ADAPTIVE DELTA MODULATION

EE 330 - DIGITAL COMMUNICATION (COURSE PROJECT)

Team Members -

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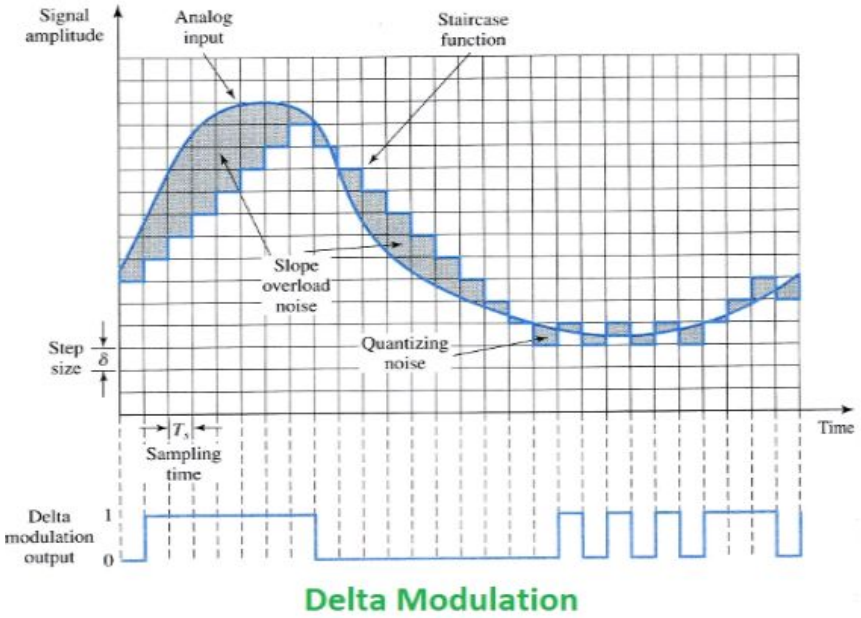
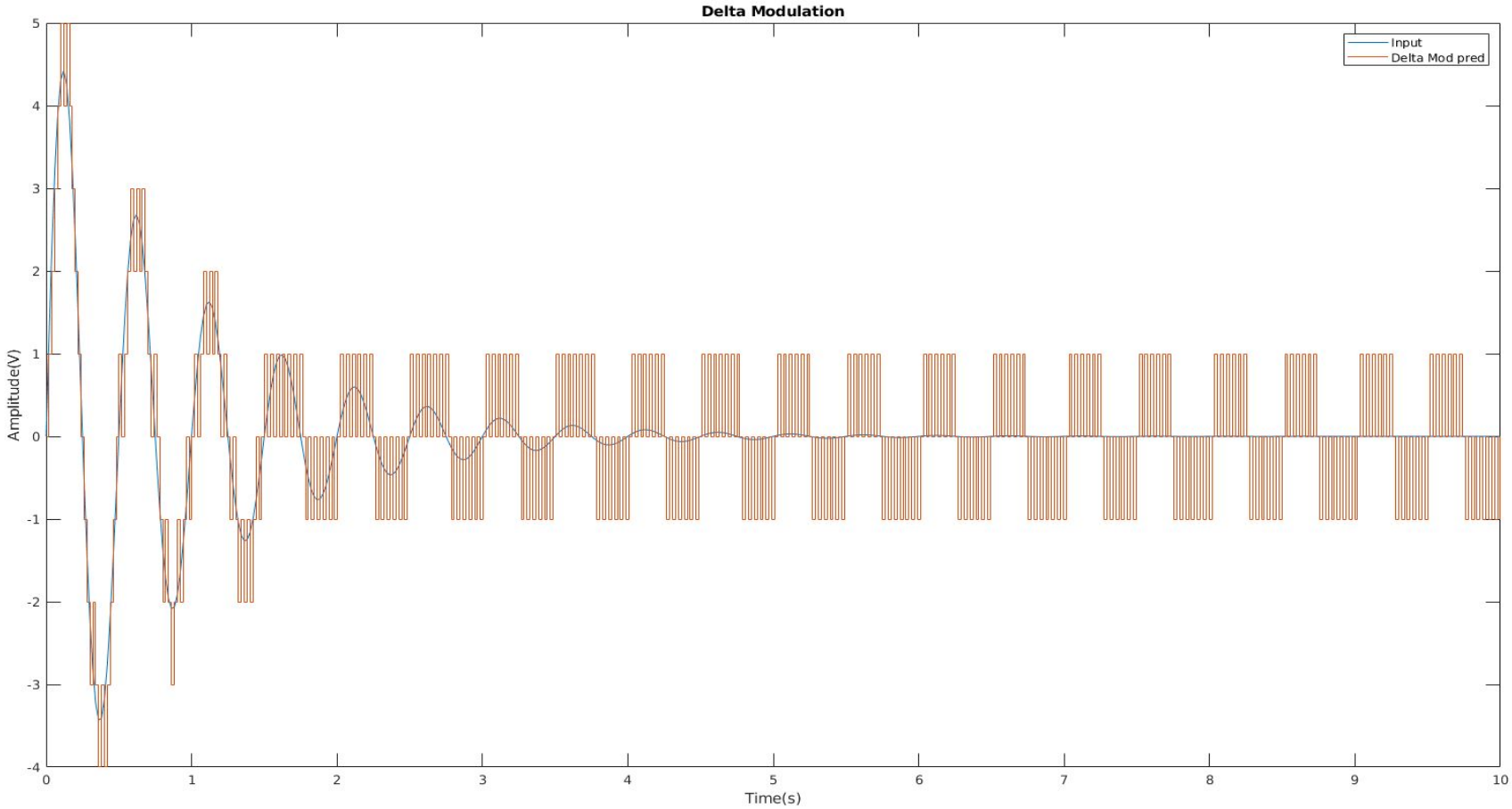
ABSTRACT

Delta modulation is a waveform coding technique which reduces the data rate to a larger extent in data communication; the problem encountered in delta modulation is the slope overload error, which is inherent in the system. In order for the signal to have good fidelity, the slope-overload error needs to be as small as possible. Hence there is need for adaptive techniques to be applied to Delta Modulation to reduce the noise.



