
REFERENCES

Advance Design System, ADS V9.0, Agilent Technology, USA.

Aggarwal, N., Gangwar, V.S., “M-shaped compact and broadband patch antenna for high resolution RF imaging radar applications,” *IEEE International Microwave and RF Conf.*, pp 356-359, Dec 2014, India.

Andreason, M. G., “Linear arrays with variable inter-element spacing,” *IRE Trans. on Antenna and Propagation*, vol. 10, pp. 137-143, Mar. 1962.

Bae, J. H., Kim, K. T., Lee, J. H., Kim, H. T., and Choi, J. I., “Design of steerable non-uniform linear array geometry for side lobe reduction,” *Microwave and Optical Technology Lett.*, vol. 36, no. 5, pp. 363-367, Mar., 2003.

Balanis, C. A., *Antenna Theory and Design*, 3rd Edition, John Wiley & Sons, 2005.

Bencivenni, C., Ivashina, M. V., Maaskant, R., and Wettergren, J., “Design of maximally sparse antenna arrays in the presence of mutual coupling,” *IEEE Antennas Wireless Propag. Lett.*, vol. 14, pp. 159–162, 2015.

Bhargav, A., and Gupta, N., “Multi-objective genetic optimization of non-uniform linear array with low sidelobes and beamwidth,” *IEEE Antennas and Wireless Propagation Letters*, vol. 12, pp. 1547-1549, 2013.

Bray, M. G., Werner, D. H., Boeringer, D. W., Machuga, D. W. “Optimization of thinned aperiodic linear phased arrays using genetic algorithms to reduce grating lobes during scanning,” *IEEE Transactions on Antennas and Propagation*, vol. 50, no. 12, pp. 1732–1742, Dec. 2002.

Caratelli, D., and Viganó, M. C., “A novel deterministic synthesis technique for constrained sparse array design problems,” *IEEE Trans. Antennas Propag.*, vol. 59, no. 11, pp. 4085-4093, Nov. 2011.

Cen, L., Yu, Z. L., Ser, W., and Cen W., “Linear aperiodic array synthesis using an improved genetic algorithm,” *IEEE Trans. Antennas Propag.*, vol. 60, no. 2, pp. 895–902, Feb. 2012.

Chen, K. S., He, Z. S., and Han, C. L., “A modified real GA for the sparse linear array synthesis with multiple constraints,” *IEEE Trans. Antennas Propagat.*, vol. 54, no. 7, pp. 2169–2173, Jul. 2006.

Cheng, Y.F., Shao, W., Zhang, S.J., and Li, Y. P., “An improved multi-objective genetic algorithm for large planar array thinning,” *IEEE Trans. Magn.*, vol. 52, no. 3, 9400304, 2016.

Coman, C. I., “*Shared aperture array antennas composed of differently sized elements arranged in sparse sub-arrays*,” Ph.D. thesis, Delft University of Technology, Pijnacker, Jan. 2006.

Coman, C.I., Lager, I.E., and Ligthart, L.P., “Optimization of linear sparse array antennas consisting of electromagnetically coupled apertures,” *In Proceedings of the First European Radar Conference, EURAD 2004*, vol. 1, pp. 301–304, Amsterdam, 2004.

Davies, D.E.N., and Ward, C.R., “Low side lobe patterns from thinned arrays using multiplicative processing,” *IEEP ROC*, vol. 127, pp 9-15, Feb. 1980.

Davis, L., Ed., *Handbook of Genetic Algorithms*. New York: Van Nostrand Reinhold, 1991.

Deb, A., Gupta, B., and Roy, J.S., “Design of thinned array using particle swarm optimization with differential perturbed velocity,” *In Proc. of 2012 International Conference on Communications, Devices and Intelligent Systems (CODIS)*, pp. 531-534, 2012.

