



Safest path Algorithm using Hardware Accelerators and Node Parsing

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Abstract- The project is to calculate and find out the safest zone to travel from one location to another. The main idea is to use motion sensors on the streetlights to detect movement of vehicles or people. The frequency of the data collected from sensors will tell us about the density of people in the entire area and frequency of vehicles. In addition to this, the number of police stations, malls, hospitals will also be taken into consideration. We will also take a note of nearby areas that are usually crowded using Google maps API and Google places API that are present in the entire path of travel. We are finding safest zone during travel assuming the maximum number of crimes happen in less crowded areas. The data of criminal activities happening in various locations is also taken into consideration so that we can identify the highly vulnerable zones and can notify the user to be on high alert in those areas. We can decrease the crime rate on a very high scale and can help people to have a safe journey by selecting the safest path to travel.

Keywords: Dijkstra Algorithm; Machine learning; compound polarity; safe zones.

I. INTRODUCTION

We are familiar with the concept of the shortest path, the shortest distance possible from source to destination but that is not the thing we seek every time when we travel from one place to another in present conditions safety is a major concern during travel. The safest path is a pavement constructed by an accumulation of all the attributes you need to reach your destination safely.

The main focus is on selecting the path which is least vulnerable to criminal acts or to choose a path where a person cannot be stormed by criminals. This selection of the safest path is not only concerned about giving safety from criminal acts but also keep other factors in mind not only safety parameters but also parameters for suitable travel. This keeps in mind that the path selected consists of basic amenities and resources. Also have an option where people can travel through places which are a little lively like within city, instead of barren roads.^[1]

During travel, if there is an emergency situation, like an accident. There should be a hospital nearby in your path. Another important facility which will be helpful is the cellular network. During your travel, you should expect a proper cellular connection throughout your path, so that you are always connected to the outer world. This will also help you to reach out to someone for help if needed. All these small facilities and utilities make the travel secure and happy which is our ultimate goal. In this paper, we refer to the use of Google maps API and Google places API. We are using these API's to find nearby police stations and hospitals on the route. We are also considering crowded places like malls, temples, restaurants etc. To make our estimation more accurate we are also using IOT i.e. we will be having motion sensors on street lights after every 100m which will detect motion of cars or people to give an accurate image of the crowd for path selection^[2]. Another layer of efficiency is added by the cellular strength in the area and the data about criminal activities happening in different locations to alert the user about the vulnerable zones if present during the commute^[3]. The vulnerable zones and the data about signal strength are integrated for better results.

II. BACKGROUND AND LITERATURE SURVEY

In the recent developments, we have seen that the shortest path algorithm has found its popularity in the field of research but the safest path algorithm is as necessary as the shortest path algorithm. With the interest of researchers in the deployment of the safest path algorithm, we found that our main objective is to provide the trade-off between safety and distance. Moving to the background of the safest path algorithm, we have noticed that the crime zone areas are the only attribute which is taken into consideration. For example, previous studies only define the study of Euclidean and spatial network variants to determine the new path for a given set of safe zones, to find paths that minimize the distance travelled outside the safe zones. The main aim of the study was to strictly avoid the entire region with the exception of the safe zones ^[4].

To make the safest path more refined we have included few more attributes like we have devised a transformation of continuous data which provide the information about the density of the people in the entire area and the frequency of automobiles. Our module also includes the number of police stations, malls and hospitals, that are present in the entire path of travel. This research methodology follows Dijkstra's Algorithm, which can efficiently produce the shortest path for selection of the route. This technique also claims to be among the best approaches in solving the shortest path problem and always provide the shortest path from one node to another. To make the result more accurate and flawless we will take note of cellular strength and criminal activities happening in the different locations. These help users to know about all the vulnerable zones if present in the path of travel and alert them before selecting the path.

III. METHODOLOGY

Calculating the safest path is a 3-step approach. The first step is the physical collection, the second is existence collection and finally the merger level. In this paper, we have used the word node for a single location or a single place. We will be calculating the polarity of each and every node and then the polarity of the whole place which is known as the compound polarity. Our approach involves the usage of the Dijkstra Algorithm. Dijkstra Algorithm is an algorithm for finding the shortest paths between which simulates a graph network. Dijkstra algorithm is one of the most popularly known algorithms used for calculating the path between nodes. Dijkstra algorithm has been chosen because it can efficiently provide the shortest path between two or more nodes. The purpose of this research is to find the path between a node and all other nodes and also collect frequency data and then finally calculate the compound polarity of the path or the safest path percentage.

We get the best results when we feed matrix data as input to the Dijkstra algorithm, so we convert each node location into a 2-dimensional matrix of latitude and longitude and then calculate the safest path. This is the first module while calculating the path the second module includes the collection of frequency data from the LDR sensor and the infrared sensor which is used in street lights. The implementation includes 5 steps which are Input source and destination, Import frequency data, applying Dijkstra algorithm, calculate compound polarity and finally generating polarity score or safest path percentage ^[5].

