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A method for the global optimization of the tooth contact pattern and transmission error of spiral bevel and hypoid gears

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Optimization objectives

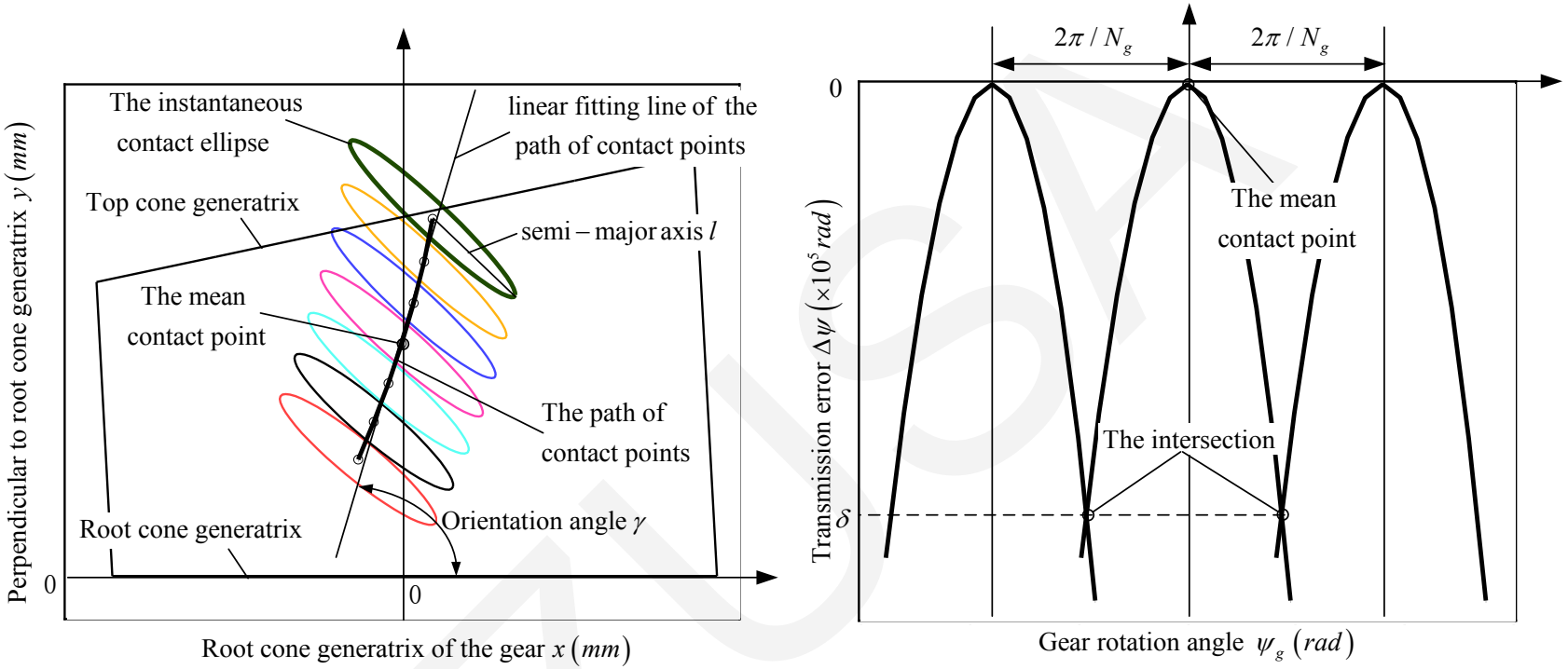

Fig. 2 The optimization objectives. (a) The contact pattern of the gear tooth surface. (b) The transmission error curve.

- The semi-major axis of instantaneous contact ellipse.
- The orientation angle of contact path.
- The intersection ordinate of the transmission error curve.

