Uncertainty Notes for The Thin Lenses Experiment

The uncertainty for the **Lens Equation** (i.e., $\frac{1}{f}=\frac{1}{o}+\frac{1}{i}$) is given by the relationship

$\delta f = f\sqrt{\left(\frac{i}{o(o+i)}\delta o\right)^2+\left(\frac{o}{i(o+i)}\delta i\right)^2}$ where δo and δi is the uncertainty in object and image distances respectively.

We can assume that the uncertainty in object distance δo is small compared to the uncertainty of the image distance δi. This a good approximation if we fix the light source (i.e., the object) and lens and **vary only the screen (i.e., the image distance) distance while focusing.**

Thus we can use the following approximation for the uncertainty of the lens equation

$$\boxed{\delta f \approx f\left(\frac{o}{i(o+i)}\delta i\right)}$$ where $\delta i = \frac{fuzzy_1\_clear\_fuzzy_2}{2} = \frac{\Delta fuzzy}{2}$ as defined in lab.

Since we make 5 measurements we will use the average of the 5 uncertainties in our final result to go along with the average of the 5 focal lengths. *Please note that the proper method of handling multiple uncertainties is via statistical methods that we will forego in this analysis.*

The **uncertainty for the conjugate foci equation** (i.e., $f=\frac{L^2-d^2}{4L}$) is given by

$$\delta f = f\sqrt{\left[\left(\frac{L^2+d^2}{(L^2-d^2)L}\delta L\right)^2+\left(\frac{2d}{L^2-d^2}\delta d\right)^2\right]}$$

Since we keep light source and screen (which define distance L) fixed in this measurement, we can ignore δL and use the following approximation for uncertainty of conjugate foci method.

$$\boxed{\delta f \approx f\left(\frac{2d}{L^2-d^2}\delta d\right)}$$ where $\delta d = \sqrt{\left[\frac{\Delta Fuzzy_{left}}{2}\right]^2+\left[\frac{\Delta Fuzzy_{right}}{2}\right]^2}$

For Lens Equation portion of the lab use the following data table.

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Note that focal length from part one (i.e., the distance object method) is denoted by f_{dist_obj} on the table below.

Trial	Lens location from light source	Object distance (cm)	Image distance (cm)	Image size (compared to object size)	focal length (cm)	δf (cm)
1	8 x f_{dist_obj} =					
2	6 x f_{dist_obj} =					
3	4 x f_{dist_obj} =					
4	2 x f_{dist_obj} =					
5	1.75 x f_{dist_obj} =					