Failure Correction in Linear Arrays with Compressive Sensing - A Comparative Analysis

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1.1 Test case 3—Comparison with [Yeo 1999], N=32, 2 faulty elements

1.1.1 Goal of the analysis

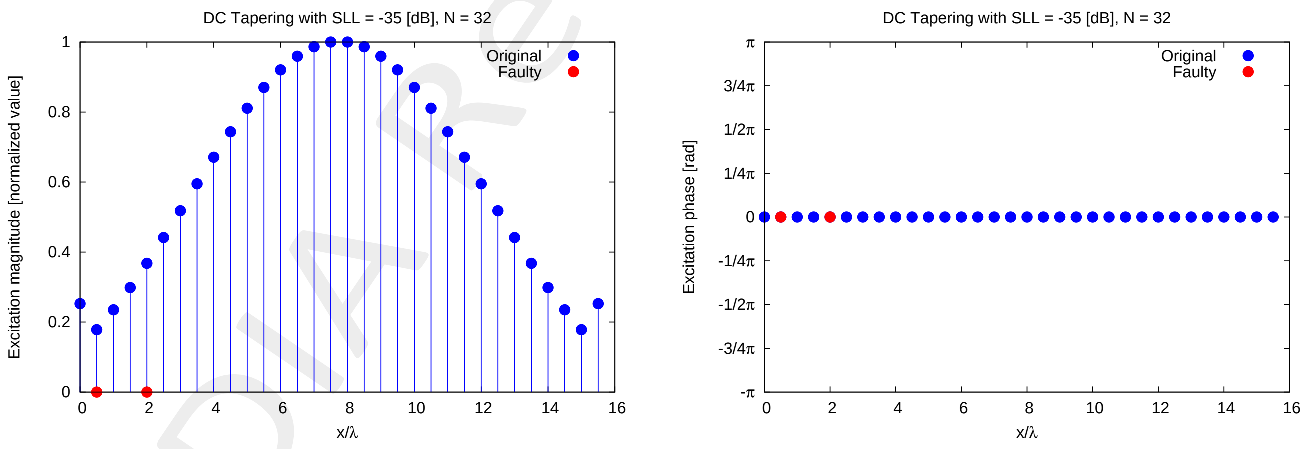
The goal of test case 3 is that of comparing the MFC method developed with the one presented by Yeo *et al.* in [Yeo.1999], which is based on Genetic Algorithms. We expect that the corrected pattern obtained with the two methods is similar. Moreover, we expect that the number of excitations changed by the proposed method is lower.

1.1.2 Parameters

The array considered in test case 3 has the following properties

- Number of array elements: $N = 32$
- Tapering: provided in Table I of [Yeo.1999], SLL=-30 [dB]
- Damaged element indexes set: $\Omega = \{2, 5\}$
- Number of faulty elements: $D = 2$
- Damaged element excitation: $\mathbf{w}_{\text{corr,immut}} = [0, 0]$

Figure 1 shows the original excitations and the damaged ones.



(a) (b)

Figure 1: Original and damaged excitations for the array considered in test case 3: amplitude (a) and phase (b).

The parameters used to configure the software are the following:

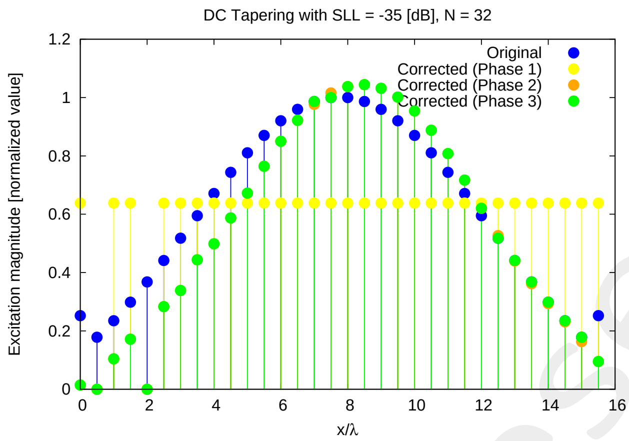
- Phase 1
  - Desired SLL: $\text{SLL}^{(1)} = -35.5$ [dB]

- Mask main lobe width: $BW^{(1)} = 13.05$ [deg]
- Mask u samples count: $K^{(1)} = 320$

