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# Research on Hydraulic Cylinder Synchronous Control of Lifting Equipment for Large Prefabricated Components Based on IGWO-BP-PID

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## INTRODUCTION & AIM

The lifting tonnage of large prefabricated components is heavy, and the adverse condition of partial load hoisting often occurs, which is prone to dangerous accidents.

In order to improve the synchronization control precision of the hydraulic cylinders of lifting equipment, a synchronous control strategy combining IGWO-BP-PID (improved gray wolf optimization-BP neural network PID) and state difference feedback is studied.

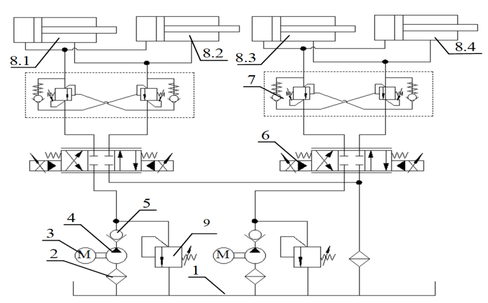


Fig.1 Hydraulic system diagram of utility tunnel spreader

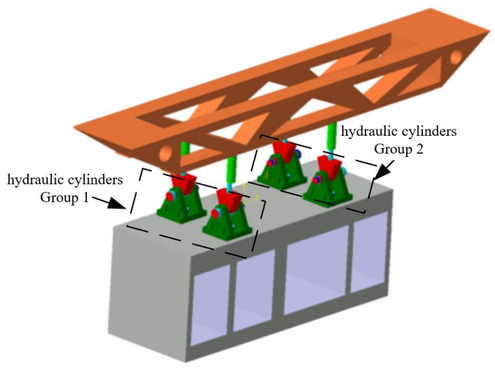


Fig.2 Special spreader model of utility tunnel section

## METHOD

Firstly, the hydraulic cylinders are divided into two groups in the longitudinal direction by analyzing the structure of the special lifting equipment and hydraulic principle. Gray wolf position is updated in the GWO to achieve optimization of BP-PID parameters by IGWO. Then, three controllers are used to analyze the system control, and the control effect of IGWO-BP-PID is verified. Finally, the synchronous control strategy combining IGWO-BP-PID and state differential feedback is adopted to jointly simulate the hydraulic cylinders in AMESim/Simulink, and compared and analyzed with the experimental data.

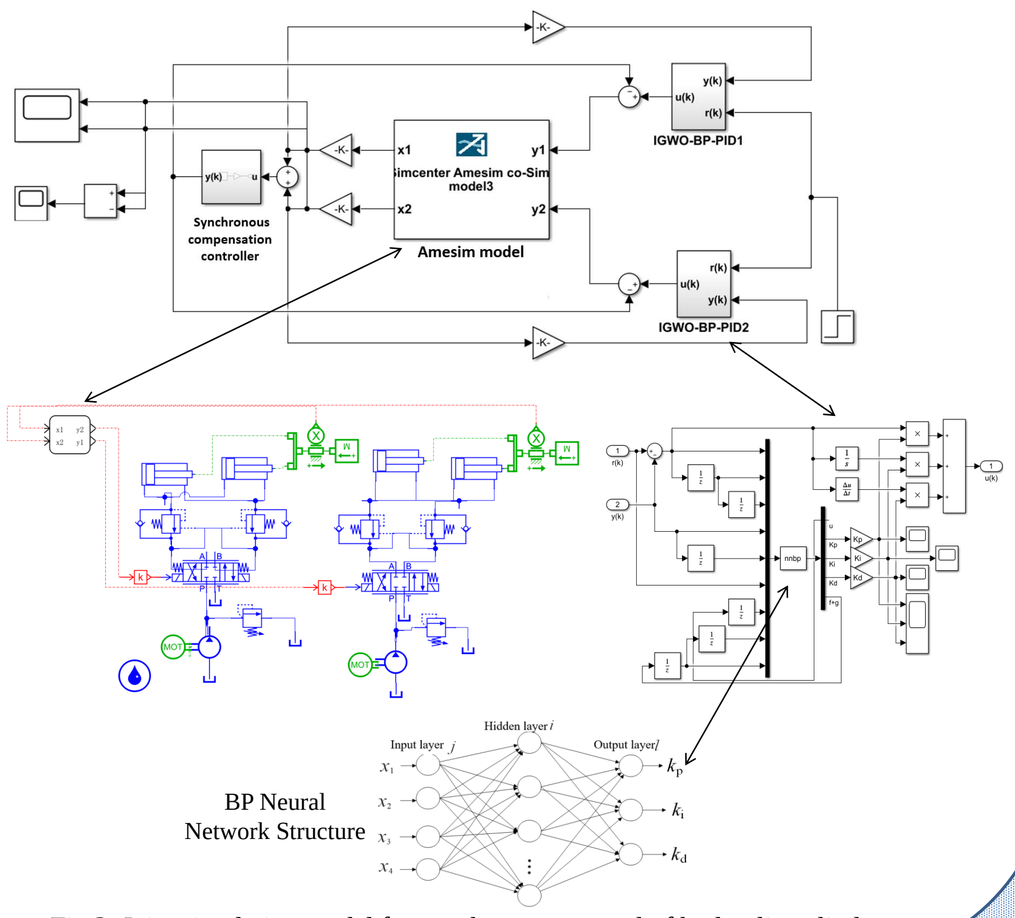


Fig.3 Joint simulation model for synchronous control of hydraulic cylinders

## RESULTS & DISCUSSION

The results show that the IGWO-BP-PID controller has no overshoot and better control effect. Compared with the conventional PID control, this proposed method shortens the oscillation adjustment time of the hydraulic cylinders, and the synchronization control accuracy is higher. The validity of the synchronization control strategy of lifting equipment is verified through the field test of an off-loaded large prefabricated component lifting.

