Placement Compelled Steering Algorithm for Wirelength Minimization in FPGA

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ABSTRACT
Placements of logical blocks in FPGA use many optimization algorithms in heuristic manner. Main objective is to provide minimization in wire length during the task placement inside Reconfigurable FPGAs, which will decrease the area, power and delay and increase the speed of execution. Optimization algorithms are applied in the Benchmark circuits and the results are compared. Due to the technological advancement, density of the devices increases so that necessitates improvement in minimization of wire length. Hence this project, proposes an optimum solution for wire length minimization.

Keywords
FPGAs, Optimization algorithm

1. INTRODUCTION
Field Programmable Gate array (FPGAs) is becoming important implementation platforms for the digital circuits. The main requirement is to utilize the FPGA s static resources in proficient manner. Most of the commercial FPGAs will have the same structure. A 2D array of programmable logic blocks that can implement multiplicity of bitwise logical functions bounded by channels of wire segments to interconnect logic block I/O.

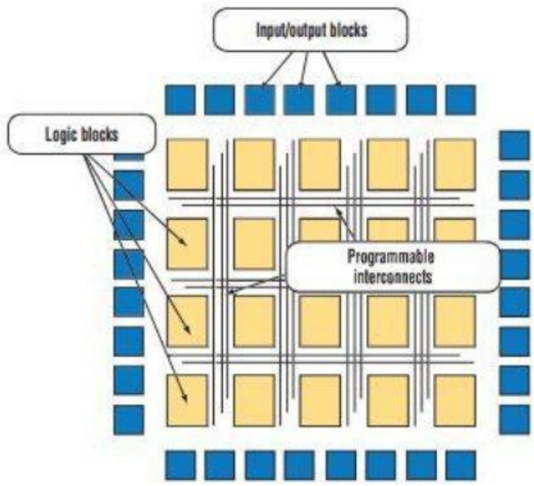

Fig 1: Basic Internal Structure of FPGA

There are two stage design in FPGA s are scheduling, Placement and Routing.

1.1 Scheduling
Determining sequence of executing the tasks with deadlines, i.e., real time Scheduling. The Worst case Response time and feasibility analysis under scheduling algorithms of great importance.

1.2 Placement
The FPGA s placement is to create a placed configuration of logic blocks involves in deciding the all logic elements where to place in a normally restricted amount of space.

1.3 Routing
The routing phase interconnects itemized sets of terminals, i.e., the signal nets of the design, by wiring inside routing areas that lie among or over the functional units. A signal net is a set of module output terminals and the corresponding module input terminals which need to be linked to each other using routing.

2. RELATED WORK
The heuristic algorithm is being used to solve the placements problem i.e. Simulated Annealing (SA), Particle Swarm Optimization (PSO) and proposed hybrid PSO-SA. These algorithms are being applied on the synchronous FIFO circuit. The device used here is XC3S500E, with the help of net list for the respective device the algorithm is implement in MATLAB. Finally results are compared and observed that PSO-SA results better that PSO and SA [1].

Genetic algorithms (GA), Ant colonies Optimization (ACO), Particle Swarm Optimization (PSO), these algorithms are being applied to the Benchmark circuits by MATLAB. Finally observed that PSO results better than the other Optimization Algorithm[4].

Numerical optimization problem solving algorithm such as Cuckoo Search Optimization (CSO) and Simulated Annealing (SA) are compared, where CSO is better than SA. Even hybrid SA does not result better than CK. SA has stability problem, restricts the success rate of the algorithm while comparing it with CK[7].

When the Cuckoo Search Optimization Algorithm is compared with Simulated Annealing and Ant Colony Optimization algorithm, Genetic Algorithm, CSO Algorithm always results better.

3. PLACEMENT PROBLEMS
FPGA placement commonly begins with the net-list of logic blocks, which comprises CLBs and I/O pads and their interconnections. The outcome of placement in the physical assignment of all blocks on the focused FPGA, that decreases one or more objective cost function. Predominantly there are three placement targets:

a) Wire length-driven placement

b) Rout ability-driven placement and

c) Timing-driven placement

Where the wire length-driven placement attempts to place logic blocks closely packed to minimize the needed wiring. Rout ability-driven placement will stable the wiring density over the FPGA. Timing-driven placements will lessen the length of the initial path to meet the timing hindrance.

But placement is a computationally tough and much more additional problem. The common placement problem is Non deterministic polynomial time complete. NP- complete primarily mean that there is no efficient way to evaluate the literal solution. Approximately solution can only be found using the heuristic technique. In this paper two heuristic algorithms i.e., Particle Swarm Optimization (PSO) and Cuckoo Search Optimization (CSO) is being used for the wire length minimization.

4. PARTICLE SWARM OPTIMIZATION(PSO)

Particle Swarm Optimization by Russell Eberhart and James Kennedy in the year 1995. They were first developing a computer software simulation of birds flocking around food source and then they realized how fine, their algorithm worked on optimization problem.