Delta Modulation


Delta Modulation
Input
Delta Mod pred
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6
7
8
9
10

ADAPTIVE DELTA MODULATION (ADM)

Adaptive delta modulation (ADM) reduces the slope-overload and granular distortions encountered in delta modulators (DM) to a greater extent. In each of the step-size algorithms of ADM, the processor detects the pattern to see if the delta modulator is operating in the granular noise region, in which case it produces an alternating .....1010..... Pattern, or in the slope over load region in which case it produces an all-1 or all-0 pattern.

When the ADM senses ..1010.. Pattern, it decreases the step-size whereas when it senses ..1111.. Or ..0000.. It increases the step-size. Different algorithms change the rate of change of step-size in different ways.

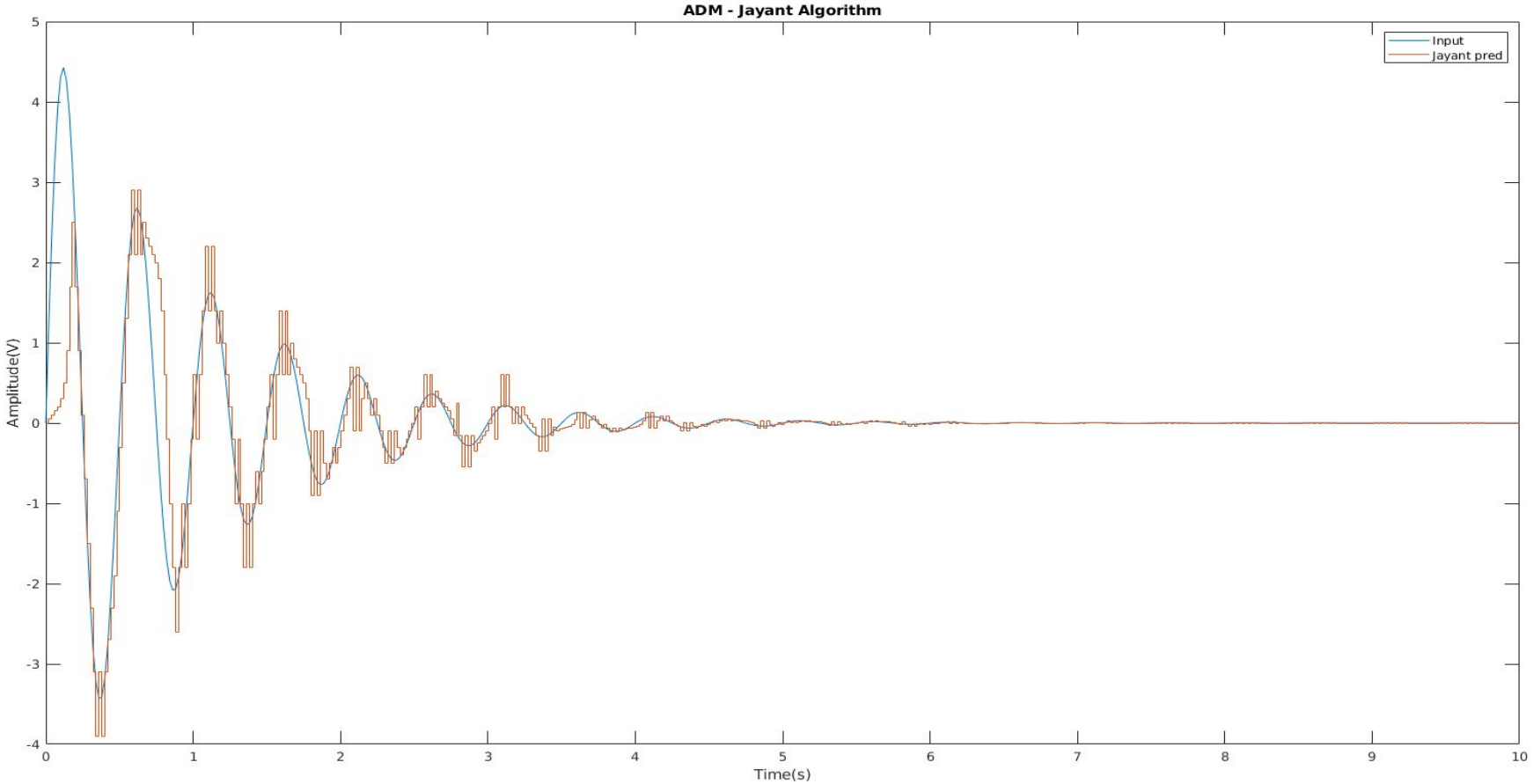
We have implemented the following different ADM algorithms:

1. Jayant Algorithm
2. SONG Algorithm
3. Modified ABATE algorithm
4. Modified SONG algorithm

1. Jayant ADM

In this method, a delta modulator which, at every sampling instant, adapts its step size Δ(for staircase approximation to the input signal) on the basis of a comparison between the two last channel symbols, Cr and Cr-1. Specifically, the ratio of the modified step size Δr to previous step size Δr-1 is either +P or –Q depending on whether Cr and Cr-1 are equal or not. A simulation of the delta modulator with a band-limited speech input has revealed that PQ=1 and PQ~1.5 represent optimal adaptation characteristics.

An important disadvantage of this technique is that the dynamic range of modulated signal increases.

