

Research and Projects in Graduate Study

Jiefeng Sun

Summary:

My master's study comprises three main contents. 1. Courses; 2. Engineering projects; 3. Research.

1. Courses

All master courses were taken within the first eighteen months of my graduate study. Three of them are important math courses and the others are related to mechanical system design and optimization including *Mechanical Kinetics*, *Mechanical Strength*, *Finite Element Method and Its Application*, and *Hydraulic Servo-system Analysis and Design*. These courses are closely related to my engineering project practice after these courses, and therefore they are thoroughly practiced and sufficiently acquired.

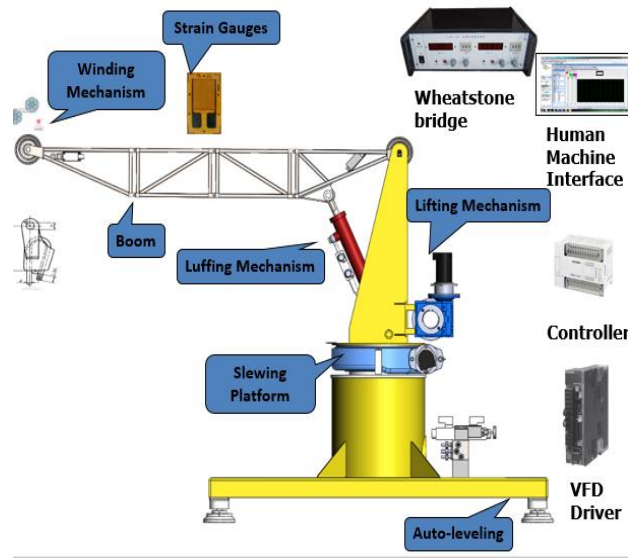


Fig. 1. Experimental Crane Composition

2. Projects (2014-2015)

My first engineering project (Principal Investigator) is to design a crane used for students' experiments. The crane is worth \$30,000 (210,000 RMB). Hydraulic system design, control system design and boom structure design are the most important tasks. In the process, we also built a novel variable frequency hydraulic power unit. The system can save more than 30% energy than traditional hydraulic power units. At this time, the equipment is used in undergraduate *Creative Design and Practice* class worth 0.5 credits. I am also helping Prof. Qu compile an experimental instruction book used by students who register in the experimental class^[1].



Fig. 2. Juniors are measuring boom dynamic stress

I also worked on overcoming the inherent weaknesses of the power unit, though it is energy-saving. For example, I solved some problems, such as long response time and instability of torque in low speed, by

optimizing the parameters of its PID controller.



Fig. 3. The variable frequency driven power unit

3. Research (2015-2016)

My research field is *vibration control*.

Current Project: A seismic isolator for polar cranes (diameter=41m) used above reactors in nuclear power plants is designed with a careful selection of components under the special operating environment. In order to achieve the best isolation effect, the nonlinearity of stiffness and damping is thoroughly investigated. A mathematical model composed the isolator and crane girders, which takes into account of nonlinear effects, especially hysteresis due to friction, is presented. A scaled experimental test is going to be carried out on a shaking table at DUT. (The project is supported by Dalian Huarui Heavy Industry Group CO. LTD.)

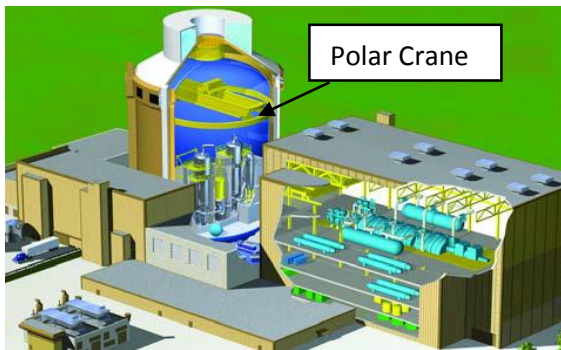


Fig. 4. A polar crane in an NPP

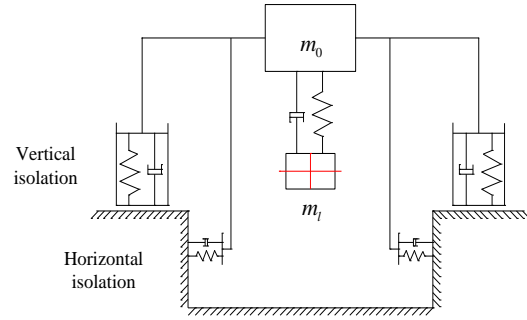
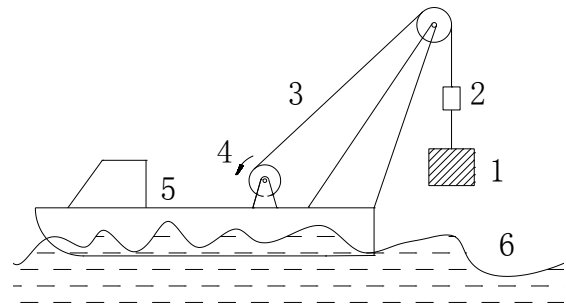


Fig. 5. System model

Completed Projects: The research project aimed at damping oscillation of loads hoisted on ocean vessels caused by waves. Instead of active vibration control, I tried to find an economical and secure solution in light of dynamics. I investigated effects of various types of damping including the linear and the nonlinear, and eventually found a damping regulating method which was greatly effective, and I published my first journal paper^[2].



