Noise Driven Route Planning Using Simulated Annealing and Enforced hill climbing Algorithm

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***Abstract*—In this paper, we study two approaches to route planning using Simulated Annealing and Enforced Hill Climbing algorithms, driven by noise, to navigate a 10x10 solution space. Our approach involves the use of way-points as intermediates to guide the route planning process, with the objective of reaching the destination while minimizing the effect of the noise attributed at every 0.1 interval. We conducted experiments with a various parameter and compared our results here. Our results indicate that for an effective route planning solution, noise can be a major driving factor. Our approach has several potential applications in areas such as robotics, autonomous vehicle navigation, and logistics.**

Keywords— Simulated Annealing, Enforced Hill Climbing, Noise Driven Route

I. Introduction and Background

Distance and time are the existing basis of optimal routes. However, sound is also a decision variable which is not considered in the current route-finding systems. This study will require collection of geotagged sound samples and their noise characterization. The noise level as the path weighting factor will be used to provide the optimal route maps for different time domain using Simulated Annealing and Enforced hill climbing Algorithms

Noise driven route planning tries to incorporate the surrounding noise into the route planning approach. We have assigned the noise data to a solution space sequentially and used that as an attribute for minimizing of our route on noise and distance.

Some previous work [2],[1]. in the area includes estimation of noise form traffic volume, which is then used for route planning. It also focusses on a singular city landscape; our work is more general [3].

II. Methodology

A. Data Collection

We collected the data using Zoom H1n handy recorder with an average sensitivity at around 7 on the dial. Our collected data was 45 min. long and was collected within the

IISERB campus at night. The audio file was then compressed and the amplitude values scaled in range 0-255 for further use.

B. Problem Formulation

We have formulated the problem as a 10x10 matrix of solution space. We then define way-points as a sequence of intermediate points via which we reach form start to the destination.

Noise is incorporated as 101x101 matrix hence we have a noise value attributed to a granularity of 0.1 to our solution space.

We are minimizing a Distance * Noise heuristic, wherein the distance is the Euclidean distance and the noise is the square rooted mean of the amplitude value of noise at the two points

C. Stimulated Annealing

Starting with an initial list of randomly generated form a uniform distribution in the solution space we iteratively "perturbing" it by randomly changing one or more points.

The algorithm then evaluates the new solution and determines whether to accept or reject it based on a probability function that depends on the temperature of the system. As the temperature decreases, the probability of accepting worse solutions decreases, leading the algorithm to converge towards an optimal configuration.

D. Enforced Hill Climbing

Starting with an initial list of randomly generated form a uniform distribution in the solution space we iteratively generate new solutions by randomly changing one or more points.

Unlike traditional Hill Climbing, we enforced number of iterations on the generation of new solution, which ensures that the algorithm does not get stuck in local optima. This allows the algorithm to explore the solution space and converge towards an optimal configuration more effectively.

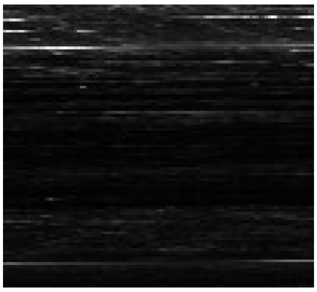

Fig. 1. Image of the Noise Matrix.(white regions corresponds to high noise)

III. Results and Discussion

The encooperated noise increases the distance but as visible form Fig. 1. and Fig. 2. the algorithm was able to avoid the regions of high noise before reaching the goal due to which the distance increased. At a comparison for the same interations Stimulated Annealing performed better than Enforced Hill climbing as visible form Table I. We also found that increasing the number iterations and decreasing the step size reduces the disatnce and noise (ref. Table I. and Table II.) but has an adverse effect on the generality of the path(ref. Fig.1. and Fig.2.) by incerasing the length of the first point.

References

[1] Wang, Zhiyong & Novack, Tessio & Yan, Yingwei & Zipf, Alexander. (2020). Quiet Route Planning for Pedestrians in Traffic Noise Polluted Environments. IEEE Transactions on Intelligent Transportation Systems. PP. 1-12. 10.1109/TITS.2020.3004660.

[2] Mahavar, Vaishali & Juremalani, Dr-Jayesh & Prakash, Indra & Mehmood, Khalid. (2019). OPTIMUM ROUTE PLANNING OF A CITY USING GIS TECHNOLOGY. 6. 402-412.

[3] Ming Cai, Jingfang Zou, Jiemin Xie, Xialin Ma,Road traffic noise mapping in Guangzhou using GIS and GPS,Applied Acoustics,Volume 87,2015,Pages 94-102,ISSN 0003-682X,

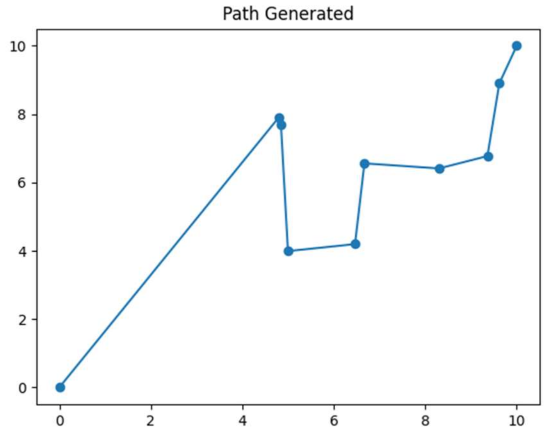

Fig. 2. Sample Generated Path. (Stimulated Annealing)

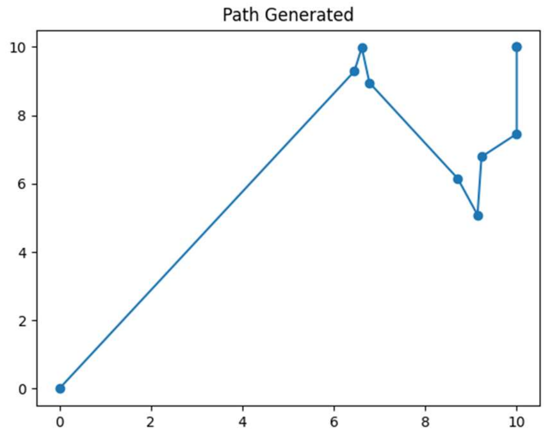

Fig. 3. Sample Generated Path. (Stimulated Annealing, 1000 iterations, 0.01 step size)

TABLE I.

Algorithm	Results for Path Generated form (0,0) to (10,10) for 100 iterations, Step Size=0.1		
	Distance of Path Generated	*Noise Encountered*	*Euclidean Distance*
Stimulated Annealing (Temp=10)	23.130714746600752	63.45964524804419	14.142135623730951
Enforced Hill Climbing	30.28171570004807	63.7875012868562	14.142135623730951

TABLE II.

Algorithm	Results for Path Generated form (0,0) to (10,10) for 1000 iterations, Step Size=0.01		
	Distance of Path Generated	*Noise Encountered*	*Euclidean Distance*
Stimulated Annealing (Temp=20)	18.000690567027263	61.28571338254475	14.142135623730951
Enforced Hill Climbing	27.97941256697052	69.74472532617249	14.142135623730951