Global Journal of Computer Science and Technology
Volume 11 Issue 1 Version 1.0 February 2011
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Algorithm Design for Row-Column Multiplication of N-Dimensional Rhotrices

By Ezugwu E. Absalom,Abiodun O. Ajibade, Junaidu B. Sahalu
Ahmadu Bello University, Samru Zaria-Nigeria

Abstracts - In this paper, a generalized formula for an alternative row-column multiplication method for rhotrices is presented. The concept established in this paper follows the basic rudiment of mathematical axioms that prove the existing relationships between rhotrices and matrices. This is an extension of the same work presented on rhotrices of order three.

Keywords: *Rhotrices, rhotrix, row-column multiplication.*

Classification: *GJCST F.2.1*

ALGORITHM DESIGN FOR ROW-COLUMN MULTIPLICATION OF N-DIMENSIONAL RHOTRICES

Strictly as per the compliance and regulations of:

Algorithm Design for Row-Column Multiplication of N-Dimensional Rhotrices

Ezugwu E. Absalom[1], Abiodun O. Ajibade[2], Junaidu B. Sahalu[3]

Abstract: In this paper, a generalized formula for an alternative row-column multiplication method for rhotrices is presented. The concept established in this paper follows the basic rudiment of mathematical axioms that prove the existing relationships between rhotrices and matrices. This is an extension of the same work presented on rhotrices of order three.

Keywords: Rhotrices, rhotrix, row-column multiplication,

I. Introduction

An alternative row-column multiplication method for rhotrices was suggested by B. Sani [3]. His work considered a comparative relationship on some common properties that relate and link rhotrices multiplication to that of the well-known row-column matrices multiplication. The purpose of this extract is to present a formalized equation representing the row column multiplication of some objects, which are in some ways between n x n dimensional matrices and (2n-1) x (2n-1) dimensional matrices for further mathematical enrichment. The name rhotrix came up as a result of the rhomboid nature of the arrangement of some mathematical arrays, which can simply be seen as the combination of matrices [1]. A rhotrix R is called a real rhotrix or an integer rhotrix if all its entries belong to the set of real numbers or set of integer numbers respectively [2]. Rows and column definition of a rhotrix: A set of rhotrices of dimension three was defined in [2] and extension in the dimension was considered possible. For instance, a set of rhotrices of dimension five can be defined as

$$\overset{*}{R} = \left\{ \left\langle \begin{array}{ccccc} & & a & & \\ & b & c & d & \\ e & f & g & h & i \\ & j & k & l & \\ & & m & & \end{array} \right\rangle : a, b, c, \ldots\ldots, m \in \Re \right\}$$

And similarly its rows and columns defined in the following order of arrangements

$$\begin{array}{ccccc} & & a & & \\ & b & & d & \\ e & & g & & i \\ & j & & l & \\ & & m & & \end{array} \quad \text{And} \quad \begin{array}{ccccc} & & a & & \\ & b & & d & \\ e & & g & & i \\ & j & & l & \\ & & m & & \end{array}$$

Respectively.

About[1]: MSc Research Student, Computer Science
About[2]: PhD, Mathematics Department of Mathematic Ahmadu Bello University, Samru Zaria-Nigeria
About[3]: Professor, Computer Science: research supervisor

Global Journal of Computer Science and Technology Volume XI Issue I Version I February 2011

