

Abhishek Thawait |19MS160 | LS3104 | Cell Bio and Imaging lab  
Group 9

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**Aim** - To determine the velocity of Popcorn after popping and its variation through time

**Material required** - Camera, tripod, black chart paper, a coin or a scale, frying pan, any stove, popcorn, light source, and measuring tape.

**Softwares used** - ImageJ, Origin, Google Sheets, Google Docs, and Paint-3D editor.

**Safety essentials** - Safety glasses to protect eyes from oil splash and clothes with maximum body coverage are recommended.

**Experimental setup** -



Fig1:- Filming the popcorn in slow motion through the shown setup above

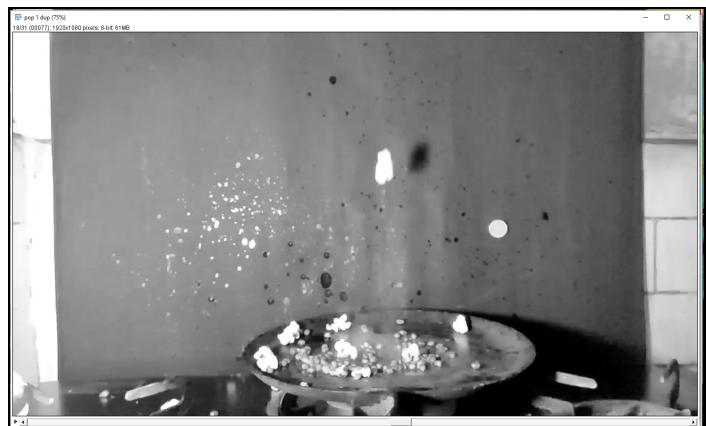
### **Procedure followed -**

- 1) The slo-mo(240 frames per second at 720p) footage of the popcorn was obtained with the setup shown in fig 1.
- 2) A single popping event was selected and trimmed from the original film. (I selected a particular event in which popcorn flew vertically.)
- 3) The 8-sec clip was then converted into an image sequence through ImageJ and then used for the analysis.
- 4) Using the reference coin in the background length scale was calibrated.
- 5) Region of Interest (ROI) was chosen such that only single popcorn is seen throughout all the frames.
- 6) Contrast/Brightness was tuned to enhance popcorn visibility. (Tried to make background black)
- 7) Thresholding was done.
- 8) The centroid of the Popcorn was recorded through Analyse particle action.
- 9) Plot for distance vs time. Fit 2nd order polynomial and find the derivative of distance i.e speed.
- 10) Plot speed vs time.

### **Pictures from the Image Analysis -**



*Fig2 :- Snapshot from the clip*



*Fig2 :- Converted to 8 bit*

### **Length scale calibration -**

1. A 2010 5 Rupee coin was used as a length reference.
2. The exact diameter (2.3cm) obtained from the internet was used.
3. Line ROI was drawn along the diameter. (53.16 pixels long)
4. The length scale was set using the info given above.