Control parameters

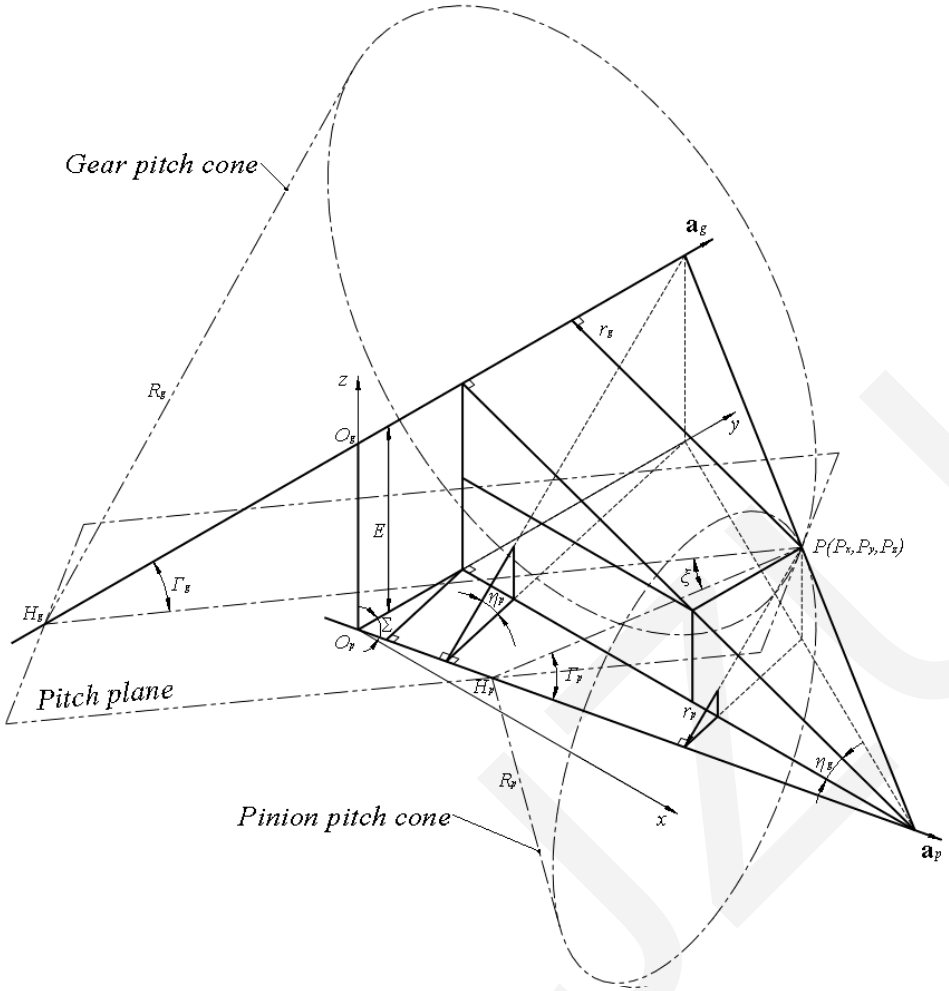

Fig. 3

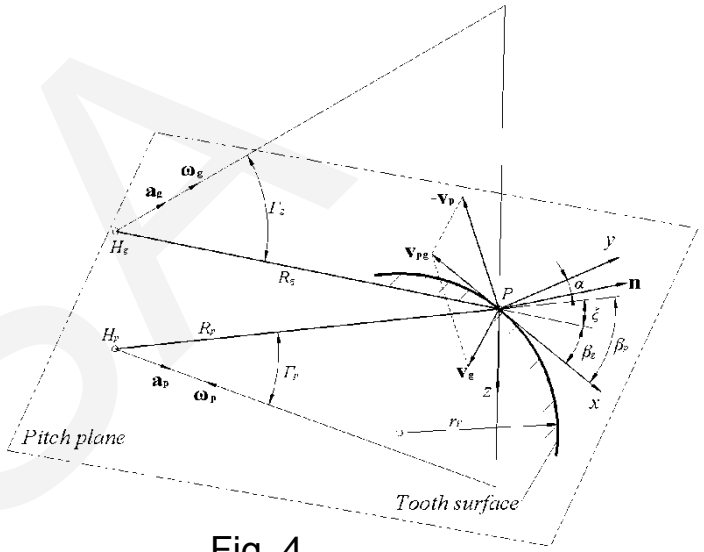

Fig. 4

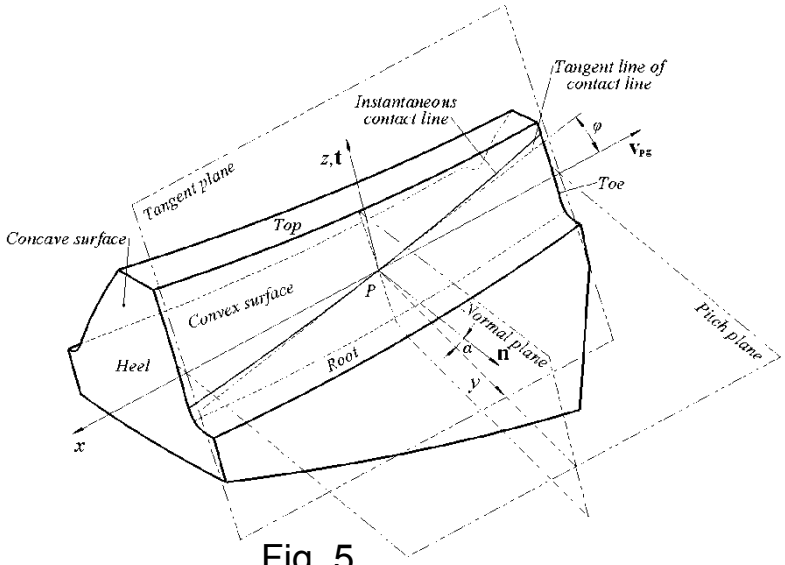

Fig. 5