II. Row-Column Multiplication N by N Dimensional Rhotrices

In an attempt to answer the question of "devising a suitable method of solving rhotrices multiplication without having to first perform any form of transformation to coupled matrix and visa-versa" posed in [3][4], an alternative method for multiplication of n-dimensional rhotrices is therefore presented, and thus recorded as follows:

$$R_n \circ Q_n = \left\langle \begin{array}{c} a_{11} \\ a_{31} \quad a_{21} \quad a_{12} \\ a_{51} \quad a_{41} \quad a_{32} \quad a_{22} \quad a_{13} \\ \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\ a_{n1} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad a_{1t} \\ \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\ a_{nt-2} \quad a_{n-1t-2} \quad a_{n-2t-1} \quad a_{n-3t-1} \quad a_{n-4t} \\ a_{nt-1} \quad a_{n-1t-1} \quad a_{n-2t} \\ a_{nt} \end{array} \right\rangle \circ \left\langle \begin{array}{c} b_{11} \\ b_{31} \quad b_{21} \quad b_{12} \\ b_{51} \quad b_{41} \quad b_{32} \quad b_{22} \quad b_{13} \\ \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\ b_{n1} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad b_{1t} \\ \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \\ b_{nt-2} \quad b_{n-1t-2} \quad b_{n-2t-1} \quad b_{n-3t-1} \quad b_{n-4t} \\ b_{nt-1} \quad b_{n-1t-1} \quad b_{n-2t} \\ b_{nt} \end{array} \right\rangle \qquad \text{.................... (1.1)}$$

The subscript n in equation (1.1) denotes the dimension of the rhotrix, where t = (n+1)/2 and t is the column order of rhotrix Rn and Qn respectively, so that if n=3, then t=(3+1)/2 = 2. If n=5, t=3 and if n=9, t=5. If we view a rhotrix as having odd rows as the main entries and even rows as the heart entries all positioned side by side each other, then we can generalize, by defining the rows and columns of rhotrix main entries as:

$$\left\langle \begin{array}{ccccccccc} a_{n1} & a_{n-11} & .. & a_{11} & & & & & \\ & a_{n2} & a_{n-12} & \cdots & a_{12} & & & & \\ & & a_{n3} & a_{n-13} & \cdots & a_{13} & & & \\ & & & \cdots & \cdots & \cdots & \cdots & & \\ & & & & \cdots & \cdots & \cdots & \cdots & \\ & & & & & a_{nt} & a_{n-1t} & \cdots & a_{1n} \end{array} \right\rangle \text{And} \left\langle \begin{array}{ccccccccc} & & & & & b_{11} & b_{13} & \cdots & b_{1t} \\ & & & & b_{31} & b_{32} & \cdots & b_{3t} & \\ & & & b_{51} & b_{52} & \cdots & b_{5t} & & \\ & & \cdots & \cdots & \cdots & \cdots & & & \\ & \cdots & \cdots & \cdots & \cdots & & & & \\ b_{nt} & b_{n2} & \cdots & b_{nt} & & & & & \end{array} \right\rangle$$

Respectively and similarly for the hearts entries. Suppose we now represent the n-dimensional rhotrices in equation (1.1) by $R_n = a_{ik}$ and $Q_n = b_{kj}$ where a_{ik} and b_{kj} represent the a_{ik} and b_{kj} elements respectively. The multiplication will then be as follow:

$$R_n \circ Q_n = \langle a_{ij} \circ b_{lj} \rangle = \lambda \sum_{k=1}^{t} (a_{ik} b_{2k-1j}) + (1-\lambda) \sum_{k=1}^{t-1} (a_{ik} b_{2kj}) \qquad \text{.................. (1.2)}$$

$n \in 2Z^{+} + 1$

$t = (n+1)/2$

$i, j = 1,2,3,\ldots\ldots\ldots., n \; and$

$k = 1,2,3,\ldots\ldots., t$ for i mod 2 = 1: $\lambda = 1$

$k = 2,4,6\ldots\ldots., t-1$ for i mod 2 = 0: $\lambda = 0$

Hence, the row-column rhotrix multiplication method is similar to matrix multiplication. However, in this case odd rows of a_{ij} multiply odd columns of b_{ij}, while even rows of a_{ij} will then multiply even columns of b_{ij}.