PSO is always compared to the flock of birds or school of fishes considering with the birds searching of food will chitter and remaining will comes closer to the direction. Likewise, the tightening pattern continues until the bird found the food. So PSO is said to be simple and easy to implement.

There are three global variables which the algorithm will keep in track Target value, Gbest(Global Best), Stopping Value. In this algorithm, each particle will be consisting of Possible Solution, Velocity value, Pbest(Particle Best).

In case of flocks of birds, X,Y,Z, are the coordinates, each particle will be keeping in track of the coordinates in the search space associated with the best solution achieved so far. This is Pbest.

Best value that is being tracked by PSO is the leading value obtained until then by any particle in the locality (neighborhood) of that particle. This is Gbest.

The elementary concept of PSO technique lies in the quickening each particle towards its Pbest and Gbest location ar each time step.

There are two equation based on which velocity and position of particles are changed.

$$V_i^k = \omega \times V_i^{k-1} + C_1 \, rand_1(P_b - X_i^{k-1}) + C_1 \, rand_1(P_b - X_i^{k-1}) \quad (1)$$

$$X^k = X_i^{k-1} + V^k \quad (2)$$

Where ω is the inertia weight, C1and C2 are acceleration constant which varies the velocity of the particle towards Pbest and Gbest.

The basic pseudo code for the Particle Swarm Optimization is shown in Fig.2 and the flowchart is as in Fig.3

PSEUDO CODE OF PSO

```
Initialize a population of particle with random values position
and velocity from the dimension in the search space
While termination condition not reached do
For Each particle i do
Adapt Velocity of the particle using equation (1)
Update the Position of the particle using equation (2)
Evaluate the fitness
if f(X^k) < f(P_b) then
P_b <- X^k
end if
if f(X^k) < f(G_b) then
G_b <- X^k
end if
end for
end while
```

Fig 2: Pseudo code of the PSO algorithm

In PSO, the number of iterations, population size, position and velocity are initialized. With the help of the equation (1) and (2), the velocity is determined and

the position is been updated. Then finds out the Pbest and the Gbest and update the individual optimal value

and global optimal value. This process continues until the termination condition reaches.

There are three idealized rules to describe the standard cuckoo search

Each one of cuckoo lays one egg at a time and dumps in unmethodically chosen nest.

The premier nest with superior eggs will be carried over to the subsequent generation.

The number of available host nest is firmed, the egg laid by the cuckoo is observed with the probability Pa (0,1), by the host bir

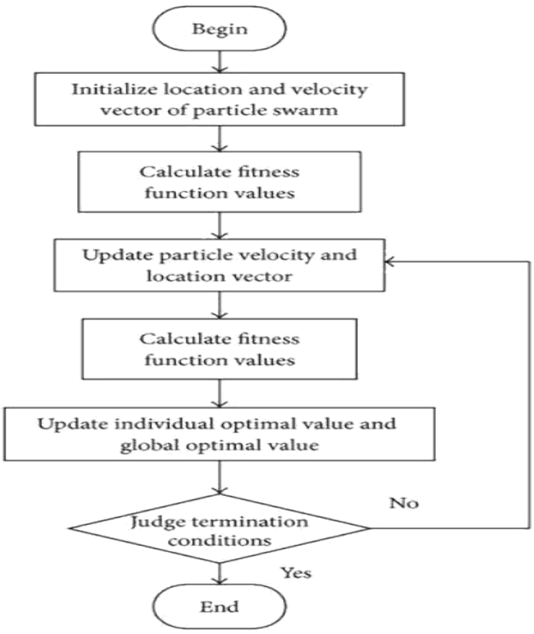

Fig 3: Flowchart of Particle Swarm Optimization(PSO)

PSEUDO CODE OF CSO

1. Begin
2. Objective function f(x), $x = (x_1, x_2, x_3, \ldots\ldots x_d)^T$
3. Generate the initial population of n
4. Host nest x_i (i = 1,2,3,.....n)
5. **While** (t < max generation) or (stop criteria)
6. Get a cuckoo randomly by Levy flight
7. Evaluate its fitness F_i
8. Choose a nest among n (say, j) randomly
9. **if** ($F_i > F_j$)
10. replace j by new solution
11. **end**
12. a function (P_a) of worse nest are abandoned and new ones are built
13. keep the best solution
14. find the current best
15. **end while** post process results and visualization
16. **end**

Fig 4: Pseudo code of Cuckoo Search Optimization

While in this case, the host birds, neither gets rid of the egg, nor plainly discards the nest and build utterly new nest. In the implementation point of view, each egg in the nest is being considered as the solution. Each egg that is being laid by cuckoo is considered as one

5. CUCKOO SEARCH OPTIMIZATION ALGORITHM

Cuckoo search is correspondingly a recent algorithm developed by Xin-She Yang and Suash Deb in the year 2009, which has been found to be proficient for solving global optimization problem. It is Meta heuristic algorithm. It deploys on broad parasitism and enhanced by Levy flight, more preferred than by isotropic random walks.

Current studies exhibit that cuckoo search is prospectively more efficient than PSO. Cuckoo is interesting bird, not because of the wonderful sound they make, but even because of their dynamic reproduction policy.

