BYTES AND BEATS

An Introduction to Programming with MATLAB

Instructor Guide

Module 1: Sound and Music

Prerequisite Domain Knowledge: None

Expected Completion Time: 50 minutes

Note: This module does not require the use of MATLAB® for students, and may be best suited as an introduction or for younger groups.

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Sound and Music

Expected Duration: 10 minutes

Learning Objectives

- Distinguish between sound and music

Motivation

If we want to make music, we should know what music is. If we are going to make sound from a computer, we should know what sound is. What is music? What is sound?

Steps

Explain the purpose of the course — to programmatically create and listen to music from a computer. Then engage in a discussion about exactly what sound and music are. Points to discuss:

- What is Sound? *(ask the students)*

Anything you can hear is sound. Some students might also identify that sound is energy, or vibrations or wave.

Example answers: music, a human voice, airplanes taking off, dishwashers, thunderclaps, barking dogs, and so forth.

- What is Music? *(ask the students)*

Music is a special kind of sound.

Music is a pleasing kind of sound.

Music has rhythm, a recognizable tune, and is made by people.

Example answers: List the songs or instruments they like.

- How is music made? *(ask the students)*

Example answers: People play instruments, they sing, and they play recordings of the same.

Music Has Rhythm and Volume

Expected Duration: 15 minutes

Learning Objectives

- Create organized music from disorganized sound.
- Understand two key aspects of music: rhythm and volume.

Motivation

If everything we hear, including music, is a kind of sound, how can we make that special thing called music? Let's do an activity to create music from sound.

Steps

- Get the attention of the class. Tell them we are going to see if we can create music from noise and hear the difference. All the students will be doing is clapping.
- Tell all the students to clap. Get them clap very enthusiastically and, hopefully, in a random fashion. Ask them if this is music yet. (The answer is "No.")
- Tell them to keep on clapping. While they are doing that, you will organize the students, group by group, to do special types of clapping. In a classroom of 20 students, try to have about four students per group. Everyone else should continue clapping as before (emphasize this) but point to one group. Tell this group that each member should clap exactly as you do, while you clap at a slow but steady rhythm (about two claps per second). The first group will be keeping the tempo for the rest of the exercise, so it should be an appropriate speed.

- Go to another group and direct those students to clap in a different rhythm. For example, they could clap twice as fast as the other group, or twice as slow, or a combination of fast and slow claps. An interesting rhythmic challenge for some students will be to get them to clap three times as fast as the first group.
- Ask them if this is music yet. (The answer is “sort of”) Tell the students that their sound has already changed because now it is no longer random—it has a structure. This is called rhythm.
- However, it still does not sound that great as music. One component that is missing is volume, or how loud the sound is. Everything is at the same volume level, so all the sounds get mixed together. Now you take over as conductor. The students keep clapping their rhythms, however, on indication by you they should clap loudly (a high-hand gesture), softly (a low-hand gesture), or stop altogether (a stop-hand gesture). Through creative conducting, try to see if they can make an interesting rhythm or song. Feel free to improvise on your methods of conducting.
- Ask the students if this is music yet. Ask what else is missing to make this more like music? (melody, singing, or lyrics are possible examples of answers). If you are brave, you can try singing or whistling to add a melody on top of the clapping.
- Explain that even though the fact that they were clapping never changed, the quality of the sound changed from random noise to something musical by adding the structures of rhythm and changing volume. Give a big round of applause for a job well done!

Sound is Made by Vibrating Air

Expected Duration: 25 minutes

Learning Objectives

- Understand that sound is caused due to vibrations
- Associate sinusoidal waves with sound vibrations

Motivation

We know what sound is because we can hear it. But what causes sound? Can we ‘SEE’ sound? What would it look like?

Materials

- Tuning fork (optional)
- A string-based musical instrument (optional)
- MATLAB
- Amplitude and Frequency App
- Sound, Music, and Noise App

Steps

PART A – Vibrations

This section requires some optional items to demonstrate that sound is caused by vibrations.

