10.017 TECHNOLOGICAL WORLD

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Our DTI Project seeks to create an inverted fish tank lantern above the hostel pond's surface to allow fish to swim into the new space, while lights in the tank create the semblance of a lantern at night and cast shadows of the fish within the tank, projecting them onto the lantern's surfaces.

As the most crucial aspect of our project is the luminance of the fish tank and the shadows cast, we sought to determine the most suitable light source and the corresponding fish tank dimensions to maximise the impact of lighting and shadows.

We sourced for high quality lights of various types, and the following lights have been tested:

LED STRIP

Shines light at a 120 degree spread

SPOTLIGHT

Concentrated uni-directional light rays

LED BULB

Shines light omni-directionally

Functional Diagram

User walks along the boardwalk path and approaches the fish tank lantern

Ultrasound sensor detects user is approaching

Lights in lantern are turned on

User continues to approach the lantern and motion is detected by the ultrasound sensor

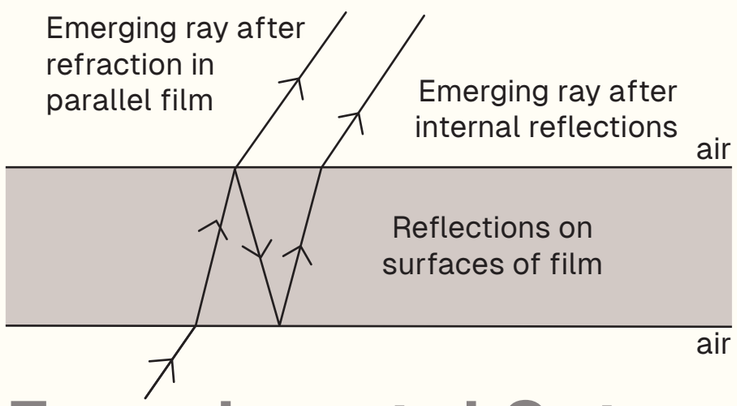
The luminosity of the lights increases accordingly until the user is at the closest distance

When the user walks away from the lantern (based on a defined distance)

Lights in the lantern dim according to the increasing distance until the lights go off

Physics Concepts

1. Refraction and reflection in parallel sided films



Refractive index

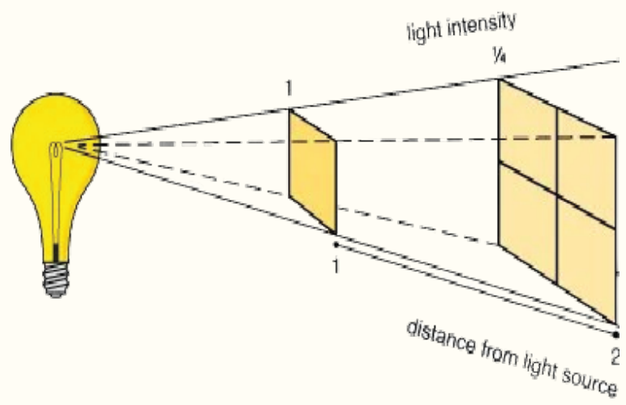
$$n = \frac{\sin i}{\sin r}$$

n = refractive index
i = angle of incident
r = angle of reflection

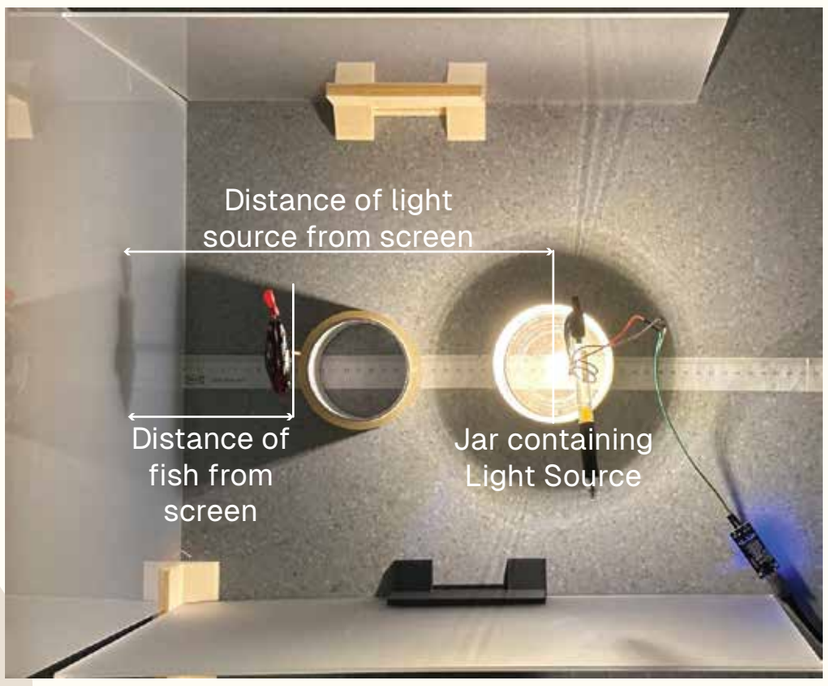
2. Inverse Square Law of Radiation

Light Intensity (I) is inversely proportional to distance from the source:

$$I \propto x^{-2}$$



Experimental Setup



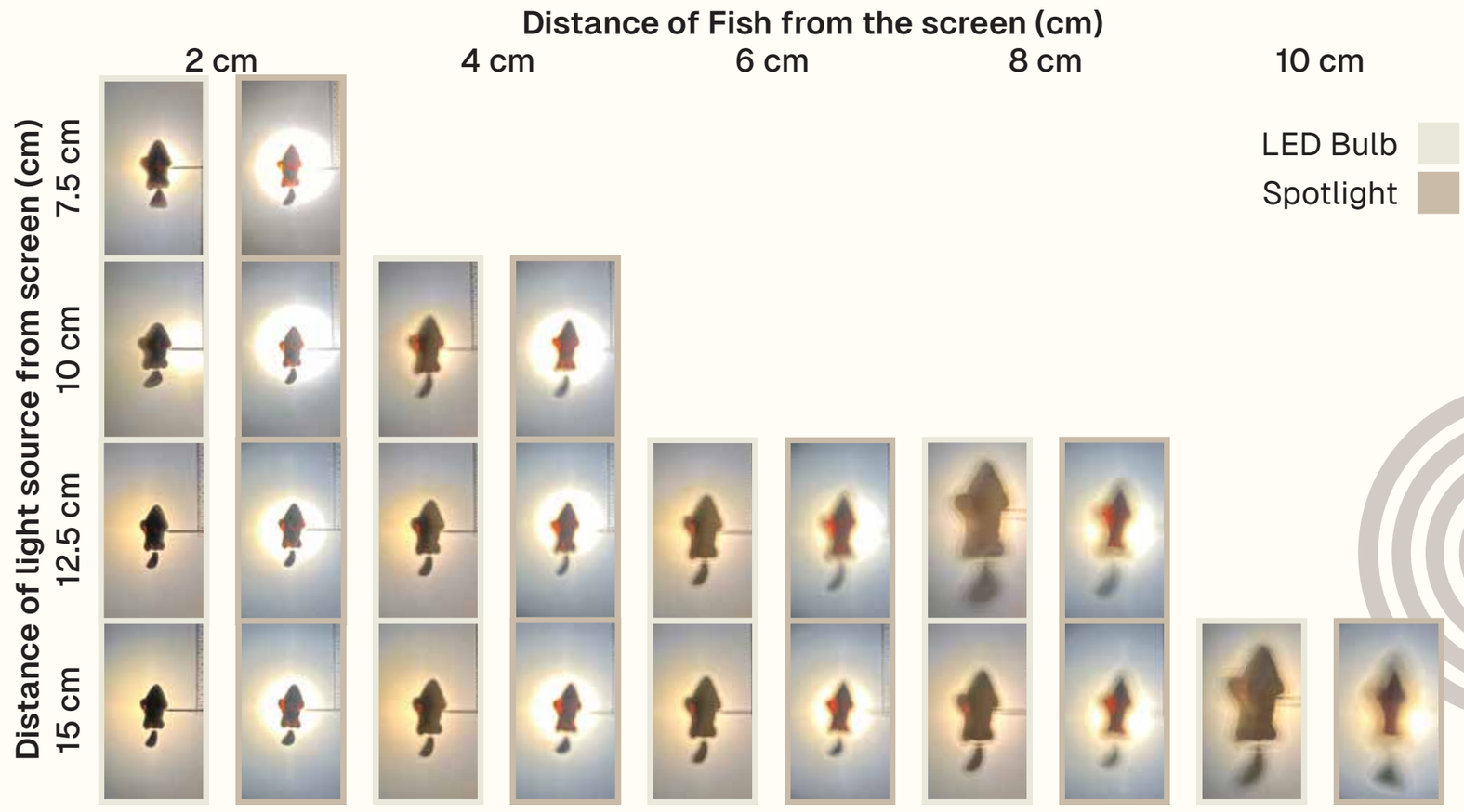
The following setup was done in a dark environment with frosted acrylic panels simulating the sides of our fish tank

Independent Variables: Type of light source, distance of light source from screen, and distance of fish from screen

Dependent Variables: Quality of shadow based on qualitative analysis

Testing and results

For each light source, we first varied its distance from the screen in **2.5 cm intervals**, from **7.5 cm to 15 cm**. For each interval, the fish's position was varied from being flush to the screen **(2 cm)** to as close to the jar as possible. The image results are organised as follows:



Analysis

1. Distance of Source from Screen

Brightness across screen decreases as distance increases
- LED: All distances result in acceptable lighting
- Spotlight: Too intense at closer distances of 7.5 / 10 cm
  - Acceptable distance is 12.5 / 15 cm

2. Distance of Object from Screen

As the fish was brought further away from the screen and closer to the light source, shadows cast got bigger

When the fish is at further distances from the screen (8, 10 cm), shadows can be seen to have multiple outlines, leading to incoherent and undesirable shadows.

Conclusion

Best Fish Tank Sizes for Lighting
(Radius for square tank)
- Spotlight: 12.5, 15 cm
- LED: 7.5, 10 , 12.5, 15 cm

Optimal Fish Tank Sizes for Shadows Cast
- Spotlight: 7.5, 10 cm (Not chosen)
- LED: 7.5, 10 cm (Chosen light)

A fish tank of 10cm radius was chosen to allow for fishes to swim past each other.

Limitations

As the human body is non uniform, the ultrasound sensor is not able to detect people walking reliably

- To detect approaching users along the boardwalk path more reliably, ultrasound sensors can be front facing
- A system of ultrasound sensors can be used in each detection region
- Experiment limitations: object used, fish, is not fully opaque, affecting shadows cast by extremely intense light

Citation

Encyclopædia Britannica, inc. (n.d.). Inverse Square Law. https://kids.britannica.com/students/assembly/view/167423