IJCSE International Journal of Computer Sciences and Engineering Open Access
Study Paper Volume-3, Issue-7 E-ISSN: 2347-2693

# A Study on Optimize Skip Stop Service Using Genetic Algorithm in Selected Indian Railway Division

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www.ijcseonline.org

Received: Jun/03/2015 Revised: Jul/10/2015 Accepted: July/24/2015 Published: July/30/ 2015

***Abstract*—** Railway authorities aim to provide transportation service to the customer in a safe as well as effective and efficient manner. The main constraints forcing them to regulate their service are the limitation of resources. This paper found the optimal coordination of stopping stations that can increase and improve overall benefits of skip stop service. A skip stop pattern must find an optimal balance between faster passenger travel time and lower service frequencies at each station. The main objective is to optimize passenger travel time with maintaining railway and infrastructural behavior.

***Keywords*—**Genetic Algorithm, Indian Railway, SkipStop Service , Optimization

## I. INTRODUCTION

This study improves the service for passenger rail service planners have limited option for reducing overall time. Most two track passenger rail operates with trains stopping at all stations in high density and highly demand area. Full express service (skip stop service) may not always possible because of high traffic density of prime time. But only one way to reducing passenger travel time is to introduce that skip stop service according to passenger demand. To enrich skip stop service we consider some railway and its infrastructural characteristics to get better optimize result. The major train related characteristics are 1. Train maximum speed, 2. Train priority, 3. Dispatching frequency, 4. Safety rules etc. and major infrastructural characteristics are 1. Number of homogeneous train track and number of platform, 2. Number of loop track in [1]platform area, 3. Length of block stations 4. Track maintenance etc. The overall study of said optimization problem can be depicted by following figure. Here skip stop service taken as input behalf of passenger service. Railway and its infrastructural constraints are preserve in database. During optimization these constraints plays important role for generating periodic timetable.

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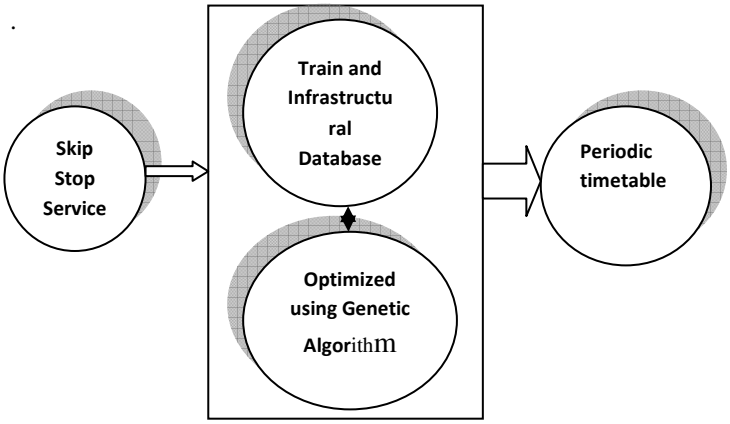


Figure 1. Proposed architecture

## II. RELATED WORK

Many Research work has been going since many year in the field of Genetic Algorithm. Train skip stop service problems has been undertaken in various modeling and framework in the literature. Three decades ago, Assad (1980) published [1] a comprehensive survey on railway transportation models including train scheduling models. About two decades later, another survey appeared in the literature (Cordeau et al., 1998), [2] concentrating on optimization models for the commonly studied railway routing and scheduling problems. Fay (2000), presents [3] a fuzzy logic-based algorithm. Decisions given by train dispatchers during a 10-h period are used to develop a rule base. Trains are evaluated in a binary scheme in the

 

algorithm, which aims to reproduce dispatcher decisions. The algorithm developed fails to find the optimal solution. Peeters and Karoon et. al. (2000) proposed [4] on timetabling generation has continued to emerge from Dutch Universities, but focused typically on generating a standard hour timetabling and skip stop service problem. Li et. al. (2008) presented [5] an advance simulation method based on the global information for solving the train scheduling problem to reduce the total travel time on the single track railway. Change et. al. (2011) analyzed [6] the Taiwan High Speed Rail operating plan to select section stopping pattern using linear approximation. The proposed technique consider the dual objectives of minimizing passenger travel time and the operating cost to the railroad. The analysis assumed a predetermined set of stopping pattern and did not consider the waiting time of passenger between train frequencies. Corman et al. (2010) test [7] a decision support system called ROMA (Railway traffic Optimization by Means of Alternative graphs) which is a local optimization re-scheduling tool for train traffic under disturbed situations. The coordination of two complex dispatching areas controlled with the help of local ROMAs showed the effectiveness of the distributed system (versus centralized one) in terms of computation time and delay minimization under various operational scenarios. Acuna-Agost et al. (2011) developed an approach [8] named SAPI (Statistical Analysis of Propagation of Incidents), which provides probability of events related with the progress of train's journey that are affected by a set of incidents or disruptions. This approach is then used to reduce the size of the search space of the mixed integer program for re-scheduling problems in order to obtain near optimal solutions in reasonable durations.

