Parallax

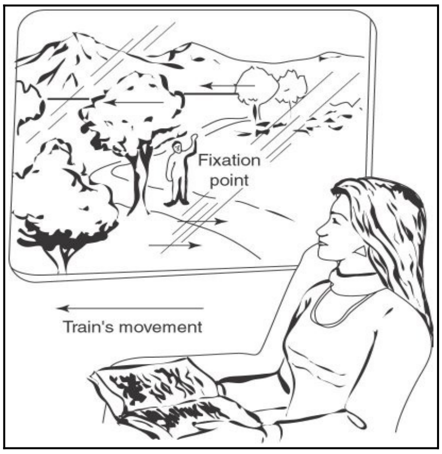

Figure 1: Source: http://www.appstate.edu/~steelekm/classes/psy3215/MonocularDepth/motionparallaxcue.htm

Introduction:

While travelling on a train and looking out of the window, you might have noticed that objects closer to you seemed to move in the backward direction while objects farther away appeared to go along with you. Of course, you would have realized that even the objects farther away slowly lag behind and disappear from your view eventually. Further, the speed at which both the near and far objects appeared to move was proportional to the speed of the train. When the train moved faster, the objects also seemed to speed up.

This optical effect of objects closer to the observer in her field of view appearing to move faster than objects farther away is called motion parallax, or simply, parallax.

The concept of parallax is used in determining which of two given objects is nearer to the observer.

Materials required:

- A foam sheet (approx 30cm x 40cm)
- A4 size sheets of paper
- 1 plane mirror
- At least 2 needles, taller than the mirrors
- Rubber band and allpins or Cloth clips
- Thumb tacks

Task 1a: Parallax in the classroom – 1

When some stationary object is seen from different viewing position, it feels like the stationary object has moved. Let us verify this by a simple activity.

Extend one of your hands in front with only index finger pointing up. Use your other hand to close your left eye. Now adjust the position of your finger such that, your finger appears exactly along one vertical edge of the blackboard. Next, keep your finger steady, open your left eye and close the right eye.
What did you observe?

Why did it happen?

Task 1b: Parallax in the classroom – 2

1) Gather two of your friends. Let's call them A and B. Now all three of you stand in one straight line. Here you as the observer are going to stand facing towards your friends. Let there be enough distance, at least 2m, between any two of you. You will observe that your view of your friend B (who is standing farther from you) is blocked by your friend A (who is standing nearer to you).
2) Now, take a few steps to your **right**. A and B should not move from their position. Observe your friends again and record them as follows:
   - A appears to have moved towards **left / right / not moved**. (select one)
   - B appears to have moved towards **left / right / not moved**. (select one)
   - Who appears to have moved more? **A / B / Both have moved equally** (select one)
   - Originally A and B were along the same line of sight. Now A is to the **left of / right of / still aligned with** B. (select one)

3) Now come back to your original position and then move a few steps **left**. What do you observe now?
   All students should take turns to be the observer and note their own observations.
4) Lastly, ask A and B to stand close to each other (almost no separation). Repeat the experiment you just performed. What do you observe?

Discussion:

1) When you are travelling in a car or a train distant objects like mountains or moon seem to be 'travelling with you' because
   a) As you move forward, these objects also move in the forward direction.
   b) These objects actually move backward, but appear to move forward in comparison with nearby objects like trees or poles.
   c) They never appear to travel along. I have never observed this.
2) While travelling in a train, I noticed two trees in a field. As the train moved, both the trees appeared to be moving backwards. But the separation between them hardly changed. This means _______________.

Task 2: Using parallax to locate the image position

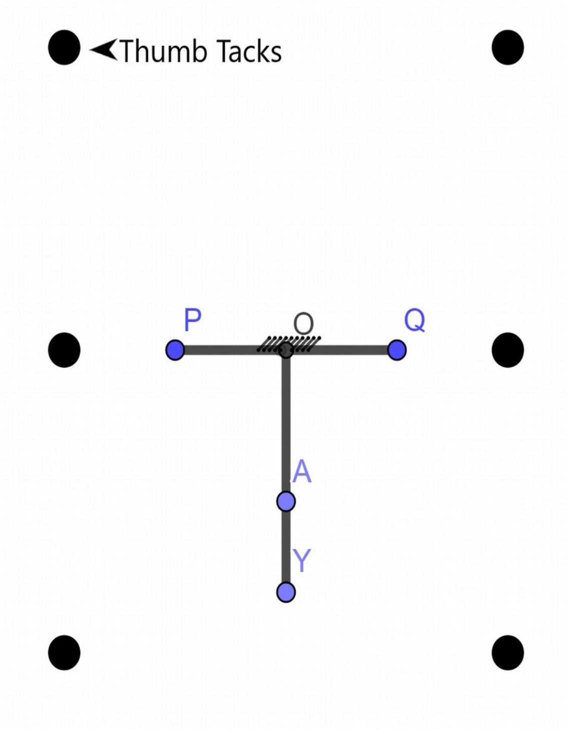

Figure 2: Setup for Task 2

When you get ready for the school, you must be checking yourself in a mirror. You would have certainly noticed that when you stand far from mirror, your image appears to be far behind the mirror and if you stand close to mirror, even your image is close to the mirror. But can we find out the exact location of your image?