Optimization algorithm

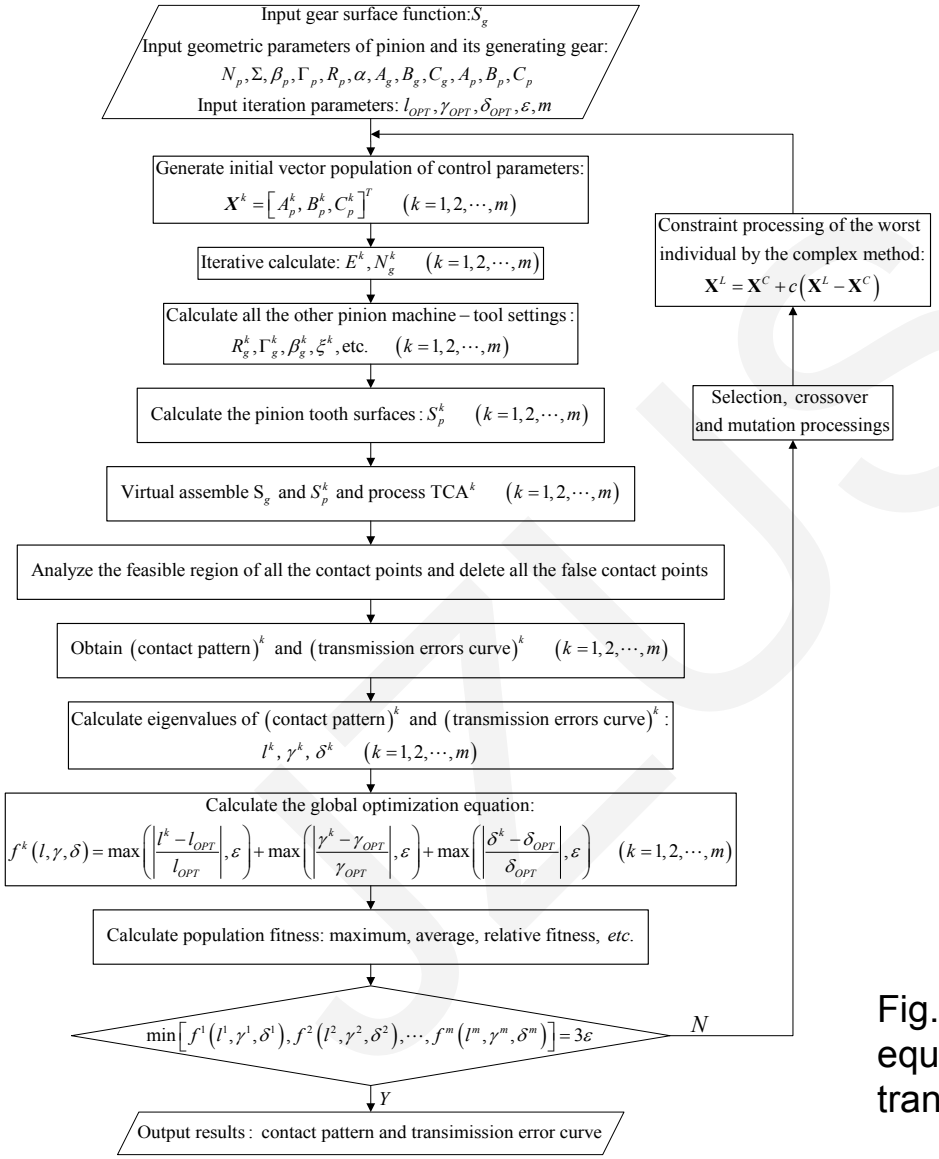

Fig. 8 Solution procedure of the optimization equation of tooth contact pattern and transmission error.

