Application of the Symmetrical and Non-symmetrical Models for Innovative Coded Design of Signals

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Abstract - **In this paper the innovative coded design techniques for improving the quality indices of data coding (e.g. self-checking codes) based on the "perfect" symmetrical and non-symmetrical relationships, namely the concept of Ideal Ring Bundles (IRBs), are given. These design techniques make it possible to configure high performance coded systems and design of signals for communications and radar, visual coding systems with respect to redundancy, signal reconstruction and low side lobe antenna design.**

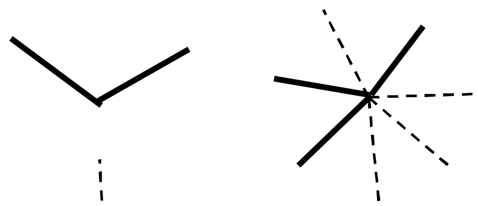
Keywords - **Circular symmetry and non–symmetry, Ideal Ring Bundle, Monolithic code, Vector data code, Multidimensional Ideal Ring Bundle, Coded design of signals.**

I. Introduction

This paper deals with optimum distributed systems theory, based on the perfect geometrical symmetry and non-symmetry relationships, which provides, essentially, a new conceptual model of visual non-redundant data coding, based on remarkable property of the Ideal Ring Bundles (IRBs). This property makes IRBs useful in applications which need to partition space-time with the smallest possible number of intersections.

II. Perfect Circular Symmetry

Let us call "Perfect Circular Symmetry" (PCS) a ring topology system joined on two non-symmetrical sub-systems, where we require all angular distances between of elements in each of its enumerate the set of angles exactly *R*-times. Here is an example of perfect circular symmetry system of 3-fold (Fig.1,a). To see this, we observe that minimal angle α_{min} is equal $360°/n$, where n – order of circular symmetry. The first non-symmetrical sub-system (solid lines) enumerates set of angles by step $360°/n = 120°$ exactly once (*R*=1), while the second (dash lines) by step $\alpha_{min} = 360°$ (Fig.1,a).



a b

Fig.1.Examples of 3-fold (a) and 7-fold (b) perfect circular symmetry

Next, we consider a more general type of PCS, where all angular distances give us each value from α_{min} to $N \cdot \alpha_{min}$ exactly $R \geq 1$ times. Here is example of PCS with n=7 (Fig.1,b), where the first non-symmetrical sub-system (solid lines) give us each central angle from $\alpha_{min} = 360°/7$ to $N \cdot \alpha_{min} = 6 \cdot \alpha_{min}$ exactly once (*R*=1), while the second (dash lines) exactly twice (*R*=2).

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III. Coded Design of Signals

Let us regard a numerical *n*-stage sequence of distinct positive integers $\{k_1, k_2, \dots, k_n\}$, where we require all terms in each sum to be consecutive elements of the sequence as being cyclic, so that k_n is followed by k_1, we configure a ring-like bundle. A sum of consecutive terms in the ring-like bundle is

$$S = n(n-1)/R+1 \quad (1)$$

An *n*-stage sequence $\{k_1, k_2, \dots, k_n\}$ of natural numbers for which the set of all *S* circular sums consists of the numbers from 1 to $S = n(n-1)+1$ (each number occurs exactly *R*-times) is called an "Ideal Ring Bundle" (IRB).

Here is an example of IRB with n=3, R=1, and S=7, namely non-symmetrical sub-system (solid lines) {1,4,2} as well as IRB with n = 4 and R =2, namely non-symmetrical sub-system (dash lines) {1, 1, 2, 3} (Fig.1,b).

Next, we regard the *n*-stage ring sequence $K_{tD} = \{(k_{11}, k_{12,\dots,}k_{1t}), (k_{21}, k_{22}, \dots k_{2t}), \dots (k_{i1}, k_{i2}, \dots, k_{it}), \dots (k_{n1}, k_{n2}, \dots, k_{nt})\}$, where all terms in each modular vector-sum to be consecutive *t*-stage sub-sequences as elements of the sequence. A modular vector-sum of consecutive terms in the ring sequence can have any of the *n* terms as its starting point, and can be of any length from 1 to *n*-1 exactly *R*-times.

Here is a set of two 2D IRBs -{(0,1),(0,2),(1,1)} and {(1,1), (1,0),(0,2),(1,1)}, which form complete set of cyclic 2D IRB code combinations on 2D ignorable array 2×3: (0,0), (0,1), (0,2), (1,0), (1,1), (1,2) exactly *R*-times. Note, each of these combinations forms massive symbols "1" or "0". We call this code a "Monolithic Ideal Ring Bundles" (MIRB) codes. This property makes MIRBs useful in applications to coded design of signals for communications and radar, positioning of elements in an antenna array, and other engineering areas.

IV. Conclusion

The Ideal Ring Bundles (IRBs) provide a new conceptual model of radio- and information technologies or systems based on symmetry laws [1]. Remarkable geometrical properties of real space-time based on perfect circular symmetry and non-symmetry have been reflected in the underlying models. These properties make useful in applications to high performance coded design of signals for communications and radar, positioning of elements in an antenna array and visual coding systems with respect to redundancy, signal reconstruction and low side lobe antenna design [2].

References

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