Waves and Optics

Two options are available for this module. 1) Wave characteristics and 2) Interference

Wave Motion

Steps to follow-

1. The camera of the phone will open after selecting Wave Motion option.
2. Please hold the camera on top of the target image given for this module.
3. You will see 2 drop down options to select waves. (Fig:1)
4. Select two waves of same type or of different type from the dropdown menu.
5. Change values of the four parameters for each wave.
6. Press Start animation to see the wave movement.
7. You can change all the parameters, amplitude, period, wavelength and phase of both the waves in real time using the slider. (Fig:2)

Theory

The wave function for a simple harmonic wave on a string can be defined by

$$y\,(x,\,t) = A\,\sin(kx \mp \omega t)$$

where A is the amplitude, $k = \frac{2\,\pi}{\lambda}$ is the wave number, $\omega = \frac{2\,\pi}{T}$ is the angular frequency. The minus sign is for waves moving in the positive x-direction, and the plus sign is for waves moving in the negative x-direction.

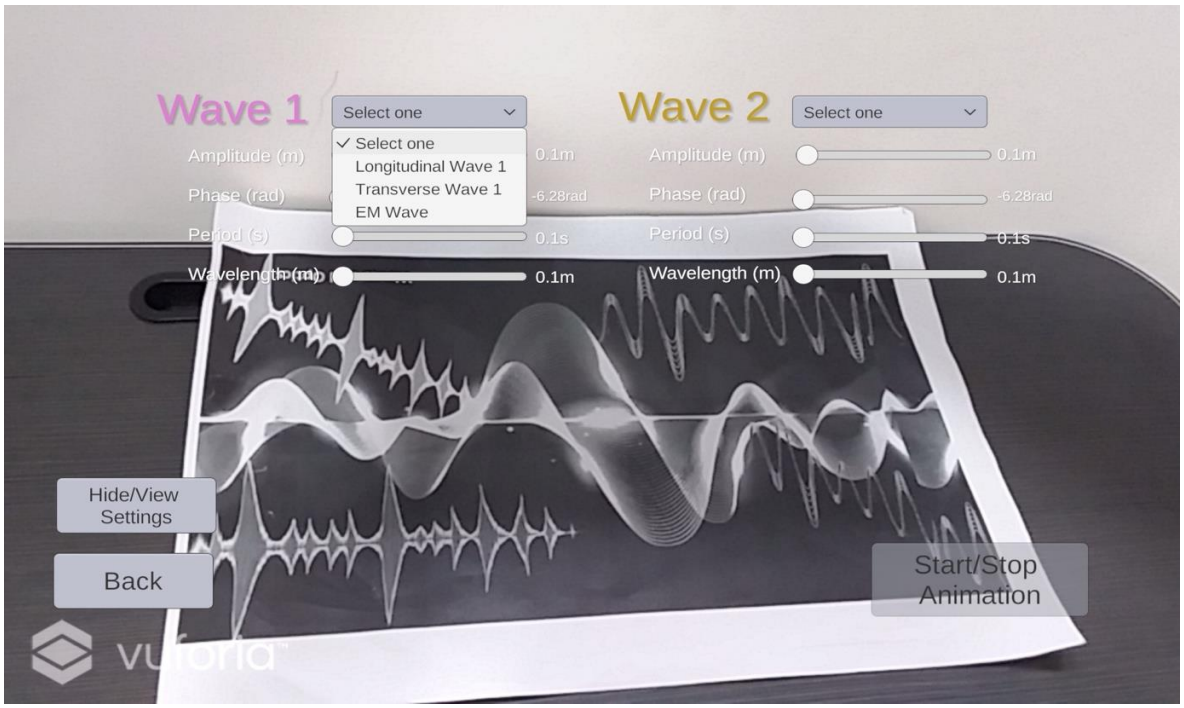

Fig. 1 Dropdown menu for two waves with different parameters

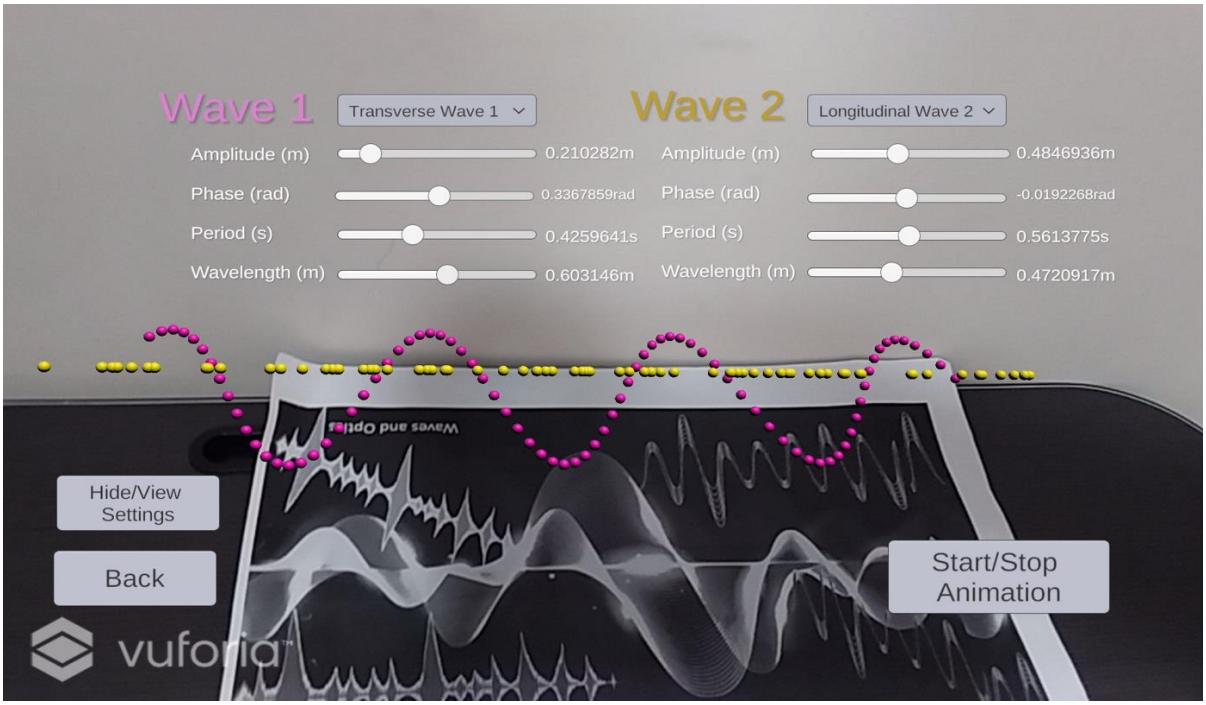

Fig. 2 Longitudinal wave and transverse wave.

Interference & Diffraction

Procedure:

1. The camera of the phone will open after selecting this option.
2. Please hold the camera on top of the target image given for this module.
3. A slit, a light and a background will become visible. (fig. 3)
4. There will be a dropdown menu to choose different patterns. (fig. 3, 4 and 5)
5. User will be able to change the slit width, slit distance, slit numbers and the wavelength of the light using sliders. And check the interference and diffraction pattern on the background screen.

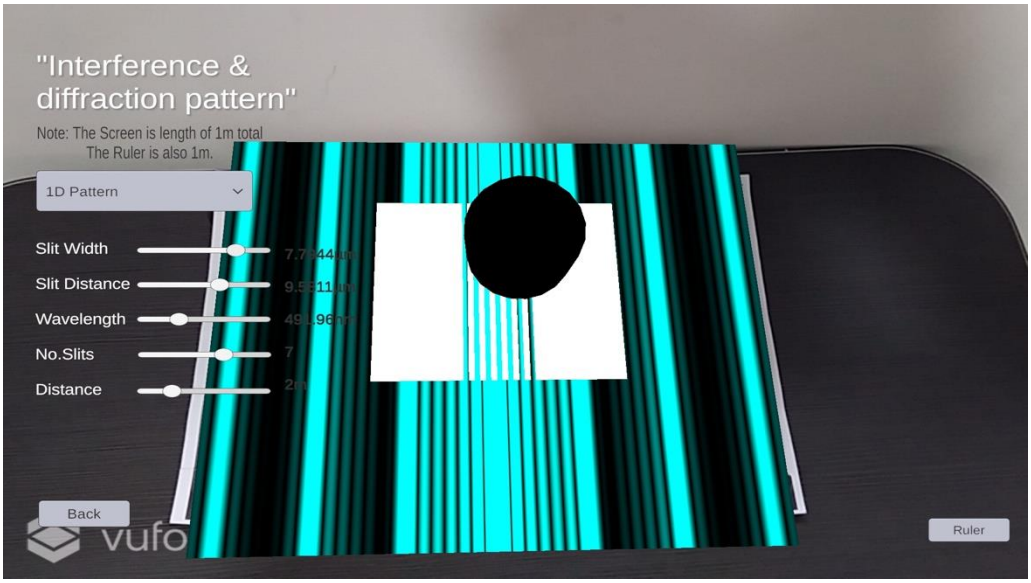

Fig. 3 Interference and diffraction pattern (1D)