## III. GENETIC ALGORITHM

Genetic Algorithm are search algorithm based on the mechanism of natural selection and natural genetics. They combine survival of the fittest among string structure with a structured yet randomized information exchange to form a search algorithm with some of the innovative flair of human search. In every generation a new set of artificial creatures is created using bits and pieces of the fittest of the old; an occasional new part tried for good measure. In this paper we used Genetic Algorithm in following manner to optimize desire output.

Step I [Start] Generate random population of chromosomes, that is, suitable solutions for the problem.

Step II [Fitness] Evaluate the fitness of each chromosome in the population.

Step III [New population] Create a new population by repeat following steps until the new population is complete.

a) [Selection] Select two parent chromosomes from a population according to their fitness. Better the fitness, the bigger chance to be selected the parent.

b) [Crossover] With a crossover probability, cross over the parents to form new offspring, that is, children. If no crossover was performed, offspring is the exact copy of parents.

c) [Mutation] With a mutation probability, mutate new offspring at each locus.

d) [Accepting] Place new offspring in the new population.

Step IV [Replace] Use new generated population for a further run of the algorithm.

Step V [Test] If the end condition is satisfied, stop, and return the best solution in current population.

Step VI [Loop] Go to step 2.

## IV. METHODOLOGY

This paper consider skip stop operation as a choice for an accelerated railway transit operation scheme. The proposed work will be done by following steps as given bellow.

**Step 1 :** Identify the required input constraints from different railway region based on their static and dynamic characteristics**.**

**Step 2 :** Gather the information related to railway database for processing using Genetic Algorithm. The information are railway and infrastructural characteristics of each railway region categorically.

**Step 3** : Initialize the Genetic Algorithm based operation for optimizing. The basic operations are..

- Encoding
- Recombination
- Crossover
- Mutation
- Fitness
- Population

**Step 4** : Built a prototype of our proposed study and match railway module with Genetic Algorithm parameter….

**Step 5** : Optimize using Genetic Algorithm methodology and getting test the output result against the selected constraints.

**Step 6** : Compare with newly outcomes result of our design approach with the existing system

**Step 7** : On the basis of comparisons conclusion will drawn.

| Real Life | Genetic Algorithm | Railway Module |
|---|---|---|
| Chromosome | String | Timetable |
| Gene | Character | Each train departure time |
| Genotype | Population | Population of time table |
| Environment | Function | Total delay |
| Breeding | Generation Procedure | Finding optimum time table |

Figure 2. Genetic Algorithm Parameter.

## V. OPTIMIZATION PROCESS USING GENETIC ALGORITHM

There are several determination factor associated with the said optimization process when implementing the Genetic Algorithm. To stopping pattern of a train can be represented by a binary string. The length of the string is the number of station for particular train travelling section. An individual binary number '1'out of string represent the train stops at that station and '0' indicates that the station was skipped the train for the proposed stopping pattern. Then we merge into one string representing a potential schedule (chromosome). The following table represents the schedule from stopping pattern.

| | Station 1 | Station 2 | Station 3 | Station 4 | Binary String / |
|---|---|---|---|---|---|
| Train 1 | 12.10 | - | - | 12.47 | 1001 |
| Train 2 | 12.56 | 13.13 | - | 13.26 | 1101 |
| Train 3 | - | 13.50 | - | 14.20 | 0101 |
| Train 4 | 14.10 | 14.21 | 14.30 | 14.45 | 1111 |

Chromosome Structure: 1001110101011111

Figure 3 : Encoding with binary number of skip stop service.

In above figure we consider 4 trains which cross 4 stations in a particular section in between small time interval. For example Train #1 entries in the section in the time 12.10 and passing the section 12.47. In such duration its skips two stations and stops 2 stations. As per proposed method we represent binary format as 1001. Since it skips at station 2 and 3 and stops at 1 and 4. In same manner we gather some initial sample of potential schedule. The proposed algorithm works as following manner is described in figure 4.

