Visualization of Flow-field around a Magnetically-Suspended Model

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Introduction

Background

- Magnetic Suspension and Balance System
  - Test model is levitated by magnetic force.
  - Wind tunnel test can be conducted without mechanical support system.
  - Aerodynamic forces can be calculated by current flowing through coils.
  - The position and attitude of the model for control are obtained by optical sensing system.

Flow Visualization

- Generally, flow visualization tests are conducted to clarify a flow field in wind-tunnel testing.

In MSBS, there are problems for visualization, because optical system of visualization might disturb the position sensing system.

Objective

To develop visualization method for magnetically-suspended model.

Sensing system of the MSBS

- The position sensing for control
  - The sensing system using CCD line sensor cameras
    - Detecting the edges and the marker of the model.
    - The position is measured from two directions, upper and lateral side.
    - 5 axes (x, y, z, pitch, yaw) can be detected by using 5 CCD cameras.
    - To decrease interference between sensing system and optical system of visualization, only blue LEDs are used for sensing.

Experimental Results

- Selection of luminescent pigment
  - Necessary conditions
    - Excitation light source is UV, and sensor LEDs are blue.
    - Long wavelength emission like yellow or red are needed.
  - Pigment with yellow emission was used.

- Levitation with oil putting and excitation light source
  - Interference between sensor and visualization system was prevented.
  - Levitation was succeeded.

- Acquisition of images in wind-tunnel testing
  - Images were acquired under ventilated condition.
  - Skin friction line was obtained by processing images.
  - Separation at trailing end of the model was visualized.

Summary

- Levitation succeeded.
- Suitable pigment from the viewpoint of measurement wavelength was selected.
- Acquisition of images under ventilation condition was succeeded.
- Skin friction line were obtained by image processing and separation line was observed.

Future works

- It is needed extension of visualized area.
- Application of other visualization method (PSP, TSP, etc.).