IQ Imbalance Analysis and Correction

Overview

The code is divided into two main sections:

1. **IQ Imbalance Analysis**: This section analyzes how different gain and phase imbalances affect the signal.
2. **IQ Imbalance Correction**: This section implements a correction technique based on the computed gain and phase imbalances.

Sections

1. IQ Imbalance Gain Analysis

This section simulates the effect of **gain imbalance** by varying it across a range of values using `logspace`. The imbalance between the I (In-phase) and Q (Quadrature) components is computed, and the **image rejection** is calculated using the Fast Fourier Transform (FFT).

Key Steps:

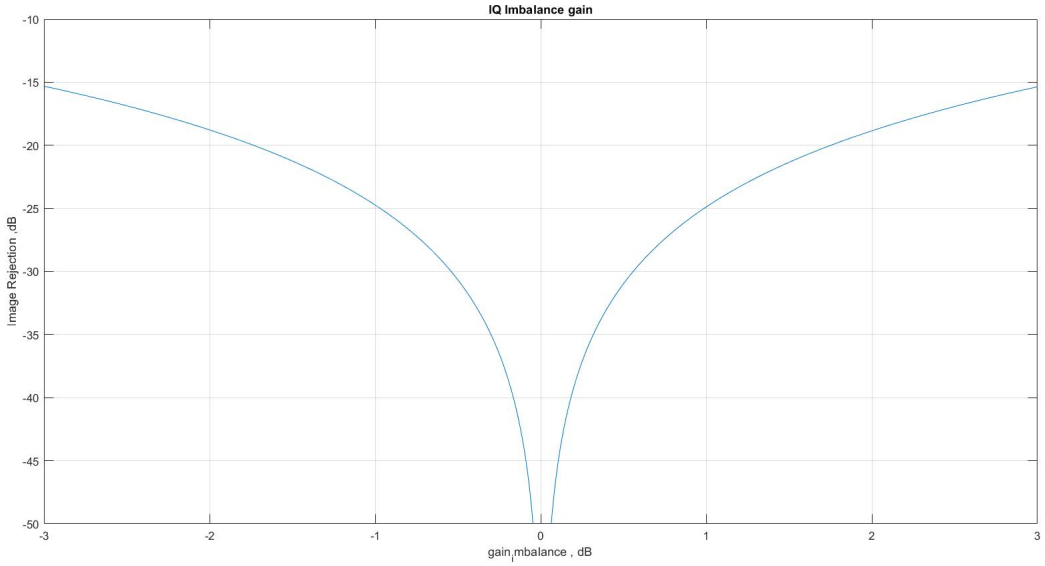
- The signal is generated for various gain imbalances.
- FFT is applied to measure signal distortion.
- **Image rejection** is computed and plotted against the **gain imbalance** in decibels (dB).

Code Snippet:

```
for gain_imbalance = logspace(-3,3,10000)
    I = cos(2*pi*f*time);
    Q = gain_imbalance * sin (2*pi*f*time - phase_imbalance);
    out = I + j * Q;
    w = fftshift(abs(fft(out)));
    IQ_Imbalance(i) = 20*log10(max( w(1:500))/(max( w(500:1000))));
end
```

Plot: `IQ Imbalance Gain`

- Displays **Image Rejection (dB)** vs. **Gain Imbalance (dB)**.



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2. IQ Imbalance Phase Analysis

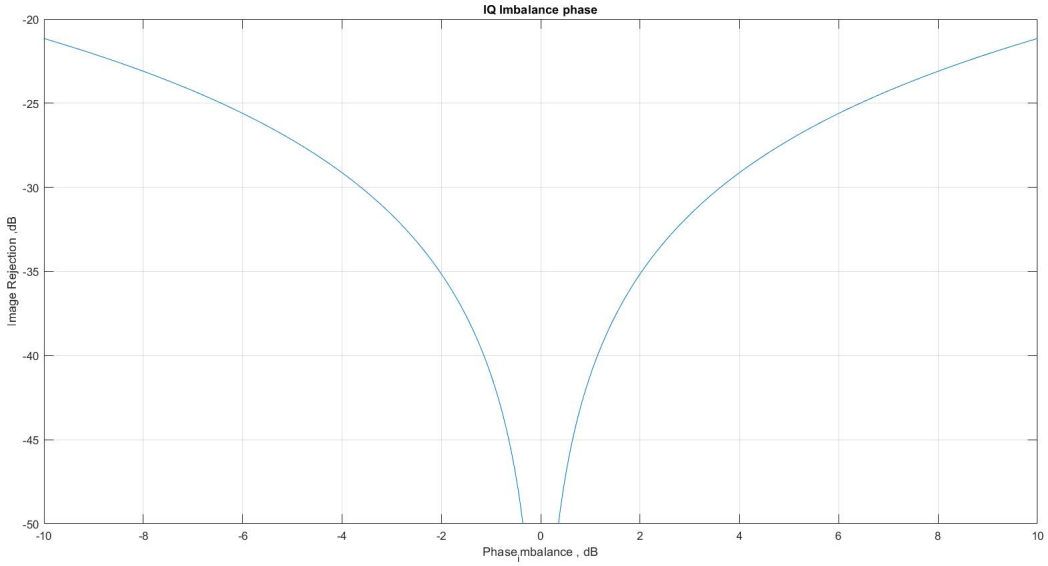
In this section, **phase imbalance** is varied while keeping the gain imbalance constant. The imbalance is measured using FFT, and image rejection is plotted against the phase imbalance in degrees.