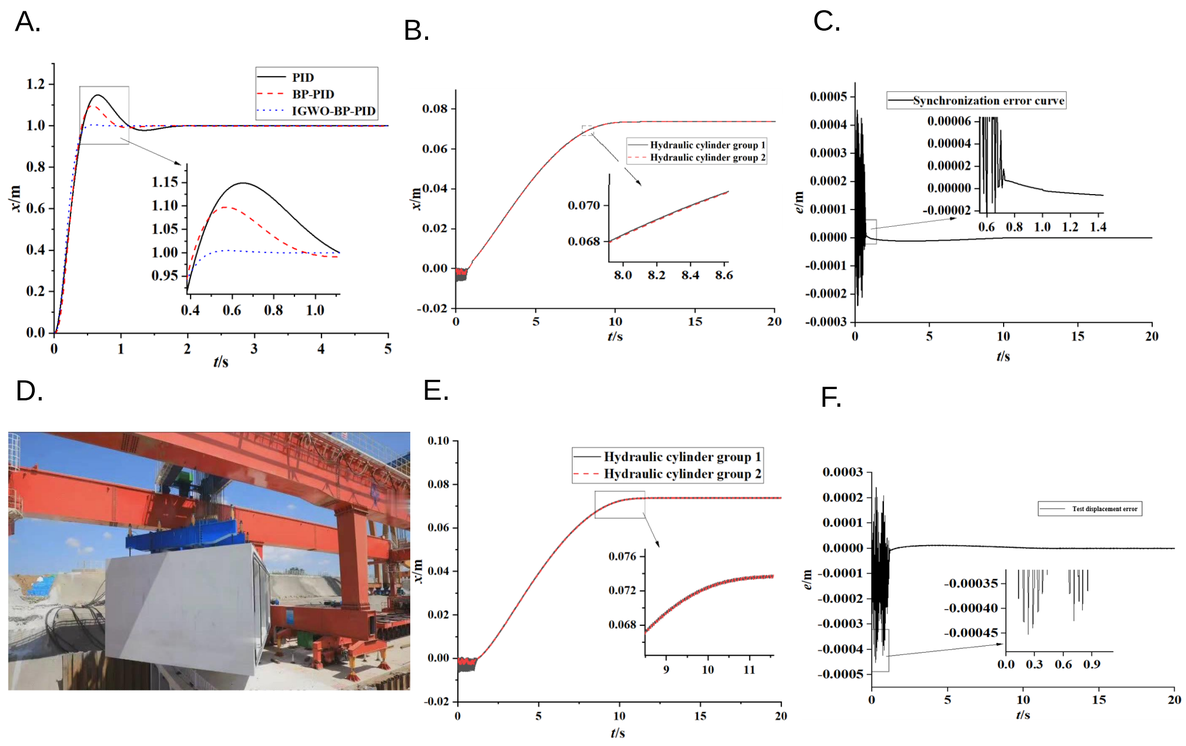


Fig.4 Comparison curve of response results of three controllers ; A) Curves of displacement response and synchronization error ; B, C ) Diagram of utility tunnel section on-site hoisting ; D) Curves of displacement and synchronization error of hydraulic cylinder group in field test; E, F)

The two groups of hydraulic cylinders of the pipe gallery hanger both remained stable after 11s. Due to the heavy mass of the pipe gallery segment, the hydraulic cylinders had a shock effect within 0~0.7s at the initial stage. After 0.7s, the shock decreased to 0, and the synchronization error was 0.011mm. The maximum synchronization error of hydraulic cylinder bank simulation is 0.44mm.

During the field test, the vibration effect of the hydraulic cylinder is significant within 0~1.6s, with a synchronization error close to 0.02mm at 1.6s, and the hydraulic cylinder group reaches a stable state after 12.2s. The maximum synchronization error of the two groups of hydraulic cylinders is 0.46mm, which reduces to 0 after 12.2s. The maximum relative error between simulation value and test value is 4.34%, falling within a reasonable range, thus verifying the accuracy of the simulation model and effectiveness of synchronous control strategy.

## CONCLUSION

The proposed synchronous control method for pipe hangers demonstrates superior control accuracy in industrial assembly hoisting, particularly under conditions of uneven load distribution. This research can serve as a valuable reference for the study of electro-hydraulic synchronous control in lifting systems or platforms handling large tonnages and partial loads. The proposed synchronous control method for pipe hangers demonstrates superior control accuracy in industrial assembly hoisting, particularly under conditions of uneven load distribution. This research can serve as a valuable reference for the study of electro-hydraulic synchronous control in lifting systems or platforms handling large tonnages and partial loads.

## FUTURE WORK / REFERENCES

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