3. Noise Cancelling Headphones

(a) $\vec{m} + \mathbb{R}\vec{\gamma} + \vec{n}$

The signal at the listener's ear is:

$$\vec{s} = \vec{m} + \mathbb{R}\vec{\gamma} + \vec{n}$$

(b) $\mathbb{R}\vec{\gamma} + \vec{n}$

In order to have a signal at the ear that matches the original music signal perfectly, we should aim to minimize:

$$\mathbb{R}\vec{\gamma} + \vec{n}$$

(c) Implemented based on formula $\vec{x} = (A^T A)^{-1} A^T \vec{b}$.

(d) $\vec{\gamma} = \begin{bmatrix} -0.0883 \\ -0.093 \\ -0.9184 \end{bmatrix}$

Using IPython, we have that:

$$\gamma_A = -0.0883$$

$$\gamma_B = -0.093$$

$$\gamma_C = -0.9184$$

which gives us that

$$\vec{\gamma} = \begin{bmatrix} \gamma_A \\ \gamma_B \\ \gamma_C \end{bmatrix} = \begin{bmatrix} -0.0883 \\ -0.093 \\ -0.9184 \end{bmatrix}$$

(e)

For the three loaded sounds, music_y is the song "Hallelujah"; noise1_y is full of static noise; noise2_y is static noise plus some other noise (laughter and train whistle).

Then, adding the first noise to the signal literally imposes the static noise upon the song; adding the second noise does the same thing, with the extra bit of laughters and train whistles.

Only the origianl music (music_y) is not full of static. Adding both noises would make the sound full of static, but the effect is especially obvious when adding the first noise.