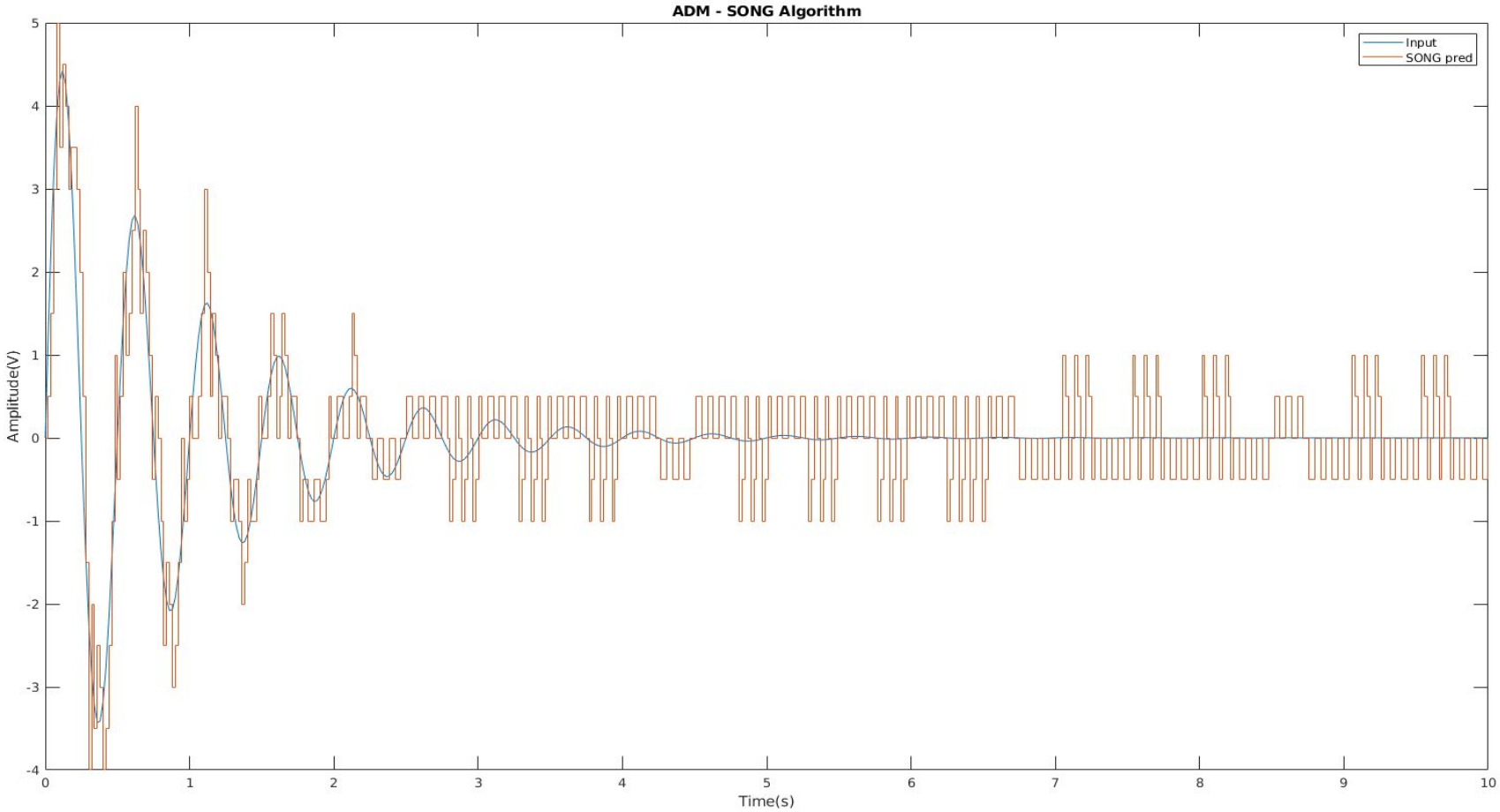

ADM - Jayant Algorithm
Input
Jayant pred
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6
7
8
9
10

2. SONG Algorithm

Let m(t) be the input signal and be its staircase approximation. Let error, at the kth sampling instant. k = 0, 1, 2, 3 . . . e (k) can be of positive or negative value. The kth transmitted symbol is '1' if e(k) > 0, otherwise it is '0' if e(k) < 0.

If e(k) = 0 , either '1' or '0' can be transmitted.

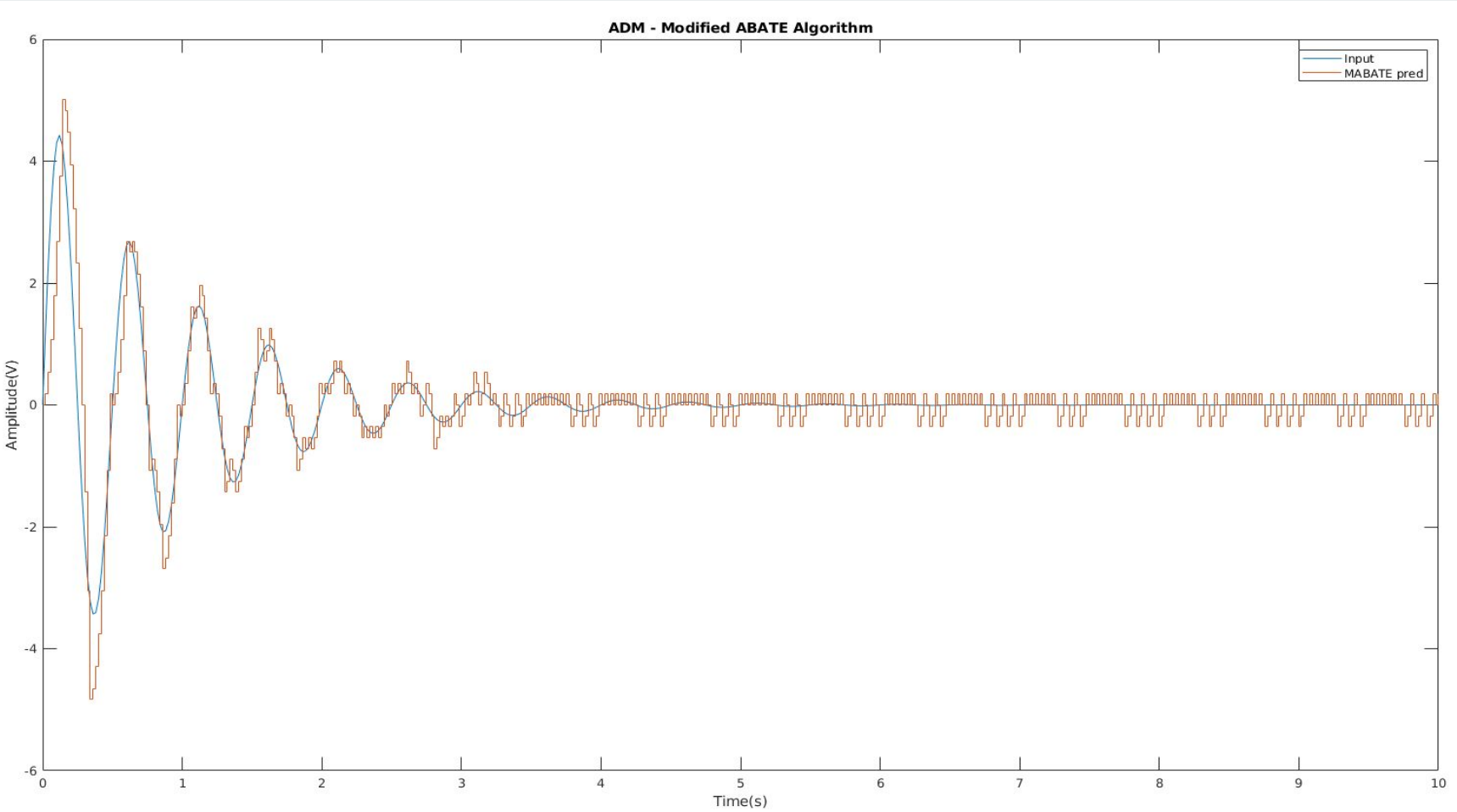
$$|s(K+1)| = \begin{cases} |s(k)| + s_o & if \ \ e(k) = e(k-1) \\ |s(k)| - s_o & if \ \ e(k) != e(k-1) \end{cases}$$


ADM - SONG Algorithm
Input
SONG pred
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6
7
8
9
10

3. Modified ABATE algorithm

This algorithm is more susceptible to slope overload than the SONG Algorithm. The speciality of this algorithm is that it adaptively follows the received signal even in a channel with high error rate.

