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Efficient Route Optimization Using Distance Matrices for Generation of Latin Square

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Abstract: Distance matrices are used for measuring the distance between two matrices. Using Distance matrices we can generate a Latin square which is also called as Sudoku code. Latin squares have a variety of different practical applications, for example they can be used to code messages, design tournaments or generate magic squares. The theory of Latin squares is very important tool in design theory. Like much of design theory, Latin squares have various applications in statistics, finite geometries and experimental design, to name a few. In this paper, attempt is made proposed an efficient parallel algorithm for Latin square design which have desirable properties for parallel array access. These squares provide conflict free access to various subsets of an n x n array using n memory modules. A transversal of such a square is a set of n entries such that no two entries share the same row, column or symbol. It will present a general construction method for building parallel Latin square of order n^2 for all n. The proposed algorithm presents a quick method to produce a Latin square design. The simulation results of the proposed algorithm for Latin square design were compared with the traditional sequential algorithm Latin square design in terms of speedup and efficiency. The results of Latin Square design were very promising and showed a potential that this design could successfully be applied to the routing problems for conflict free data access.

Keywords: Efficiency, Time to execute, Cost, Latin square, Permutation.

I. INTRODUCTION

A Latin square of order *n* is an *n x n* matrix A= (*aij*) with entries a, i, j Є{1,2,….,n} containing *n* distinct symbols such that each symbol appears in each row and column exactly once. It is called a Latin square because its numbers could be Latin letters in what might have a counterpart with Greek letters, satisfying the all pairs property. Euler was the first person to define Latin squares and investigate its properties mathematically. In this paper attempt is made to present a Latin square design algorithm and compare it with random data transmission over a network.

A metric or distance function is a function d(x,y) that defines the distance between elements of a set as a non-negative real number. If the distance is zero, both elements are equivalent under that specific metric. Distance functions thus provide a way to measure how close two elements are, where elements do not have to be numbers but can also be vectors, matrices or arbitrary objects. Distance functions are often used as error or cost functions to be minimized in an optimization problem.

There are multiple ways to define a metric on a set. A typical distance for real numbers is the absolute difference,

d:(x,y)↦|x−y|d:(x,y)↦|x−y|.

But a scaled version of the absolute difference, or even

d(x,y)={01if x=y if x≠y.d(x,y)={0if x=y1if x≠y.

are valid metrics as well. Every normal vector space induces a distance given by

$d(\vec{x},\vec{y})=\|\vec{x}-\vec{y}\|$ d(x→,y→)=‖x→−y→‖.

High-performance interconnects are receiving an increasing amount of attention from the computer industry recently as interconnects are becoming a limiting factor to the performance of modern computer systems. This trend will even continue in the near future as technology improves. In this paper, the focus is on routing permutations in a type of switch-based interconnect.

Adopting an (multistage interconnection network) MIN in a distributed system enables processors to send their messages concurrently. However, routing must be carefully handled so that there is no conflict during message delivering. In general, there are two types of conflict-free routings in an MIN: routing with link-disjoint paths and routing with node-disjoint paths. Link disjoint paths imply that no two different message paths share the same link in

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the network at a time, which is a mandatory requirement for routing. Node-disjoint paths imply that no two different message paths pass through the same switch in the network at a time. In this paper, the attempt will be made to optimize the efficient path using distance matrices and latin square. A distance matrix is square matrix (two-dimensional array) containing the distances, taken pairwise, between the elements of a set. Depending upon the application involved, the distance being used to define this matrix may or may not be a metric. If there are N elements, this matrix will have size $n \times n$. In graph-theoretic applications the elements are more often referred to as points, nodes or vertices and a latin square is an $n \times n$ array filled with n different symbols, each occurring exactly once in each row and exactly once in each column.

