Creating a Virtual Ripple Tank in Microsoft Word

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Aripple tank is an excellent apparatus for displaying the interference pattern generated by circular waves originating from two points in a shallow basin of water. What sets it apart from the interference by sources of sound and light is that it allows the interfering waves to be seen and measured (see Fig. 1). This paper describes a fairly quick way to investigate two-dimensional wave interference on a computer without putting that computer near a wet, sloshing tank of water. Microsoft Word was used for this purpose, although a wide range of other simple drawing programs may be employed.

The idea is to use a set of equally spaced concentric circles, which have been pre-prepared and can be downloaded (as a Microsoft Word document) from the web.[1] By overlapping these circles with an identical set of circles, an interference pattern is created. Such a pattern is located at Ref. 2 on the web and can also easily be downloaded.

There are a number of ways that the interference pattern can be used. For a nice illustration of how the pattern is affected by the distance between the wave sources, select one of the sets of circles and move it using the arrow keys (or click and drag it). To produce a hard-copy version for demonstration purposes, print the single set of circles (downloaded from Ref. 1) once on a blank sheet of paper and a second time on a transparency. Then place the transparency on the paper and you'll have a nice interference pattern that changes as you slide the sheets over one another. Or make a pair of transparencies to use in the same way on an overhead projector.
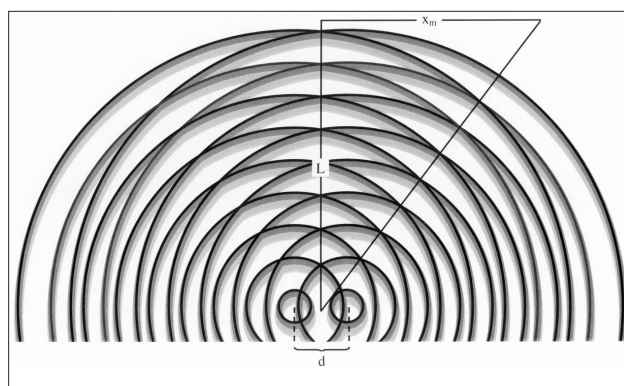

Fig. 1. Schematic of the interference pattern observed in a ripple tank.
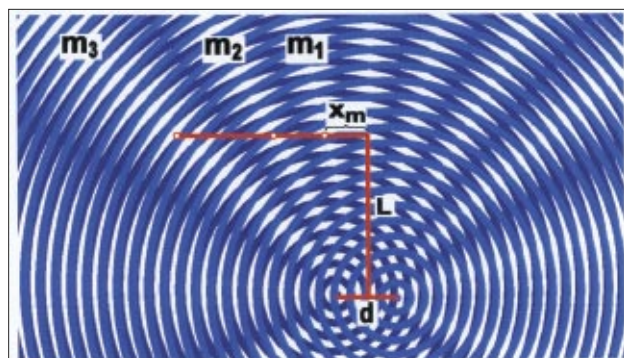

Fig. 2. An interference pattern generated by Microsoft Word zoomed in 500%.

In order to determine how well the patterns follow the familiar interference equation

$$d \sin \theta = m\lambda, \qquad (1)$$

try the following: In the Word document (interfer-

ence pattern downloaded from Ref. 2), zoom in to **500%** (see Fig. 2). At this magnification, use the **Line** tool to draw a line representing the distance between the sources (*d*). Next draw a line (*L*) perpendicular to *d* along the *m* = 0 fringe. Finally, draw a line perpendicular to *L* out to the center of any other fringe (*x_m*). See Figs. 1 and 2. You can determine the lengths of these lines to 1/100th of an inch by right-clicking on the line, selecting **Format Autoshape**, selecting the **Size** tab, and reading the height or width of the line.

Equation (1) tells us how the lengths of the lines are related. For small θ we may use $\sin\theta \approx \tan\theta = x_m/L$ to rewrite Eq. (1) as

$$x_m \approx m\lambda L/d. \tag{2}$$

In the more general case, $\sin\theta = x_m/\sqrt{x_m^2 + L^2}$, and so Eq. (1) gives

$$x_m = m\lambda L/\sqrt{d^2 - m^2\lambda^2}. \tag{3}$$

It is a simple matter to test virtual ripple tank patterns against theoretical predictions by substituting values of *m*, *x_m*, *L*, and *d* into Eqs. (1) and (2) along with the known value of λ (the patterns located at Refs. 1 and 2 were drawn so that the wavelength of the "waves" is 0.050 in). Figure 3 shows in graphical form a typical set of values of *x_m* versus *m* with *L* and *d* held constant. As expected, the measured values of *x_m* agree with those predicted by Eq. (1) only when *x_m* is small, while the agreement with Eq. (3) is excellent throughout the entire range.

The procedure described here allows interference patterns to be easily generated and studied in a quantitative way. It is also worth pointing out that the pattern downloaded from Ref. 1 makes an excellent template for creating the circular spatial beat patterns discussed in Thomas Greenslade's paper "Photocopied Beats."[4] The circular pattern provided with Ref. 4 suffers from some distracting moire effects.

References

1. See EPAPS Document No. E-PHTEAH-44-027606 (http://ftp.aip.org/cgi-bin/epaps?ID=E-PHTEAH-44-027606) for a downloadable version of the single set of concentric circles. For more information on EPAPS, see http://www.aip.org/pubservs/epaps.html. Interested readers can email the author for instructions on how to build their own circles and interference pattern.
2. See EPAPS Document No. E-PHTEAH-44-027606 (http://ftp.aip.org/cgi-bin/epaps?ID=E-PHTEAH-44-027606) for the Word document containing the interference pattern.
3. If you experience problems working with the lines from the Drawing toolbar, click the **Draw** button, select **Grid…**, and uncheck the box "snap o bjects to the grid."
4. Thomas Greenslade, "Photocopied Beats," *Phys. Teach.* **43**, 514 (Nov. 2005).

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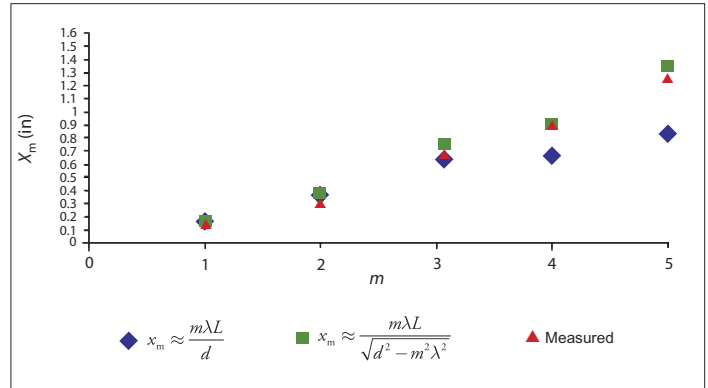
Fig. 3. The position from the central max (*x_m*) vs the fringe order (*m*). Values measured from a pattern created in Microsoft Word are compared to two common interference equations.