Algorithm 1: Rhotrix multiplication algorithm For

i: 1 to n

if i mod 2 $\neq$ 0

{

col: upperbound = (n+1) / 2

β = 1

}

Else

{

col: upperbound = (n-1) / 2

β = 0

}

For j: 1 to upperbound

For k: 1 to upperbound

R[i,j] = R[i,j] + β*A[i,k] * B[2k-1,j] + (1- β) *A[i,k]*B[2k,j]

Endfor

Endfor

Endfor

III. Row-Column Multiplication Process

Consider any two rhotrices say R_9 and Q_9:

$$R_9 \circ Q_9 = \left\langle \begin{array}{ccccccccc} & & & & a_{11} & & & & \\ & & & a_{31} & a_{21} & a_{12} & & & \\ & & a_{51} & a_{41} & a_{32} & a_{22} & a_{13} & & \\ & a_{71} & a_{61} & a_{52} & a_{42} & a_{33} & a_{23} & a_{14} & \\ a_{91} & a_{81} & a_{72} & a_{62} & a_{53} & a_{43} & a_{34} & a_{14} & a_{15} \\ & a_{92} & a_{82} & a_{73} & a_{63} & a_{54} & a_{44} & a_{35} & \\ & & a_{93} & a_{83} & a_{74} & a_{64} & a_{55} & & \\ & & & a_{94} & a_{84} & a_{75} & & & \\ & & & & a_{95} & & & & \end{array} \right\rangle \circ \left\langle \begin{array}{ccccccccc} & & & & b_{11} & & & & \\ & & & b_{31} & b_{21} & b_{12} & & & \\ & & b_{51} & b_{41} & b_{32} & b_{22} & b_{13} & & \\ & b_{71} & b_{61} & b_{52} & b_{42} & b_{33} & b_{23} & b_{14} & \\ b_{91} & b_{81} & b_{72} & a_{62} & b_{53} & b_{43} & b_{34} & b_{14} & b_{15} \\ & b_{92} & b_{82} & b_{73} & b_{63} & b_{54} & b_{44} & b_{35} & \\ & & b_{93} & b_{83} & b_{74} & b_{64} & b_{55} & & \\ & & & b_{94} & b_{84} & b_{75} & & & \\ & & & & b_{95} & & & & \end{array} \right\rangle \quad \ldots\ldots\ldots\ldots\ldots\ldots (1.3)$$

We then define multiplication of any two rhotrices using the row-column multiplication method similar to that of the matrices without any special consideration of the rhotrix hearts as separate entities on their own. Similar to the addresses used in identifying the row-column entries in a matrix, we associate the entries in a rhotrix by specific symbols (indexes) which run through all the entries as in the rhotrices R9 and Q9 above respectively. Thus, the multiplication will then be as follows:

Global Journal of Computer Science and Technology Volume XI Issue I Version I February 2011

$$\left.\begin{aligned}
R_{11} &= a_{11}\, b_{11} + a_{12} b_{31} + a_{13} b_{51} + a_{14}\, b_{71} + a_{15}\, b_{91} \\
R_{12} &= a_{11}\, b_{12} + a_{12} b_{32} + a_{13} b_{52} + a_{14}\, b_{72} + a_{15}\, b_{92} \\
R_{13} &= a_{11}\, b_{13} + a_{12} b_{33} + a_{13} b_{53} + a_{14}\, b_{73} + a_{15}\, b_{93} \\
R_{14} &= a_{11}\, b_{14} + a_{12} b_{34} + a_{13} b_{54} + a_{14}\, b_{74} + a_{15}\, b_{94} \\
R_{15} &= a_{11}\, b_{15} + a_{12} b_{35} + a_{13} b_{55} + a_{14}\, b_{75} + a_{15}\, b_{95}
\end{aligned}\right\} \quad \text{i = 1, j, k = 1, 2, 3, 4, where i is odd}$$