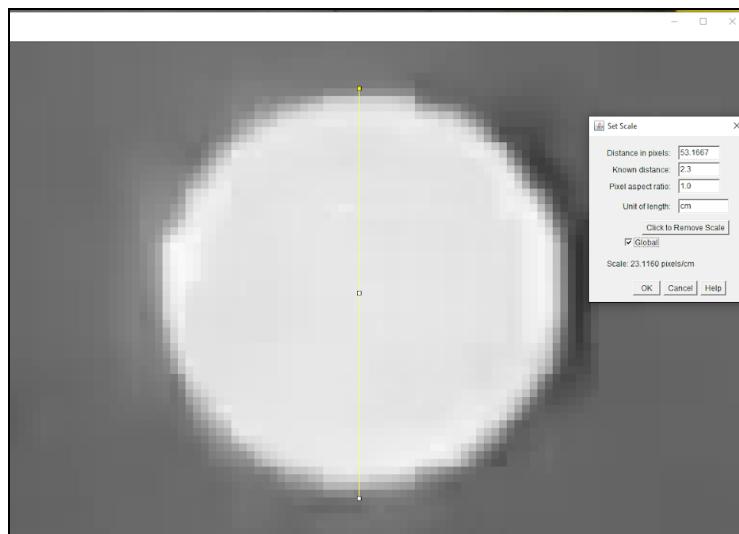


Fig 3- ROI drawn across diameter

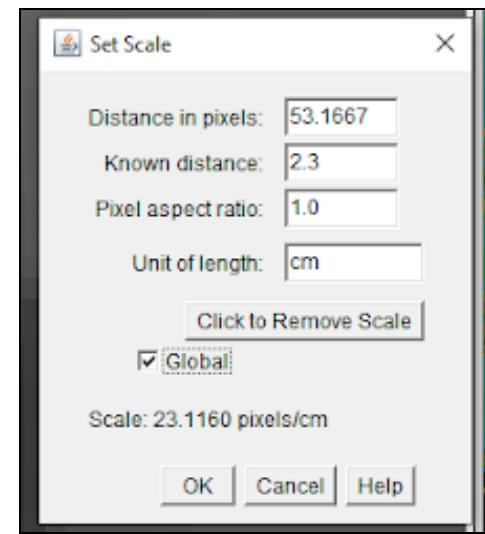


Fig 4- Set scale box

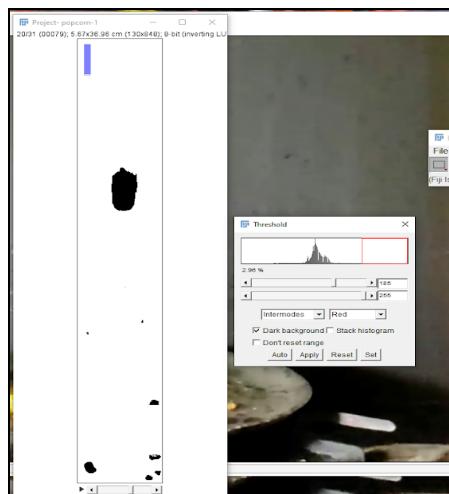