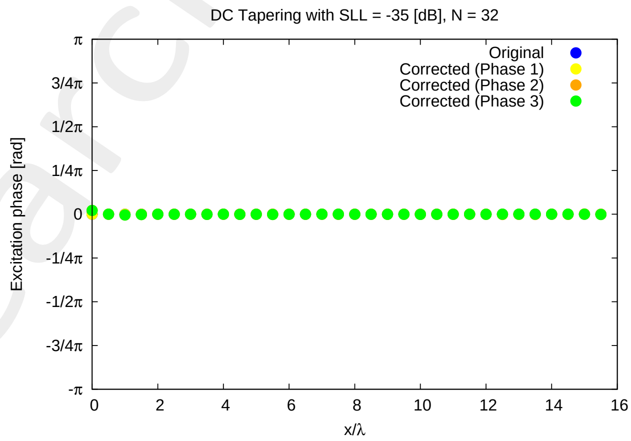
- Phase 2
  - Desired SLL: $SLL^{(1)} = -35$ [dB]
  - Mask main lobe width: $BW^{(2)} = 13.05$ [deg]
  - Mask u samples count: $K^{(2)} = 320$
- Use Hessian: Yes

1.1.3 Results

Figure 2 compares the original excitations with the corrected excitations obtained with the proposed method.



(a)



(b)

Figure 2: Original and corrected excitations for the array considered in test case 1: amplitude (a) and phase (b).

Figure 3 compares the original, faulty and corrected radiation patterns.

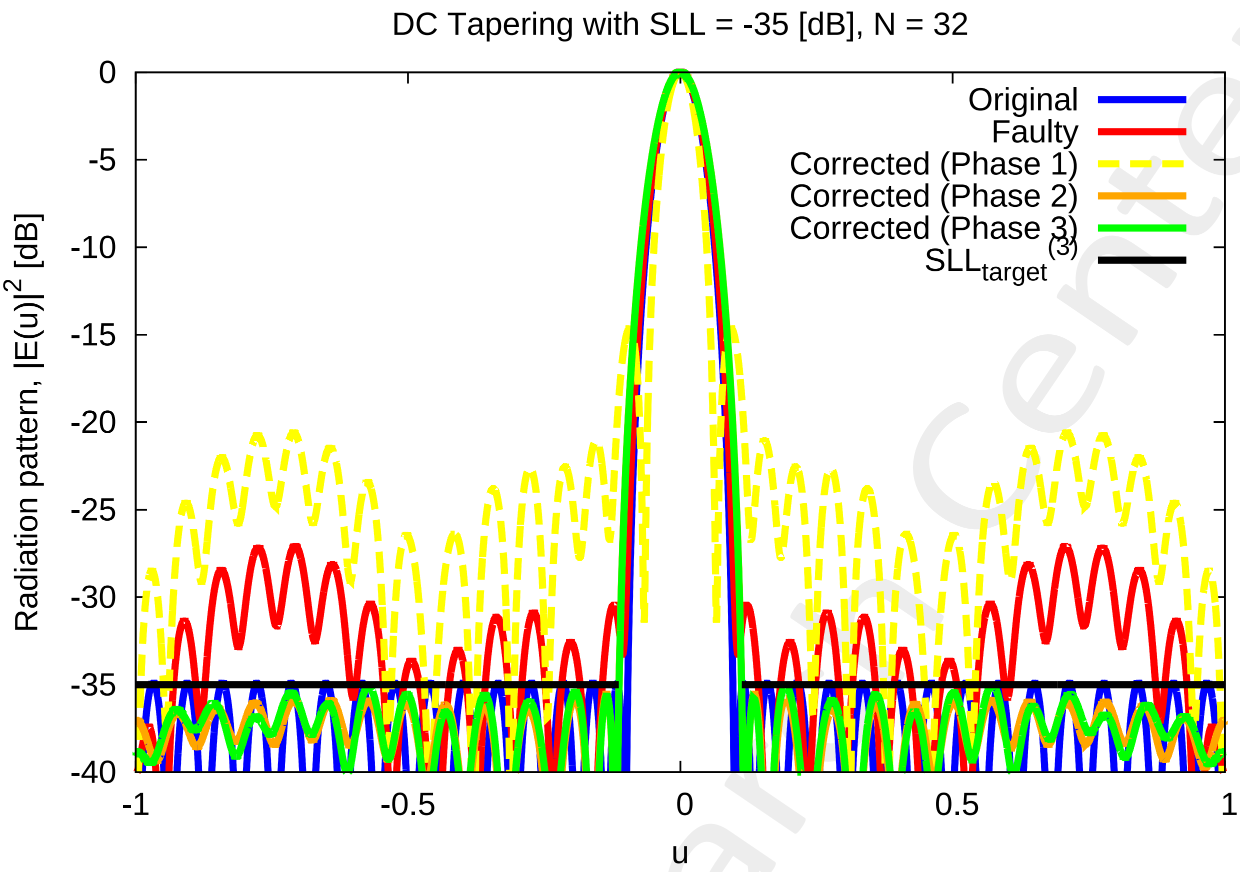


Figure 3: The radiation pattern for the original, faulty and corrected excitations.