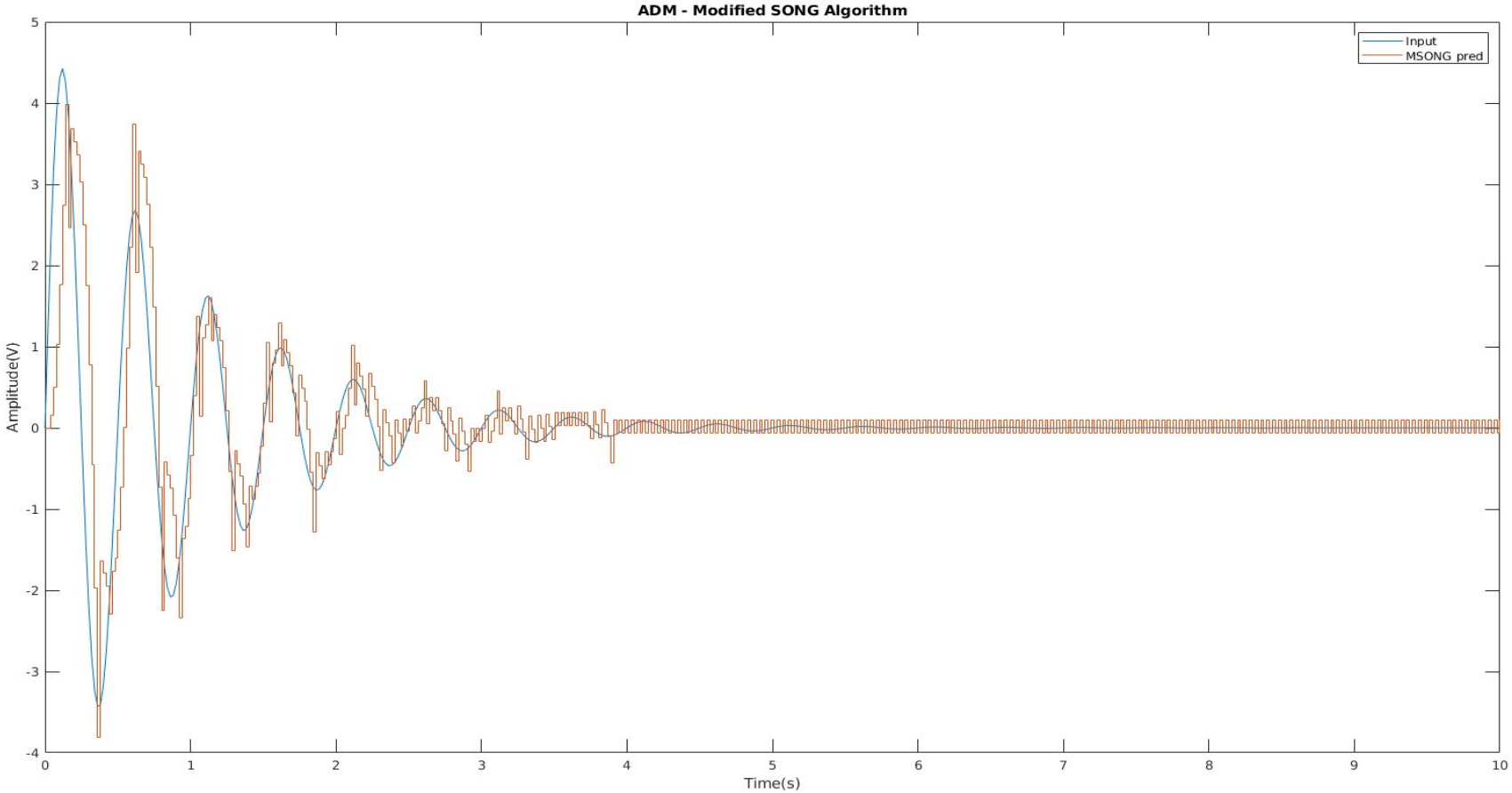
$$|s(K+1)| = \begin{cases} (|s(k)| + s_o) \cdot e(k) & \text{if } e(k) = e(k-1) \text{ and } s(k) < 8s_0 \\ s(k) \cdot e(k) & \text{if } e(k) = e(k-1) \text{ and } s(k) = 8s_0 \\ s_0 \cdot e(k) & \text{otherwise} \end{cases}$$


ADM - Modified ABATE Algorithm
Input
MABATE pred
Amplitude(V)
Time(s)
6
4
2
0
-2
-4
-6
0
1
2
3
4
5
6
7
8
9
10

4. Modified SONG Algorithm

In this algorithm the rate of change of step-size in the slope-overload region can be So or **α** * So or **α**^2 * So etc., by proper choice of α>1, the rate of change of step-size can be made greater than So. It is seen that choice of gives a better performance to slope overload and the parameter β takes care of the granular noise as a result of which a better performance is obtained as compared to SONG and modified ABATE algorithms.

$$|s(K+1)| = \begin{cases} (\alpha|s(k)| + s_o)e(k) & \text{if } e(k) = e(k-1) \\ (\beta|s(k)| - s_o)e(k) & \text{if } e(k) \neq e(k-1) \\ & \text{and } \beta \cdot s(k) > s_0 \\ s_0 \cdot e(k) & \text{if } e(k) \neq e(k-1) \text{ and } \beta \cdot s(k) < s_0 \end{cases}$$