1 Load, 2 Compensator, 3 Cable, 4 Winding Drum, 5 Boat, 6 Wave

Fig. 6. Compensation system

Study and Practice in Undergraduate Study

Jiefeng Sun

Summary:

My undergraduate study is divided into three main contents. 1. Courses; 2. National Competition and School Grant; 3. Research assistant.

1. Courses

My major is Mechanical Engineering with a concentration on NC (Numerical Control) machine tools. So, I acquired knowledge of mechanical design and mechatronics, and also practiced what I have learned in technological competitions, school grant projects and research assistant work.

2. National Competition and School Grant (2012-2013)

I joined in The Chinese National Fifth 3D Competition as the leader of our team.

Our first work is a rescue robot with six tracks. In order to coordinate the 2 degrees of freedom of each track and save the number of independent motors, a complex planetary gear system is used to distribute power. The robot is able to travel on rough terrains and climb hills. When encountering big barriers such as big stones, stairs, it will rotate its track arms instead of track pads and climbs over the barriers. This new method has issued a patent named: [A Novel Power Distribution System of a Vehicle with Six Tracks](#)^[3].



Fig. 1. The rescue robot with six tracks

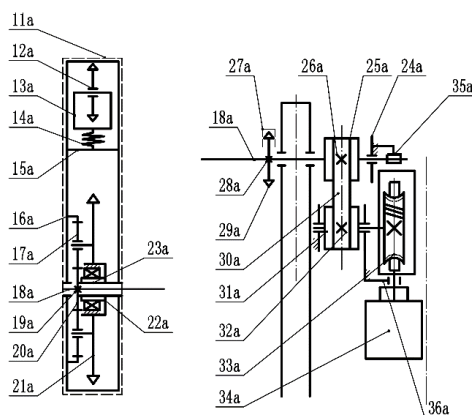


Fig. 2. Power distribution system of the robot

Our second work is a voiced controlled wheelchair. We designed every component of the mechanical system with Pro/E software, and tested its control system in a mini vehicle. The wheelchair could help disable people who cannot use their hands to control electrical wheelchairs if they are able to speak. The wheel chair has also issued a [patent](#) two years after submitting an application^[4].



Fig. 3. The voice-controlled wheelchair

For more information, please visit our team's webpage: <http://bbs.3ddl.net/thread-293936-1-1.html>.



Fig. 3. Our team in the competition

We built a voiced controlled mini-vehicle that can be used to test the control scheme designed for the wheelchair. I coded to control the motion of its two steering wheels. At first, our first design used DC motors to drive the vehicle, but it was not able to travel alone a straight line. Then, we changed the DC motors to step motors, and the slope of the oblique line decreased. In order to get more accurate control, we used feedback control to eliminate the velocity difference of two DC motors.

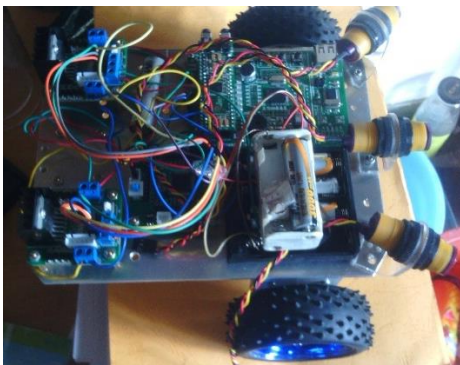


Fig. 3. The voiced controlled vehicle

3. Research assistant (2014)

I took part in Prof. Rui's lab as a research assistant in my senior year. I worked with Li Yang on the effect of different concentration of Niobium on crack

propagation in single crystal γ -TiAl based on simulation through molecular dynamics method. The atomic trajectory figures and energy evolution figures have been obtained by the simulation of a center crack and a boundary crack on a crystal structure model of the γ -TiAl alloy. We published a paper in 2015, and I was the third author^[5].

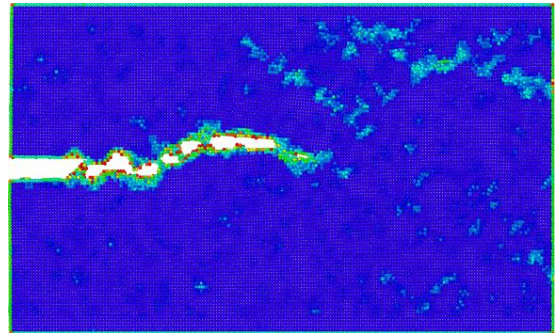


Fig. 3. Boundary crack propagation $t=180ps$

My publications

- [1] Qu F, Sun T, Sun J. Crane Teaching Experiment Platform (Published):China,CN 201510528289.9[P].
- [2] Qu F, Sun J, Zhang C, et al. Research on a passive compensator with variable parameters for marine hoisting[J]. Journal of Harbin Engineering University (EI Compendex), 2016,Accepted for publication
- [3] Yang L, Song M, Sun J. A Novel Power Distribution System of a Vehicle with Six Tracks:China,CN 201520086796.7[P].
- [4] Yang L, Rui Z, Hu X, et al. A Smart Voice Controlled Wheelchair China,CN 201410765517.X. [P].
- [5] Rui Z, Yang L, Sun J, et al. Effect of Different Concentration of Niobium on Crack Propagation in Single Crystal γ -TiAl Alloy based on Molecular Dynamics Simulation[J]. Journal of Materials Science and Engineering, 2016,Accepted for publication (Sep 27, 2016)