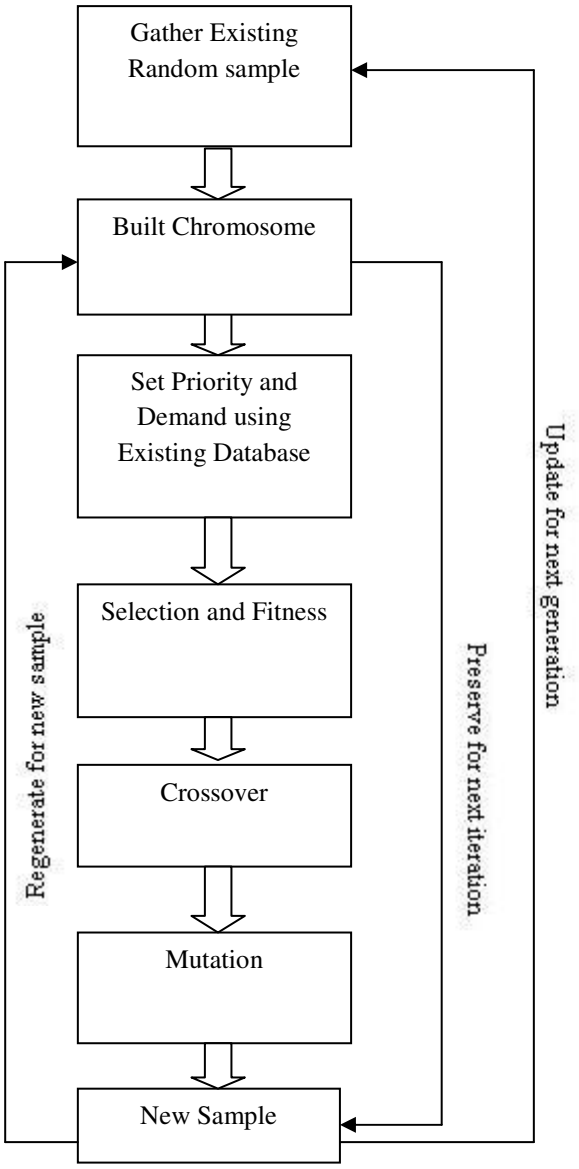


Figure 4. Proposed Genetic Algorithm to search for improves skip stop service.

An initial sample must be generating from previous existing railway timetable, then build a chromosome from

combining of individual genes. On the determination of priority and passenger demand, schedule is based off total travel time of all passengers ridding the train plus any unfilled demand by the train.

Schedules were selected randomly based on their total priority determined in the previous phase. Initially all schedules have a relatively equal change to being selected for the next iteration. This phase of optimization selection behavior is modeled by using fitness function to scale the priority of train. This phase allows for very small improvement to be exaggerated delay in proposed process to ensure that these small improvements are not overlooked the algorithm.

Once the schedules are selected then they will be paired off. Out of different crossover method One-point crossover method chosen where to split the binary representation of chromosome of the schedule. The crossover module creates a new schedule based on the best previous schedules. The following table shows how the works between the stopping pattern of train.

| Train # 1 | Train # 2 | Train # 3 | Train # 4 |
|---|---|---|---|
| 1001 | 1101 | 0101 | 1111 |

| New Train # 1 | New Train # 2 | New Train # 3 | New Train # 4 |
|---|---|---|---|
| 0101 | 0011 | 1010 | 0010 |

Figure 5 : One Point Crossover

The new schedules created after successful completion of crossover phase and are then passes through the mutation module. This phase allows the search algorithm to new schedules. The new schedule is checked to make sure that all trains start and stop at in selected section before it is allowed to continue on to the next iteration. If search results satisfy maximum priority value as well as passenger demands then the mutation probability increases significantly to generate a new search pool.

## VI. CONCLUSION

In this paper we have worked for the field of coverage railway traffic scheduling with an emphasis on skip stop service. Instead of manual anticipation method Genetic Algorithm based optimization process can reduce significantly time delay and enhance security management issue. This research concentrated on the modeling and solution process. In the future, this research can utilized in many different ways by changing input values to create the general condition for skip stop operation.

## VII. ACKNOWLWDGEMENT

Any work small or big is always a tough ask for a sole individual to get it correct working as per the requirements. This paper also not any different. We would like to thank Indian Railway authorities for their immense support. The authors also acknowledge to Mrs Arpita Sengupta for her massive assist of said research work.

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