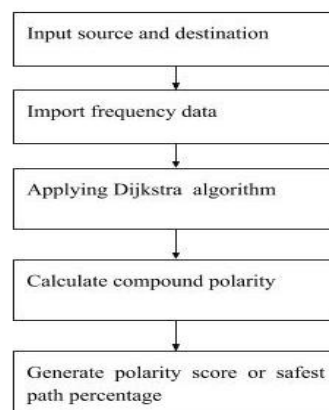


Figure 1: Research Methodology

IV. SYSTEM ARCHITECTURE

The system architecture is something which defines the behaviour and the view of the system. The system architecture of our approach is shown in figure 2. The shown figure displays the various modules possessed in the system. The module's description is described below:

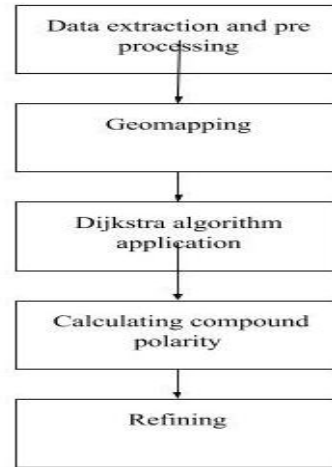


Figure 2: System Architecture

A. Data extraction and pre-processing

We collected the frequency data from light detecting sensor and Infrared sensors which will be installed on every 10th street light. After getting the frequency data, we used geotagging to optimize the data storage so that we can use this data to integrate with the shortest path data which we will be getting after applying Dijkstra algorithm for individual nodes. We used physical address, date and time stamp and some local information to optimize the process and make it highly efficient to find the safest path ^[6].

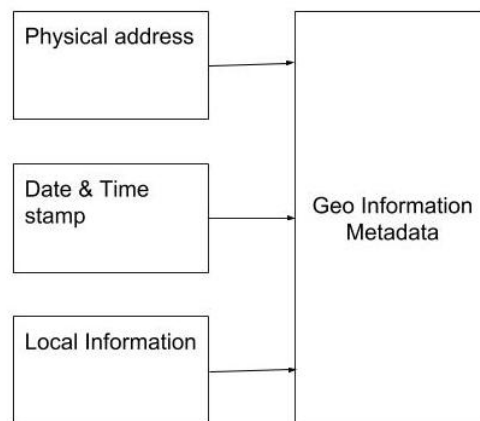


Figure 3: Data Flow

Physical address includes the geolocation of each sensor, the date and time stamp includes the date and time at which the frequency data is recorded and the local information includes communicating data between two or more sensors.

B. Geo-Mapping

In this step, we gather the list of all the places between the source and destination this includes hospitals, shops, restaurants, police stations etc. We made our own corpus in which each place is given some polarity according to the importance of that place while considering the safest path. For example, a police station is given the highest polarity score in any other place.

Police station	10
Hospital	8
Shop	7
Restaurant	9

TABLE 4: Example of Polarities

The above table shows an example data from our corpus. Places are searched within boundaries on each and every point from source to destination. On each point, the algorithm search in the radius of 2km for places and then finally integrate and maps the result of each point to the other to form 2 paths with the greatest polarity scores ^[7]. After selecting these paths, the context of both the paths are saved for further use which is applying Dijkstra algorithm.

C. Dijkstra Algorithm application

After collecting the node details the next step is to apply the Dijkstra algorithm between nodes to find the shortest and safest path from the 2 paths selected in the above step ^[8]. All the circle represents a node or the location of each place and all the line represents the path between them. The value or weight of the path represents the distance between each node in a compressed version. Therefore, to calculate the most efficient route from node 1 to node 4

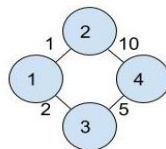


Figure 4: Location Mapping

Dijkstra algorithm follows 4 steps.

Step 1: Temporarily assign $k(n) = 0$ and $k(z) = \text{infinity}$ for all other z . $k(n)$ means the Cost of n $k(z)$ means the current cost of getting to node x .

Step 2: Find the node z with the smallest temporary value of $k(z)$. If there are no temporary nodes or if $k(z) = \text{infinity}$, then stop. Node z is now labelled as permanent. Node z is now labelled as the current node. $k(z)$ and parent of z will not change again.

Step 3: For each temporary node labelled vertex q adjacent to z , make the following comparison: if $k(z) + Pzq < K(z)$, then $k(z)$ is changed to $K(z) + Pzq$ assign z to have parent n .

Step 4: Return to step 1.

Finally, after a certain iteration, a point will come when we will get the cheapest temporary node. If none exists or $K(n) = \text{infinity}$, then stop. There are no more temporary nodes and no nodes have values of infinity, so we're done. After running and completion of the algorithm, we get the shortest path between each node^{[9] [10] [11]}.