Fig 5- Thresholding

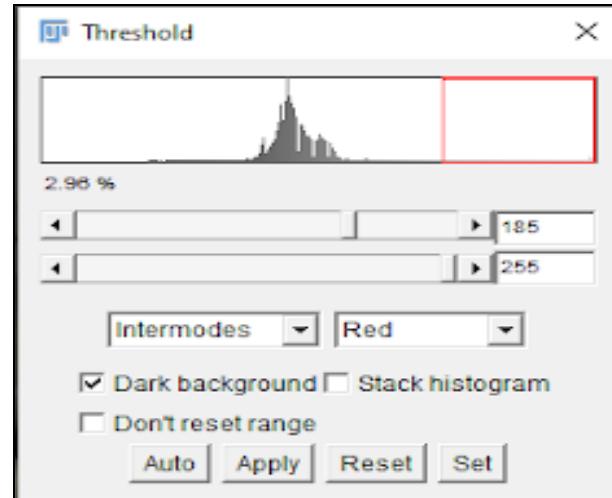
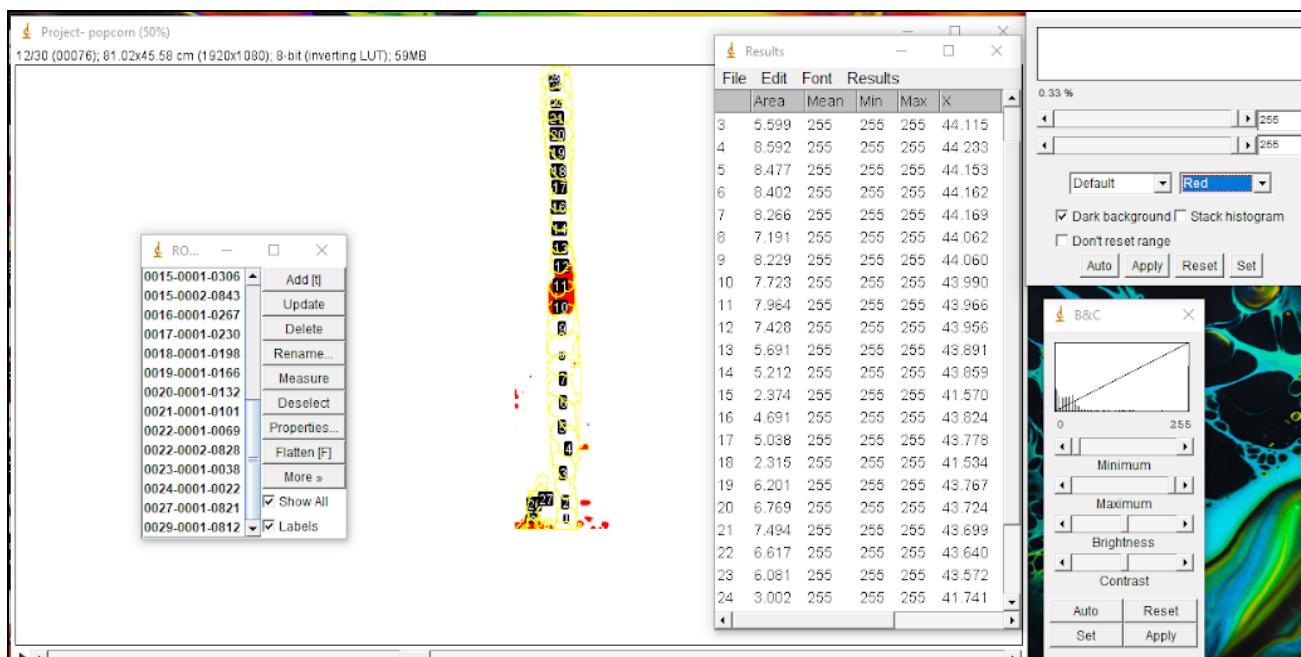
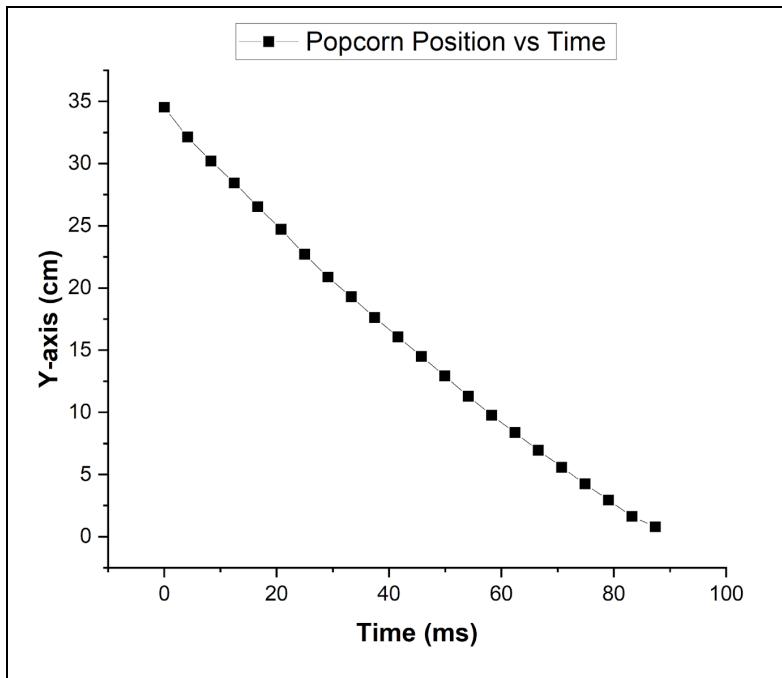