Multiprocessor systems often use interconnection networks to connect processors or memory modules. A time-shared bus is the simplest form of interconnection networks, but it cannot provide the performance required in multiprocessor systems today. A crossbar switch network is an alternative used in the earlier systems to implement interconnection. The only delay to connect inputs to outputs is that of a single switching gate, but a crossbar switch network is very expensive and even prohibitive to be implemented as an interconnection network for a great number of processors or memory modules. Researchers have turned their attention to multistage interconnection networks (MINs).

II. DESIGN METHODOLOGY

The stages in the proposed methodology are shown below in the form of flow chart. Streamlined constrained reasoning powerfully boosts the performance of backtrack search methods for finding hard combinatorial objects. It uses so-called spatially balanced Latin squares to show how streamlining can also be very effective for local search: the approach is much faster and generates considerably larger spatially balanced Latin squares. The paper also provide a detailed characterization of streamliner and solution topology for small orders. It can believe that streamlined local search is a general technique suitable for solving a wide range of hard combinatorial design problems. A new scheme for the purpose of routing in the wireless networks. Proposed approach is for the case in which node need to collect data and send it to a other node. It can show that in order to find the routes that give energy efficiency. In this paper, introduce a new scheme for the purpose of routing in the wireless networks. The proposed approach is for the case in which many need to collect data and send it to a other connected node. It can be show that in order to find the routes that give energy efficiency.

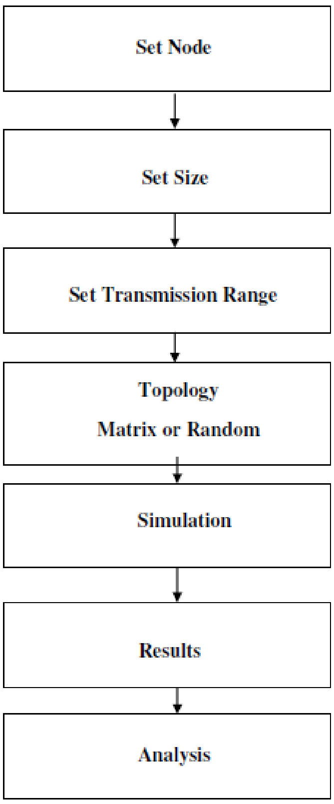

Fig. 1: Design flow chart

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III. IMPLEMENTATION

Implementation of the algorithm can be done in a rule by rule. Consider a network in which 'n' number of nodes are available. These nodes act as a different cluster. These nodes are created on the canvas of Microsoft visual studio which shows the graphical user interface (GUI). On this GUI there is programming for the implementation of the desired result. The canvas acts as the matrix platform with (x,y) co-ordinate over this matrix the latin algorithm is applied.

A. Formation of network

The figure 2 shows the creation of the nodes, these nodes together create wireless network.

In figure 3 there are yellow coloured circular loop which indicates that the one node is in transmission range of the other. The number of yellow coloured circle over a single node shows the number of connected node with that node. Also the green coloured circle over each node shows the transmission range or cluster of each node. The transmission range can be change from the toolbar.

