Experiment No. -

AIM **To Generate Walsh code using Hadamard matrix and check orthogonality between the rows.**

Theory Walsh code is a linear code which maps binary strings of length n to binary codeword of length 2^n. These codes are mutually orthogonal and used as error correcting codes. Walsh codes are used in CDMA mobile technology to provide orthogonality to each user.

Walsh codes are generated by Hadamard matrix of the order 2^n. A Hadamard matrix of the order n is an n*n matrix of 0 and 1 and $HH^T = nI_n$, where I_n is the n*n identity matrix.

$$H_N = [1]$$

$$H_{2N} = \begin{bmatrix} H_N & H_N \\ H_N & \overline{H}_N \end{bmatrix}$$

$$H_{4N} = \begin{bmatrix} H_{2N} & H_{2N} \\ H_{2N} & \overline{H}_{2N} \end{bmatrix}$$

Each row of Hadamard matrix constitutes the Walsh code.

Properties of Walsh Code:

1. Hamming distance between any two Walsh code is $2^n - 1$.

   Hamming distance between any two rows is 3 for n = 2

   $2^n - 1 = 2^2 - 1 = 3$

2. Walsh codes are mutually orthogonal.

   Orthogonality check:

   (a) Number of bits agreement –Number of bits disagreement

Total number of bits should be zero.

Example: $W_1 = 1\ \ 0\ \ 1\ \ 0$

$W_2 = 0\ \ 1\ \ 1\ \ 0$

No. of bits agreement =2

No. Of bits disagreement =2

$$\therefore \frac{2-2}{4} = 0$$

(b) Orthogonal functions have zero cross correlation. It is obtained if the product of the two signals summed over a period of time is zero. Thus, when the XORing of two binary sequences results in an equal number of 1 and 0 the cross correlation is zero.

$W_1 = 1\ \ 0\ \ 1\ \ 0$

$W_2 = 0\ \ 1\ \ 1\ \ 0$

$0\ \ 0\ \ 1\ \ 1$

No. of 1 s = 2

No. of 0 s = 2

Hence W1 and W2 are orthogonal

Answer the following question

1. Functions of Walsh code in IS-95 CDMA system in forward link and reverse link.
2. Applications of Walsh codes.

CONCLUSION: