Contemporary Engineering Sciences, Vol. 7, 2014, no. 19, 923 - 929
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/ces.2014.4653

Effective Clustering Algorithms for VLSI Circuit Partitioning Problems

R. Manikandan

School of Computing
SASTRA University
Thanjavur-613401, India

V. Leela

School of Computing
SASTRA University
Thanjavur-613401, India

Abstract

In this article, the effective circuit partitioning techniques are employed by using the clustering algorithms. The technique uses the circuit netlist in order to cluster the circuit in partitioning steps and it also minimizes the interconnection distance with the required iteration level. The clustering algorithm like K-Mean, Y-Mean, K-Medoid are performed on the standard benchmark circuits. The results obtained shows that the proposed techniques improves the time and also minimize the area by reducing the interconnection distance.

Keywords: Cluster, K-Mean, Y-Mean, K-Medoid, VLSI Circuit partitioning

1 Introduction

The circuit partitioning plays the dominant role in the VLSI physical design. The partitioning steps used to minimize the larger circuit into smaller circuit. The main goal of partitioning is to identify the strongly connected cells in order to minimize the connected distance among the cells. Similarly the clustering is used to cluster the objects which are similar within the group and different from the objects present in other group. The cluster partition the circuit into non overlapping subsets [2]. The clustering algorithm are used in various applications like market research, security and physical geography.

In this paper the standard benchmark circuit are taken for partitioning techniques with the clustering algorithm like K-Mean,Y-Mean and Fuzzy c mean. The netlist of the benchmark circuit are taken as input and the matrix are generated in order to cluster the circuit based on the gate distance matrix. The output obtained from the algorithm allows to discuss the clustering algorithm performance and also gives the beneficial output with the reduction in time and interconnection distance. local optimization problem was also reduced in circuit partitioning

2 Clustering Techniques

The clustering is an active approach for exploring the common metric similarities within the data and making them as groups. Every Clustering techniques, nominates the clustered data set into numerous groups such that the common features among the group is maximum when compared to other groups [9]. The process of data clustering is simple with few sets of data but when its a large amount of data, it has to be categorized into small number of groups to analyze the performance.

2.1 K –Means

K-Means is one of the simplest methods among all partitioning based data clustering methods. It segments the circuit into *k* clusters, where *k* is the number of user desired clusters and defined by the user. Every cluster are assigned with centroids. All the data sets are set in a cluster having centroid nearest to that data object. In each iteration centroids change their location step by step. This process is continued until centroid are stable at place [6] .

Step 1: Assign the random values for cluster Centre and start the process by selecting the clusters in data.

Step 2: Calculate the assigned values of the matrix function by Equation (1).

$$u_i j = \left\{ 1 if \left|\left| x - \underline{c} \right|\right|^2 < \| x - c \| \text{ , } for each k = i \right. \quad \text{----- (1)}$$

Step 3: Evaluate the centroid of the data using the Equation (1). Then compare the value if it is less than tolerance value or below a threshold value ,then stop the function.

Step 4: Apprise the values of the centers according equation (2).and move to step 2.

$$ci = \frac{1}{|gi|} \sum_{xk \in gi} xk \qquad \text{-------(2)}$$

2.2 Fuzzy C Mean

Fuzzy C-Means clustering (FCM), is the data clustering algorithm in which each data set belongs to a cluster to a degree assigned by a membership [8] .This techniques works iteratively until no further clustering is possible. Fcm undergoes following techniques for centroid calculations [10] .

Step 1: Assign the process randomly in matrix **U** within 1 by estimating in Equation (3)are satisfied.

$$\sum_{i=1}^{c} uij = 1, \forall j = 1,...n. \quad \text{----(3)}$$

Step 2: Estimate cluster points in centers assigned in fuzzy using Equation (4).

$$ci = \frac{\sum_{j=1}^{n} uij}{\sum_{j=1}^{n} uij} xj \quad \text{-----(4)}$$

Step 3: Calculate the cluster centroids function and check the values ,if it is below the tolerance or threshold value then terminate the function.

$$j(u, c1,...c) = \sum_{i=1}^{c} ji = \sum_{i=1}^{c} \sum_{j=1}^{n} u\,ij\,d\,\overset{2}{i}j \quad \text{------(5)}$$

Step 4: Update new matrix function by u and estimate the cluster from step 2.

$$uij = \frac{1}{\sum_{k=1}^{c} \frac{dy}{d\,k}} \quad \text{k=0,1..n.} \quad \text{-----(6)}$$

2.3 Y -Means

In order to overcome the drawbacks of K means algorithm ,Y-means clustering established. The basic Y-mean clustering undergoes the following process. As the initial process it allows the self defined cluster value k, then it undergoes the following process as like K means in order to detect the centroids ,then it checks for degeneracy ,if its found it removes the empty cluster else undergoes splitting and merging action [7]. The number of clusters is adjusted by removing empty clusters as well as merging and linking existing clusters. Due to the fact that the final number of clusters is independent of initial k. But it has the time complexity and iteration steps when the data sets are high. In order to overcome the drawbacks of basic Y-mean algorithm, Improved Y-Mean clustering techniques are employed in circuit clustering [1] and process are followed

Step 1:Initialize the size of the cluster Ci by (n/k)=S, where n is the no of data points and k is the cluster size.

Step 2:Create the array Bk and include all the Ak(data array) to Bk until the value is equal to Ci Cluster.

Step 3: Compute the arithmetic mean function M and compare the initial cluster value with the new data points.ie i<k<j

$$M = \frac{I}{K}\sum_{i=1}^{k}\frac{1}{\|C_i\|}\sum_{dj \ni i} D_a C_i \qquad \text{------(7)}$$

Step 4: Compute the distance D of all A to M of Initial Clusters Cj If Akof Dkand M is less than or equal to other distances then remain in same cluster else undergoes merging and splitting techniques with centroids by the gaussian distribution is given by

$$f(x) = \frac{1}{\sqrt{2\prod\sigma}} e \;\frac{(x-\mu)^2}{2\sigma^2} \qquad \text{-----(8)}$$

Step 5:Recompute M and move to BK until there exit no change in clusters .

3 Experimental Results

The circuit clustering of the standard benchmark circuit netlists are taken in the format of spice netlist. Then the input file to Turbo C+ is given with netlist of various circuit in order to generate the connectivity matrix which gives the essential distance based gate based upon their connections. The matrix format of the output file is processed for circuit clustering techniques through K-mean,Y-mean and fuzzy-c mean algorithm [4].

The ISPD98 benchmark suite is chosen asthe test circuits. The circuit clustering is performed using Matlab 2010A.The table 1 shows the net cuts of the circuit obtained from the clustering algorithm. The table 2 shows the runtime and the accuracy's obtained from the clustering algorithm. The figure 1 gives the comparison between the three algorithm in performance based in circuit clustering. The Y mean has the higher iteration along with Fuzzy C mean for the performance. The circuit are clustered by reducing the interconnection distance among the gates, where it identifies the similar subset among the gates in order to minimize the larger circuit into smaller circuit. The local optimization problem of the clustering algorithm were also minimized [5] .

Circuit	K-mean	Y-mean	Fuzzy c-mean
	net cut	net cut	net cut
ibm01	216	213	215
ibm02	254	262	250
ibm03	779	741	735
ibm04	438	440	437
ibm05	1714	1769	1765
ibm06	364	367	365
ibm07	719	734	729
ibm08	1150	1143	1152
ibm09	521	523	519
ibm10	757	752	753

Table 1. The net cut of the clustering algorithm in benchmark circuit

circuit	K-mean		Y-mean		Fuzzy c-mean	
	R	A	R	A	R	A
ibm01	1.3	82	1.2	85	2	86
ibm02	1.2	81	1.1	84	1,9	85
ibm03	1.7	83	1.5	85	2.7	86
ibm04	1.5	84	1.3	84	3	87
ibm05	2	84	1.4	86	4	88
ibm06	2.7	82	2	84	3.4	85
ibm07	4	79	3.5	82	4.7	84
ibm08	4.5	80	4	83	6	89
ibm09	3.5	81	3.3	85	5.4	87
ibm10	5.7	84	4	86	5.8	89

