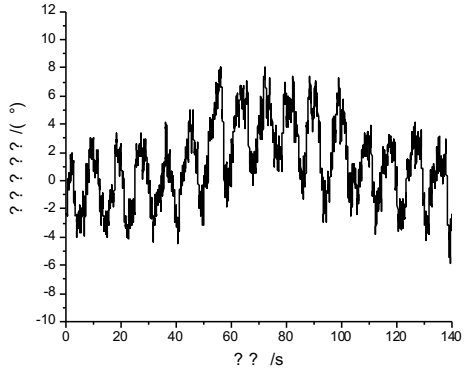

Fig.5 Simulation of terrain slope curve

Conclusion or Summary

In the simulation 2.0 m/s operating speed, the average elevation error was 1.61 mm and the average slope error was 0.56 °. The test results show that the rapid and accurate performance of terrain elevation and slope simulation can meet the requirement of farmland terrain simulation, to provide a test platform for sowing and sowing deep control system test.

Acknowledgements

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