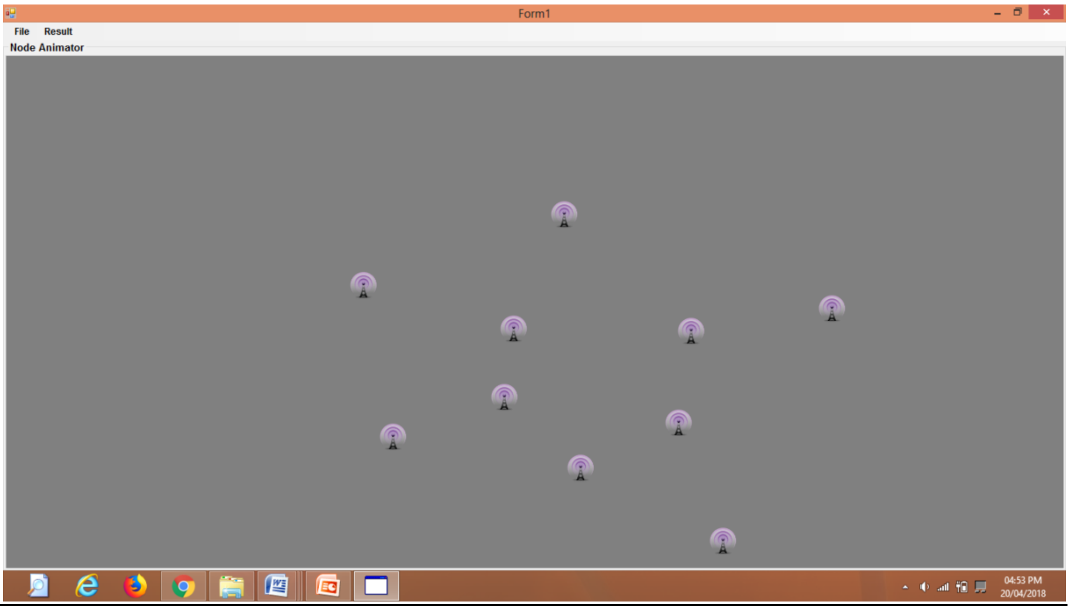

Fig. 2: Creation of nodes

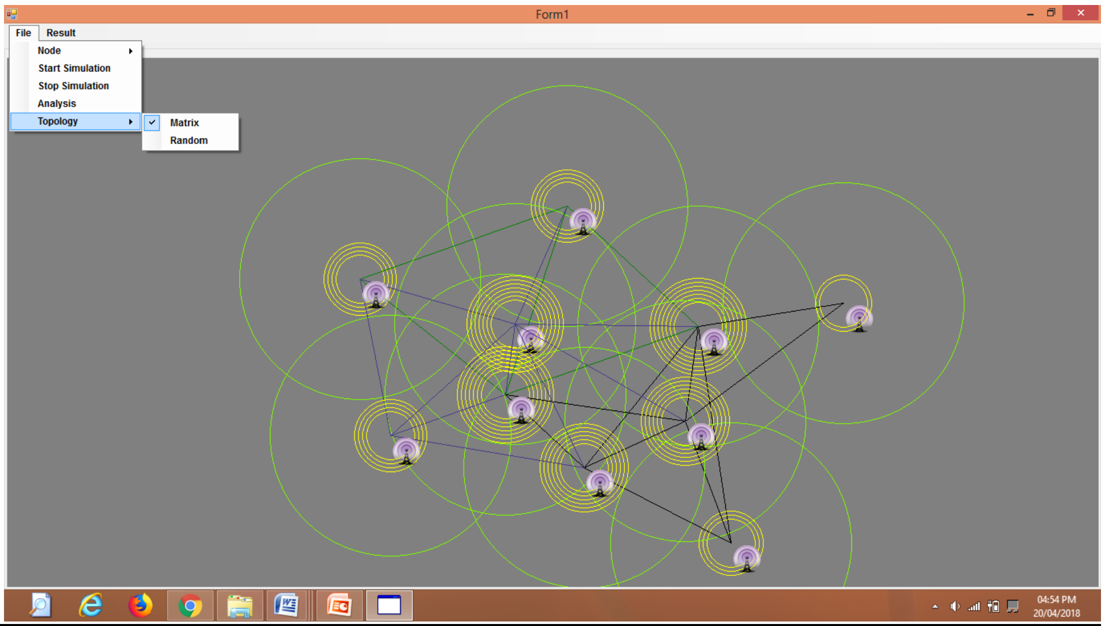

Fig. 3: Transmission range of the network

B. Routing in network

Figure 4 shows the transmission of packets over the wireless network. The communication can be performed over a period. After performing simulation for a time the results can be seen from the results section of toolbar.

