B-7-1 BEAM COMPRESSION ARRAYS FOR RADARS

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Introduction

This paper describes the recent progress in the beam compression arrays for radars developed by the authors. The harbour radar system with one half beam compression by multiplicatively processing has been reported. In this paper, three different array types for the beam compression are shown.

The Multiplicative Array for shipborne small radar shows the improved bearing resolution and gives the precise radar picture. The Hybrid Array may suppress 1st negative side lobe which may mask small echoes near a large target. The Frequency Multiplier Array can produce more sharp beam than that of the multiplicative array. One-fourth beam compressed pattern to a comparable linear array is shown in this paper.

The availability of these beam compression arrays against the inherent multi-targets problem may be reasonable since using a short pulse and operating the radar in the practical situations that the coherency between signals from those targets are negligible. This has been evaluated and concluded experimentally.

Multiplicative Small Array for Shipborne Radar

Fig.1 shows the configuration of a typical Multiplicative Array, and Fig.2 shows synthesizing those element patterns to get the one half compressed beam.

Fig.3 shows a shipborne radar implemented at X band that array has about 60cm in length and that beam width of 1.9 deg. of arc at -3 dB. In Fig.4, the incompressed and compressed echoes obtained at Yokohama Port, Japan, are displayed respectively. Improvement in the resolution is seen clearly.

Hybrid Array

The multiplicative pattern has produced inherently large 1st side lobes with negative polarity which may be harmfull on account of masking small echoes near a large target.

Combining an additive component to the multiplicative output as shown in Fig.5, the side lobes may be suppressed. Fig.6 shows the output pattern of the Hybrid Array.

Frequency Multiplier Array

Passing the signal outputs of the array elements into the frequency multiplier circuit and processing those signals by the multiplication circuit, the output pattern of the Frequency Multiplier Array may be more sharpened than of the Multiplicative Array. Fig.7 shows the configuration of a typical Frequency Multiplier Array with two antenna elements. The pattern shown in Fig.8 (a) and (b) are of the incompressed (linear addition) and compressed beam, respectively. The compression ratio of the array to a comparable linear array is about one-fourth in the beam width.

Conclusion

In this paper three different arrays have been introduced. The Multiplicative Array for small radar has been successfully implemented. This shipborne radar with 60 cm array gives so precise picture as obtained by a 120 cm antenna. The radar may be usefull to small ships such as fisher boat and yacht.

The Hybrid Arrar shows the desirable side lobe characteristics while the compression ratio is approximately identical to the Multiplicative Array's. Further it is seen experimentally that the radar picture obtained by the Hybrid Array seems to be more natural contrast than by the Multipicative Array. The high contrast may be due to the nonlinearity in the multiplicative operation.

By using the Frequency Multiplier Array for radar the size of the array may be saved by one-fourth to the conventional antenna.

References

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3. T. Suzuki "Compression of radar beam by signal processing" National Convention Record of IECE,Japan S7-4, 1977.
4. A. Ksiensky :Signal processing antenna system" The Ohio State University Summer Short Course 1965.

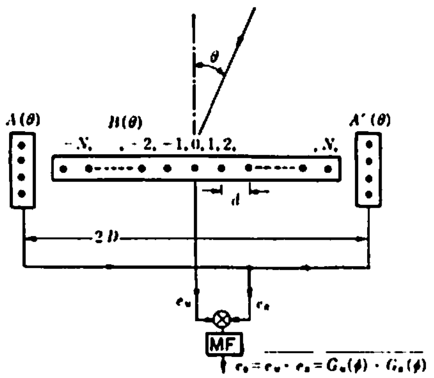
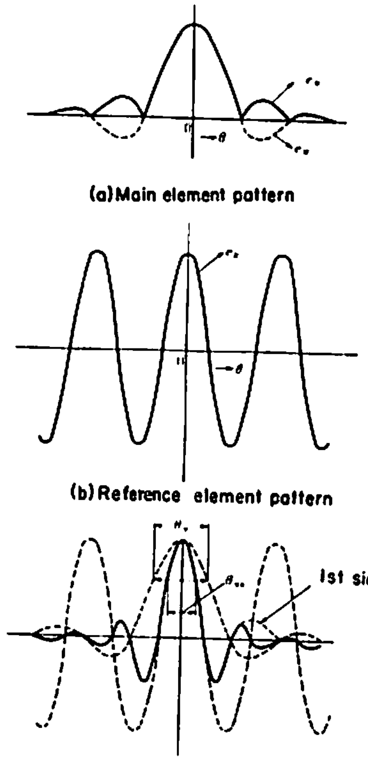


Fig. 1 Multiplicative Array



(a) Main element pattern

(b) Reference element pattern

(c) Multiplicative Array Pattern (Solid line)

Fig.2 Element pattern and compressed pattern

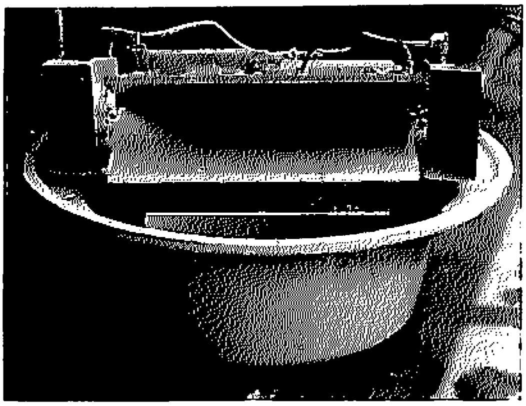
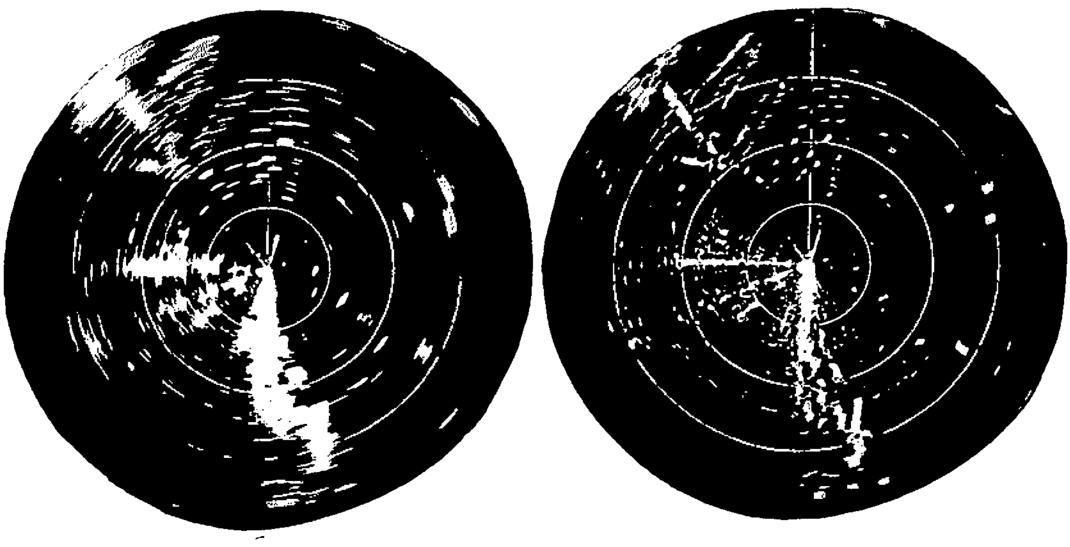


Fig.3 Shipborne beam compression radar



(a) Incompressed echo

(b) Compressed echo

Fig.4 Compressed and incompressed echoes

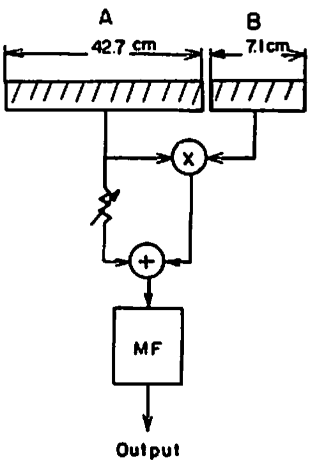


Fig.5 Hybrid Array

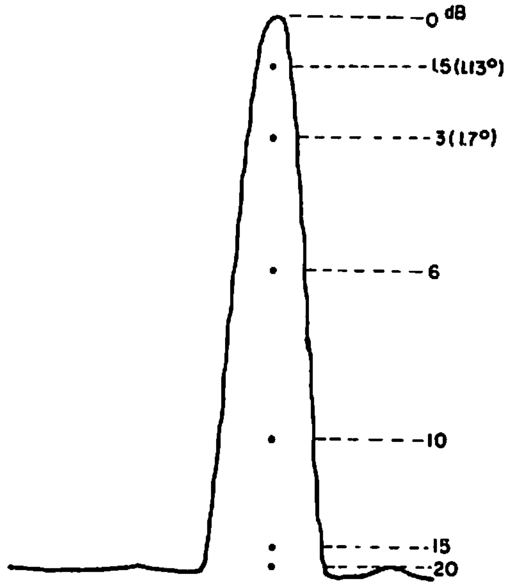


Fig.6 Hybrid array pattern

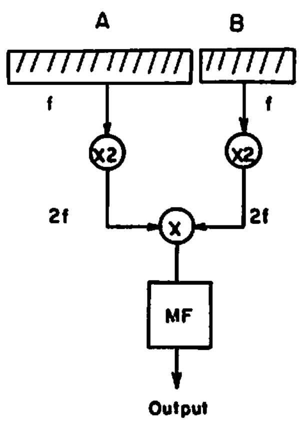
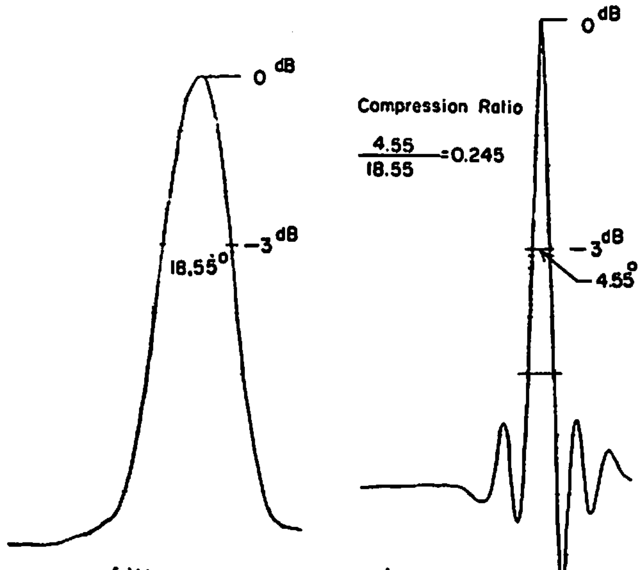


Fig.7 Frequency Multiplier Array



(a) Linear Pattern (b) $\frac{1}{4}$ Compressed Pattern

Fig.8 Frequency Multiplier Array Pattern