- A tuning fork and a glass of water

- Hit a tuning fork and ask the class if it is making a sound.
- While it is still ringing, hold the tuning fork still and ask the class if the tuning fork is moving.
- The tuning fork is vibrating very rapidly, and the sound we hear is due to the prongs vibrating the air around them.
- The speed of the vibrations determines the pitch.
- To view these vibrations, immerse the vibrating fork into a glass of water and watch the splashing that occurs.
- Explain that tuning forks are used in music because the sound that the tuning fork makes is an exact musical pitch that you try to "tune" your instrument to.
- Ask the students to hum the pitch of the tuning fork.
- While they are humming, have them put their hand up to the throat to feel the vibrations.

OR

- A musical instrument (like a guitar)
- You can also do this activity with just a music instrument and have the students feel the instrument vibrating when sound is produced.

OR

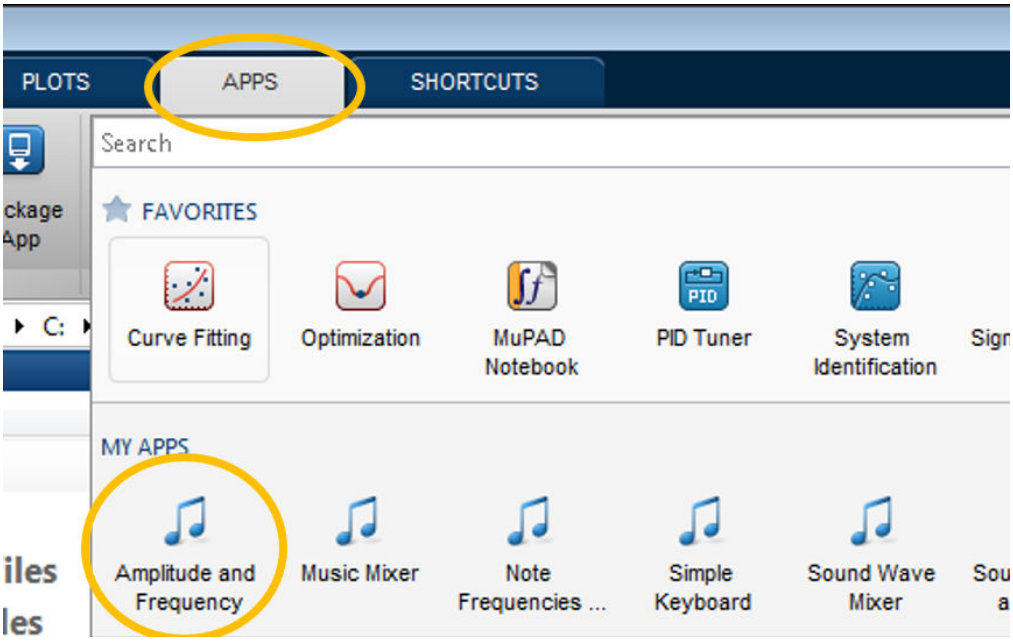
- If you do not have access to these, you can show this video.
- Showing only the first 2-3 demos in the video should suffice.

