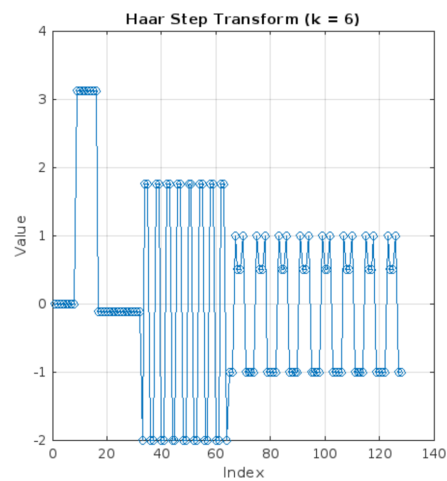
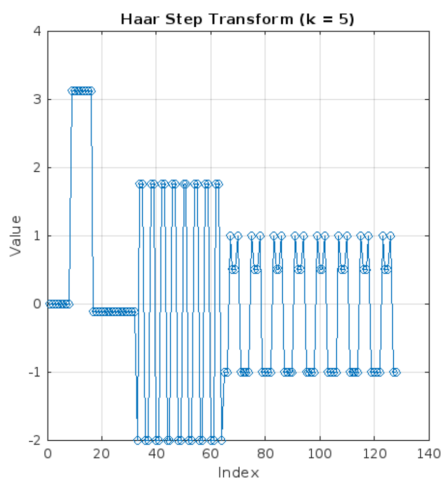
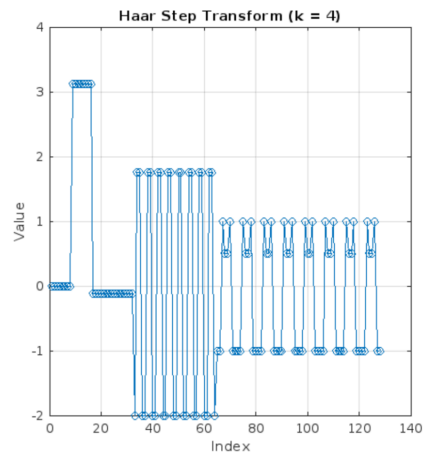
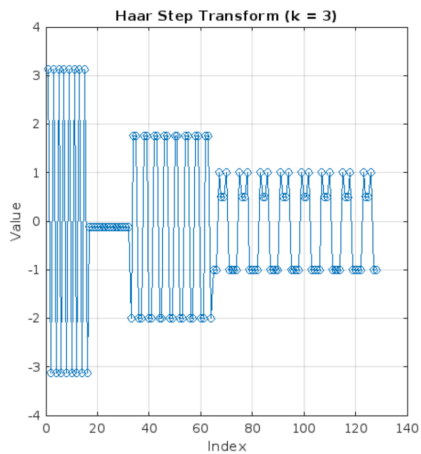
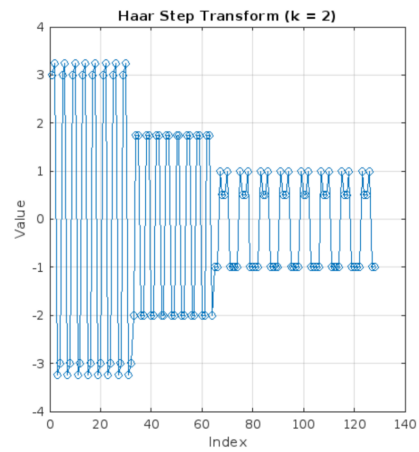
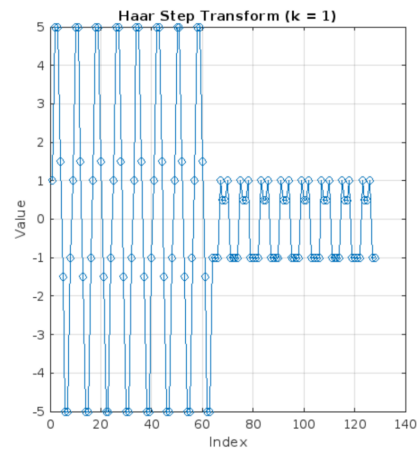
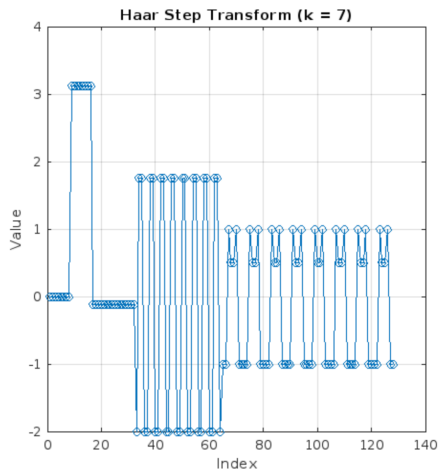


Project 2A: Compression of Audio Signals using Haar Wavelets

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(Problem 3)





At $k = 4$, The transformed vector starts to exhibit a distinct structure, which (at least to the naked eye) is retained almost exactly as n increases to 5,6, and 7.

