Noise Driven Route Planning Using Genetic and A* Algorithms

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Abstract- The Primary objective of this research is to find the optimal path between the two points by incorporating the noise and distance as the decision variable. The research involves collecting geotagged sound samples and characterizing their noise levels to be used as a path weighing factor. The proposed algorithm i.e., Genetic and A* are employed to generate optimal route maps that minimize the both noise and distance for various time domains. The study points out the significance of taking sound into account while planning routes and the possible advantages of using noise-driven pathfinding algorithms. In this research, the best path was determined by minimizing noise levels and travel distance using a Genetic algorithm and the A* algorithm.

Keywords—*Genetic, A*, Noise Level, Noise Map, IISERB*

I. Introduction and Background

Route layout is a crucial component of contemporary transportation networks, and research on how to make routes more effective and safer is continuing. However, noise pollution is not taken into account by existing route-finding algorithms when deciding the best course of action. The effects of noise pollution on people's physical and mental health have grown to be a serious problem in metropolitan settings. This study uses Genetic and A* algorithms to use noise and distance as decision factors in order to determine the best route between two sites.

In metropolitan places across the globe, noise pollution has grown to be a major problem that affects both the natural environment and the well-being of people. People's physical and mental health, including sleep disruption, hearing impairment, and cardiovascular disorders, have been found to be significantly impacted by noise levels. Therefore, there is an increasing need to create innovative strategies to lessen noise pollution.

Another field of study that has made great strides recently is route planning. The most typical method of route planning is to maximize efficiency for both time and distance. However, sound should also be taken into account while planning because it is an important aspect. This is especially important in cities where transportation noise contributes significantly to total noise pollution levels.

As a result, this study suggests a novel method for route planning that takes noise levels into account as a path weighting factor. The suggested method entails gathering geotagged sound samples, describing their noise levels, and applying those noise levels as a route weighted factor. In order to create the best route maps with the least amount of noise and distance over a range of time domains, genetic and A* algorithms are used.

Overall, the suggested strategy has the possibility to significantly reduce noise levels while also enhancing urban residents' quality of life. It could be feasible to create more effective and environmentally responsible transportation systems by including noise levels into the route design process.

II. Methodology

A. Noise Level & GPS Data Collection

To collect the noise level data first we need to identify the area for which we want to optimize the path. I have selected the map for Indian Institute of Science Education and Research Bhopal (IISERB) for our analysis. During the first stage, I identified the major points or intersection of roads in the IISERB campus, there were thirteen such unique points. Then each identified points were given a unique name. Then to record the noise level data at each point I used the Zoom H1n Handy Recorder to record the noise data.

At each point the noise level data was collected in the form of voice recording for two minutes each.

The recorded data was in ‘mp3’ format. The required data was collected in the afternoon time between 12:00pm to 01:00pm.

During the same time the GPS coordinates i.e., latitudes and longitudes were collected using a GPS device such as a smartphone. The collected data consisted of 13 different coordinates of each point.

B. Data Analysis

As the collected noise data was in the mp3 format i.e., the noise data was in compressed format, this makes it difficult to analyze its properties such as volume or intensity. Hence to analyze the noise level we need to convert the noise data from mp3 format to a more suitable format such as decibels(dB). Decibels(dB) are frequently used to describe the noise levels; they are logarithmic measure which are used to calculate noise levels. The properties of noise data such a average, minimum, maximum noise levels can be analyzed when the noise data is converted to a suitable format such as decibels(dB). This format will be useful in this research where the main aim is to find the optimal path by minimizing the noise levels between two unique points.

The conversion was done using a python code. This code used the *librosa* python package is used to analyze the audio signals. It calculates the RMS values and converts the RMS values into decibels(dB).

Then these values were put into a spreadsheet along with the unique names of the position and their respective latitudes and longitudes. Now we use this spreadsheet to geotag the noise level onto the IISERB map. To do this we use the *folium* python package. Here the output was the heat map of IISERB for better visualization. Name of the output file is ‘*IISERB Heat MAP.html*’.

III. RESULTS

For this research work we used the two search algorithm i.e., Genetic and A* to find the optimal route by minimizng the distance and noise level. In this algorithm the path weighing factor was considered to be noise level.