ADM - Modified SONG Algorithm
Input
MSONG pred
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
1
2
3
4
5
6
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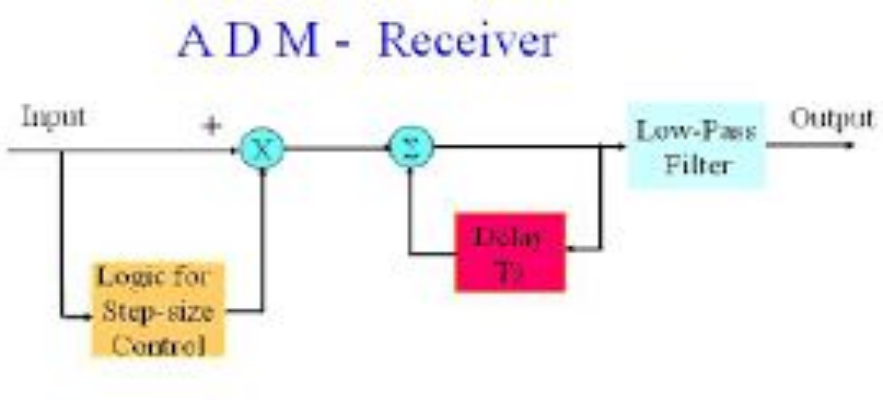
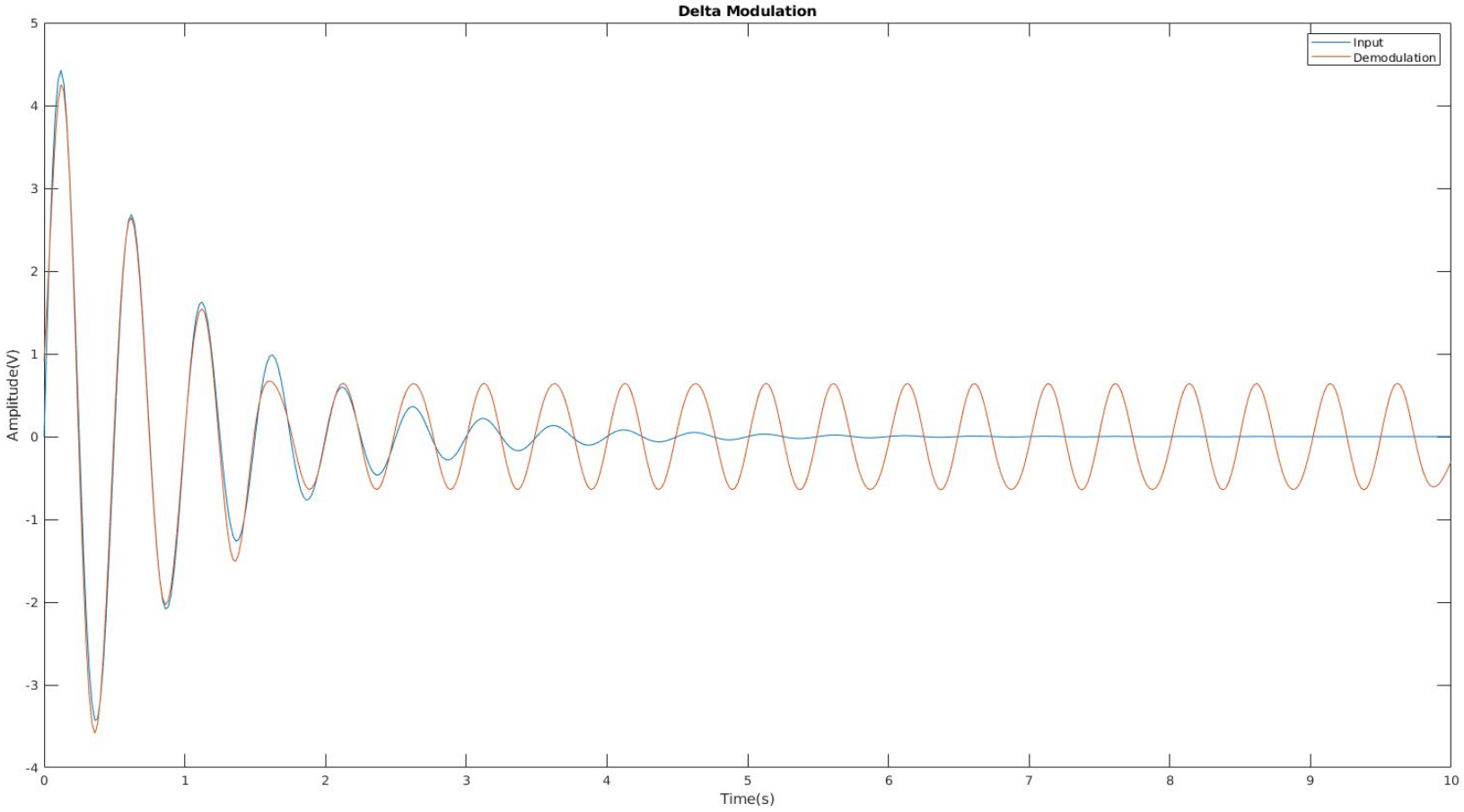
ADM DEMODULATION