- Deligkaris, K. V., Zaharis, Z.D., Kampitaki, D.G., Goudos, S.K., Rekanos, I.T., and Spasos, M. N., “Thinned planar array design using boolean PSO with velocity mutation,” *IEEE Trans. Magn.*, vol. 45, no. 3, pp. 1490–1493, Mar. 2009.
- Donelli, M., “Linear antenna synthesis with a hybrid genetic algorithm,” *Progress In Electromagnetics Research, PIER* vol. 49, pp. 1–22, 2004.
- Donelli, M., Martini, A., and Massa, A., “A hybrid approach based on PSO and hadamard difference sets for the synthesis of square thinned arrays,” *IEEE Transactions on Antennas and Propagation*, vol. 57, no. 8, pp. 2491-2495, 2009.
- Fuchs, B., Skrivervik, A., and Mosig, J. R., “Synthesis of uniform amplitude focused beam arrays,” *IEEE Antennas Wireless Propag. Lett.*, vol. 11, pp. 1178–1181, 2012.
- Gangwar, V. S., Singh, A. K., and Singh, S. P., “An effective approach for the synthesis of unequally spaced antenna array by estimating optimum elements density on the aperture,” *IEEE Antennas Wireless Propag. Lett.*, vol. 16, pp 2278 - 2282, 2017.
- Gangwar, V. S., Singh, A. K., and Singh, S. P., “Side lobe level suppression in randomly spaced linear array using genetic algorithm,” In Proc. *IEEE Int. Microw. RF Conf.* 2015, Hyderabad, India, pp. 381–384, Dec. 10–12th, 2015b.
- Gangwar, V. S., Singh, A. K., Patidar, H., and Singh, S. P., “Optimistic design of thinned planar antenna array for radar operating scenarios,” In Proc. *IEEE International Conf. on Microelectronics, Computing and Communication 2016*, West Bengal, India, pp 1-4, Jan. 23-25th, 2016.
- Gangwar, V. S., Singh, A. K., Thomas, E. and Singh, S. P., “Side lobe level suppression in a thinned linear antenna array using particle swarm optimization,” In Proc. *IEEE International Conf. on Applied and Theoretical Computing and Communication Technology (iCATccT) 2015*, Karnataka, India, pp 787-790, Oct. 29-31st, 2015a.
- Goldberg, D. E., *Genetic Algorithms in Search, Optimization, and Machine Learning*, Addison Wesley Longman, New York, NY, USA, 1989.

Goldberg, D.E., Deb, K., and Clark, J.H., “Genetic algorithms, noise, and the sizing of populations,” *Complex Syst.*, vol. 6, no. 3, pp. 333–362, 1991.

Goudos S. K., K. A. Gostis, K. Siakavara, E. E. Vafiadis, and J. N. Sahalos, “A multi objective approach to subarrayed linear antenna arrays design based on memetic differential evolution,” *IEEE Trans. Antennas Propag.*, vol. 61, no. 6, pp. 3042–3052, Jun. 2013.

Goudos S. K., Vasiliki Moysiadou, Theodoros Samaras, Katherine Siakavara and John N. Sahalos, “Application of a comprehensive learning particle swarm optimizer to unequally spaced linear array synthesis with side lobe level suppression and null control,” *IEEE Antennas Wireless Propag. Lett.*, vol. 9, pp. 125–129, 2010.

Goudos, S. K., Siakavara, K., Samaras, T., Vafiadis, E. E., and Sahalos, J.N. , “Sparse linear array synthesis with multiple constraints using differential evolution with strategy adaptation,” *IEEE Antennas Wireless Propag. Lett.*, vol. 10, pp. 670–673, 2011.

Ha, B. V., Mussetta, M., Pirinoli, P., and Zich, R. E., “Modified compact genetic algorithm for thinned array synthesis,” *IEEE Antennas Wireless Propag. Lett.*, vol. 15, pp 1105-1108, 2016.

Harrington, R. F., “Side lobe reduction by non-uniform element spacing,” *IEEE Transactions on Antennas and Propagation*, vol. 9, 187, March 1961.

Haupt, R. L., “Thinned arrays using genetic algorithms,” *IEEE Transactions on Antennas and Propagation*, Vol. 42, No. 7, 993-999, 1994.

Haupt, R. L., “An introduction to genetic algorithms for electromagnetic,” *IEEE Transactions on Antennas and Propagation Magazine*, vol. 37, no. 2, pp. 7-15, April 1995.

Haupt, R. L., “Interleaved thinned linear arrays,” *IEEE Transactions on Antennas and Propagation*, vol. 53, no. 9, pp. 2858-2864, 2005.

Haupt, R. L., *Antenna Arrays: A Computational Approach*, John Wiley & Sons, Inc., 2010.

High Frequency Structure Simulator, HFSS ver.12, Ansoft Corp., Pittsburgh PA 15219 USA.