$$\left.\begin{aligned}
R_{31} &= a_{31}\, b_{11} + a_{32} b_{31} + a_{33} b_{51} + a_{34}\, b_{71} + a_{35}\, b_{91} \\
R_{32} &= a_{31}\, b_{12} + a_{32} b_{32} + a_{33} b_{52} + a_{34}\, b_{72} + a_{35}\, b_{92} \\
R_{33} &= a_{31}\, b_{13} + a_{32} b_{33} + a_{33} b_{53} + a_{34}\, b_{73} + a_{35}\, b_{93} \\
R_{34} &= a_{31}\, b_{14} + a_{32} b_{34} + a_{33} b_{54} + a_{34}\, b_{74} + a_{35}\, b_{94} \\
R_{35} &= a_{31}\, b_{15} + a_{32} b_{35} + a_{33} b_{55} + a_{34}\, b_{75} + a_{35}\, b_{95}
\end{aligned}\right\} \quad \text{i = 3, j, k = 1, 2, 3, 4, where i is odd}$$

$$\left.\begin{aligned}
R_{51} &= a_{51}\, b_{11} + a_{52} b_{31} + a_{53} b_{51} + a_{54}\, b_{71} + a_{55}\, b_{91} \\
R_{52} &= a_{51}\, b_{12} + a_{52} b_{32} + a_{53} b_{53} + a_{54}\, b_{72} + a_{55}\, b_{92} \\
R_{53} &= a_{51}\, b_{13} + a_{52} b_{33} + a_{53} b_{53} + a_{54}\, b_{73} + a_{55}\, b_{93} \\
R_{54} &= a_{51}\, b_{14} + a_{52} b_{34} + a_{53} b_{54} + a_{54}\, b_{74} + a_{55}\, b_{94} \\
R_{55} &= a_{51}\, b_{15} + a_{52} b_{35} + a_{53} b_{55} + a_{54}\, b_{75} + a_{55}\, b_{95}
\end{aligned}\right\} \quad \text{i = 5, j, k = 1, 2, 3, 4, where i is odd}$$

$$\left.\begin{aligned}
R_{71} &= a_{71}\, b_{11} + a_{72} b_{31} + a_{73} b_{51} + a_{74}\, b_{71} + a_{75}\, b_{91} \\
R_{72} &= a_{71}\, b_{12} + a_{72} b_{32} + a_{73} b_{52} + a_{74}\, b_{72} + a_{75}\, b_{92} \\
R_{73} &= a_{71}\, b_{13} + a_{72} b_{33} + a_{73} b_{53} + a_{73}\, b_{72} + a_{75}\, b_{93} \\
R_{74} &= a_{71}\, b_{14} + a_{72} b_{34} + a_{73} b_{54} + a_{74}\, b_{74} + a_{75}\, b_{94} \\
R_{75} &= a_{71}\, b_{15} + a_{72} b_{35} + a_{73} b_{55} + a_{74}\, b_{75} + a_{75}\, b_{95}
\end{aligned}\right\} \quad \text{i = 7, j, k = 1, 2, 3, 4, where i is odd}$$

$$\left.\begin{aligned}
R_{91} &= a_{91}\,b_{11} + a_{92}b_{31} + a_{93}b_{51} + a_{94}\,b_{71} + a_{95}\,b_{91}\\
R_{92} &= a_{91}\,b_{12} + a_{92}b_{32} + a_{93}b_{52} + a_{94}\,b_{72} + a_{95}\,b_{92}\\
R_{93} &= a_{91}\,b_{13} + a_{92}b_{33} + a_{93}b_{53} + a_{94}\,b_{73} + a_{95}\,b_{93}\\
R_{94} &= a_{91}\,b_{14} + a_{92}b_{34} + a_{93}b_{54} + a_{94}\,b_{74} + a_{95}\,b_{94}\\
R_{95} &= a_{91}\,b_{15} + a_{92}b_{35} + a_{93}b_{55} + a_{94}\,b_{75} + a_{95}\,b_{95}
\end{aligned}\right\}\quad \text{i = 9, j, k = 1, 2, 3, 4, where i is odd}$$