Code Snippet:

```
for phase_imbalance = -0.2:0.001:0.2
    I = cos(2*pi*f*time);
    Q = gain_imbalance * sin (2*pi*f*time - phase_imbalance);
    out = I + j * Q;
    w = fftshift(abs(fft(out)));
    IQ_Imbalancep(i) = 20*log10(max( w(1:500))/(max( w(500:1000))));
end
```

Plot: `IQ Imbalance Phase`

- Displays **Image Rejection (dB)** vs. **Phase Imbalance (degrees)**.



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3. IQ Imbalance Correction

This section calculates the imbalance parameters:

- **Gain imbalance correction factor** is determined using the ratio of RMS values of I and Q.
- **Phase imbalance correction** is applied by adjusting the phase relationship between I and Q components.

The signal is corrected based on these calculated values, and the corrected signal is compared to the original signal both in the frequency domain (via FFT) and the time domain.

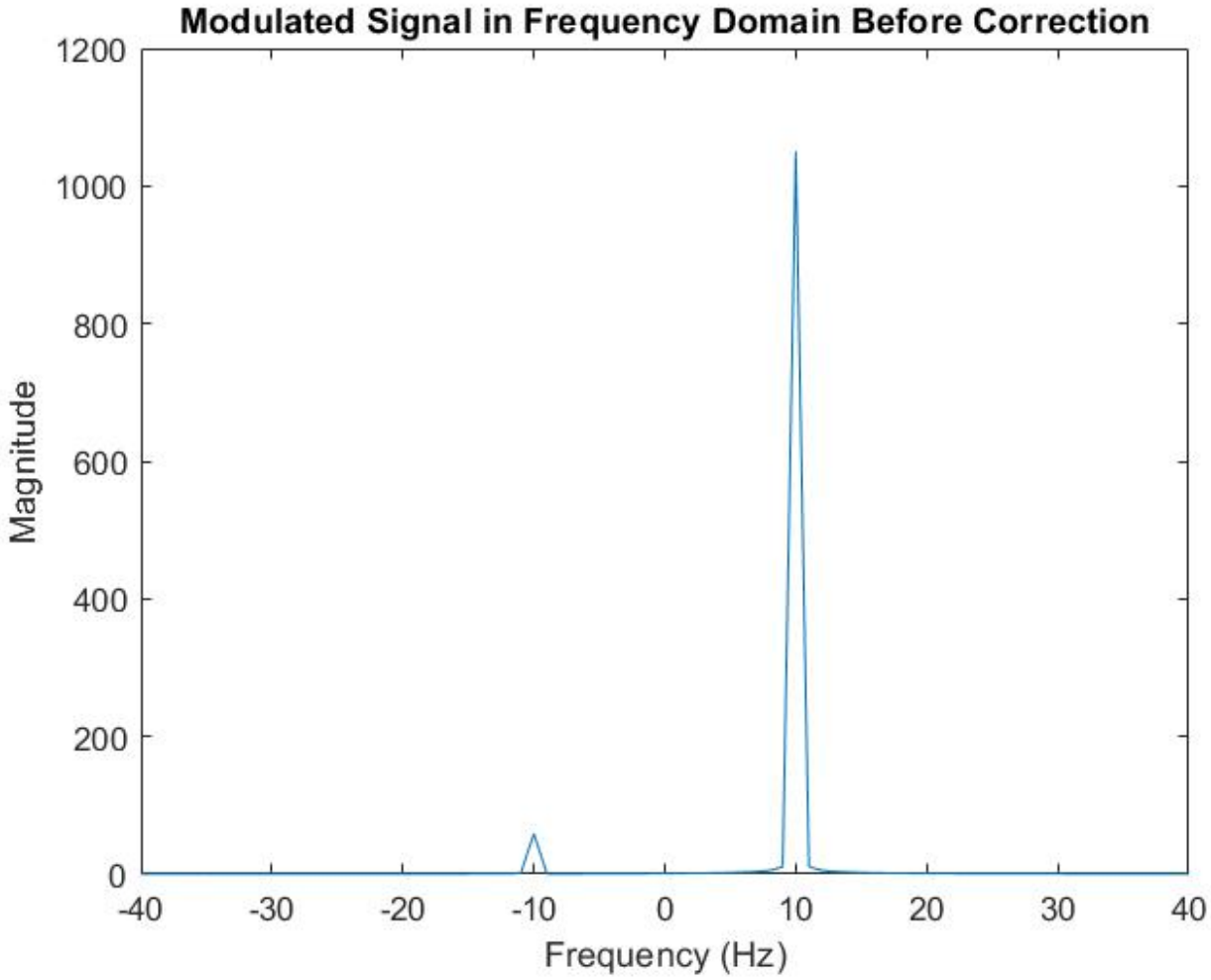
Correction Formula:

```
gain_bar = rms(Q)/rms(I);
phase_bar = -sum(I .* Q)/sqrt(sum(Q .^2)* sum(I .^2));
I_new = I;
Q_new = tan(phase_bar) * I + Q / (gain_bar * cos(phase_bar));
out_corr = I_new + j * Q_new;
```