Hodjat, F., and Hovanesian, S. A., "Non-uniformly spaced linear and planar array antennas for side lobe reduction," *IEEE Trans. Antennas Propagat.*, vol. AP-26, no. 2, pp. 198-204, Mar. 1978.

Holland, J. H., *Adaptation in natural and artificial systems*, University of Michigan Press, Ann Arbor, Mich, USA. 1975.

Hooker, J.W., and Arora, R. K., "Optimal thinning levels in linear arrays," *IEEE Antennas and Wireless Propagation Letters*, vol. 9, pp. 771-774, 2010.

Ishimaru, A., "Theory of unequally-spaced arrays," *IEEE Transactions on Antennas and Propagation*, vol. 10, pp. 691-702, Nov. 1962.

Jain, R., and Mani, G.S., "dynamic thinning of antenna array using genetic algorithm," *Progress In Electromagnetic Research B*, vol. 32, pp. 1-20, 2011.

Jianfeng, Y., *et al.*, "Side lobe reduction in thinned array synthesis using immune algorithm," *Microwave and Millimeter Wave Technology*, pp. 1131-1133, 2008.

Jin N. and Samii Y. R., "Advances in particle swarm optimization for antenna designs: Real-number, binary, single-objective and multi-objective implementations," *IEEE Trans. Antennas Propag.*, vol. 55, no. 3, pp. 556-567, Mar. 2007.

Kadri, B., M. Boussahla, and F. T. Bendimerad, "Phase-only planar antenna array synthesis with fuzzy genetic algorithms," *IJCSI International Journal of Computer Science Issues*, vol. 7, issue 1, no. 2, pp. 72-77, 2010.

Kazemi, S. and H. R. Hassani, G. R. Dadashzadeh, and F. Geran, "Performance improvement in amplitude synthesis of unequally spaced array using least mean square method," *Progress In Electromagnetic Research B*, vol. 1, pp. 135-145, 2008.

- Kennedy, J., Eberhart, R. C., “Particle Swarm Optimization,” In Proc. *IEEE Int. Conf. Neural Networks*, Piscataway, NJ, pp. 1942-1948, 1995.
- Khodier, M. M., and Christodoulou, C. G., “Linear array geometry synthesis with minimum side lobe level and null control using particle swarm optimization.” *IEEE Trans. Antennas Propag.*, vol. 53, no. 8, pp. 2674–2679, Nov. 2005.
- King, D. D., R. F. Packard, and R. K. Thomas, “Unequally spaced, broadband antenna arrays,” *IRE Trans. on Antennas and Propagation*, vol. 8, pp. 380-384, Aug. 1997.
- Kumar, B. P. and G. R. Branner, “Design of unequally spaced arrays for performance improvement,” *IEEE Transactions on Antennas and Propagation*, vol. 47, no. 3, March 1999.
- Kumar, B. P. and G. R. Branner, “Generalized analytical technique for the synthesis of unequally spaced arrays with linear, planar, cylindrical or spherical geometry,” *IEEE Transactions on Antennas and Propagation*, vol. 53, no. 2, pp. 621-634, Feb. 2005.
- Kurup, D. G., Himdi, M., and Rydberg, A., “Synthesis of uniform amplitude unequally spaced antenna arrays using the differential evolution algorithm,” *IEEE Trans. Antennas Propag.*, vol. 51, no. 9, pp. 2210–2217, Sep. 2003.
- Leeper, D. G., “Isophoric arrays-massively thinned phased arrays with well-controlled side lobes,” *IEEE Trans. Antennas Propag.*, vol. 47, no. 12, pp. 1825–1835, Dec. 1999.
- Ligthart, L. P., “*Antenna design and characterization based on the elementary antenna concept*,” Ph.D. thesis, Delft University of Technology, Pijnacker, Dec. 1985.
- Lin, C., Qing, A., and Feng, Q., “Synthesis of unequally spaced antenna arrays by using differential evolution,” *IEEE Trans. Antennas Propag.*, vol. 58, no. 8, pp. 2553–2561, Aug. 2010.
- Lin, Z., Jia, W., Yao, M., and Hao, L., “Synthesis of sparse linear arrays using vector mapping and simultaneous perturbation stochastic approximation,” *IEEE Antennas Wireless Propag. Lett.*, vol. 11, pp. 220–223, 2012.