There are some species like Ani and Guira which lay eggs in joint nest, yet they may remove other eggs to improve the hatching probability of their own eggs. Quite other species captivate the obligate brood parasitism by laying eggs in the nest of distinct host birds.

solution. The main aim of the CSO is to use new and better solution (cuckoo) to replace a worst solution in nest.

This algorithm uses a balanced mixture of local random walk and the global explorative random walk
controlled by Pa.
The equation for the local random walk can be written as

Xit+1 =Xj + αs ×H (Pa-) × (Xjt- Xkt) (3)

Where the Xjt and Xkt are different solution selected randomly. H (u) is Heaviside function. is the random number from uniform distribution and S is the step size. Global random walk using Levy flight is given by

Xit+1 = Xit + αL(S,λ)

(4)

Where,

$$L(S,\lambda) = \frac{\lambda\Gamma(\lambda)\sin(\frac{\Pi\lambda}{2})}{\Pi}\frac{1}{S^{1+\lambda}}, \quad (S>>S_0>0) \tag{5}$$

Where is L is the characteristic scale of the problem.

Mostly α = (L/10), sometimes α = (l/100) for more effective results and it will avoid cuckoo flying too far. The pseudo code of the cuckoo search algorithm is as in Fig.4 and the flowchart is given in Fig.5

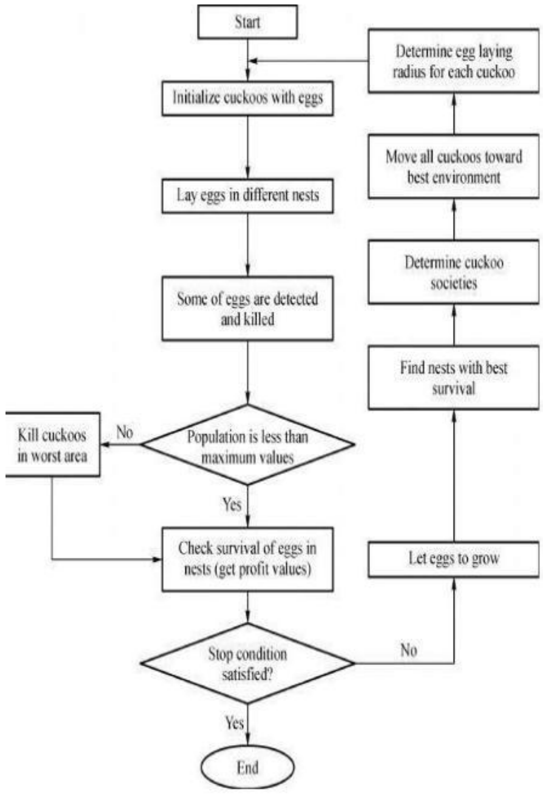

Fig 5: Flow chart of Cuckoo Search Optimization

6. PROPOSED WORK

Many Heuristic algorithms are compared with Cuckoo Search optimization, but the comparison between Particle Swarm optimization and CSO has to be done to observe which algorithm results better. Any device can be taken for implementing the optimization in MATLAB. For the placement process based on the net list in the device Plan Ahead tool in Xilinx is used.

Basic PSO algorithm is being implemented in MATLAB and same for the CSO algorithm. Results are to be compared with PSO and CSO with various parameters such as Runtime, wire length, number of iteration etc.

7. RESULTS AND FUTURE WORK

As the results are considered, the PSO is been implemented in the MATLAB for the n×n matrix and the cost is being found with the help of the Manhattan distance, for the 500 iterations and this is of 2-D.The particles are placed randomly and with the help of Manhattan distance wire length is found. Result obtained for the PSO is of decreasing curve which symbolizes that the cost reduces as the iteration gets increased. For the future work the PSO and CSO algorithm has to implemented based on the net list and FPGA device has to be used and the results have to be compared.

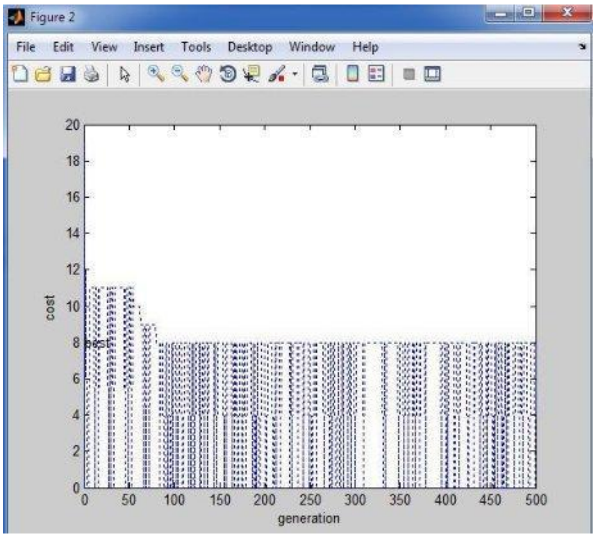

Fig 6: Result for the PSO algorithm

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