(Problem 5.1)

We start by loading and listening to a Handel piece

```
load handel; % Load the built-in Handel audio sample
handel = y(1:65536); % Keep the first 65536 elements
sound(handel, Fs); % Play the original audio
```

```
k = 1;
handel_transformed = haar_step(handel, k);
sound(handel_transformed, Fs);
```

– Song becomes quite tinny

```
k = 2;
handel_transformed = haar_step(handel, k);
sound(handel_transformed, Fs); % Play sound after k=2
```

– Song becomes grainy and muffled, some melody lines sounded missing

```
k = 3;
handel_transformed = haar_step(handel, k);
sound(handel_transformed, Fs); % Play sound after k=3
```

– Even grainier, some highs and lows are missing. The midsection is still discernible. Sounds a bit distorted.

Presumably, as the value of k increases, only the very basic structure of this song will remain, trading the highs, lows, and other details in favor of smaller file size due to more compression.

(Problem 5.2)

To analyze compression, we set the second half of the Haar coefficients to zero:

```
c = haar(handel);  
c1 = c;  
c1(32768:end) = 0; % Zeroing detail coefficients  
handel1 = haar_inv(c1);  
sound(handel1);
```

The reconstructed audio sounded much more like the original, especially the vocal chorus which sounds almost exactly the same. However, there were some ornamental sounds and instruments that seemed to be missing. This matches the expectations of lacking the finer details when reconstructing audio, but the primary structure is still retained.

We also graphed this by using

figure;

```
subplot(2,1,1);
```

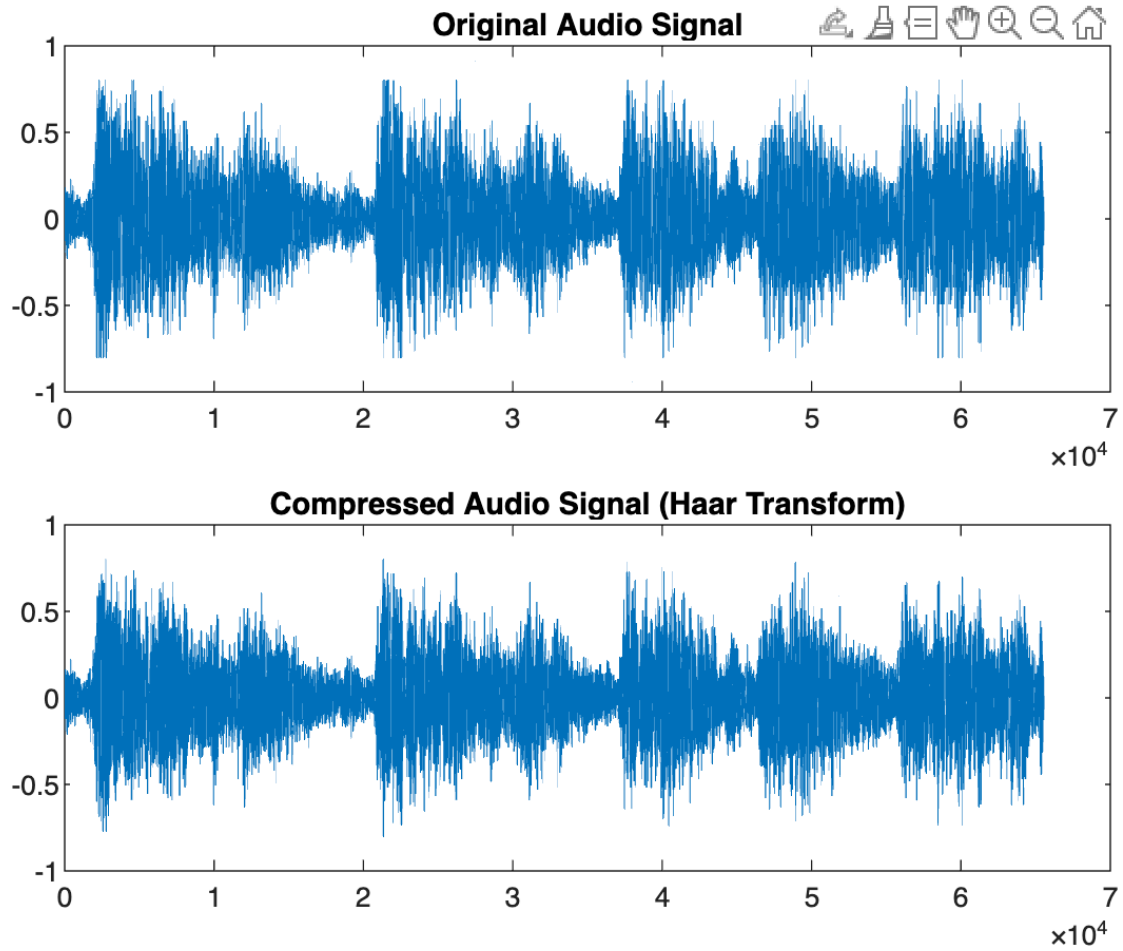
```
plot(handel);
```

```
title('Original Audio Signal');
```

```
subplot(2,1,2);
```

```
plot(handel1);
```

```
title('Compressed Audio Signal (Haar Transform)');
```



Which matches up with what we were hearing.

Trying again with `c1(16384:end)` also did the expected thing of deleting more details