Figure 4 shows the value of the L1-norm cost function for each iteration of the algorithm.

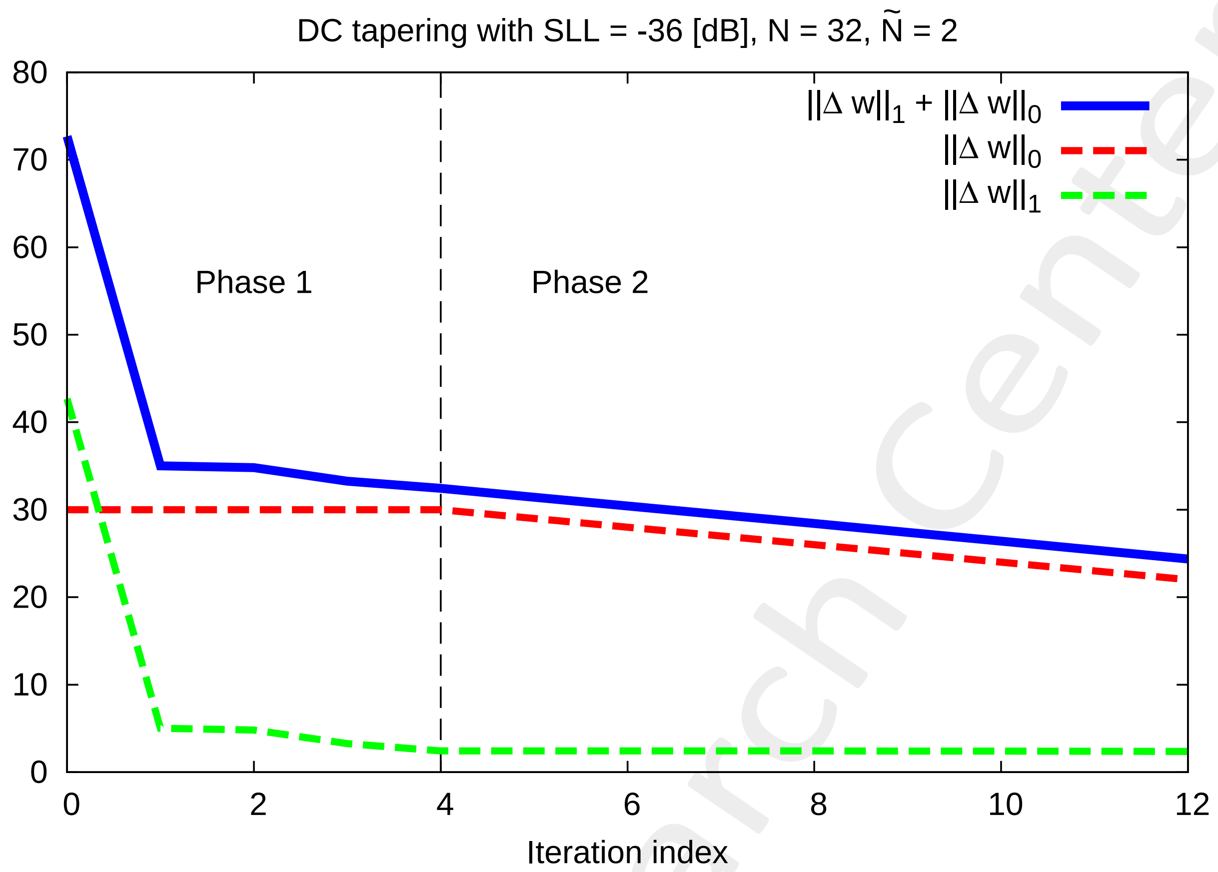


Figure 4: The value of the L1-norm cost function for each iteration of the algorithm.

Table I reports the SLL of the radiation patterns for the original, faulty and corrected excitations.