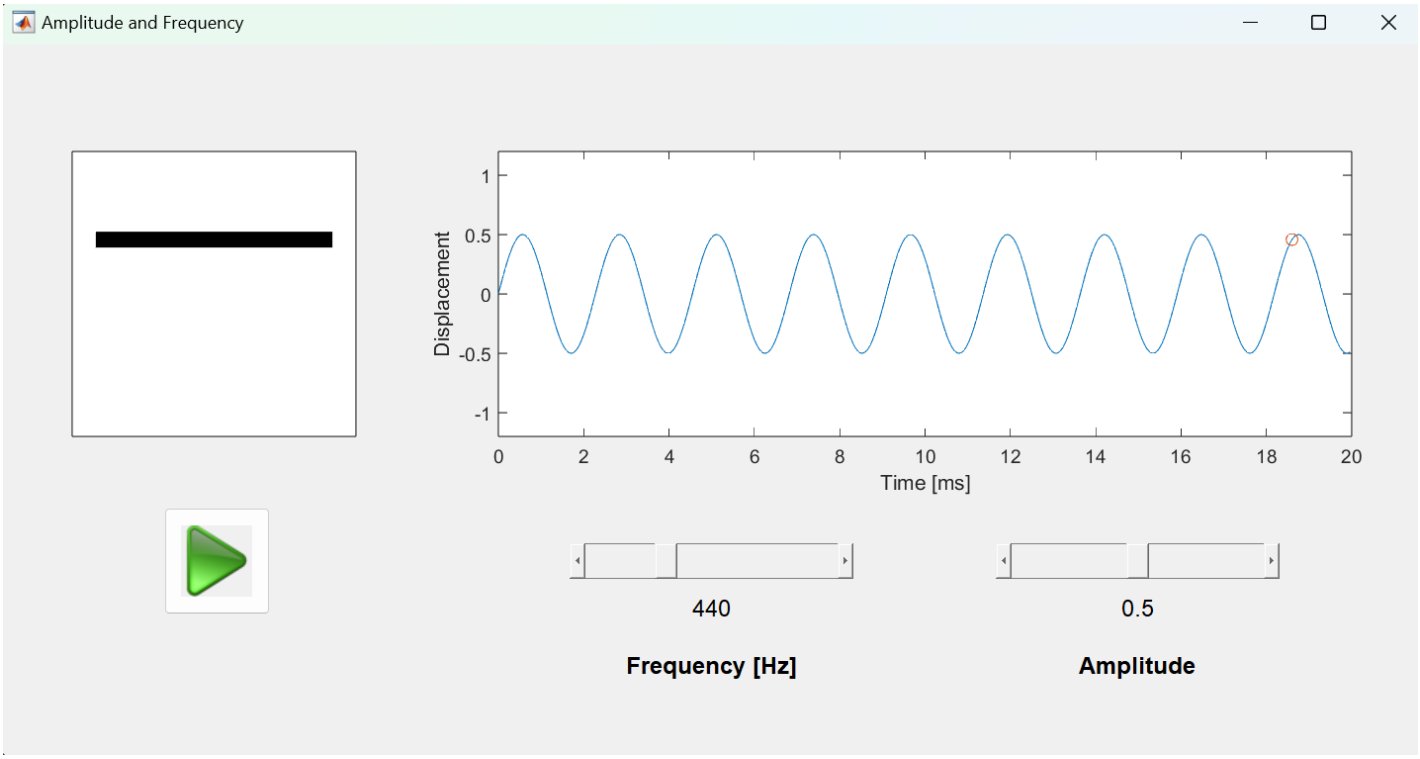
PART B – Waves

- Ask the students if they have ever wondered how a guitar causes sounds?
- It works in the same basic way as a tuning fork. When the guitar string is plucked, it causes a vibration in the air and, thus, a sound. What makes a guitar sound like a guitar is that much of this air comes from the vibrating air column inside the guitar. The shape of the guitar affects the way the sound vibrates and is heard.
- Ask the student what sound looks like? (kind of a trick question)
- Show them this video which shows guitar strings in slow motion: (20-40 times slower than real time)
- Tell the students that if we could see the air molecules moving, their vibrations can be characterized/ represented by such a shape.
- Watch this short video to learn more about sound waves.
- This shape is called a wave, specifically a sine wave, and that is why you have the term '**sound waves'**.
- OPTIONAL: You may also show this fun music video that demonstrates many experiments to 'SEE' sound.

Open the "Amplitude and Frequency" App in MATLAB by going to the APPS Tab:

Note: The students must not open the app right now





- Use the app to reinforce the above concepts.