Pinhole camera

Introduction

Pinhole camera is an elementary device which captures the image of an object on to a small screen. It allows light from the object to pass through a very small hole which is just the size of a pin. Collecting this light on a screen forms an up-side down and left-right reversed image of the object. This device demonstrates the ray nature of light. The pinhole camera described here can be made using household items.

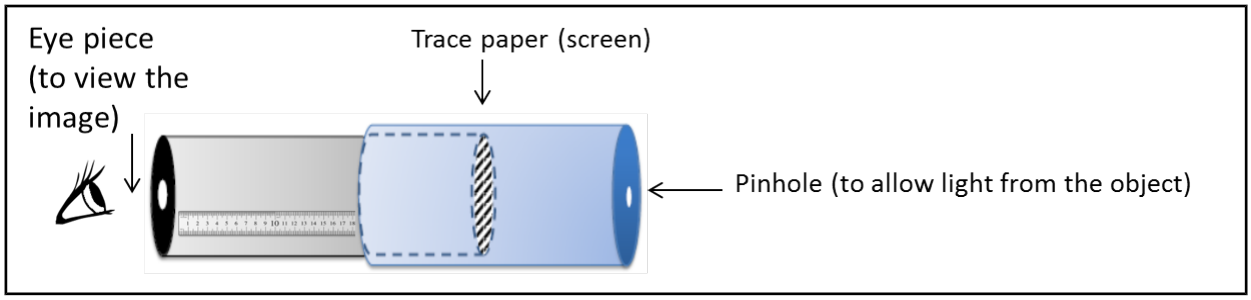

Figure 1: One design of a Pinhole Camera

Materials Required

- Black chart paper, tracing paper/translucent polythene sheet, print out of a ruler on paper, measure tape, scissors, adhesive, cutter, cello tape, aluminum foil used in kitchen.

Task 1: Making Pinhole Camera

1. Cut a rectangular piece from the black chart paper and fold into a hollow tube such that the longer side of the paper is the height of the tube, and tape it or use rubber bands so that the tube is firm. You can keep the diameter up to 3cm and height 25 cm.

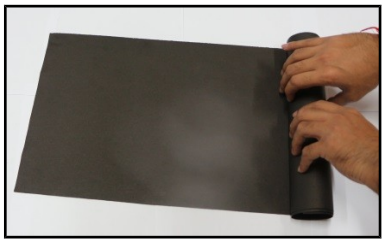

Fig. 2(a): Rolling cardpaper

Fig. 2(b): Cardpaper as pipe

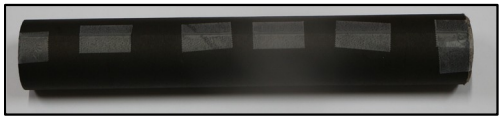

Fig. 2(c): Cello Tape on pipe

You can also vary the diameter and length of the tube. Smaller diameter will increase the clarity of the image. (One can also use the cardboard tubes on which the aluminium foils or kitchen paper tissues are rolled.)

2. Cover the other end of the tube with a plastic semi-transparent sheet. This sheet will work as screen. Let us call this tube as the image tube (IT). Put the markings on screen on every 5 mm. This will help in measuring size of the image formed on the screen in task 2.

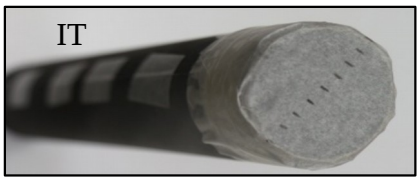

Fig. 3: Wrapping trace paper for screen

3. Fold another rectangular chart paper into a cylindrical tube such that it is smaller in length and slightly larger in diamer than of the IT and the IT can slide inside smoothly. Cover one end of the tube with a circular chart paper and make a hole using a pin in the centre. One can also use a sheet of aluminum foil for this purpose. We will call it Pinhole tube (PT).

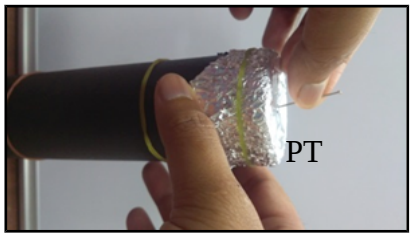

Fig 4: Making a camera

4. Insert IT inside PT such that the screen just touches the pinhole (refer Fig. 1). Mark a point ‘O’ on the IT where PT ends. Now bring the PT out and stick a strip of white paper on IT along its lenght. Considering point ‘O’ as a zero point, put markings at 5 mm intervals on the paper so that it can be use as a scale. This scale will be used to measure l i.e. the distance between the screen and pinhole. Now the pinehole camera is ready to use.

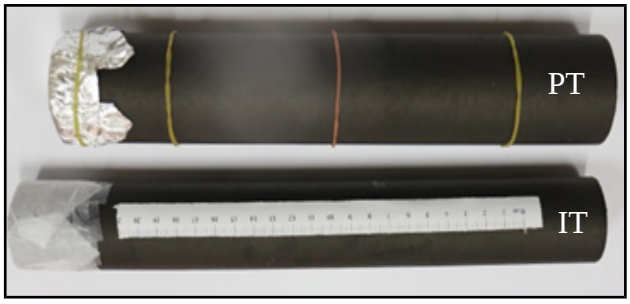

Fig. 5 (a): Pasting scale on image tube (left)

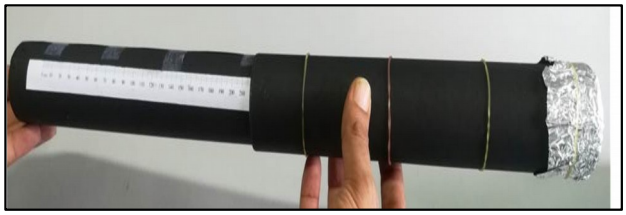

Fig. 5 (b): Pinhole camera is ready to use

5. To view an image, point the pinhole towards the object and adjust the distance between the screen and the pinhole to view a clear image of the object on the screen. Shown below is a picture of a building when viewed through the pinhole. One can notice the image of the object is up-side down and left-right reversed.