	Pattern SLL [dB]	HPBW [deg]	DRR	$\left\|\mathbf{w}_{corr,mut}-\mathbf{w}_{orig,mut}\right\|_1$	$\left\|\mathbf{w}_{corr,mut}-\mathbf{w}_{orig,mut}\right\|_0$
Original excitations	-34.92	4.15	0.178		
Faulty excitations	-27.11	4.29	0.178		
Corrected excitations (init.)	-14.67	3.31	1.0	7.42	30
Corrected excitations (Phase 1)	-35.55	4.77	0.0137	2.44	30
Corrected excitations (Phase 2)	-35.04	4.75	0.0137	2.37	22
State of the art [Yeo.1999]	-34.76	4.78	0.0584	3.57	30

Table I: Comparison of the original, faulty and corrected excitations.

Figure 5 shows the corrected patterns obtained with the proposed and reference methods are shown, along with the original and faulty patterns.

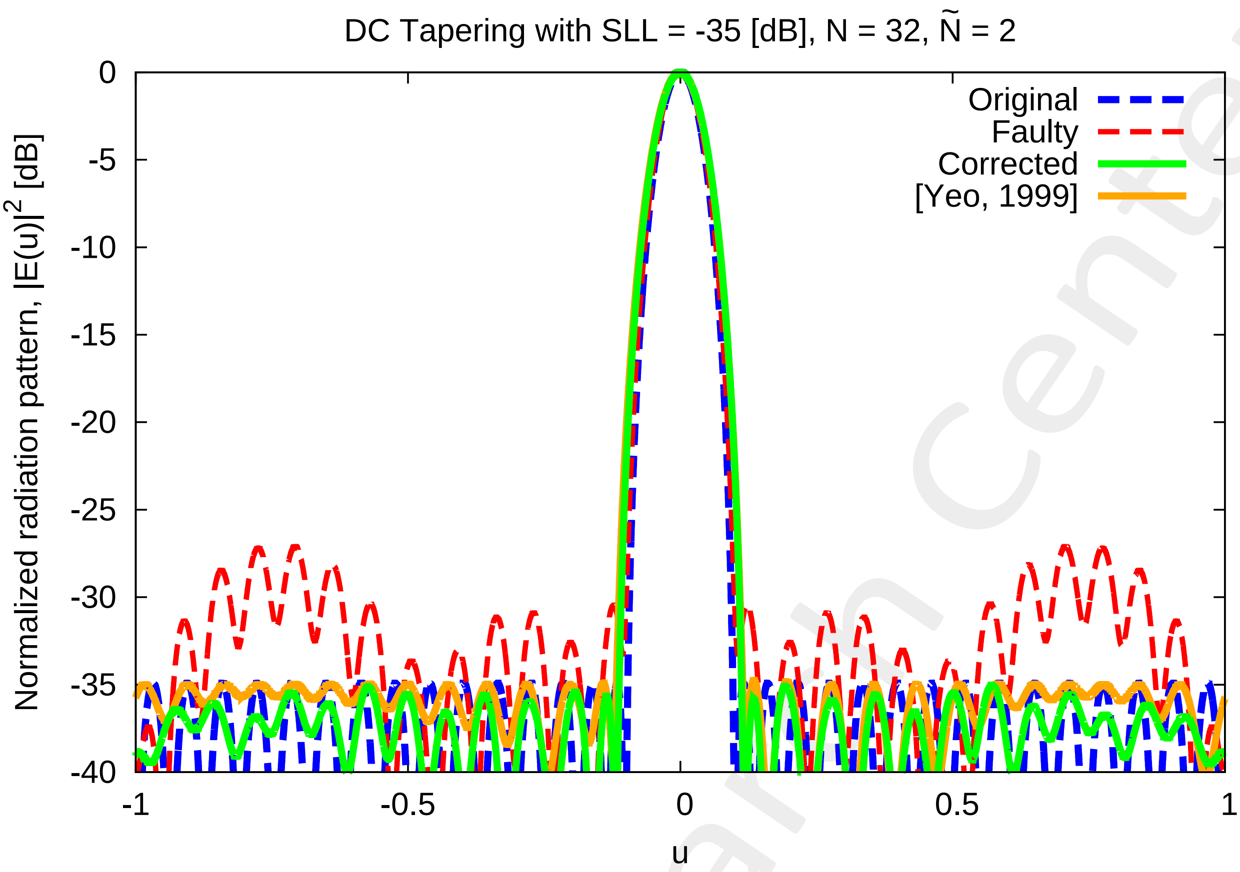


Figure 5: The corrected patterns obtained with the proposed and reference methods are shown, along with the original and faulty patterns.

1.1.4 Observations

The proposed method succeeded in providing a set of corrected excitations. Moreover, it provided a solution that matches the radiation power of the original pattern, has better beamwidth and SLL than the solution presented in [Yeo.1999], and uses fewer corrections.

