# Schlieren Imaging System

Supervised by: Dr. Sudipto Mukhopadhyay
Mentor: Mr. Manish Singh

Student Name: Devendra Choudhary
Roll No.: B19ME024

## Introduction

- Schlieren imaging is a method of flow visualization technique. Schlieren photography is a technique by which the flow of fluids with varying density can be photographed.
- The schlieren technique relies on small differences in the index of refraction bending light rays behind an obstruction.

## Objective

- Design a schlieren experimental system using a smartphone.
- Using this setup design we can record different variable air density which can not be visible to the human eye.
- We record videos with of candle flame with single mirror using smartphone camera and also using DSLR.
- Then we do this experiment with biconvex lenses.

## CAD Models for mirror and mobile stand

# Components

Mirror

Lens

Point Light Source

Camera (DSLR or Smartphone camera)

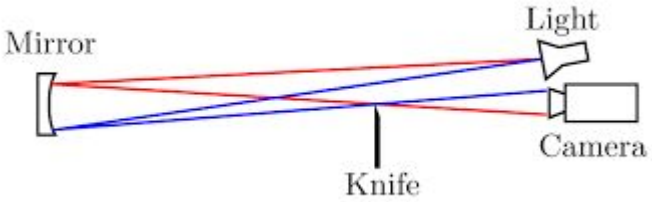
Knife edge

Burner or candle

# Working Principle

The deflection of light by a gradient in refractive index is the foundation of Schlieren flow visualisation. The flow density gradient is directly correlated with the index gradient. At a viewing screen, the deflected and undeflected light are contrasted. A razor edge partially obstructs the unobstructed light. Depending on whether the light was previously blocked or unblocked, the pattern of shadows created by the light that is refracted toward or away from the knife edge will vary. The expansions (low density regions) and compressions (high density regions) that define the flow are represented by this shadow pattern in terms of light intensity.

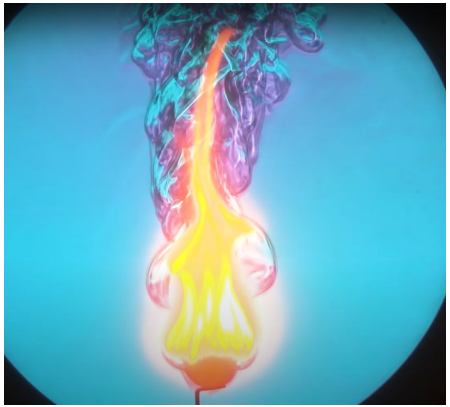
# Single-mirror




A point light source illuminates a spherical mirror. A knife edge is placed at the focal point of the spherical mirror and is positioned to block off half the light at the focal point. The camera is located further back on the axis of mirror.

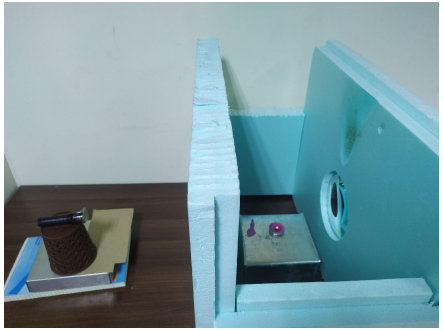
# Color Schlieren

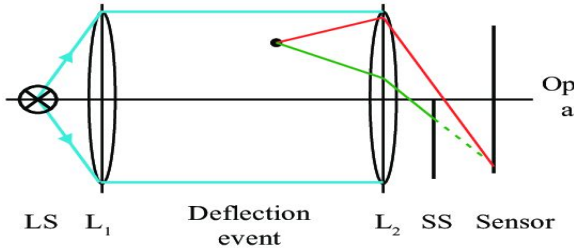
The traditional use of a knife edge causes phase differences in the incoming light rays to be converted into brightness differences. However, a different delineation can also be used by placing a split, two-color filter at the position of the knife. This provided a relatively smooth and transparent color filter that allowed enough light through to produce a visible image.



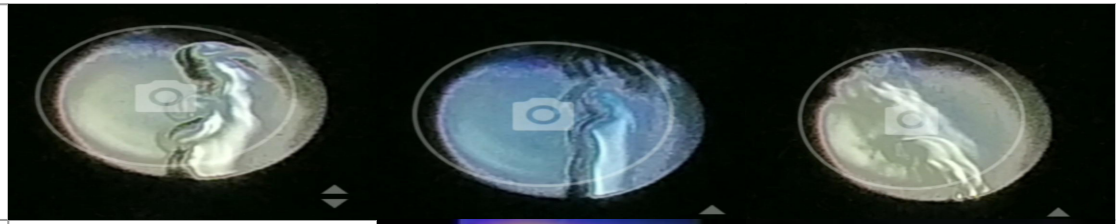
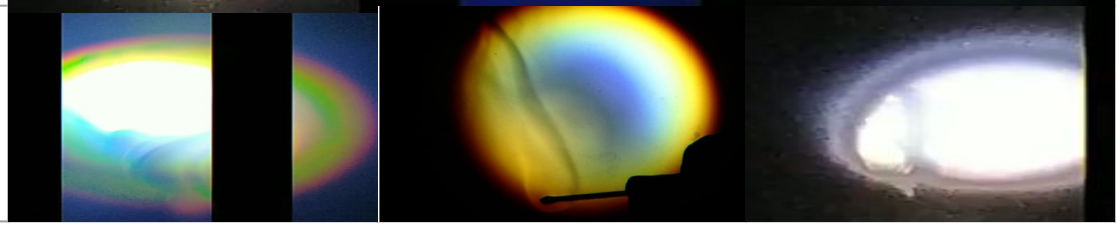
# Schlieren Setup with Biconvex lenses

- We put light source at focus of first lens which convert light to a parallel beam.
- Then this beam is converged by second mirror at focus where we put knife edge.
- We put camera  behind the knife edge.
- Then we put test ( candle flame, match stick between both lenses which divert light beam.





# Results

| | |
|---|---|
| Single Mirror System |  |
| Color Schlieren |  |
| Schlieren system with biconvex lenses |  |

# Applications

Schlieren photography is used to visualise media flows, which are themselves transparent (thus, their movement cannot be seen directly), but generate gradients in refractive index that become visible in schlieren photographs either as shades of grey or even in colour. Refractive index gradients can result from changes in the fluid's temperature or pressure as well as from differences in the component concentrations in mixes and solutions. The analysis of shock waves in ballistics and supersonic or hypersonic vehicles is a common application of gas dynamics. It is possible to visualise flows brought on by heating, physical absorption, or chemical processes. Schlieren photography can therefore be used to solve a variety of engineering issues, including those involving heat transmission, leak detection, the investigation of boundary layer separation, and characterization of optics.

**References:**


- https://www.instructables.com/Phone-Camera-Schlieren-Optical-Setup/
- https://www.researchgate.net/publication/347042296_Design_of_a_Schlieren_System_for_Visualization_of_Heat_and_Mass_Transfer


Thanking You