# Optimization of Non-level Pedestrian Crossings Using Genetic Algorithm

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**ABSTRACT:** Today, a significant proportion of movements are available for distances below one kilometer is carried out with the feet. The separation of pedestrian traffic with traffic passing through highways and highways is one of the issues that, in addition to ensuring the safety of pedestrians, also covers the flow of traffic. One of the safe passageways of these pedestrian crossings is the construction of passageways of non-level pedestrians (overpasses or underpasses). Therefore, the mathematical model in this research was designed with the goal of the minimum total distance of pedestrians to the passage. Model inputs were prepared using the ArcGIS software, such as applying the population to applications and obtaining distances, then by solving this model, an optimal locating of non-level passes was performed using Genetic Algorithm. In order to optimize and optimize the management of project costs, the passageways were prioritized based on effective parameters. Thus, by identifying the effective parameters such as the size of the pedestrian and the volume and speed of the vehicles, using the ArcGIS software, the information layers of the parameters were created and applied to the layers using the required hierarchical weighting method and this method of prioritizing the non-level crossings of the pedestrian is done. The research method was carried out on a case study and non-level crossings of passageways were locally located in the area. The importance of effective parameters for prioritizing non-level passes, pedestrian accidents, and the volume of passing pedestrians from the street had the most important factor. Finally, 21 points for constructing of pedestrian crossing is determined that prioritized based on Genetic Algorithm.

## 1. INTRODUCTION

The pedestrian cross-sectional area is a pedestrian facility, which is built on the basis of vertical separation of pedestrians and cavalry as underpasses or overpasses. Recent trends in pedestrian-friendly urban development areas have given rise to an interest in re-examining the common engineering practices used in pedestrian crossings [1-4]. In this paper, the parameters affecting the location of a non-level crossing, such as vehicle volumes, pedestrian volumes, vehicle speed, and time required for passing, distance from adjacent transverse passage, crash data and land use, and other cases are studied.

An algorithm for finding optimal points for the construction of a non-level pedestrian crossing is one of the important issues that seems to be very important to find a way to properly allocate optimal points due to the density of urban passages and the cost of a pedestrian bridge

## 2. METHODOLOGY

The general research method in this study is that in order to optimize the location, a mathematical model is first defined and then the problem is solved using the genetic algorithm

(GA) method. Solve this problem based on the parameters defined by Matlab software. The mathematical model is inspired by the idealized model of Charts and Cooper [5]. It tries to minimize the target function simultaneously and according to the weight of each parameter. The purpose of the design of this model is to minimize the distance between the demand points and the non-pedestrian crossings.

The objective function is defined as below:

$$Min\ Z = \sum i \in I \sum j \in J \sum k \in K \sum j \in N_i h_i d_{ij} R_{kj} y_{ij} x_{ij} \quad (1)$$

Where $h_i$ demand of parameter $i$, $d_{ij}$ distance between $i$ point demands and location of non-level crossing ($j$), $R_{kj}$ standard distance between $k$ and non-level crossing ($j$), $L$ distance for servicing and covering the pedestrians.

Also, constrains of problem are listed below:

$$\sum j \in N_i x_j \le J \quad (2)$$

$$\sum j \in J y_{ij} = 1 \quad i = I \quad (3)$$
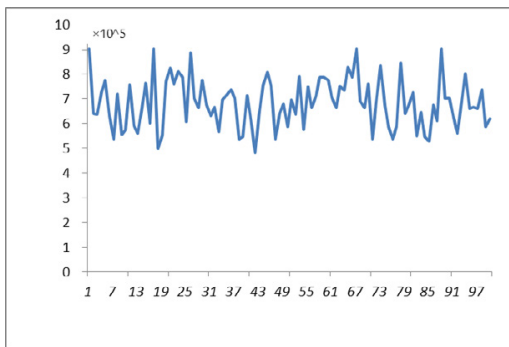
$$y_i = \sum j \in N_i x_j \le 0 \quad (4)$$

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**Fig. 1. Solution diagram with 100 iterations**



**Fig. 3. Prioritization of the of located passageway**

$$[10101001011101101010110]$$

**Fig. 2. Final result obtained from Matlab**

Where *i* demand points for non-level crossing, j candidate location for non-level crossing, and k is specific points such as intersections and elementary Schools.