1.2 Test case 4—Comparison with [Yeo 1999], N=32, 3 faulty elements

1.2.1 Goal of the analysis

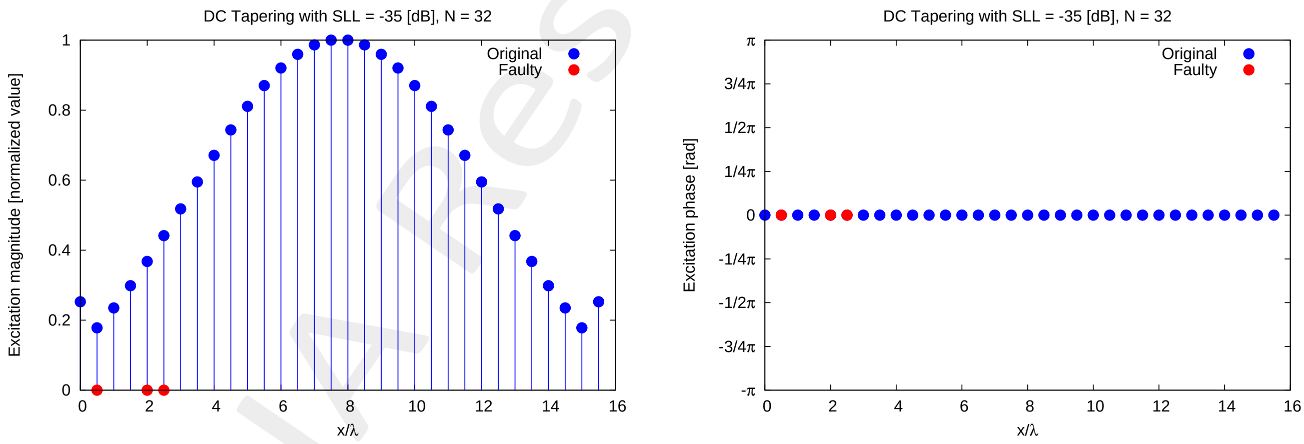
The goal of test case 4 is that of comparing the MFC method developed with the one presented by Yeo *et al.* in [Yeo.1999], which is based on Genetic Algorithms. We expect that the corrected pattern obtained with the two methods is similar. Moreover, we expect that the number of excitations changed by the proposed method is lower.

1.2.2 Parameters

The array considered in test case 4 has the following properties

- Number of array elements: $N = 32$
- Tapering: provided in Table I of [Yeo.1999], SLL$=-30$ [dB]
- Damaged element indexes set: $\Omega = \{2, 5, 6\}$
- Number of faulty elements: $D = 3$
- Damaged element excitation: $\mathbf{w}_{\text{corr,immut}} = [0, 0, 0]$

Figure 6 shows the original excitations and the damaged ones.



(*a*) (*b*)

Figure 6: Original and damaged excitations for the array considered in test case 4: amplitude (a) and phase (b).

The parameters used to configure the software are the following:

- Phase 1
  - Desired SLL: $\text{SLL}^{(1)} = -35.7$ [dB]
  - Mask main lobe width: $\text{BW}^{(1)} = 14.2$ [deg]

