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ECE 153B – Winter 2021

Final Project Proposal
Spatial Audio Headphones

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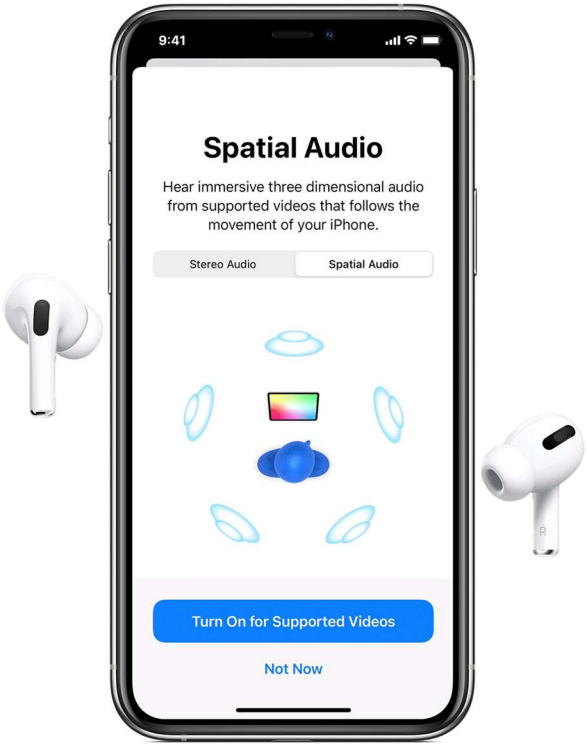
Description



Apple has released headphones that simulate surround sound. By turning your head, the audio seems to change the location it comes from. I will do my best to replicate this feature.

My final product will be used as follows:

1. Sync the connected HC-05 module to a computer.
2. Plug in headphones to the Discovery's headphone jack.
3. Run a custom C++ script on the computer to send the wave file to the HC-05.
4. Place the Discovery Board with its accelerometer on your head.
5. Rotate your head to experience the 3D sound.

Peripherals

Computer with Bluetooth

I will use my laptop to store a WAVE file and C++ script. Upon running the script, the WAVE file's data will be sent over UART to the HC-05.

HC-05

Receives the music data from the computer with Bluetooth and sends it to the STM32 so that the sound can be played through the headphone jack.

Accelerometer

Obtains the orientation of the user's head. This will be sent to the STM32 so that sound level calculations can be made.

Headphone Jack

I will need to use a DAC to convert the digital sound data to an analog signal.

Software

Communication between computer and HC-05.

I am expecting communication between the computer and HC-05 will require solving the bounded buffer problem. The STM32 has a limited amount of memory, so the computer must know whether the STM32 is ready for new data or not. In addition, I will likely need to use my own WAVE file parser to collect sample data from a file. I expect this will be the hardest part of the assignment.

STM32 Configuration

- Headphone jack DACs
- Accelerometer I2C
- HC-05 UART
- Large music data buffer queue needed (maybe 50 kB?)
- RTC interrupt at every 1 / 82.2 kHz to load and then play the next sample

Spatial Audio Algorithm

I am imagining this algorithm for calculating the audio.

1. In main, there is a while loop that is always trying to read the next wave file sample from the HC-05. Once a sample is read, it is added to the buffer if there is room. If there is no room, it requests for the sample to be re-sent.
2. At every odd RTC interrupt, we will pull a sample from the buffer into a current sample buffer. The formula I think I will use to find the left and right sample is here.
3. At every even RTC interrupt, we will play the current sample on the DAC.
4. This will continue until no more sound samples are left.

Block Diagram