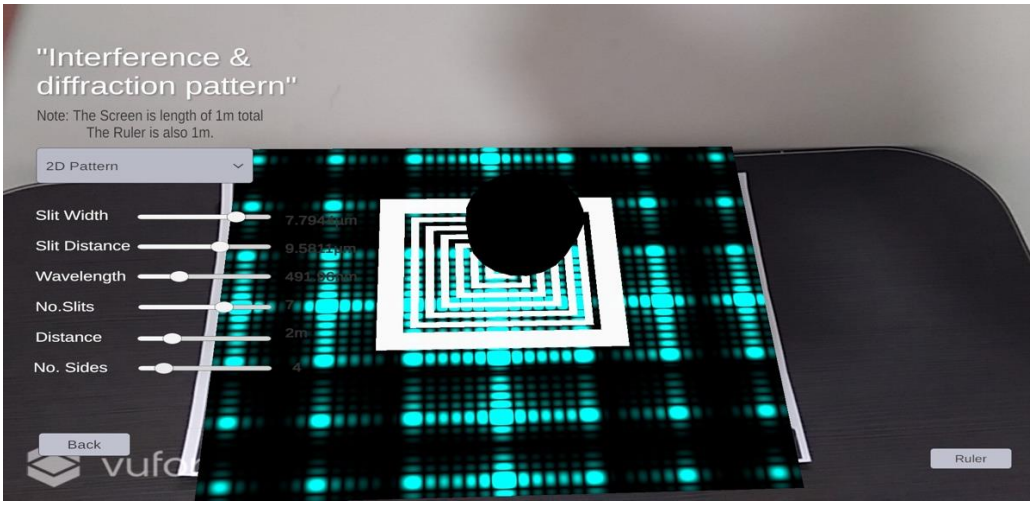

Fig. 4 Interference and diffraction pattern (2D)

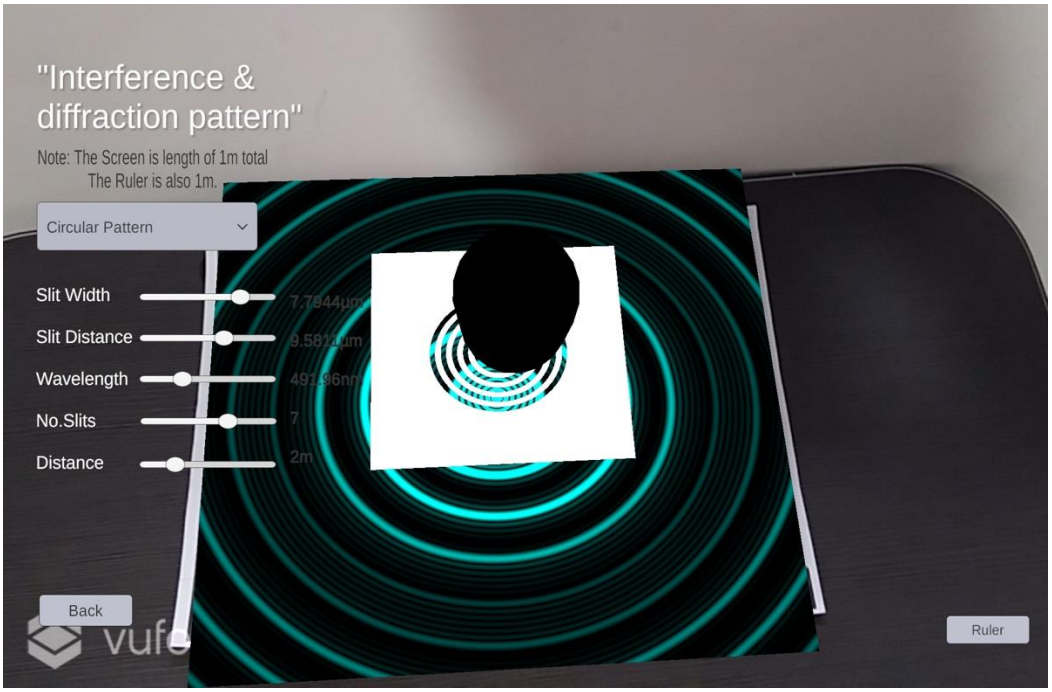

Fig. 5 Interference and diffraction pattern (Circular)

Theory

The wave spreads, or diffracts, as a wave moves through an opening in a barrier. They interfere when two waves occupy the same spot. When a bigger wave results in this interference, we call it constructive interference. As the wave size is diminished, it is called destructive interference.

Suppose a wave appears to occur on a barrier that has two openings, as shown below. The wave passes through each opening and diffract. These two diffracted waves will overlap, and there will be interference (see Fig. 6a). This interference results in a fringe pattern called an interference and diffraction pattern (see Fig. 6b).

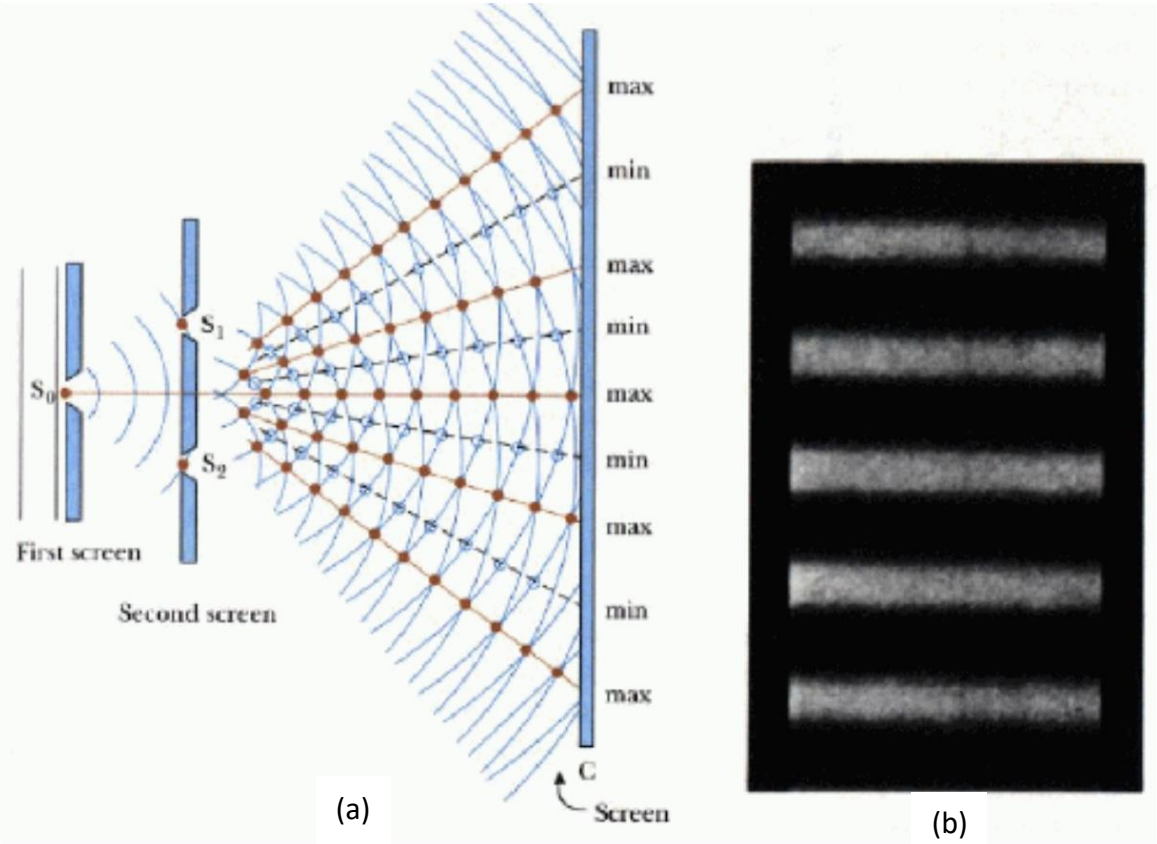

Fig. 6 Double Slit Interference and Diffraction

Equations that has been used in the AR module-

$$I = \left(\frac{sinNx}{sinx}\right)^2 \times \left(\frac{sin\beta}{\beta}\right)^2$$

$$x = \frac{\pi d sin\theta}{\lambda}$$

$$\beta = \frac{\pi a sin\theta}{\lambda}$$

Here, I = intensity of the wave, N = No. of slits, d = slit distance, a = slit width and λ = wavelength.