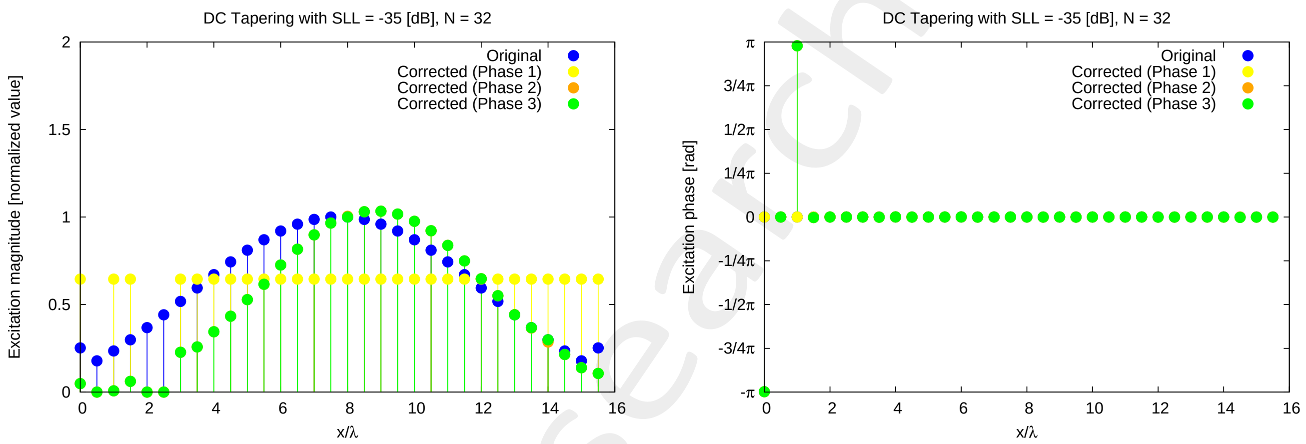
- Mask u samples count: $K^{(1)} = 320$

- Phase 2
  - Desired SLL: $\text{SLL}^{(2)} = -35.28$ [dB]
  - Mask main lobe width: $\text{BW}^{(2)} = 14.2$ [deg]
  - Mask u samples count: $K^{(2)} = 320$

- Use Hessian: Yes

1.2.3 Results

Figure 7 compares the original excitations with the corrected excitations obtained with the proposed method.



(a) (b)

Figure 7: Original and corrected excitations for the array considered in test case 1: amplitude (a) and phase (b).

Figure 8 compares the original, faulty and corrected radiation patterns.

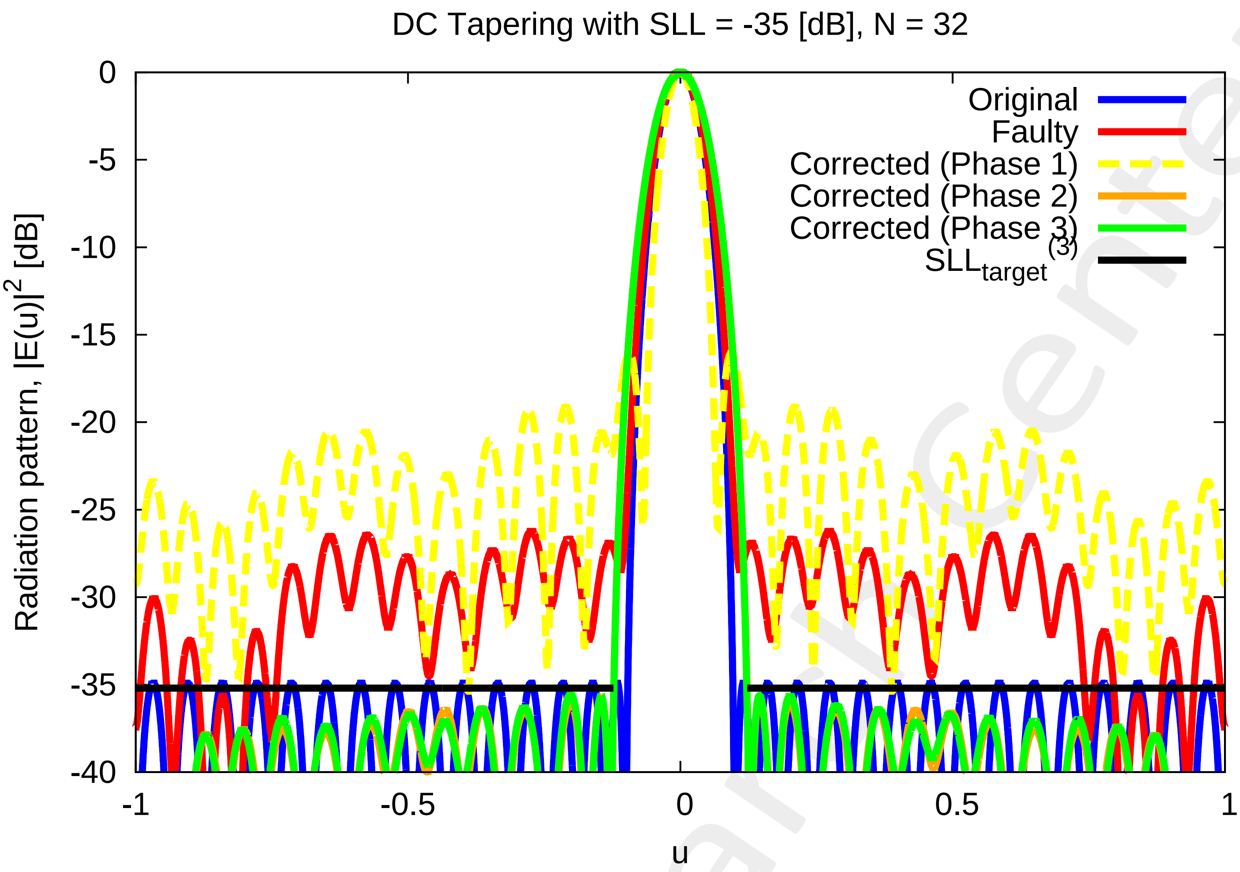


Figure 8: The radiation pattern for the original, faulty and corrected excitations.