- Liu, C., and Wu, H. N., "Synthesis of thinned array with side lobe levels reduction using improved binary invasive weed optimization," *Progress In Electromagnetic Research M*, vol. 37, pp. 21-30, 2014.
- Lo, Y. T. and S. W. Lee, "A study of space-tapered arrays," *IEEE Trans. on Antenna and Propagation*, vol. 14, no. 1, pp. 22-30, Jan. 1966.
- Mahanti, G. K., Pathak, N., and Mahanti, P., "Synthesis of thinned linear antenna arrays with fixed side lobe level using real-coded genetic algorithm," *Progress In Electromagnetic Research*, vol. 75, pp. 319-328, 2007.
- Mailloux, R. J., and Cohen, E., "Statistically thinned arrays with quantized element weights," *IEEE Transactions on Antennas and Propagation*, vol. 39, no. 4, pp. 436-447, 1991.
- Man, K.F., Tang, K.S., and Kwong, S., *Genetic Algorithms: Concepts and Designs*. London, U.K.: Springer Verlag, 1999.
- MATLAB ver. 8, Mathworks, Inc., Natick MA, USA.
- Nihad, I. D., "Synthesis of thinned planar antenna arrays using teaching learning based optimization," *International Journal of Microwave and Wireless Technologies*, Page 1-7, 2014.
- Numazaki T., Mano, S., Katagi, T., and Mizusawa M., "An improved thinning method for density tapering of planar array antennas," *IEEE Transactions on Antennas and Propagation*, vol. AP-35, no. 9, pp 1066-1070, Sep. 1987
- Oliveri, G., Caramanica, F., Migliore, M. D., and Massa, A., "Synthesis of non-uniform MIMO arrays through combinatorial sets," *IEEE Antennas Wireless Propag. Lett.*, vol. 11, pp. 728–731, 2012.
- Oliveri, G., and Massa, A., "GA-enhanced ADS-based approach for array thinning," *IET Microw. Antennas Propag.*, vol. 5, issue. 3, pp. 305–313, 2011a.

- Oliveri, G., and Massa, A., "Bayesian compressive sampling for pattern synthesis with maximally sparse non-uniform linear arrays," *IEEE Trans. Antennas Propag.*, vol. 59, no. 2, pp. 467–481, Feb. 2011b.
- Oliveri, G., Caramanica, F., Fontanari, C., and Massa, A., "Rectangular thinned arrays based on McFarland difference sets," *IEEE Trans. Antennas Propag.*, vol. 59, no. 5, pp. 1546–1552, May. 2011.
- Oliveri, G., Manica, L., and Massa, A., "ADS-based guidelines for thinned planar arrays," *IEEE Trans. Antennas Propag.*, vol. 58, no. 6, pp. 1935–1948, June. 2010.
- Oraizi, H., and Fallahpour, M., "Non-uniformly spaced linear array design for the specified beamwidth/side lobe level or specified directivity/side lobe level with coupling considerations," *Progress In Electromagnetic Research M*, vol. 4, pp. 185–209, 2008.
- Papapolymerou J., and Bernhard J.T. "Multifunction antennas and antenna systems," *IEEE Trans. Antennas Propag.*, vol. 54, no. 1, Jan. 2006.
- Robinson, J., and Samii, Y. R., "Particle swarm optimization in electromagnetic," *IEEE Trans. Antennas Propag.*, vol. 52, no. 2, pp. 397–407, Feb. 2004.
- Rocca, P., "Large array thinning by means of deterministic binary sequences," *IEEE Antennas Wireless Propag. Lett.*, Vol. 10, pp 334-337, 2010.
- Sandler, S. S., "Some equivalence between equally and unequally spaced arrays," *IRE Trans. Antennas and Propag.* pp. 380-384, July 1960.
- Sartori, D., Oliveri, G., Manica, L., and Massa, A., "Hybrid design of non-regular linear arrays with accurate control of the pattern side lobes," *IEEE Trans. Antennas Propag.*, vol. 61, no. 12, pp. 6237–6242, Dec. 2013.
- Skolnik, M. I., G. Nemhauser, and J. W. Sherman III, "Dynamic programming applied to unequally spaced arrays," *IEEE Transactions on Antennas and Propagation*, Vol. 12, 35-43, January 1964.