Delta Modulation
Input
Demodulation
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
1
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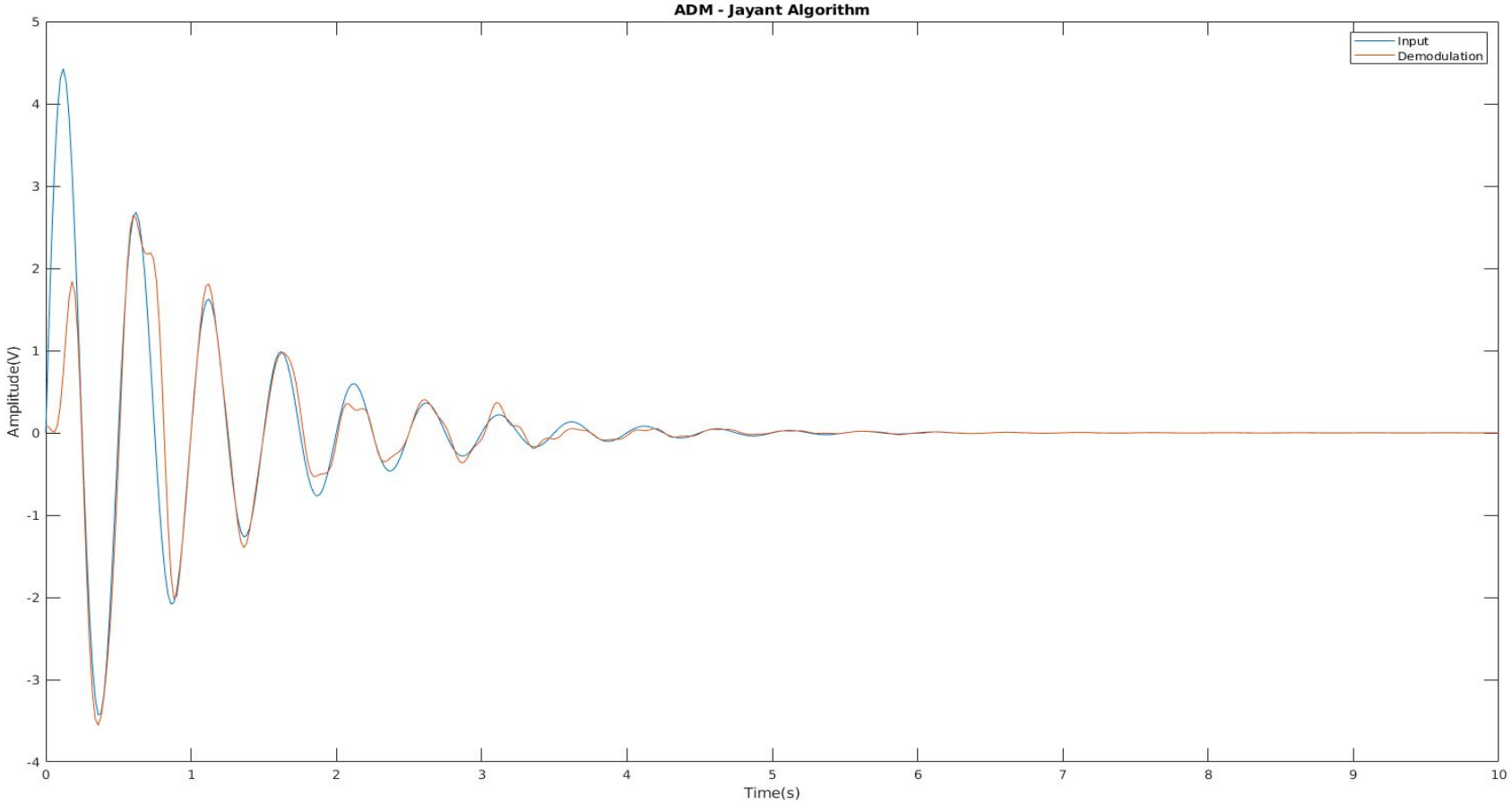
ADM - Jayant Algorithm
Input
Demodulation
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
0
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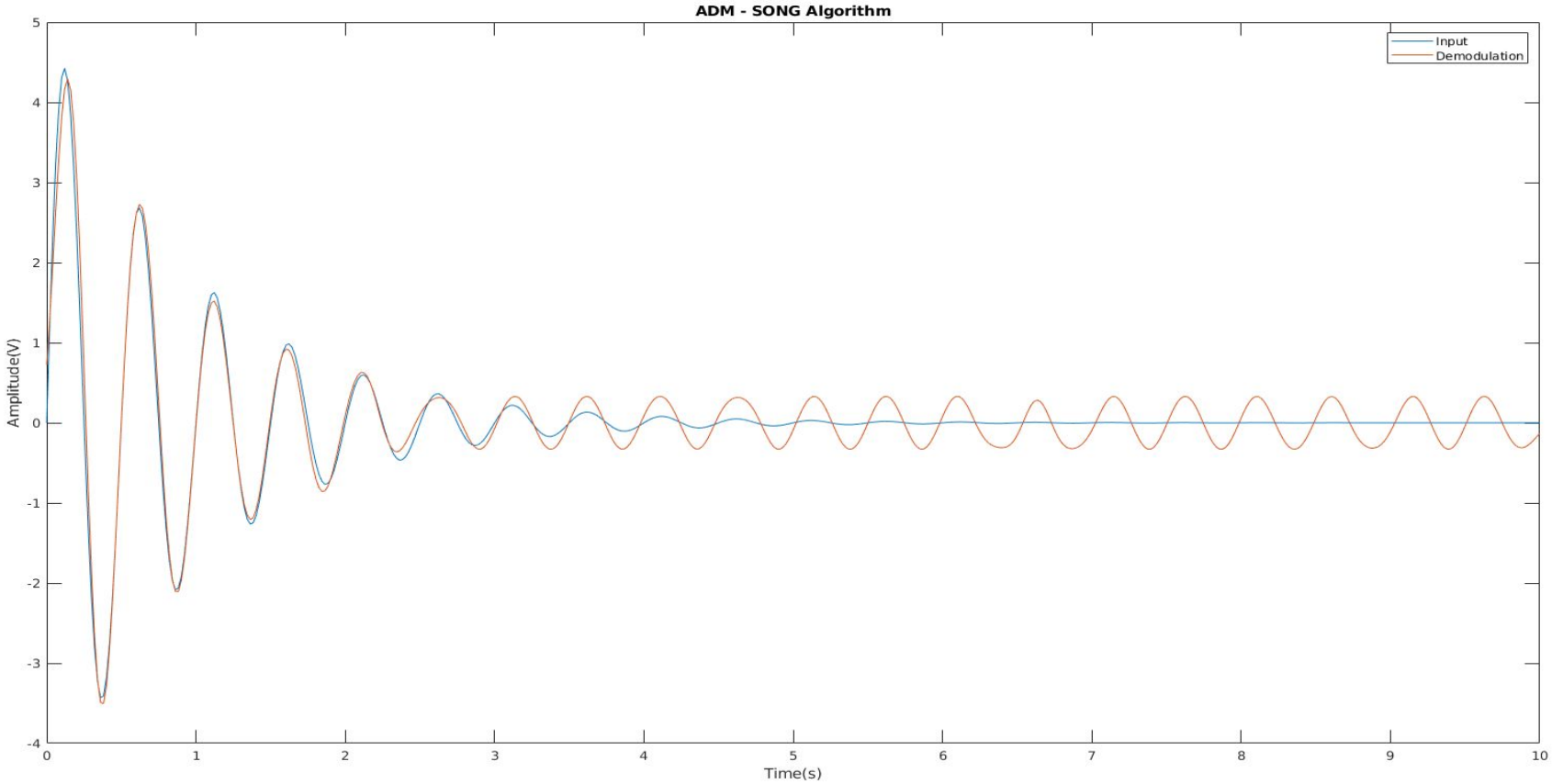
ADM - SONG Algorithm
