Project Title:	Gyroscopic Stabilizers for Construction Cranes and Gondolas
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Project ID:	CICR/03/13
Research Institution:	City University of Hong Kong
Subject Area:	Construction Safety and Health

Objective

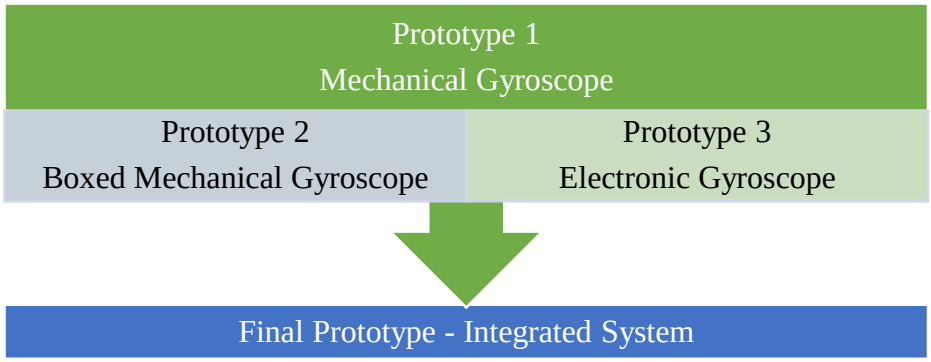
To design a feasible gyroscopic stabilizer for construction cranes to minimize payload rotation and swing.

Background

Payload of a tower crane swings due to external disturbance such as wind. Excessive swing will lead to safety issues. Although moderate swing will not cause safety concern, it prolongs construction schedule and lowers productivity. This research is to design a gyroscopic stabilizer for construction cranes to minimize the pendulation and swing of payload.

Data and Methodology

1. Investigate the mathematical modeling and dynamics of the crane and hoisting system;
2. Study the nonlinear dynamics of a gyroscope;
3. Apply the controlling devices for the gyroscopically stabilized crane system;
4. Assess the limitations and risks of the use of gyroscopes in construction cranes; and
5. Build a laboratory model to demonstrate the effectiveness of the system.



Results and Findings

1. Both angle of gyroscope position and the rotor spinning speed have influence on the stabilization performance;
2. The hoisting system exhibits significant pendulum dynamics under given crane payloads and rigging configurations. Under environmental wind load, payload behaves as an inverted pendulum-type motion;
3. A simulation model of pendulum-type hoisting system is created using MSC-ADAMS;
4. Load distributed vertically and perpendicular to the wind load has little effect on the performance of stabilization;

5. Several prototypes have been developed and tested. A final prototype of gyroscopic stabilizer is then developed, which consists of an electronic and mechanical gyroscope. In the prototype, the electronic gyroscope tracks the real-time amplitude of payload and the mechanical gyroscope actuates the control scheme based on the feedback data.

Recommendations

1. The gyroscopic stabilizer could remain stable under fluid flow associated with the propulsion of the body passing in a predetermined direction;
2. The investigation of computer simulation suggests that the crane movement could be minimized by considering the inertia of the crane;
3. An enclosed box with mechanical gyroscope could improve the system stability.