1) For our reference, we will draw a "T" shaped figure in the middle of an A4-size paper. Attach the paper to a drawing board using 6 thumb tacks (see figure 2). Make sure the paper is completely flat and there are no creases or bumps.
2) We are going to keep our mirror on the top line of the "T" (i.e. line PQ in the figure). The line OY, which is perpendicular to PQ, will be reference line for our object, whose image we want to see.
3) Place a mirror upright along the line PQ, such that its centre is approximately at O.
4) In any good experiment, it is important to identify possible errors and minimize them. In this case, there are two important points to remember.

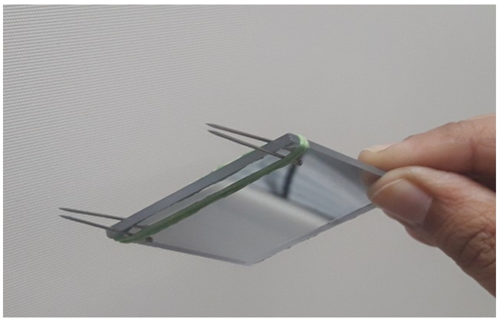

Figure 3: Allpin and rubber band arrangement

   a) The typical mirrors which we use are just a plain glass with a reflective coating on the back surface. Make sure the reflecting surface is placed exactly on the line PQ.
      Question: How can we find out if our mirror is front coated or back coated?
   b) The mirror should be exactly upright and firmly affixed to the board. This can be done in either of two ways.
      In the first method, you can attach binder clips or cloth clips on both sides of the mirror to give it support. The clips can then be firmly affixed to the board with allpins on the side.
      Alternatively, you can attach allpins directly to the mirror using a rubber band and then mount it on the drawing board (see figure 3).
5) Let's take a needle and mount it somewhere along the line OY (recommended distance is about 5 cm from the point O). Let's call the position of the needle 'A'. You must ensure that the needle is strictly vertical.
6) Now adjust yourself such that the drawing board is at your eye-level. Look in the mirror. You will see the image of the needle at A. Move your head to make sure that you can see both the needle at A and its image.
7) Our goal is to now put a second needle behind the mirror such that, it is at the same position as the

image. Take another needle (call it M) and place it behind the mirror, such that it coincides with the needle at A. You can see tip of M above the mirror.

8) Move your head so that the image of A in the mirror (call it A') is aligned with the top visible part of the needle M.
9) Now, move your head slightly to the **right**. Observe the image of A and the needle M again. There can be one of the three following situations. Explain the reasons in each case.
   a) The two are no longer aligned. A' is now to the **left** of M.
      This means A' has moved **more than / less than / same as** (select one) than M.
      This means A' is **closer than / farther than / at same distance as** (select one) M.
   b) The two are no longer aligned. A' is now to the right of M.
      This means A' has moved **more than / less than / same as** (select one) than M.
      This means A' is **closer than / farther than / at same distance as** (select one) M.
   c) The two are still exactly aligned.
      This means A' has moved **more than / less than / same as** (select one) B.
      This means A' is **closer than / farther than / at same distance as** (select one) M
10) Check that you get the opposite behaviour when you move your head to the **left.**
11) Depending on which of the above three situations has occurred, adjust the position of M to get it as close to A' as possible. Repeat steps 8 to 10. Keep repeating this process till you are satisfied that M is exactly at same distance as A'. Encircle this final position of the needle M and mark it as point B.
12) Once you have obtained point B remove the mirror and the needles. Draw a line to join the points A and B. Does the point O lie on this line (exactly or approximately)?
13) Measure distances OA and OB. What can be concluded from this?

Discussion:

1) Why is it important for the mirror and the needles to be strictly vertical?

2) Did you find O, A, B to be perfectly collinear? If not, what could be the possible reason?

3) In case O, A and B are not perfectly collinear, can OA and OB be termed as the object distance and image distance, respectively? Would you still find OA=OB? Explain.