CHAPTER 19
Practical 1
Pedestrians

Aims

In this practical we will construct a simple beeping tone as used on UK pedestrian crossings and introduce some basic analytical procedures. We will discuss the design and purpose of the beeping, and discover there are reasons why it sounds the way it does.

Analysis

This practical was inspired by a discussion on the Yahoo sound design list when a film maker wanted a particular type of British road crossing signal. Being an artificial, publicly recognised sound it is given by a government standards document. However, getting an audio example was simple enough since I live near to a main road. The recording, captured about 3m away from the source,

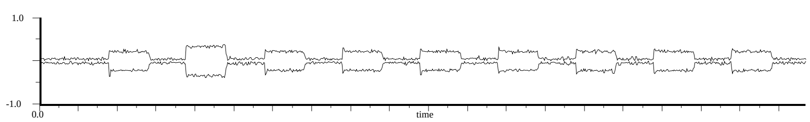

fig 19.1: Recording of a pedestrian crossing signal near a busy road

is shown in Fig. 19.1. Notice the background noise level from car engines and general street sounds. There are three points of interest, the timing of the beeps, their frequency, and the waveform of the signal. Let's begin by measuring the timing. The x-axis scale of Fig. 19.2 is in seconds, so one beep lasts for 100ms. The off time is also 100ms. We call the ratio of on time to off time the *duty cycle* of the signal. In this case it is 1 : 1, sometimes given as a percentage for the on part, thus 50%.

Next we wish to find out something about the waveform. Experienced ears can guess a frequency below 5kHz with quite good accuracy. I guessed about 2kHz, but let's see what the spectrum analysis thinks. It is immediately clear from plot in Fig. 19.3 that there's one strong frequency. The list of numbers on the right side is called the *peaks list* and it shows some weak frequencies at the low end of the spectrum, probably originating from traffic sounds. The main

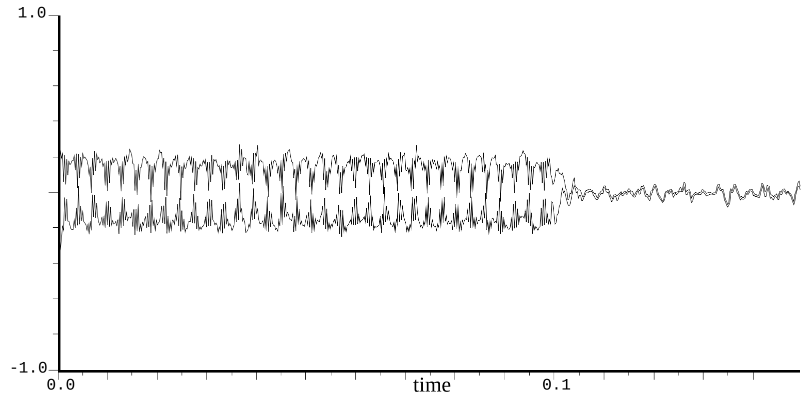

fig 19.2: Measuring the timing pattern of the beeps.

peak is given as 2.5kHz. We can also tell from the spectrum that the beep does not have any other significant harmonics [1].

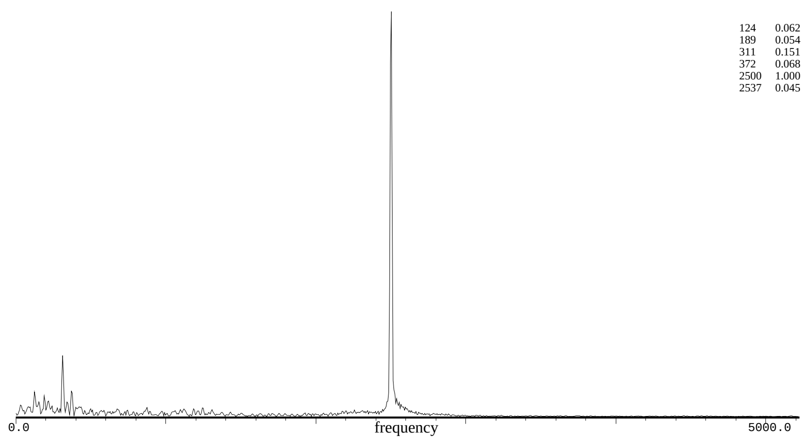

fig 19.3: Spectrum plot of one beep from a pedestrian crossing sound

Model

Our model can be succinctly summarised thus: The pedestrian crossing signal is a 2.5kHz sinusoidal wave broken at 100ms with a 50% duty cycle.

[1]Zooming in on the spectrum plot reveals weak components at 5kHz and 7.5kHz which show it actually has a little distortion, but we shall ignore this here.

Method

We will use a 2.5kHz sine wave oscillator and multiply it by a control signal that alternates between 0 and 1 every 100ms

DSP Implementation

There are several ways to implement the described model even once we decide to use a simple oscillator and control gate. For this exercise I will introduce just one simple solution, using a counter.

Counter controlled beeping

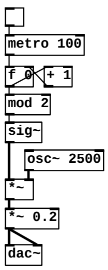

fig 19.4: Crossing beeps

The patch shown in Fig. 19.4 works as follows. A toggle switch activates a metronome with a fixed period of 100ms. Ten times per second a bang message passes into the hot inlet of a float box which is wired as a counter with an increment of 1. The counter advances upwards without limit. Taking modulo 2 of the counter output gives an alternation between 0 and 1, since $2\,mod\,2 = 0$, $3\,mod\,2 = 1$, $4\,mod\,2 = 0$ etc. From this we derive an audio signal via `sig~` as a modulator. The output of a sine oscillator set to a frequency of 2500Hz is multiplied by the 1 or 0 signal. A fixed scaling of 0.2 is applied to make the output a little quieter. It is sent to both channels of the DAC. Ensure that `compute audio` is be switched on. Start the metronome by activating the toggle and you should hear a regular beeping sound.

Results

Source .... **http://synthsound.org/sd/pedestrian.html**

Conclusions

By analysing recordings we can extract useful data. A simple indicator sound can be made by modulating a constant tone on and off.

Discussion

Limitations

One problem is that turning off the metro doesn't always stop the tone. If the state of the counter is 1 at the moment it is switched off it remains that way, with the tone constantly sounding. The result is also somewhat inaccurate. The real crossing sound has some harmonic distortion caused by the transducer, a sudden attack transient caused by the abrupt tone switching, and resonance from its housing.

Practical design considerations

The tone switching causes a click at the start of each tone burst. In this case it is desirable. To see why, consider some other features of the sound. Why choose 2.5kHz?. There are two sides to the road and at least two beepers to aid sight impaired pedestrians (or fully sighted people in bright sunlight). At a staggered crossing where there are several beepers we need to know which one is active for safety reasons. The choice of 2.5kHz is deliberate. It is high enough in frequency to be easily located but not too high to be inaudible to elderly pedestrians. Recall that a sharp attack makes a sound easier to locate. In practice the transducer is housed to make the sound as local to the crossing and easy to locate using IID cues as possible. So the choice of frequency and modulation method is not accidental.

Deviations from specification

The recorded tone did not exactly match the specifications document which defines a range of tolerences rather than precise values. The duty cycle and modulation frequency matched properly, but the tone frequency is given as (as low as) 1kHz but measured closer to 2.5kHz.

Exercises

Exercise 1

Record and analyse another simple indicator sound. You could try a microwave oven timer or a simple electronic doorbell. Specify a model for the sound and synthesise it as well as you can.

Exercise 2

Listen to the sounds next time you cross a big city road. What do you notice about the tone, directionality and timing of the crossing signals? How do you think these help road safety?

References

UK Highways Agency (2005) “TR2509: Performance specification for audible equipment for use at pedestrian crossings”