Input
Demodulation
Amplitude(V)
Time(s)
5
4
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-1
-2
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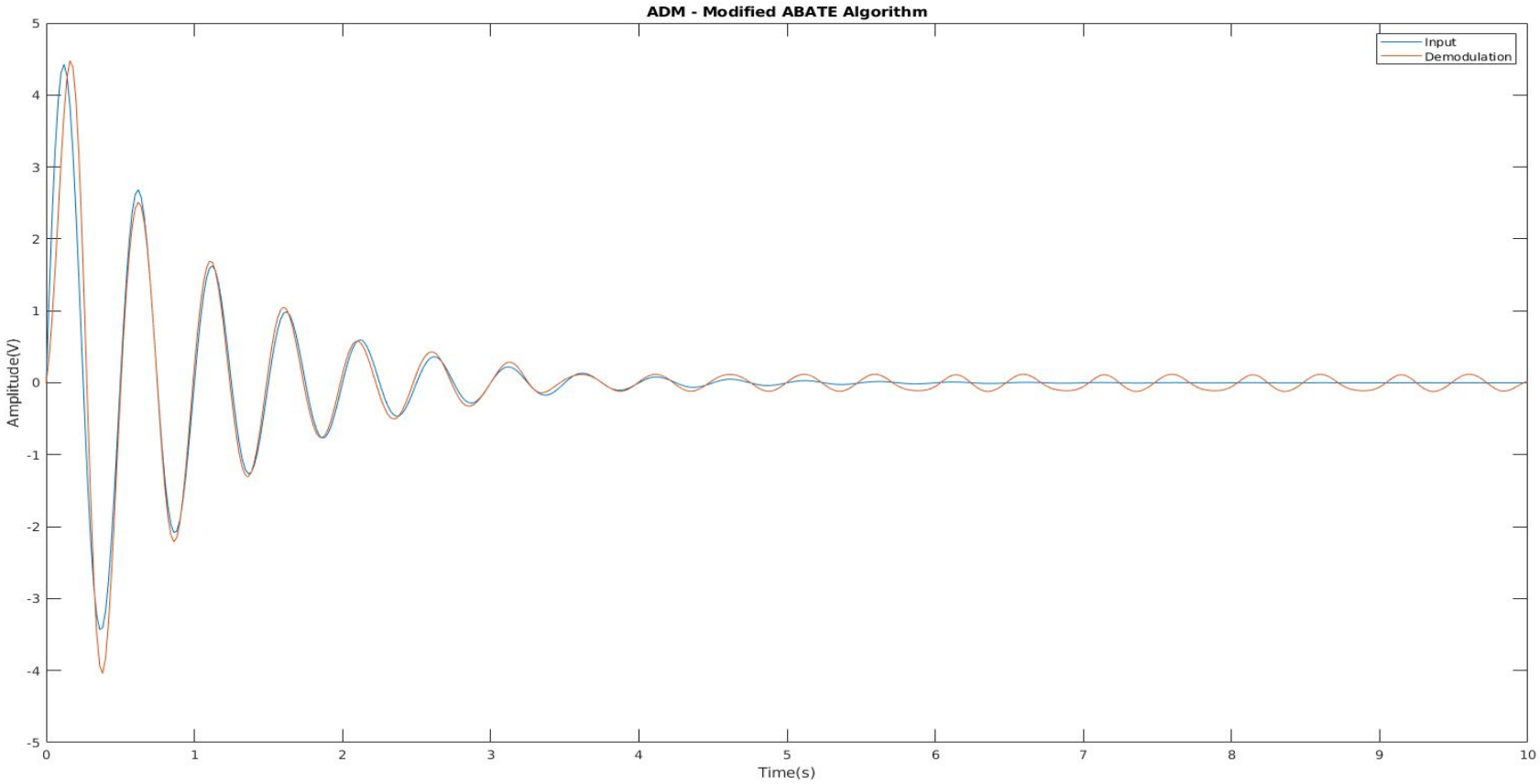
ADM - Modified ABATE Algorithm
Input
Demodulation
Amplitude(V)
Time(s)
5
4
3
2
1
0
-1
-2
-3
-4
-5
0
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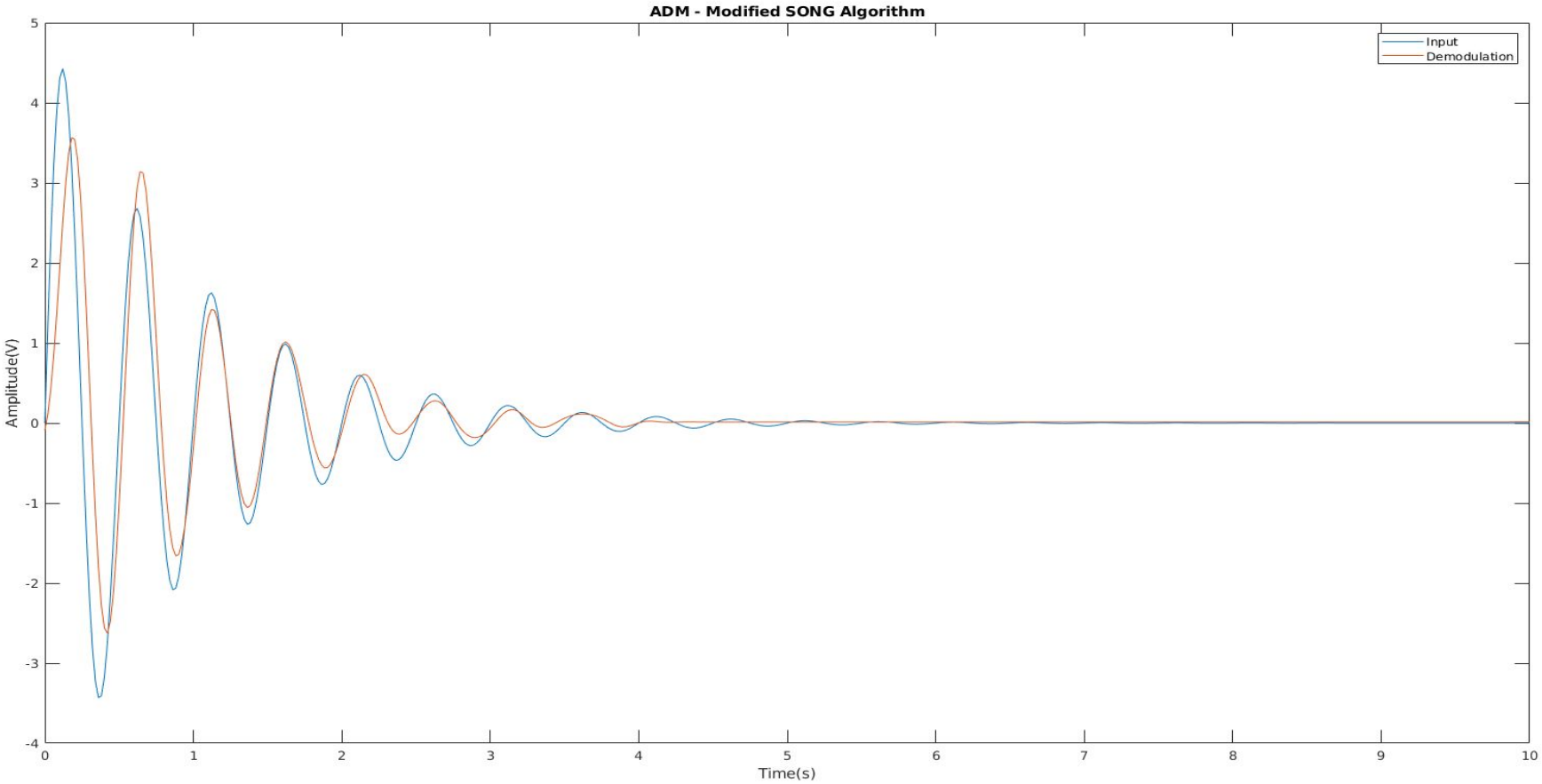