Figure 9 shows the value of the L1-norm cost function for each iteration of the algorithm.

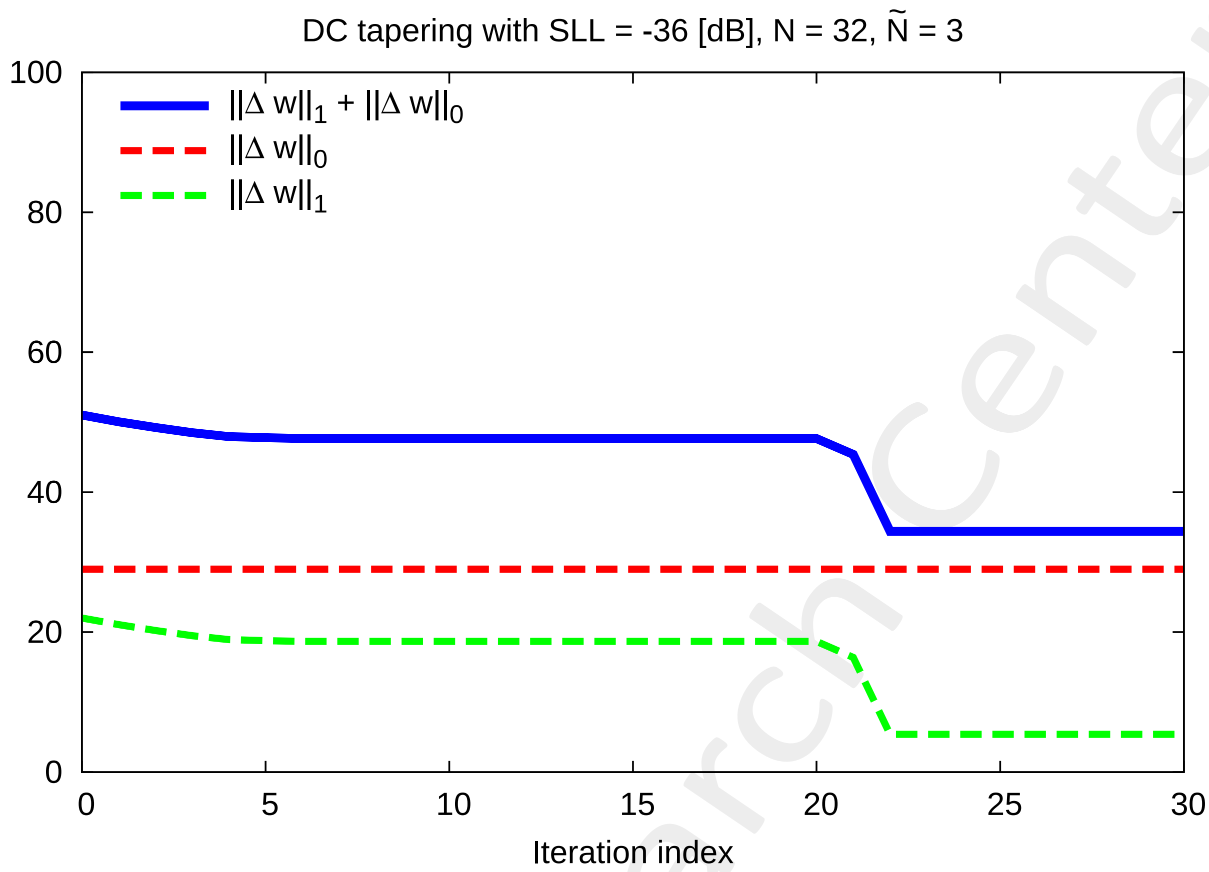


Figure 9: The value of the L1-norm cost function for each iteration of the algorithm.

Table II reports the SLL of the radiation patterns for the original, faulty and corrected excitations.

	Pattern SLL [dB]	**HPBW [deg]**	**DRR**	$\left\|\mathbf{w}_{corr,mut} - \mathbf{w}_{orig,mut}\right\|_1$	$\left\|\mathbf{w}_{corr,mut} - \mathbf{w}_{orig,mut}\right\|_0$
Original excitations	-34.92	4.15	0.178		
Faulty excitations	-26.24	4.38	0.178		
Corrected excitations (init.)	-16.08	3.35	1.0	7.20	29
Corrected excitations (Phase 1)	-35.75	5.26	0.005	3.92	29
Corrected excitations (Phase 2)	-35.28	5.25	0.005	3.87	24
State of the art [Yeo.1999]	-35.28	5.31	0.041	5.62	29

Table II: Comparison of the original, faulty and corrected excitations.