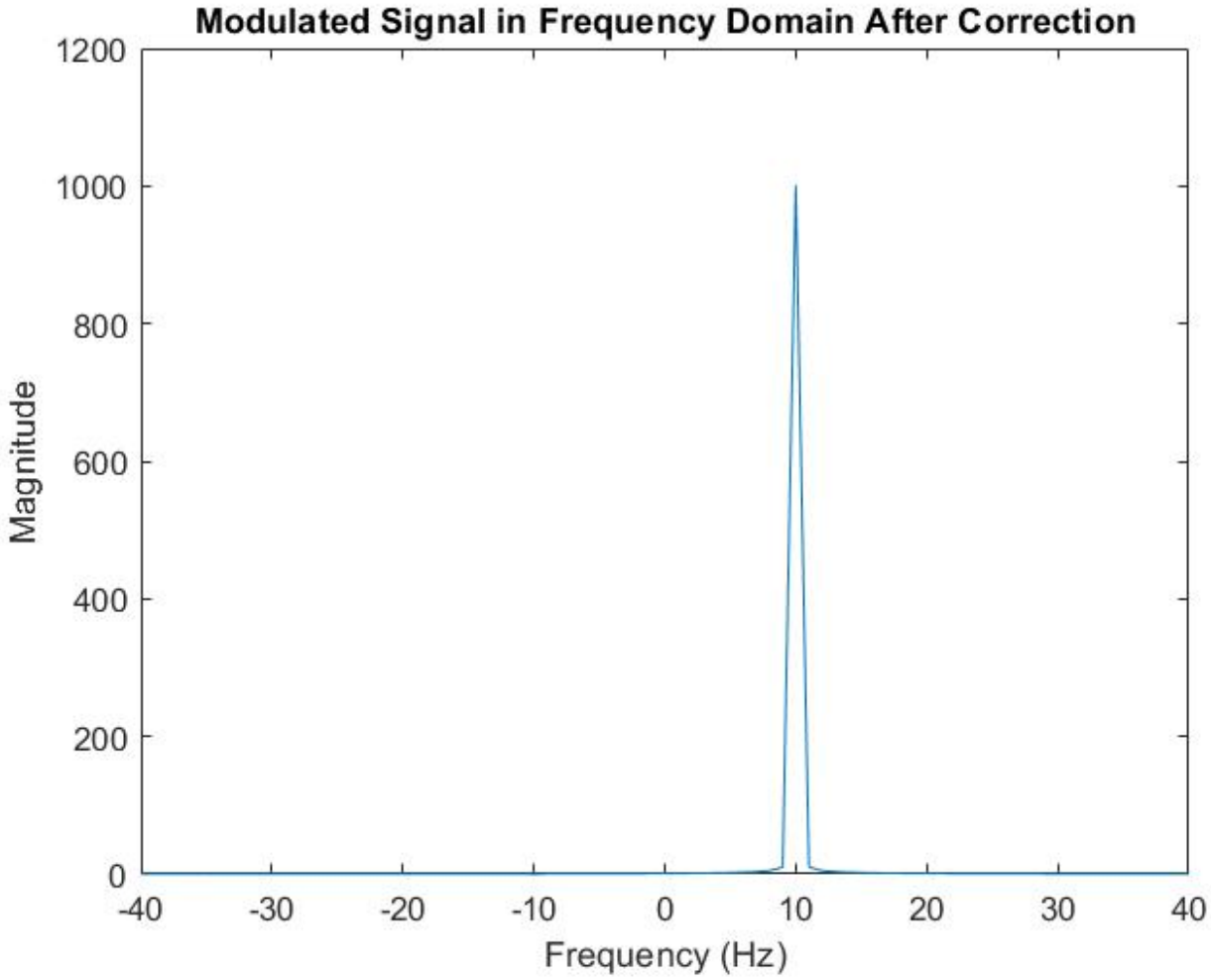
- `IQ_Imbalance = -25.0545`
- `IQ_Imbalance_corr = -60.8393`

Plot: `Frequency Domain Before and After Correction`

- Frequency domain representation before and after correction is visualized using FFT.
- **Before Correction**



- **After Correction**



Plot: `Time Domain After Correction`

- Time domain signal before and after correction is compared.

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