$$\left.\begin{aligned}
R_{21} &= a_{21}\,b_{21} + a_{22}b_{41} + a_{23}b_{61} + a_{24}\,b_{81}\\
R_{22} &= a_{21}\,b_{22} + a_{22}b_{42} + a_{23}b_{62} + a_{24}\,b_{82}\\
R_{23} &= a_{21}\,b_{23} + a_{22}b_{43} + a_{23}b_{63} + a_{24}\,b_{83}\\
R_{24} &= a_{21}\,b_{24} + a_{22}b_{44} + a_{23}b_{64} + a_{24}\,b_{84}
\end{aligned}\right\}\quad \text{i = 2, j, k = 1, 2, 3, 4, where i is even}$$

$$\left.\begin{aligned}
R_{41} &= a_{41}\,b_{21} + a_{42}b_{41} + a_{43}b_{61} + a_{44}\,b_{81}\\
R_{42} &= a_{41}\,b_{22} + a_{42}b_{42} + a_{43}b_{62} + a_{44}\,b_{82}\\
R_{43} &= a_{41}\,b_{23} + a_{42}b_{43} + a_{43}b_{63} + a_{44}\,b_{83}\\
R_{44} &= a_{41}\,b_{44} + a_{42}b_{44} + a_{43}b_{64} + a_{44}\,b_{84}
\end{aligned}\right\}\quad \text{i = 4, j, k = 1, 2, 3, 4, where i is even}$$

$$\left.\begin{aligned}
R_{61} &= a_{61}\,b_{21} + a_{62}b_{41} + a_{63}b_{61} + a_{64}\,b_{81}\\
R_{62} &= a_{61}\,b_{22} + a_{62}b_{42} + a_{63}b_{62} + a_{64}\,b_{82}\\
R_{63} &= a_{61}\,b_{23} + a_{62}b_{43} + a_{63}b_{63} + a_{64}\,b_{83}\\
R_{64} &= a_{61}\,b_{44} + a_{62}b_{44} + a_{63}b_{64} + a_{64}\,b_{84}
\end{aligned}\right\}\quad \text{i = 6, j, k = 1, 2, 3, 4, where i is even}$$

$$\left.\begin{aligned}
R_{81} &= a_{81}\,b_{21} + a_{82}b_{41} + a_{83}b_{61} + a_{84}\,b_{81}\\
R_{82} &= a_{81}\,b_{22} + a_{82}b_{42} + a_{83}b_{62} + a_{84}\,b_{82}\\
R_{83} &= a_{81}\,b_{23} + a_{82}b_{43} + a_{83}b_{63} + a_{84}\,b_{83}\\
R_{84} &= a_{81}\,b_{44} + a_{82}b_{44} + a_{83}b_{64} + a_{84}\,b_{84}
\end{aligned}\right\}\quad \text{i = 8, j, k = 1, 2, 3, 4, where i is even}$$

The resulting multiplicand of the two rhotrices, R9 **Q9** is also given in the form shown below:

$$\text{Let } R_9 \circ Q_9 = R = \left\langle \begin{array}{ccccccccc} & & & & R_{11} & & & & \\ & & & R_{31} & R_{21} & R_{12} & & & \\ & & R_{51} & R_{41} & R_{32} & R_{22} & R_{13} & & \\ & R_{71} & R_{61} & R_{52} & R_{42} & R_{33} & R_{23} & R_{14} & \\ R_{91} & R_{81} & R_{72} & R_{62} & R_{53} & R_{43} & R_{34} & R_{24} & R_{15} \\ & R_{92} & R_{82} & R_{73} & R_{63} & R_{54} & R_{44} & R_{35} & \\ & & R_{93} & R_{83} & R_{74} & R_{64} & R_{55} & & \\ & & & R_{94} & R_{84} & R_{75} & & & \\ & & & & R_{95} & & & & \end{array} \right\rangle$$

