Mixed Covering, Locating, and Detecting Arrays via Cyclotomy

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For ω a primitive element of the finite field of order q, and v a divisor of $q-1$, one can partition the nonzero elements of the field into cyclotomic classes $\{C_\beta = \{\omega^{\alpha v+\beta} : 0 \leq \alpha < (q-1)/v\} : 0 \leq \beta < v\}$. For such a partition, the *cyclotomic vector* is indexed by the field elements, and has value β when the index belongs to class C_β, or 0 when the index is 0. The additive translates of a cyclotomic vector yield a $q \times q$ *cyclotomic array* on v symbols. For every positive integer t, for q sufficiently large with respect to v, such a cyclotomic array is always a covering array of strength t. Indeed for small values of t, this cyclotomic method produces the smallest known covering arrays for numerous parameters within the range of practical application. In this talk, we extend these ideas in three directions, primarily through computational results. First, we show that cyclotomy can produce arrays with more restrictive properties, namely locating and detecting arrays. Secondly, we show that the same techniques can provide arrays with larger coverage or separation. Finally, we show that certain cyclotomic arrays for the same order q but different values of v can be juxtaposed to produce mixed-level locating, detecting, and covering arrays.

Keywords: covering array, detecting array, locating array, cyclotomy, cyclotomic vector