Determining Fluid Viscosity Using Compter Vision

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***Abstract*—This report presents an experiment utilizing computer vision techniques to determine the viscosity of a fluid by analyzing the motion of a ball falling through the fluid. The experiment involves recording videos of the falling ball and applying image processing algorithms to calculate the ball's velocity. By applying Stokes' Law, which relates the drag force on a sphere to its velocity in a viscous fluid, we can then determine the viscosity of the fluid. The report discusses the experimental setup, image processing techniques used, experimental results, and future work.**

I. Introduction

In this experiment, we employ computer vision techniques to analyze the motion of a ball falling through a fluid. By applying Stokes' Law, which relates the drag force on a sphere moving through a viscous fluid to its velocity, we aim to determine the viscosity of the fluid. This approach provides a non-invasive and potentially more accurate method compared to traditional viscosity measurement techniques.

II. Prior Knowledge Required

a) Background Image Subtraction: The Gaussian Mixture Model for background subtraction involves subtracting a reference image (background) from subsequent frames in a video to isolate moving objects.

b) Canny Edge Detection: Canny edge detection is used to detect edges in images, which can be useful for identifying the outline of the falling ball.

c) Video Processing Using Python: Knowledge of Python programming language and its libraries for video processing, such as OpenCV, is essential for implementing the image processing algorithms.

III. Experimental Setup

The experiment setup consists of a transparent container filled with a fluid of interest. A high-speed camera is positioned to record the motion of a ball as it falls through the fluid. The camera's frame rate is chosen to capture the motion with sufficient detail. The experiment was conducted with balls of different sizes and fluids of varying viscosities. The recorded videos were processed using the described image processing techniques. The velocity of the falling ball was calculated for each frame, and the viscosity of the fluid was determined using Stokes' Law. The code which was used for plotting the graphs for a given dataset is given here.

IV. Future Work

- Explore the use of the background-oriented schlieren technique to measure the velocity of the fluid as it flows through a transparent horizontal pipe. This technique can provide a visual representation of the fluid's density gradients, which can be used to infer its velocity.
- Investigate the use of wiggle features in the image processing algorithm to enhance the detection and tracking of small-scale fluid movements. Wiggle features can capture subtle changes in the fluid's motion, providing more detailed information about its velocity profile.

V. Conclusion

This experiment demonstrates the feasibility of using computer vision and Stokes' Law to determine the viscosity of fluids. The results show that the method can provide accurate viscosity measurements and has the potential for applications in various fields. Further improvements and refinements to the experimental setup and analysis techniques are needed to enhance the accuracy and efficiency of the method.

References

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