By comparing entries, we have the following resultant equations:Those entries for which i assumes odd values are calculated as:

$$R_{11}=\sum_{K=1}^{5} a_{1K} b_{2k-11},\ R_{12}=\sum_{K=1}^{5} a_{1K} b_{2k-12},\ R_{13}=\sum_{K=1}^{5} a_{1K} b_{2k-13},\ R_{14}=\sum_{K=1}^{5} a_{1K} b_{2k-14},\ R_{15}=\sum_{K=1}^{5} a_{1K} b_{2k-14}$$

$$R_{31}=\sum_{K=1}^{5} a_{3K} b_{2k-11},\ R_{32}=\sum_{K=1}^{5} a_{3K} b_{2k-12},\ R_{33}=\sum_{K=1}^{5} a_{3K} b_{2k-13},\ R_{34}=\sum_{K=1}^{5} a_{3K} b_{2k-14},\ R_{35}=\sum_{K=1}^{5} a_{3K} b_{2k-15}$$

$$R_{51}=\sum_{K=1}^{5} a_{5K} b_{2k-11},\ R_{52}=\sum_{K=1}^{5} a_{5K} b_{2k-12},\ R_{53}=\sum_{K=1}^{5} a_{5K} b_{2k-13},\ R_{53}=\sum_{K=1}^{5} a_{5K} b_{2k-13},\ R_{53}=\sum_{K=1}^{5} a_{5K} b_{2k-13}$$

While those entries for which i takes an even values are similarly calculated as:

$$R_{21}=\sum_{K=1}^{4} a_{2K} b_{2k1},\ R_{22}=\sum_{K=1}^{4} a_{2K} b_{2k2},\ R_{23}=\sum_{K=1}^{4} a_{2K} b_{2k3},\ R_{24}=\sum_{K=1}^{4} a_{2K} b_{2k4}$$

$$R_{41}=\sum_{K=1}^{4} a_{4K} b_{2k1},\ R_{42}=\sum_{K=1}^{4} a_{4K} b_{2k2},\ R_{43}=\sum_{K=1}^{4} a_{2K} b_{2k2},\ R_{44}=\sum_{K=1}^{4} a_{2K} b_{2k4}$$

IV. Generalized Form of Row-Column Multiplication

Splitting equation (1.2), the summations are as follows:

$$R_{i,j} = \sum_{k=1}^{t} a_{ik} b_{2k-1j} \qquad \textbf{Entries for the odd rhotrix of } R. \qquad \dots\dots\ \dots\dots(1.4)$$

$$R_{i,j} = \sum_{k=1}^{t-1} a_{ik} b_{2kj} \qquad \textbf{Entries for the even rhotrix of } R. \qquad \dots\dots\dots\dots(1.5)$$

The differences between these two summations are reflected in the two upper bounds (i.e. *t*, and *t-1*), and for index *b (i.e. 2k-1 and 2k-0)*. We want to devise a generalized formula to handle these two sets of entries. Consider the function:

$$f(x) = \begin{cases} 1, & if\ x\ is\ odd \\ 0, & if\ x\ is\ even \end{cases}, \qquad defined\ by \quad f(x) = \frac{1}{2}[(-1)^{x+1} + 1], \quad x = 1, 2, \dots$$

Replacing 1 and 0 with *f(i)* in the index of *b* in equations (1.4) and (1.5) respectively, we have:

$$R_{i,j} = \sum_{k=1}^{t} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad \text{Entries for the order 3 rhotrix of } R_{i,j}. \quad \dots\dots(1.6)$$

$$R_{i,j} = \sum_{k=1}^{t-1} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad \text{Entries for the order 2 rhotrix of } R_{i,j}. \quad \dots\dots(1.7)$$