Fig 6 and 7- Thresholding box & Centroid detection



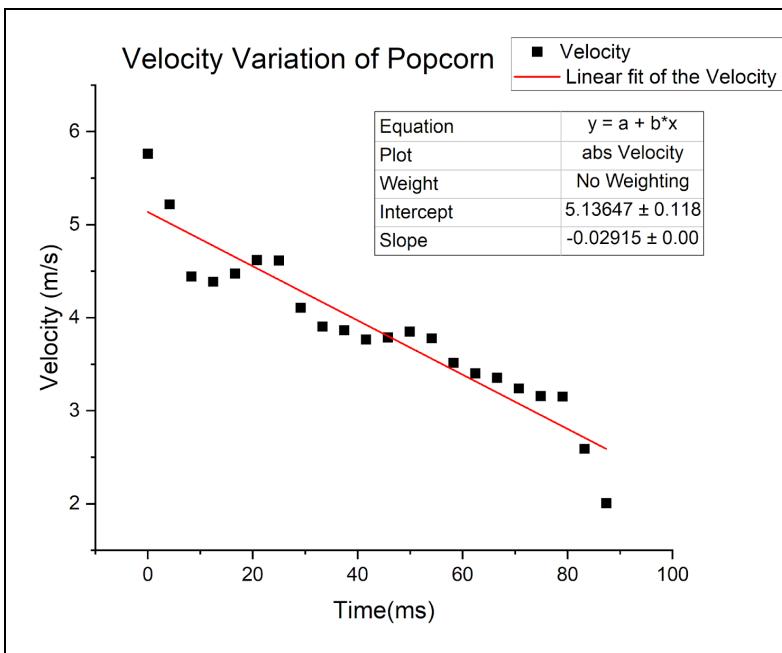
## Graphs and Interpretation -

### Plot 1 -



- The graph shows the popcorn's course of movement through time
- The plot seems to curve a little in concave-up direction. Suggesting the absolute slope is decreasing.
- That means velocity is decreasing as popcorn goes up.

### Plot 2-



- Velocity is calculated by finding the derivative of the function fitted to the above graph.
- Overall velocity is seen to be decreasing as popcorn goes up. (shown by linear fit)
- Velocity drops from 5.7m/s to 2m/s within 90ms since the beginning of the flight.
- Two jumps in velocity are seen around 20sec and 50sec.

## Inference -

**Decrease in velocity** - The velocity is decreasing because of the gravitational pull acting downwards and due to the drag caused by the air resistance.