Case studies and discussion

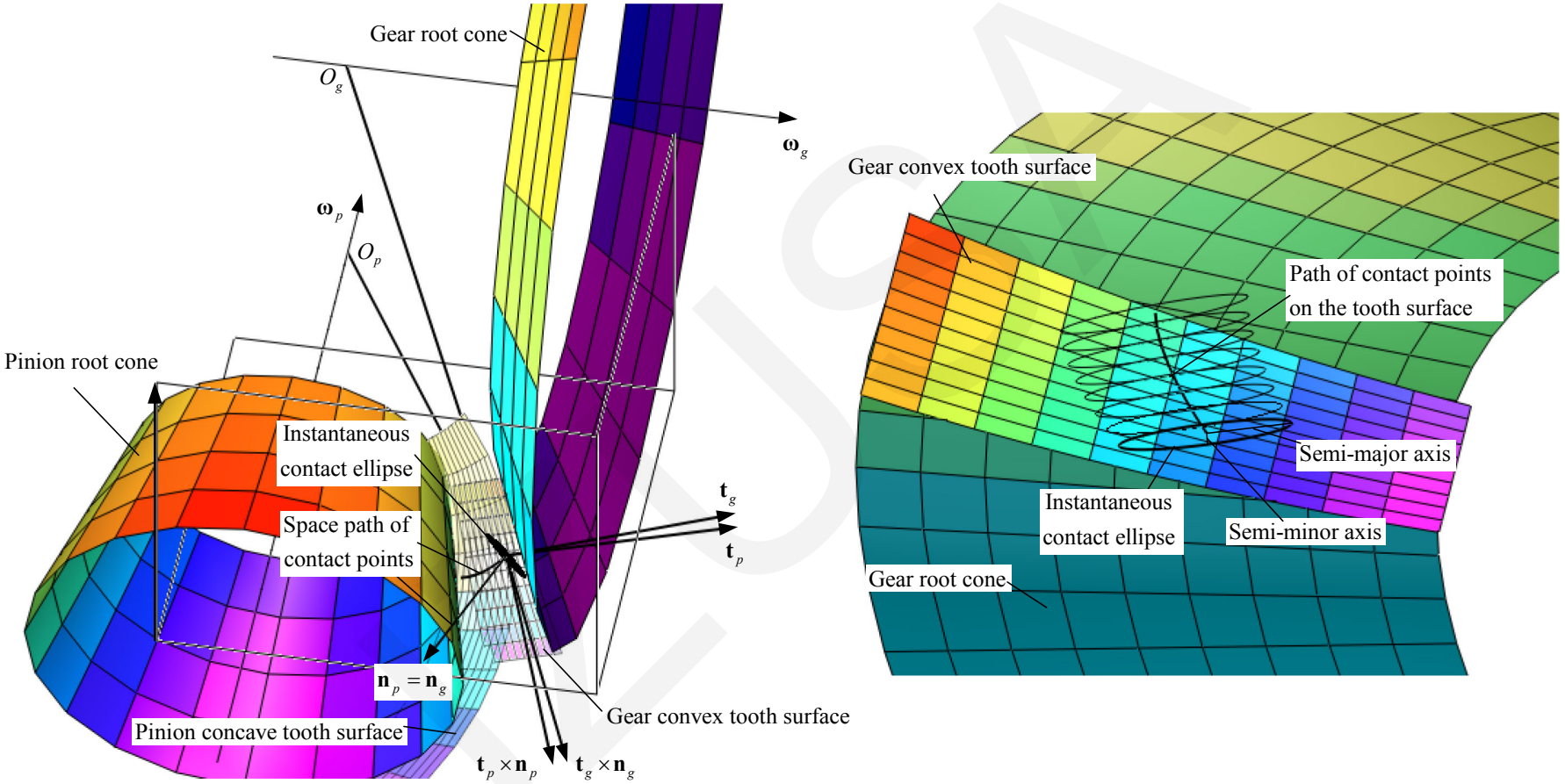

Fig. 10 Optimized three-dimensional path of contact points and contact ellipses. (a) Contact pattern of the gear drive. (b) Contact pattern of the gear tooth surface.