D. Calculating Compound Polarity

After calculating the polarity of each node we calculate the compound polarity of the whole path and then decide which path is the safest. In this step, we also use the frequency data which we collected in step 1 and integrate that data with the Dijkstra algorithm data to get a more efficient safest path. We send location coordinates to the server and waits for the response which will be Yes or No. After receiving Yes from the server, we will send date and time stamp for that coordinates. After having details of frequency data, the physical address of each sensor, the server will respond to the client. After getting this data, we integrate this result with the algorithm data and finally get the compound polarity.

After Server receives the response it checks all the information it has like frequency data, google places, information of sensors and if the data is sufficient for the given area then this data is merged with the algorithm and we get the compound polarity. This result is finally delivered to the user in a quantitative form as an safety percentage which is tantamount to the compound polarity^[12].

E. Refining

To make the algorithm more efficient and robust with time we are training the data which we collect from the users as they use this algorithm in their daily lives. Training and collection of data will help us in future, and we will be able to make an accurate prediction about the safety of people. With the use of machine learning, we will include the past experiences of other users at different location. With the help of old data and use of machine learning, we will be able to pinpoint the areas which people should avoid during the travel.

V. RESULTS

When we implemented this research with the real scenario of cities the results were astonishing. We used the road network of Chicago for the experimental analysis of our research as Chicago is a place with a very high crime rate so we expected to have lower safety score inside the city.

A. Experimental Setup

We used source location as Blue Island and destination as Oak Street Beach both of these locations are in different sectors of Chicago, Blue Island is in Bronzeville and the other is in Downtown region which is the main hub of Chicago.

Now when we searched for the safest path, the path which was selected consisted of 2 hospitals, 1 church, 4 major restaurants and 3 major shopping Outlets under the radius of 2 km from the path of travel the given path is 20.8 miles long and the ETA is 30 minutes as shown in Figure 1. But the Compound Polarity score came out to be only 42.73% safe which is fairly low for a lively place like this. This situation was completely understood by the Homicide map of Police District which is shown in Figure 2 as it is clearly seen the homicide rate is 700% higher in Bronzeville area in comparison to Downtown region and in our scenario as we are moving from Bronzeville to Downtown we have a score of 42.73% in spite of having so many major places nearby. This huge increase in the homicide rate of Bronzeville in comparison to Downtown it clearly shows that criminals do not target people if they are at crowded locations like downtown and the main victims are the people which are found alone at barren places.

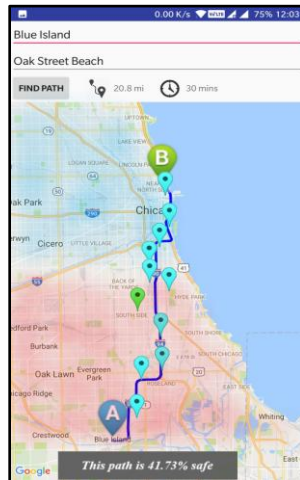


Figure 5: Chicago Region

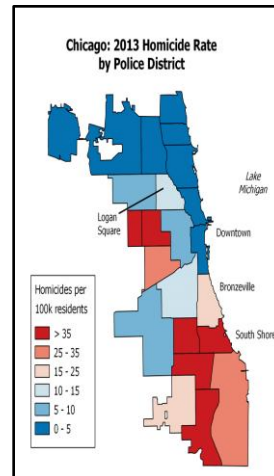


Figure 6: Chicago Homicide scale

Blue and red regions in figure 1 represent the Downtown and Bronzeville regions

These statistics proved that the results we are getting are practical in real life and these results will be enhanced in the later stages as we will be able to implement motion sensors on the streets to get results with a very high accuracy.

VI. CONCLUSION AND FUTURE WORK

In this paper, we have discussed how we are retrieving the safest path by using motion sensors data for calculating the density of people and then optimizing it by using Dijkstra's algorithm for generating the compound polarity of the places. This will help us in generating the safety percentage score. To refine this approach even further we are merging it with the data of vulnerable zones and average signal strength throughout the path and this ultimately gives us our final possible path of travel with utmost safety. The Safest path will be able to save a lot of people from the hand of criminals and will also be able to provide an ease of travel with proper resources throughout their path and the user will always be in optimum radius with places in case of emergency from where help can arrive ^{[13] [14]}.

In Future, we can enhance the Dijkstra Algorithm by utilizing artificial intelligence (AI) method such as Ant Colony Optimization (ACO) which will result in more efficient safest path structure and which will be more accurate. We will try to implement Machine Learning by training our gathered data from sensors and data of vulnerable zones with a suitable ML model to make enhanced path predictions and these predictions will act as a gateway to Real-time safety predictions during navigation using Augmented Reality which will be really helpful for the human society ^[15].

VII. References

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