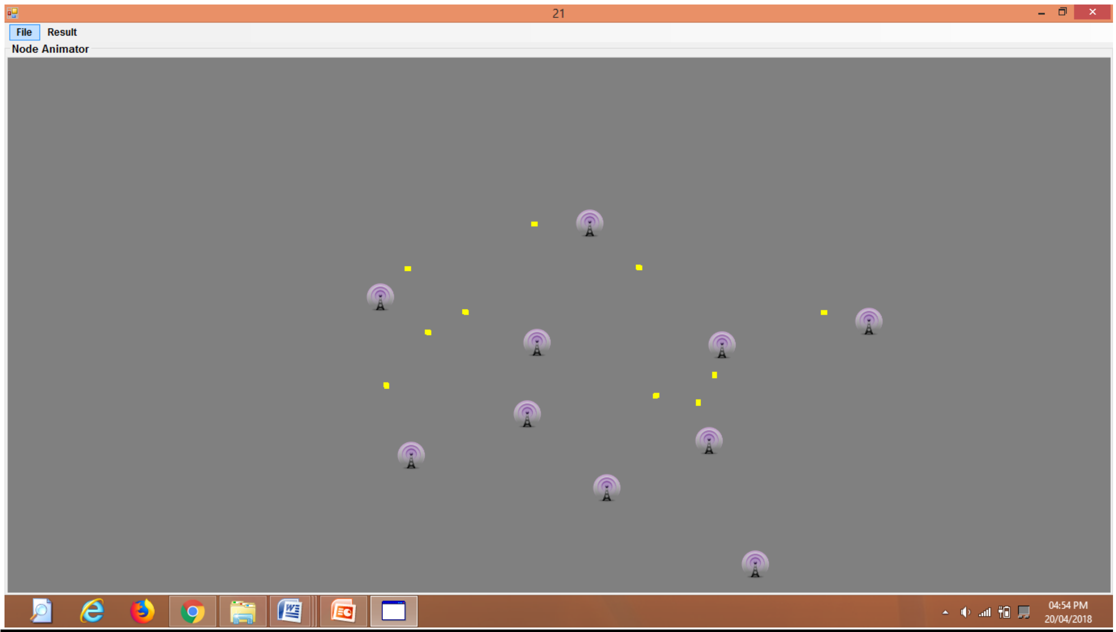

Fig. 4: Node to node communication or routing of packets over the network

C. Analysis of packets

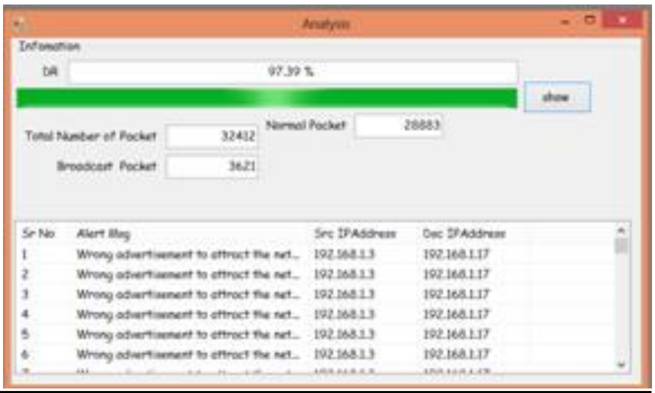

Fig. 5: Analysis of packets for matrix topology

The figure 5 gives the analysis of the total number of packets transmission over a network for matrix topology. In analysis window it is seen that what are the total number of packets routed in which what are the normal packets.

D. Output of matrix and random topology

This section describes the computational experiments used to evaluate the performance of the proposed algorithm. The simulation is carried out Microsoft visual studio. The simulation results obtained based on speedup of an algorithm. In matrix processing speedup emphasizes time reduction of a given problem and it is defined as sequential execution time over random execution time. The simulation result of matrix and random algorithm is given in figure 6 and in figure 7 respectively.

In below figure 6 which shows the different output parameter of matrix topology, as simulation time increases the efficiency will also get increases. The graph of throughput versus simulation time shows that as the simulation time is increasing the is also increasing. In energy consumption versus simulation time graph it is observe that as the time increases the energy consumption gets reduced. This derive the effect of the routing algorithm in a network. As the energy consumption is less the temperature is the network is also gets balanced. In packets delay versus simulation time graph it can be observe that as time increases the packets delay get reduced. Showing that the delay in packets routing gets reduced as compared to the random topology which shows higher delay.