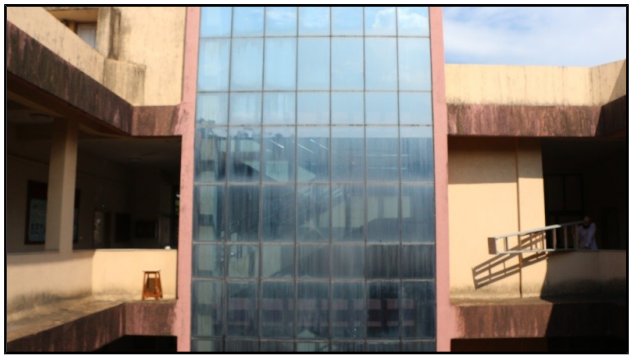

Fig. 6 (a): Object

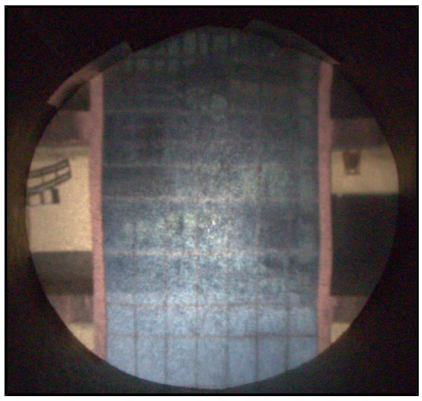

Fig. 6(b): Image in Pinhole camera.

Fig. 6 (c): Object

Fig. 6(d): Image in pinhole camera.

Discussion

1. What will happen to the image if,
   I. hole becomes bigger?

_____

_____

II. you increase the distance between pinhole and screen?

_____

_____

III. you move pinhole away from the object?

_____

_____

Task 2: Measuring the Height of a Huge Object

Rays from object fall on trace paper (screen) after passing through pinhole, and forms an image on the screen (Fig. 7). You have to measure three quantities, distance (D) between pinhole and the object, screen-pinhole distance (l) and size (h) of the image on the screen.

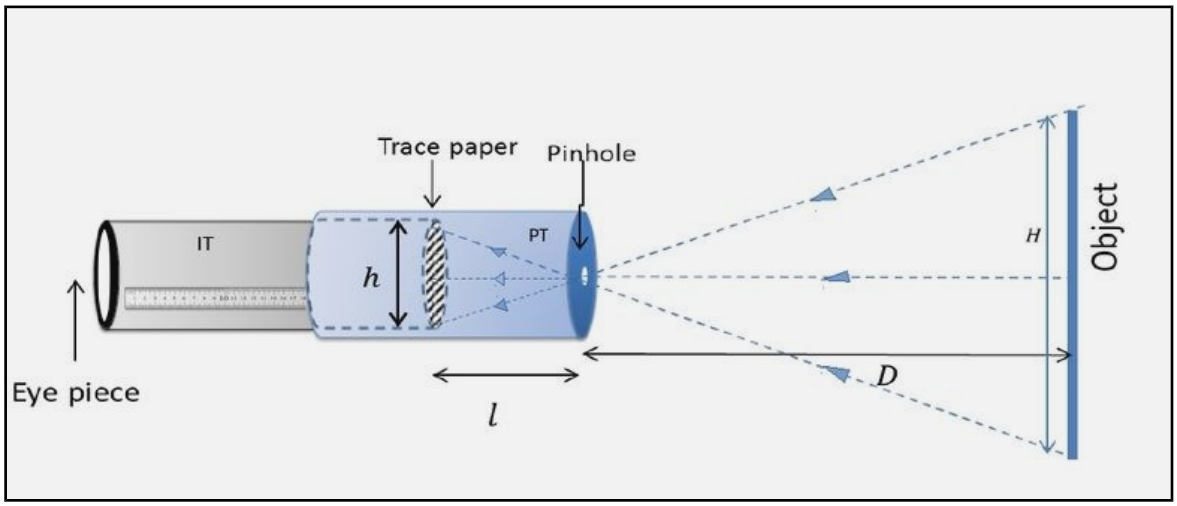

Fig. 7: Ray Diagram

1. Let height of the object be H.
2. Measure the distance D between the pinhole and the tree.
3. Move the IT such that you can see a clear inverted image of the object, such that the top of the image and bottom of the image simultaneously coincides with a marking on the screen. Count the number of markings n between the top and the bottom of the image on the screen. Then the height h of image in mm is $5(n\text{-}1)$.
4. Using the scale on the IT, note down (l).
5. The height of the object is given by the formula $H = hD/l$. As you vary l, h will also change. Tabulate your reading below:

D (cm)	d (cm)	$H = hD/l$ (cm)

Average height of the object, (Mean) H = _____

Questions to Think

- If you place a second pinhole behind the screen of first pinhole, will the image now be still inverted, or upright, left right reversed or not left right reversed than compared to the original object?
- As we calculate H knowing D can we calculate D knowing H using methodology discussed in Task 2?