A. Genetic Algorithm

A heuristic optimization technique called the Genetic algorithm is based on the ideas of genetics and natural selection. It serves as a search-based optimization approach that imitates the natural process of evolution to identify the optimum option out of a huge pool of alternatives. The method comprises a population of potential solutions, where each potential solution is expressed by a collection of parameters or genes. To create new candidate solutions, these genes are then merged and altered through crossover and mutation processes. Each potential solution is assessed for fitness using a fitness function that gauges how effective it is in resolving the issue.

Numerous optimization issues have been successfully solved using the Genetic Algorithm in a variety of disciplines, including engineering, economics, and biology. Genetic Algorithm have been utilized in engineering for a variety of purposes, including the best structural design, procedure parameter optimization, and transportation routing. Genetic Algorithm are currently used in finance for management of risks, investment optimization, and trading technique enhancement. Genetic Algorithm have been applied to the study of gene expression, genome symmetry, and folding of proteins in biology.

One benefit of the Genetic Algorithm is the fact it may tackle complicated issues that could be unattainable or extremely challenging to resolve using conventional optimization methods. By adjusting the fitness function, genetic operators, and other parameters, the method is also extremely adaptable and may be quickly applied to many problem types. The GA can be computationally costly and may need multiple attempts to converge to an ideal solution, which is its fundamental disadvantage.

We calculated the optimal path between the main gate of IISERB and H7 in IISERB. For this we ran the genetic algorithm in python we gave input as the latitudes and longitudes along with the noise level data in decibels to the program. The program first calculated the *Euclidean distance* between the two coordinates. A Euclidean distance, the most popular mathematical space, is used to measure a straight-line length between both locations. Then we defined the algorithm for individual, crossover and mutation. And at the end we defined the genetic algorithm using the above information. After the running the program, we saved the path in a map.

After running the code it gave us the best route by minimizing the noise level and distance between two points.

B. A* Search Algorithm

Applications for route-finding and graph traversal frequently employ the search technique known as the A* algorithm. It is a development of the Dijkstra's method, which locates the shortest route between any two nodes in a balanced network. Heuristics are used by the A* algorithm to direct the search and increase its effectiveness by lowering the number of nodes that must be searched. The heuristic function aids in choosing the most promising nodes to investigate next by estimating the cost of the shortest route from the current node to the destination node.

Numerous applications, including robots, video games, and transportation planning, utilize the A* algorithm. Robots that are autonomous employ the A* algorithm for routing and avoiding obstacles. A* algorithm is used in video games for enemy AI and non-player character pathfinding. The A* method is used in transportation planning to identify the shortest route between two points on a map.

We used the A* algorithm in our research to find the optimal path by lowering the noise level and the distance between the two points. We ran the A* algorithm in the python by proving it with inputs such as geographic coordinates and the noise level data in decibels at each respective coordinates. In the program we found the optimal path to H7 in IISERB campus from main gate of IISERB. Similar to the Genetic Algorithm it calculated the Euclidean distance and then reconstructed the path. Then we defined the A* algorithm and then we took the output of it to construct the map of optimal path between the given points.

IV. DISCUSSION

Noise pollution, which has a detrimental impact on people's physical and mental health, has grown to be a serious issue in many places due to the global urbanization trend. In this research work, we concentrate on creating silent routes and offer a routing service that incorporates a Genetic and A* model into the routing process in order to reduce noise level along routes. To perform this research we first collected the noise level data in *mp3* format at 13 different points in the IISERB campus. Along with that we also collected their geographical coordinates of the same respective points in the IISERB campus. Then we converted this noise data into the form that can be used to perform the analysis. We converted it to the decibels(dB) format. Then we geotagged this noise level data with the respective coordinates on to the map. The ouput of this was heat map of IISERB campus which indicated noise level by the means of colour at different location.

Then we used this data into the Genetic and A* algotihm to find a path which has minimizing the noise level and the distance. The output by runing this code was a path from one point to another point in the IISERB campus. For testing we found the optimal path from the main gate of IISERB to H7 of IISERB.

We also incurred some error while running the algorithm. First, as we used the point level data and not the continuous data the algorithm thought that the reference as that specific point only. Rather it should have taken whole map and then should have given the appropriate path as a solution. Second, was that I only considered two paths to reach to a point from start to end in the IISERB campus but as in the campus there was one more path specifically the Hill side road which could have taken into consideration while planning the research.

In the future research I would like to incorporate these mistakes into the new model. Which will be able to give me appropriate result and which wiil be able to give optimal path between these routes. In future, I would also like to incorporate the research for the pedestrains and also like to include the time component as path weighing function.

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