When the mathematical model of optimal locations for the construction of non-level pedestrian crossings was created, the priority of each of the passages should be made according to the parameters that determine the importance of each passage. Prioritization is based on a series of influential parameters that are selected based on previous studies.

Due to the importance of different parameters, the weight of each parameter should be determined. For this purpose, weighing the parameters through the hierarchy analysis method is performed using Expert Choice software.

Two methodologies for this research are considered that the first is the optimal locating of non-level crossings and the second is their prioritization. In the first stage, the problem solving method is that an arterial street is first considered and its digital map is prepared, then the population statistics of the region, which includes the population of each block, is investigated. In the next step, the residential areas are divided into smaller pieces and the intervals are determined using the GIS. In the following, suitable points for the construction of non-level pedestrian crossings in each goal street are identified, and the distance between these points and specific points using the GIS is determined from the blocks. In the next step, using the math model, the optimal number of points for the passageways is determined from the points of the candidate with the minimum sum of the distance to the block, so that by minimizing the production of the pedestrian area, more pedestrian crossings are more likely to be used. In the second step, the problem solving methodology determines the parameters that affect the prioritization of the passageways and obtain the necessary information by field surveying. Using the GIS of the information layer, each parameter is created on its layer. Finally, by performing a hierarchical analysis, the weight required is determined by the effect level of each layer and applied in the GIS to determine the priority of each pass.

In order to verify the proposed algorithm, a case study of the above issues has been made, which is referred to

below. The area chosen for the case study is part of Shariati Street in Tehran's 7th District. The length of the study area is 2,500 meters, with the presence of various travel attraction applications on this street and the surrounding alleys, increasing travel facilities. To obtain the block distance to the passage, using the ArcMap capability, the center of the level of each block and the distance between the center of each block's surface and the candidate's passageways are obtained. To obtain the distance between candidate passes to specific points of the rules, ArcMap captures the gap and is prepared for the input of the model.

## 3. RESULTS AND DISCUSSION

The chromosomes of this algorithm consist of 21 genes, which are actually like a $21 \times 1$ matrix, which is zero or one. To begin with, the population of 30 chromosomes and the number of repetitions 40 were resolved, which ultimately yielded the best result when the chromosome population was increased to 100 and the number of replicates reached 100 generations.

The designed model in one area selects the minimum number of available passes. In this model, points are given as the points of reference that are recommended to be built at the nearest point to the safe passageway. In the answers given, 100% of the points are covered.

Another issue to be mentioned is the importance of the crash factor in prioritizing the construction of a non-level passageway. According to the experts, the importance of the accident factor in the priority of construction alone is 38%, which according to five other criteria has a high coefficient.

## 4. CONCLUSIONS

With the study of regulations and pedestrian ordinances and the need to pay attention to the basic parameters for facilitating walking, a model for locating non-level passages was designed. In order to solve this model and reach the optimal solution, it was decided to solve the genetic algorithm according to the previous research. Therefore, in a case study that part of Tehran's 7th district was operated in this way, and non-level crossings were located. Following the implementation of the research method in the case study and observing the results and analyzing the responses as well as studies on the research, the following results were obtained:

In the model, the points are referred to as the rules of reference, which is recommended at the closest point to be

constructed by a safe passage. In the answers given, 100% of the rule points are covered.

The significance of the accident factor (fatal and injured accidents) in prioritizing the construction alone is 38%, which is very important between five other criteria.

In prioritizing the construction of non-road crossings, the coefficient of importance of fatal accidents with 23.9%, the volume of pedestrians with 20% and the volume of vehicles is 19.3%, respectively.

Educational user is also more important than other utilities in prioritizing construction of non-level crossings.

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