Finite element analysis

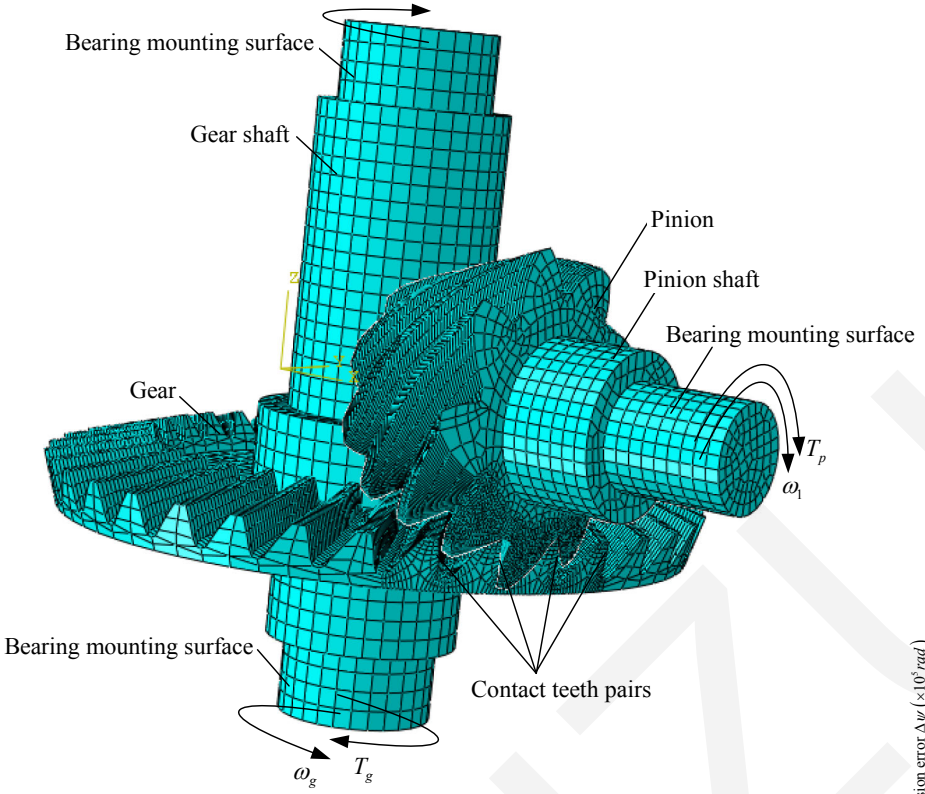

Fig. 11 Finite element model of the simplified hypoid gear drive system.

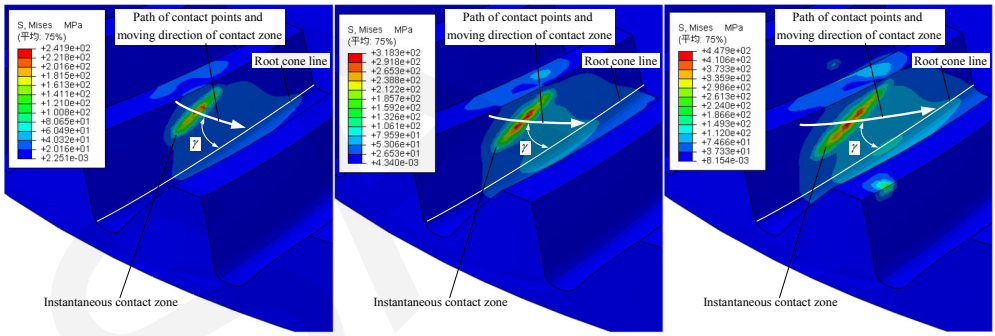

Fig. 12 Loaded contact pattern of the gear convex face.

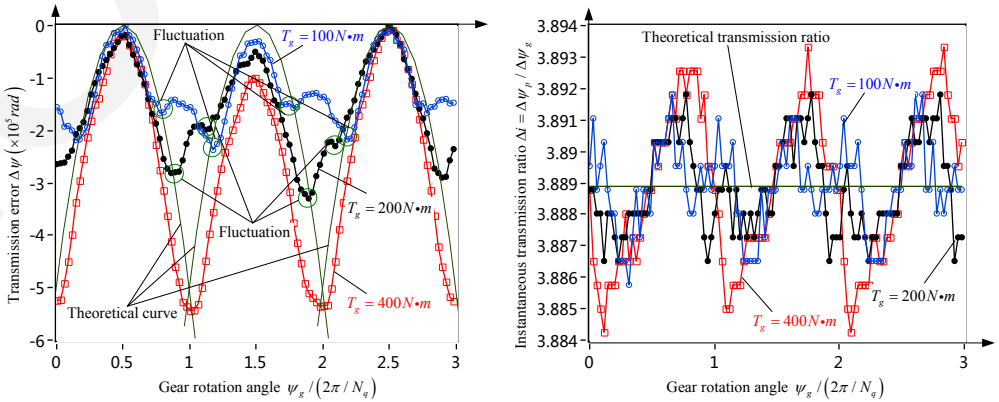

Fig. 13 Loaded transmission error curve and instantaneous transmission ratio of the gear drive.

Conclusions

- Three optimization objectives were selected to restrict most of the common defects, and the optimal values and the method for calculating the optimization objectives are presented.
- A new set of fundamental equations for pitch cone parameters of a hypoid gear drive was established.
- Three control parameters were selected to determine the pinion tooth surface, and an iterative method for calculating pinion machine-tool settings was presented.
- A global optimization equation was established, and a complex-constrain genetic algorithm method for solving the optimization equation was presented.
- Case studies of a hypoid gear drive indicated that the optimization objectives, the control parameters, and the optimization algorithm were well matched.
- An FEM of the hypoid gear drive system was established and its quasi-static meshing characteristics analyzed. The results verified the correctness of the optimization method.