Aim ↬ To study the concept and fundamentals of Amplitude Demodulation.

Software Required ↬ MATLAB

Theory ↬

Amplitude Demodulation is the process of extracting the original message signal from a modulated carrier wave. In AM systems, the modulated signal contains the carrier and sidebands, and demodulation reverses the process by recovering the baseband signal. Envelope detection is a common technique for AM demodulation, which works by tracking the envelope of the modulated signal. This method is simple and effective for low-cost, real-time systems.

The modulated signal s(t) is represented as:

$$s(t) = [A_c + m(t)] \cdot cos\ (2\pi f_c t)$$

where:

- A_c is the amplitude of the carrier signal,
- m(t) is the message signal,
- f_c is the frequency of the carrier signal.

The demodulation process focuses on extracting m(t) from s(t). The envelope detector follows the peaks of the modulated signal to retrieve the message signal. A rectifier and low-pass filter can be used to obtain a smooth output, removing high-frequency components and leaving only the baseband signal.

The Hilbert transform is a mathematical tool used to obtain the analytic signal, which provides the instantaneous amplitude (envelope) and phase of a real-valued signal. In amplitude demodulation, we use the absolute value of the Hilbert transform to extract the envelope of the modulated signal, which corresponds to the original message signal. This method allows us to recover the message by detecting changes in the amplitude of the AM signal.

Demodulation Circuit ↴

An envelope detector consists of a diode for rectification and an RC circuit for filtering. The diode rectifies the positive half of the modulated signal, while the RC circuit smooths the signal, resulting in the original message. For effective demodulation, the carrier frequency must be high compared to the message signal frequency.

Frequency Spectrum of Demodulated Signal ↴

In the frequency domain, demodulation results in the removal of the carrier frequency, leaving the original message signal frequencies. The sidebands are also eliminated during demodulation, isolating the desired baseband frequencies.

Applications of AM Demodulation ↴

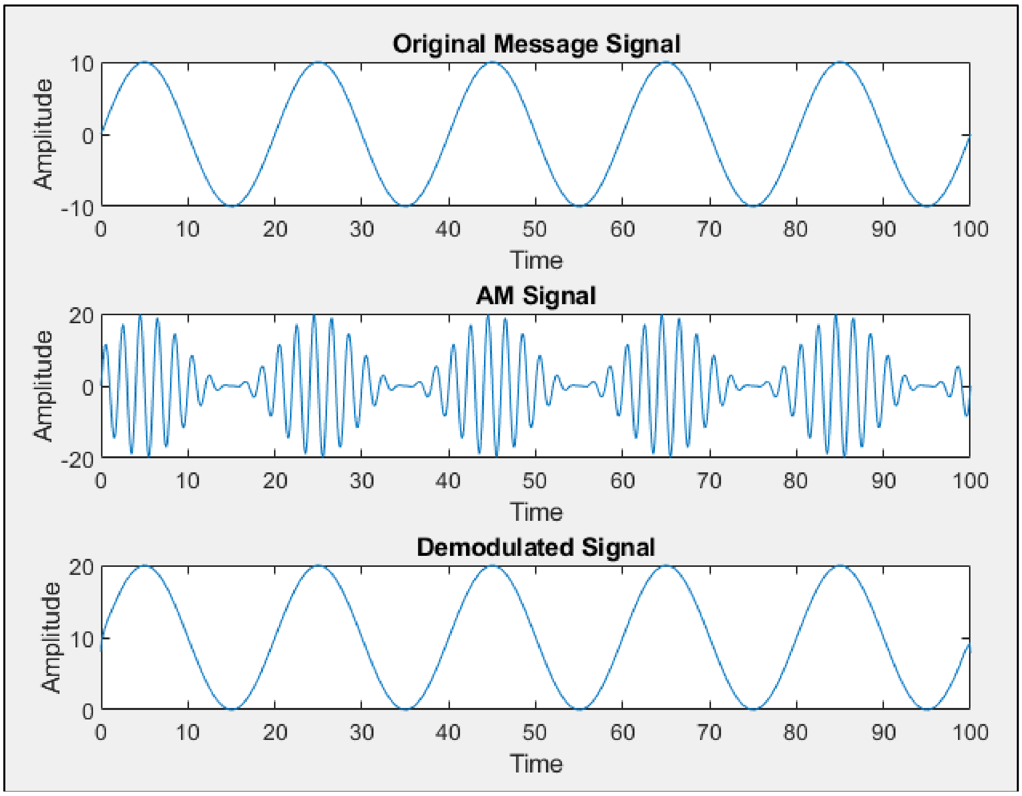
AM demodulation is widely used in radio broadcasting, aviation communication, and telemetry systems. Despite the advent of advanced digital systems, AM demodulation remains relevant due to its simplicity and effectiveness in long-distance analog communication.

Code ↬

```
% Amplitude Demodulation
clc;
clear;
close all;

Am = 10;
Fm = 0.05;
Fc = 0.5;
u = 1;
t = 0:0.1:100;

mt = Am * sin(2*pi*Fm*t);
Ac = Am / u;
ct = Ac * sin(2*pi*Fc*t);
A = ct .* (1 + u*sin(2*pi*Fm*t));
dm = abs(hilbert(A));

figure;
subplot(3,1,1);
plot(t, mt);
xlabel('Time');
ylabel('Amplitude');
title('Original Message Signal');

subplot(3,1,2);
plot(t, A);
xlabel('Time');
```

```
ylabel('Amplitude');
title('AM Signal');

subplot(3,1,3);
plot(t, dm);
xlabel('Time');
ylabel('Amplitude');
title('Demodulated Signal');
```

Output ↬



Result ↬

The experiment successfully generated the demodulated signal from the AM signal. The envelope detector accurately recovered the original message signal. The demodulated signal closely matches the original message, confirming proper detection of the baseband signal.

Conclusion ↬

The experiment demonstrates effective amplitude demodulation using an envelope detector. The carrier's envelope was successfully tracked, and the original message was recovered. This method is simple and ideal for low-complexity systems, where accurate signal recovery is crucial.

Precautions ↬

- Ensure proper filter design to avoid noise in the demodulated signal.
- Choose an appropriate carrier frequency to ensure successful demodulation.
- Ensure that the modulation index does not exceed 1 to prevent signal distortion.