ADM - Modified SONG Algorithm
Input
Demodulation
Amplitude(V)
Time(s)
5
4
3
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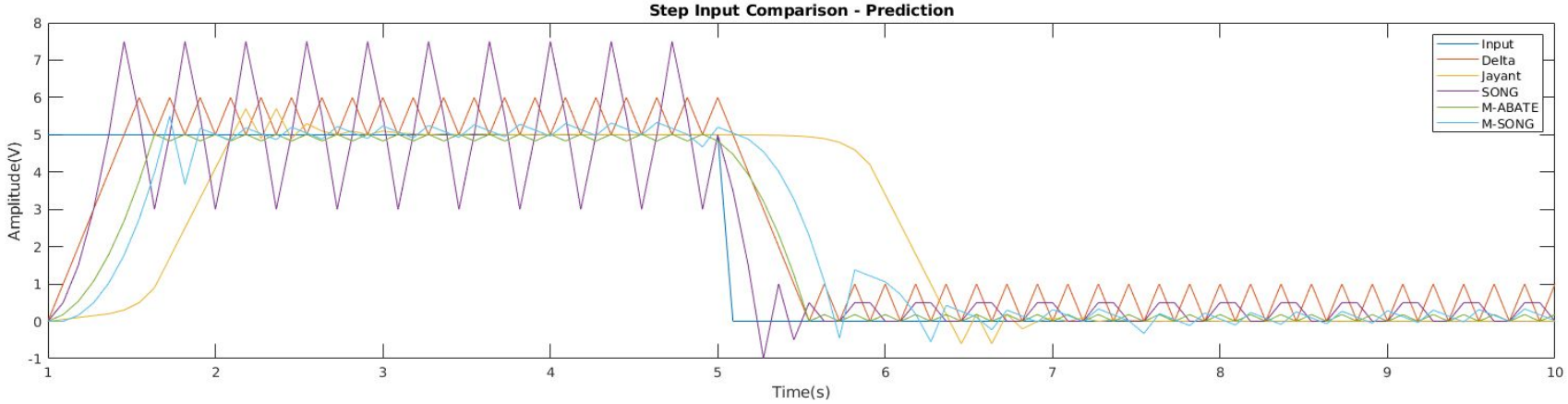
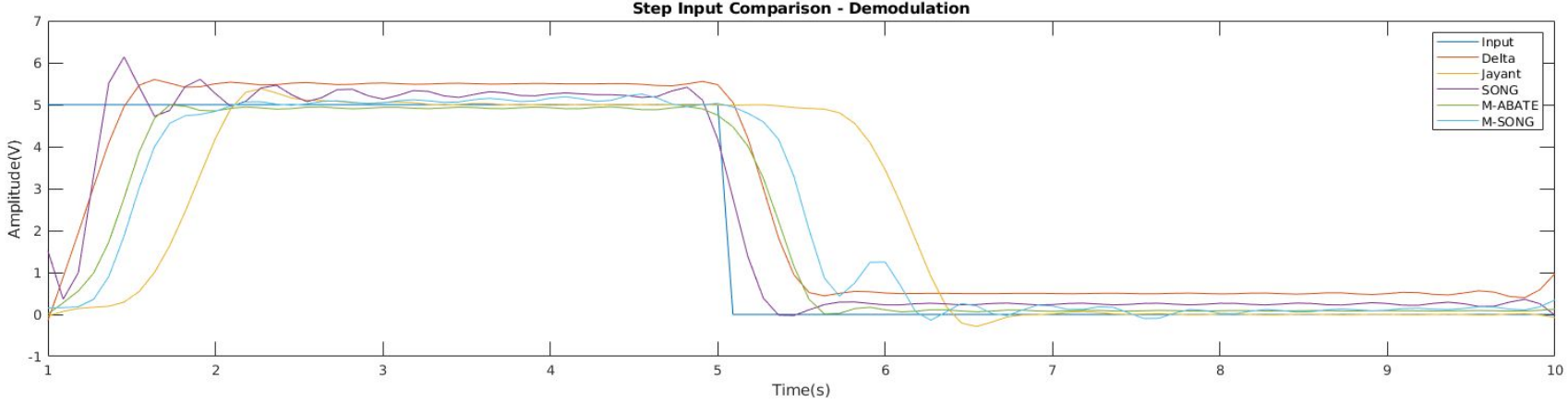

Step Input Comparison - Prediction
Amplitude(V)
Time(s)
Input
Delta
Jayant
SONG
M-ABATE
M-SONG


Step Input Comparison - Demodulation
Amplitude(V)
Time(s)
Input
Delta
Jayant
SONG
M-ABATE
M-SONG