Similarly consider these two functions:

$$(x) = \begin{cases} 3, & \text{if } x \text{ is odd} \\ 2, & \text{if } x \text{ is even} \end{cases} \quad \text{defined by} \quad g(x) = \tfrac{1}{2}[5-(-1)^x], \quad x = 1,2,\dots n$$

$$g(x) = \begin{cases} 5, & \text{if } x \text{ is odd} \\ 4, & \text{if } x \text{ is even} \end{cases} \quad \text{defined by} \quad g(x) = \tfrac{1}{2}[9-(-1)^x], \quad x = 1,2,\dots n$$

Replacing only the differences in equations (1.6) and (1.7), for the upper bounds 3 and 2, and 5 and 4 respectively we obtain the equations:

For n = 5

$$\langle R_{ij} \rangle = \sum_{k=1}^{\frac{1}{2}[5-(-1)^i]} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad i = 1,2,\dots,5 \qquad j,k = 1,2,\dots,\tfrac{1}{2}[5-(-1)^i] \quad \dots\dots(1.8)$$

For n = 9

$$\langle R_{ij} \rangle = \sum_{k=1}^{\frac{1}{2}[9-(-1)^i]} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad i = 1,2,\dots,9 \qquad j,k = 1,2,\dots,\tfrac{1}{2}[9-(-1)^i] \quad \dots\dots(1.9)$$

This approach can further be extended to n-dimensional rhotrices, finally let us consider the function

$$h(x) = \begin{cases} t, & \text{if } x \text{ is odd} \\ t-1, & \text{if } x \text{ is even} \end{cases} \quad \text{defined by} \quad h(x) = \tfrac{1}{2}[2\mathrm{t}-1-(-1)^x], \quad x = 1,2,3,\dots n$$

Hence from equation (1.1), we know that t= (n+1)/2, therefore, n = 2t-1, by substituting t and t-1for the function h (i), we obtain this equation.

$$\langle R_{ij} \rangle = \sum_{k=1}^{\frac{1}{2}[\mathrm{n}-(-1)^i]} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad i = 1,2,\dots,n \qquad j,k = 1,2,\dots,\tfrac{1}{2}[\mathrm{n}-(-1)^i] \quad \dots\dots(1.10)$$

Equation (1.10) can further be expressed as:

Let $\mathrm{p} = \frac{1}{2}[\mathrm{n}-(-1)^i]$ and by substituting the value of p into equation (1.10), we have

$$\langle R_{ij} \rangle = \sum_{k=1}^{p} a_{ik} b_{2k-\frac{1}{2}[(-1)^{i+1}+1]j} \qquad i = 1,2,\dots,n \qquad j,k = 1,2,\dots,\mathrm{p} \quad \dots\dots(1.11)$$

Algorithm 2: Extended row-column multiplication

```
For
i: 1 to n
        P=: ½((-1)i+1+1)
        For j: 1 to t
        For k: 1 to t
           R [i,j] = R[i,j] + A[i,k]*B[2k-p,j]
        Endfor
    Endfor
Endfor
```

V. Conclusion

In this paper, we have shown a more simplified method of rhotrix row-column multiplication by taking a holistic approach in deriving a new form of a generalized equation, the approach used in this paper does not require any form of rhotrix transformation to either matri x or coupled matrix before any possible multiplication could be achieved. The approach and results analyzed shows that the equations (1.2) and (1.13) can be used to solve rhotrices of any dimension and yet gives the same result equivalent to the initial method proposed [3].

References Références Referencias

1) Ajibade, A. O.,2003, the concept of rhotrix in mathematical enrichment, International Journal of Mathematical Education in Science and Technology, Vol. 34:2s, 175-179.
2) Mohammed, A., 2009, A remark on classifications of rhotrices as abstract structures, International Journal of Research in Physical Sciences, Vol.4:8, 192-197.

3) Sani, B. 2004, the row-column multiplication of high dimensional rhotrices, International Journal of Mathematical Education in Science and Technology, Vol.35:5, 777-781.
4) Sani, B. 2007, Conversion of a rhotrix to a 'coupled matrix', International Journal of Mathematical Education in Science and Technology, Vol. 38:5, 657-662.