MUS 470/470L Homework 1

Fall 2018

Due date: Tuesday, September 18.

1. Implement the first four real spherical harmonic basis functions in code.
2. Graph a linear combination of these using any 3D graphing software API.
3. Illustrate the basic microphone directivty patterns using this graphing software by selecting coefficients of the linear combination in the previous part.
4. Design a simple UI which allows the user to change the coefficients of the four functions, and also has presets for examples of the directivity patterns in the previous part.

Just to be sure we are all on the same page, here are formulas for the real spherical harmonic functions of order zero and one, using the formulas from Wikipedia page 7, section 4.3:

$$
\begin{aligned}
y_{0,0} &= \frac{1}{2}\frac{1}{\sqrt{2\pi}} \\
y_{1,-1} &= \frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\sin\phi \\
y_{1,0} &= \frac{1}{2}\sqrt{\frac{3}{\pi}}\cos\theta \\
y_{1,1} &= \frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\cos\phi
\end{aligned}
$$

As explained in Wikipedia page 3, section 2, the angle θ is *colatitude* measuring 0 at the north pole, $\pi/2$ at the equator, and π at the south pole. The angle ϕ is *longitude* or *azimuth*, measuring values $0 \leq \phi < 2\pi$ starting from the positive x-axis.

Refer to the microphone patterns in the article below, using all but the last one, the lobar pattern or shotgun mic. This last one needs higher order spherical harmonics, and you can do this one for extra credit, but it's optional.

References:

1. *Wikipedia:* https://en.wikipedia.org/wiki/Spherical_harmonics click here
2. *Microphone Geeks:* http://microphonegeeks.com/different-microphone-polar-patterns/ click here