Figure 10 shows the corrected patterns obtained with the proposed and reference methods are shown, along with the original and faulty patterns.

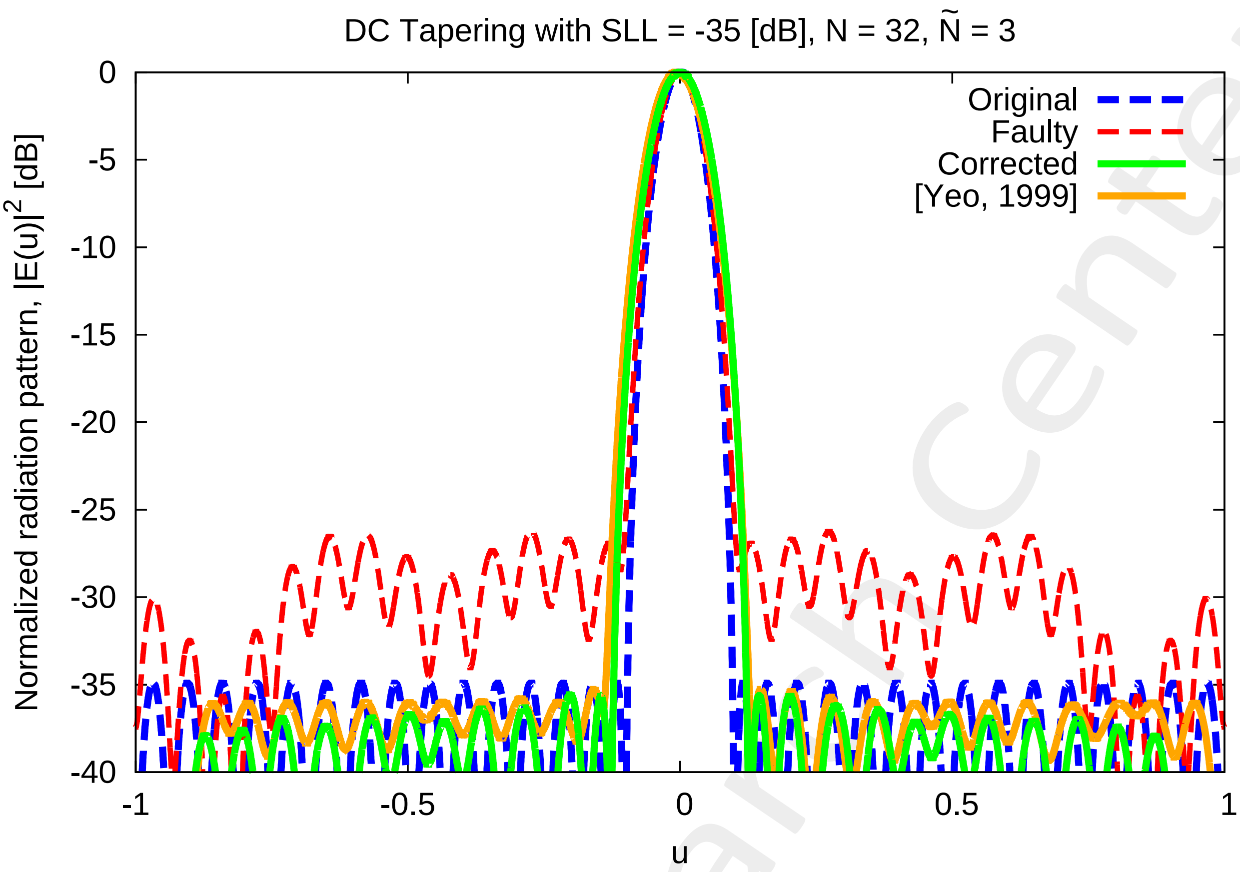


Figure 10: The corrected patterns obtained with the proposed and reference methods are shown, along with the original and faulty patterns.

1.2.4 Observations

The proposed method succeeded in providing a set of corrected excitations. Moreover, it provided a solution whose SLL and HPBW is slightly batter those of the solution provided by the method presented in [Yeo.1999]. Finally, the solution of the proposed method matches the peak of the original pattern.

However, the number of excitations changed is rather high (24 out of 29).

More information on the topics of this document can be found in the following list of references.

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