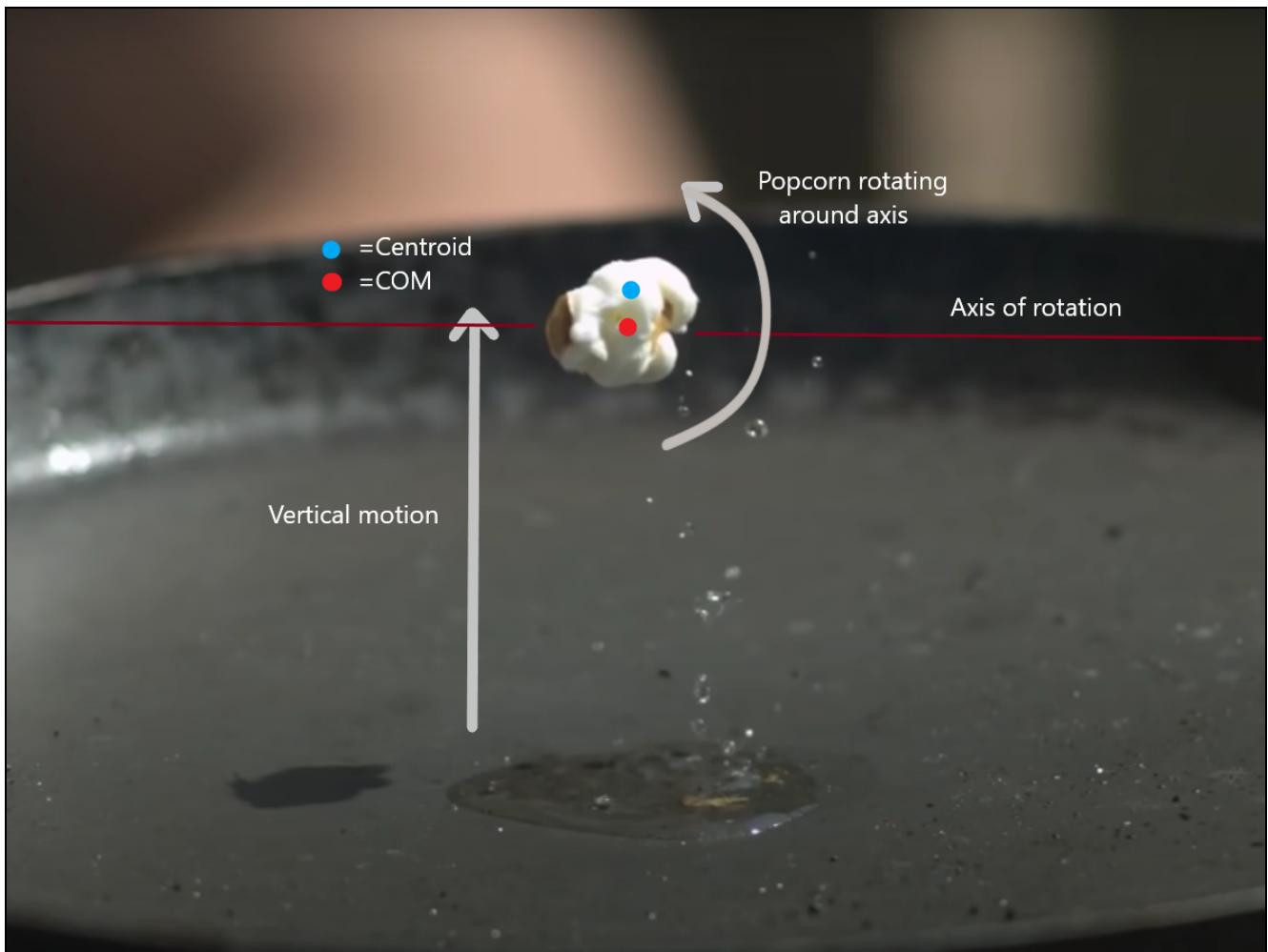


Fig 3- Picture showing course of motion of the flying popcorn, Source- Slowmoguys(Youtube)

**Two Jumps in the velocity-time graph**- The two mounds showing the local increase in the velocity can be due to the rotation of popcorn. The centroid of the popcorn was tracked for velocity determination and Popcorn being an asymmetrical object its centroid would follow a spiral path while going up. When the centroid would circulate up wrt to the COM, the velocity of the centroid will increase. This increase is observed as jumps in the graph.

## **Log of Attempts -**

1. Popcorn experiment - Tired to film slow-mo in daylight outside. Made a DIY stove through Diya wigs and tin cans. The flames were uncontrollable and the high temperature burned the popcorn. Only a few popped. (27/Nov)
2. Tried converting the MP4 file to AVI format. Did it via online tools but video quality dropped poorly. (12/Dec)
3. Tried importing MP4 video into FIJI through FFmpeg plugin. (was successful) But maybe due to conversion the results after thresholding were not coming satisfactorily.
4. Converted imported MP4 video into Image sequence and then used it for analysis. (successful). (13/Dec)

## **Other Experiments by group members -**

1. Ink diffusion on water at different temperature, Pratyasha Biswas (19M079)
  2. Measuring the pupil roundness of different predators, Priya Binwal (19MS061)
  3. Measuring the variation in no. of sunspots over a period of 13 years and finding the nature of the melting rate of ice at room temperature. Shreyas Agarwal(19MS095) & Udit Ghosh(19MS097)
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