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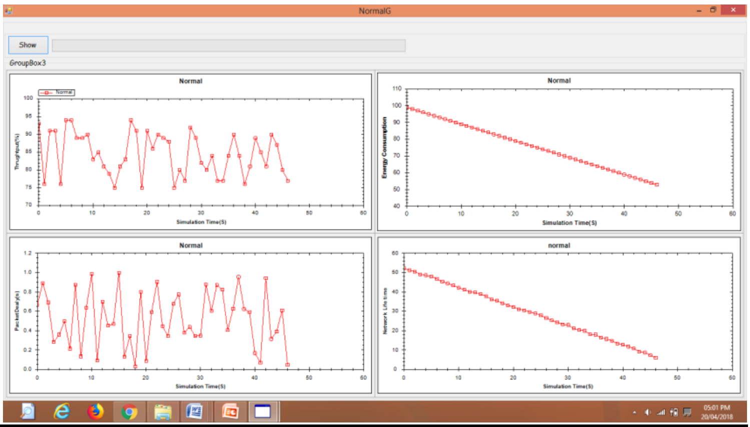

Fig. 6: Graphical output of different parameter for matrix topology

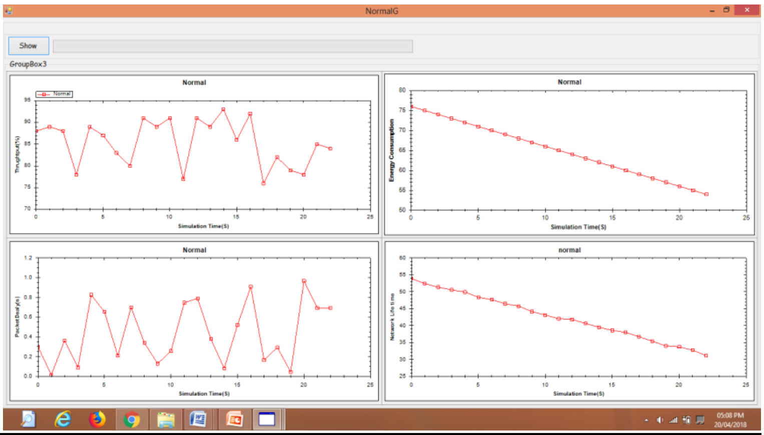

Fig. 7: Graphical output of different parameter for random topology

Each solution in the search space is associated with a numeric objective values. So, the quality of a solution is proportional to the value of the objective function. In the case of the permutation routing in baseline network, the quality of solution is related to the Latin square. The best solution is the one that replicate the Latin square. Further, result obtained by matrix approach is far better than results generated by traditional random approach.

IV. RESULTS & ANALYSIS

A. Throughput of Matrix Topology

The above figure 8 shows the throughput of matrix topology. The graph shows result of throughput versus simulation time. The red line indicates the matrix simulation. From the graph it is observe that as the simulation time increases the throughput of the network also increases. At the bottom of the graph simulation value is obtained which is 21.9825.