*R-Runtime; *A-Accuracy

Table2. The performance analysis of clustering algorithm with benchmark circuit

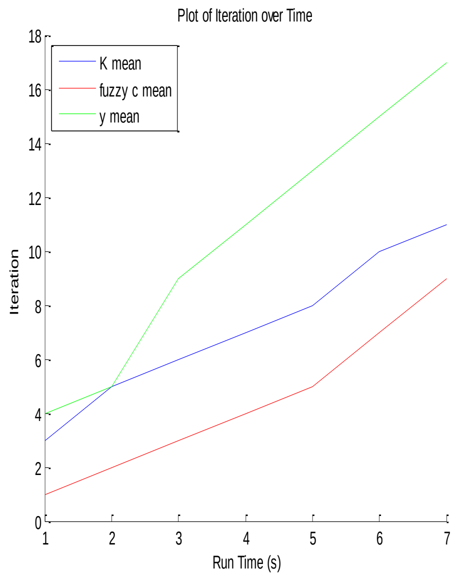

Fig.1. The plot of iteration over time of clustering algorithm.

4 Conclusion

The circuit clustering of the ISPD98 benchmark circuit is partitioned using the clustering algorithm in order to minimize the interconnection distance and also reduce to the time of partitioning. Thus the Fuzzy-c mean gives the accurate result when we compared to other two algorithm but increases the run time [3]. Y-mean has less runtime because of trained sets.

The distance based matrix sets are given for data generation of clustering algorithm. The local optimum problem is also reduced when compared to other clustering algorithm with following data sets.

References

[1] V.Leela, K.Sakthi priya,R.Manikandan "A comparative analysis between k-mean and y-means algorithms in fisher's iris data sets" International Journal of Engineering and Technology (IJET),Vol 5 No 1 Feb-Mar 2013.

[2] Azuaje, F., Dubitzky, W., Black, N., Adamson, K., "Discovering Relevance Knowledge in Data: AGrowing Cell Structures Approach," IEEE Transactions on Systems, Man, and Cybernetics-Part B: Cybernetics, Vol. 30, No. 3, June 2000 (pp.448).

[3] Khalid Hammouda, Prof. Fakhreddine Karray,"A Comparative Study of Data Clustering Techniques", University of Waterloo, Ontario, Canada N2L 3G1.

[4] Rachitha Sony Krotha, Suneetha Merugula”A Brief Survey On Document Clustering Techniques Using MATLAB “International Journal of Computer & Organization Trends –Vol 3 Issue1- 2013.

[5] Ramandeep Kaur,Dr. Gurjit Singh Bhathal “ A survey of clustering techniques” International Journal of Advanced Research in Computer Science and Software Engineering , Volume 3, Issue 5, May 2013.

[6] Abhilash C B,Sharana basavanagowda “A Comparative study on clustering of data using Improved K-means Algorithms “International Journal of Computer Trends and Technology (IJCTT) - volume4Issue4 –April 2013.

[7] H.S. Park , C.H. Jun, A simple and fast algorithm for K-medoids clustering, Expert Systems with Applications, 36(2):2009, 3336–3341.

[8] Peter J. Rousseeuw, Silhouettes: a graphical aid to the interpretation and validation of cluster analysis Journal of Computational and Applied Mathematics 20 (1987) 53-65.

[9] Seyed Mohammad Razavi Zadegan, Mehdi Mirzaie, Farahnaz Sadoughi, Ranked k-medoids: A fast and accurate rank-based partitioning algorithm for clustering large datasets ,Knowledge-Based Systems 39 (2013), 133–143.

[10]Xiaodong Liu , Xinghua Feng , Witold Pedrycz,Extraction of fuzzy rules from fuzzy decision trees: An axiomatic fuzzy sets (AFS) approach,Data & Knowledge Engineering 84 (2013), 1–25.

Received: June 11, 2014