- Skolnik, M. I., Introduction to radar systems, 2nd Edition, McGraw-Hill, 1990.
- Tang, K. S., Man, K. F., Kwong, S., and He, Q. H., “Genetic algorithms and their applications,” *IEEE Signal Process. Mag.*, vol. 13, no. 6, pp. 22–37, Nov. 1996.
- Teruel, O. Q., and Iglesias, E. R., “Ant colony optimization in thinned array synthesis with minimum side lobe level,” *IEEE Antennas Wireless Propag. Lett.*, vol. 5, pp. 349-352, 2006.
- Tomiyasu, K., “Combined equal and unequal element spacings for low side lobe pattern of a symmetrical array with equal-amplitude elements,” *IEEE Trans. Antennas Propag.*, vol. 39, no. 2, pp. 265–266, Feb. 1991.
- Trucco, A., “Thinning and weighting of large planar arrays by simulated annealing,” *IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control*, vol. 46, no. 2, pp. 347-355, 1999.
- Unz, H., “Linear arrays with arbitrarily distributed elements,” *IEEE Transactions on Antennas and Propagation*, vol. 8, pp. 222-223, March 1960.
- Wang, J., Yang, B., Wu, S.H., and Chen, J. S., “A novel binary particle swarm optimization with feedback for synthesizing thinned planar arrays,” *Journal of Electromagnetic Waves and Applications*, vol. 25, nos. 14-15, pp. 1985–1998, 2011.
- Wang, W. B., Feng, Q. Y., and Liu, D., “Synthesis of thinned linear and planar antenna arrays using binary PSO algorithm,” *Progress In Electromagnetic Research*, vol. 127, pp. 371-387, 2012.
- Wang, X. K., Jiao Y.-C., and Tan, Y.Y. “Gradual thinning synthesis for linear array based on Iterative Fourier Techniques,” *Progress In Electromagnetic Research*, vol. 123, pp. 299-320, 2012a.
- Wang, X.-K., Jiao, Y.-C., Liu, Y., and Tan, Y.Y., “Synthesis of large planar thinned arrays using IWO-IFT algorithm,” *Progress In Electromagnetic Research*, vol. 136, pp. 29-42, 2013.

- Weile, D.S., and Michielssen, E., “Genetic algorithm optimization applied to electromagnetic: A Review,” *IEEE Trans. Antennas Propag.*, vol. 45, no. 3, pp. 343–353, March. 1997.
- Willey, R.E., “Space tapering of linear and planar arrays,” *IEEE Trans. Antennas Propag.*, vol. 10, no. 4, pp. 369–377, Jul. 1962.
- Yan, K. K., and Lu, Y., “Side lobe reduction in array pattern synthesis using genetic algorithm,” *IEEE Trans. Antennas Propag.*, vol. 45, no. 7, pp. 1117–1122, July 1997.
- Yu, C. C., “Side lobe reduction of asymmetric linear array by spacing perturbation,” *IEE Electronics Lett.*, vol. 33, no. 9, pp. 730-732, Apr. 1997.
- Zaman, M.A., and Matin, M. A., “Non-uniformly spaced linear antenna array design using firefly algorithm,” *International Journal of Microwave Science and Technology*, vol. 2012, pp. 1–8, 2012.
- Zhang, F., Jia, W., and Yao, M., “Linear aperiodic array synthesis using differential evolution algorithm,” *IEEE Antennas Wireless Propag. Lett.*, vol. 12, pp. 797–800, 2013.
- Zhang, L., Jiao Y.-C., Chen, B., and Zhang, F.-S., “Synthesis of linear aperiodic arrays using a self adaptive hybrid differential evolution algorithm,” *IET Microw. Antennas Propag.*, vol. 5, issue. 12, pp. 1524–1528, 2011.
- Zhang, L., Jiao, Y. C., Chen, B., and Li, H., “Orthogonal genetic algorithm for planar thinned array designs,” *Int. J. Antennas Propag.*, vol. 2012, Article ID 319037, 1-7, 2012.
- Zhang, L., Jiao, Y. C., Weng, Z. B., Zhang, F. S., “Design of planar thinned arrays using a boolean differential evolution algorithm,” *IET Microw. Antennas Propag.*, vol. 4, no. 12, pp. 2172–2178, 2010.
- Zhang, S., Gong, S. X., and Zhang, P. F., “A modified PSO for low side lobe concentric ring arrays synthesis with multiple constraints,” *J. Electromagn. Waves App.*, vol. 23, no. 11-12, pp. 1535–1544, 2009.