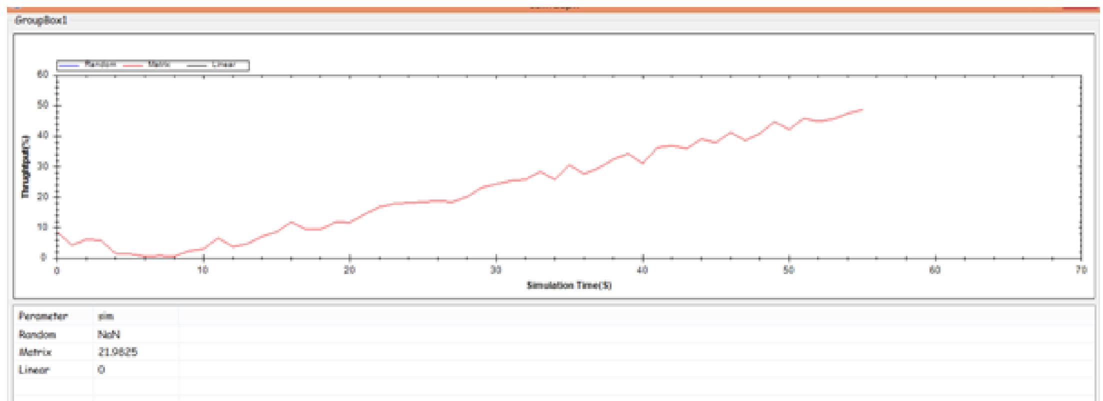

Fig. 8: Throughput of matrix topology

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B. Throughput of Random Topology

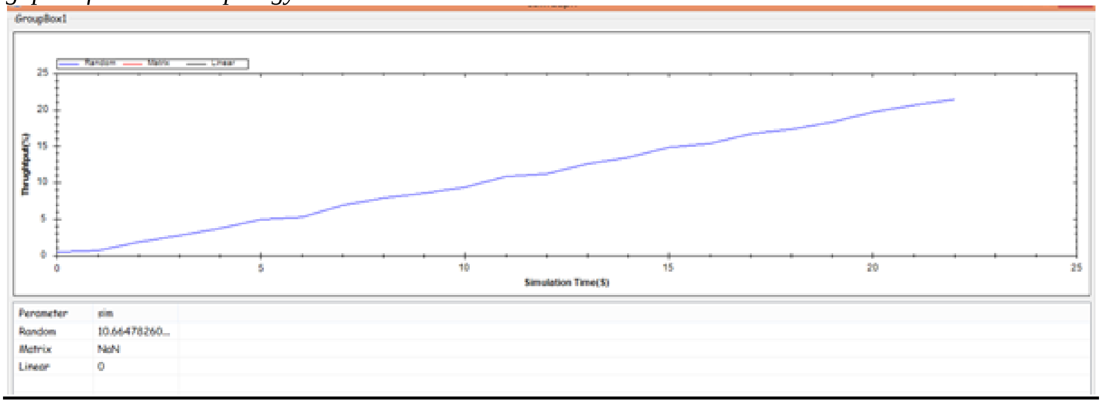

Fig. 9: Throughput of random topology

The above figure 9 shows the throughput of random topology. The graph shows result of throughput versus simulation time. The blue line indicates the random simulation. From the graph it is observe that as the simulation time increases the throughput of the network also increases but it is directly proportional to time. At the bottom of the graph simulation value is obtained which is 10.6647. By observing the two results it is found that in matrix topology the throughput value is higher than the random topology's value clearly indicating the effect of matrix algorithm. As the simulation time increases the throughput value of the both topology increases. To route permutations self-routing style is applied. The proposed algorithm is based on Latin square, which corresponds to a set of admissible permutations of a network and can be viewed as a system parameter of the network. The performance of improved algorithm is measured on the basis of speedup and quality of solution. We compare the algorithm in this paper to the other previously proposed random permutation routing algorithms. The results have demonstrated that permutation routing with matrix algorithm could be a better choice in routing network due to its better quality solution and it achieve speedup.

V. CONCLUSION

This paper present an optimal all-to-all personalized exchange algorithm for a class of unique-path, self-routable multistage networks. The new algorithm is based on a special Latin Square, which corresponds to a set of admissible permutations of a multistage network and can be viewed as a system parameter of the network. The given methods for constructing the Latin Square used in the algorithm. Time complexity for an $n \times n$ network, which is optimal for all-to-all personalized exchange. By taking advantage of fast setting of self routable switches and the property of single input/output port per processor in a multistage network, it is believed that a multistage network could be a better choice for implementing all-to-all personalized exchange due to its shorter communication latency and better scalability. The results have demonstrated that Latin Square algorithm could be a better choice for conflict free routing in interconnection network due to its desirable properties of array access, better efficiency.

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