International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 08 | August -2020 ISSN: 2582-3930

Route navigation using air pollution monitoring sensors

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Abstract - Innovation in approach is the primary factor that attributes to change. In today's age where time is invaluable, there comes a place along the way, where quality needs assessment. Hence a procedure was followed wherein time and quality were attempted to an evaluated in synchronicity. Combining paths between two points and the quality of air to find out the best path for the user. The data from air quality laboratories can be exploited further than the present usage, that is, observation.

***Key Words*:** Air pollution, Path, air quality, routes

1.INTRODUCTION

When we need to measure the pollution in a particular area we need to have an air pollution monitoring station installed for that area. The cost of installing the station is high [2]. So earlier when the readings were obtained there was a need for monitoring stations for that particular area [2][3]. In this paper, we are trying to focus on identifying critical operations and implementing a setup for it.

Why is it important?

Our project mainly focuses on minimizing the cost of air pollution monitoring systems as well as providing real-time analysis. The cost of our project is in the range of 2 thousand to five thousand which is far much less than the cost of installing pollution monitoring stations. In this paper, we consider deploying sensors on the city bus which provides wider coverage in the city and more options and flexibility on the selection of bus routes. City buses also have different installation infrastructures, more dynamic speed, stop and, moving patterns [4][5]. The city bus moves through every small route in the city giving us a good amount of data for route selection. The project thus gives data about the pollutants present in every part of the city and optimizes the route based on the data secured giving the cleanest route to the destination.

2.Current System

The air quality index was looked at only from an observatory point of view. No significant progress was made about it, outside of pollution monitoring. Although we believe the same data can be processed differently, making it economically efficient and using it for multiple purposes [2].

What we are aiming for is the consideration of multiple parameters in assessing situations and find out results that best suit the user requirement. This approach is unusual to our predecessors. who only sought to acquire data, we are focusing on going further and put that data to good use.

Key components of the approach

The project has two components

1. Parameter

2.User priority

Parameters help define the nature of the problem and narrow down the results, given a query. Multiple parameters related to the same entity which under normal circumstances wouldn't be considered at the same time can be used in cooperation with each other to achieve better results.

Parameters can have segregated by the importance they hold on one another, hence user priority comes to use.

Volume: 04 Issue: 08 | August -2020 ISSN: 2582-3930

User priority is a ratio which when multiplied by the parameters will give intended results as per the user need [6].

3.Methodology

To compare the time and QOA (Quality of Air) we first use Dijkstra's algorithm to get the shortest path between the two nodes in terms of time. We then apply the same algorithm to find the shortest path between two defined nodes.

What is Djikstra's algorithm?

Suppose you would like to find the shortest path between two intersections on a city map: a starting point and a destination. Dijkstra's algorithm initially marks the distance (from the starting point) to every other intersection on the map with infinity. This is done not to imply that there is an infinite distance, but to note that those intersections have not been visited yet. Some variants of this method leave the intersections' distances unlabeled. Now select the current intersection at each iteration. For the first iteration, the current intersection will be the starting point, and the distance to it (the intersection's label) will be zero. For subsequent iterations (after the first), the current intersection will be a closest unvisited intersection to the starting point (this will be easy to find), depicted below.

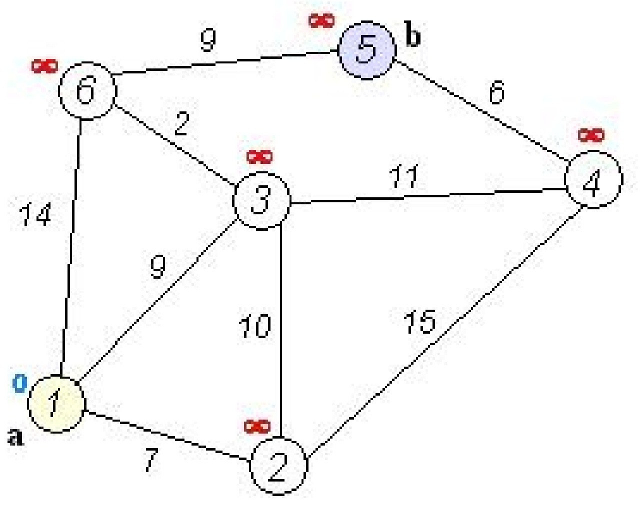

Fig -1: Figure

On dividing the execution into three modes where one being the route prioritizing time, two the compromise between the two and finally the path which would ensure the total quality of the air we shall carry out the process.

For experimentation purposes we considered the following:

If there are two paths to choose from the condition for total air quality or shortest distance is easily met, however, the condition to ensure both conditions are met in adequate proportions we considered a graph where the x-axis would represent distance and the y-axis would represent the air quality (air quality has been given a standard of 1 to 5, where 1 represents the purest of air quality and 5 the least pure).

To describe the above we consider two paths with the parameters

Path A: Distance 3, QOA 1

Path B: Distance 3, QOA 5

On plotting the above on the graph we get the following

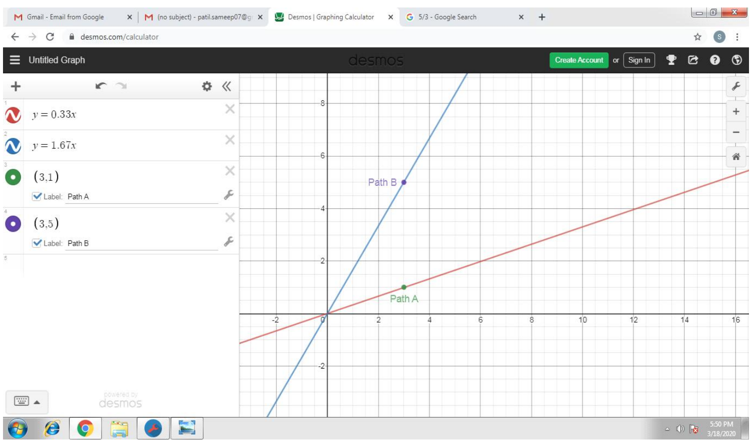

Fig -2: Figure

We then proceed further by calculating the slope of the graphs.

We acquire 0.3 slopes for path A and 1.67 for path B, thereby giving us the conclusion that lesser the slope value more adequately is the representation of both parameters

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 08 | August -2020 ISSN: 2582-3930

After keeping one parameter constant we get the above the results. Now let us consider random values in the next example.

Example:

Path A: Distance 4, QOA 6

Path B: Distance 5, QOA 3

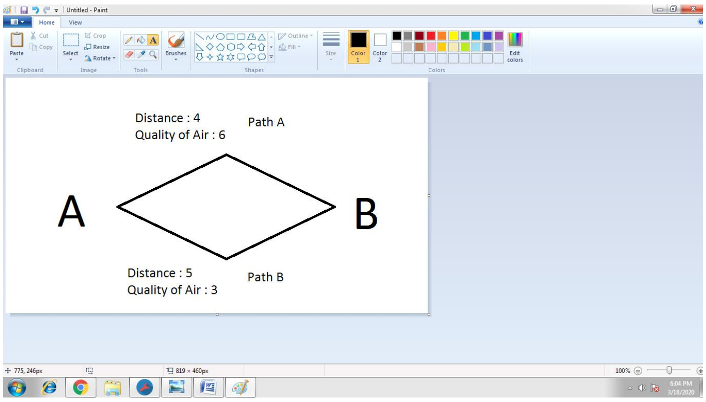

Fig -3: Figure

We get the slope ratios as follows

Path A- 1.5

Path B- 0.6

Which means that path B is the more adequate path. This can be put into words as well, which would go as follows, even though we one would require to walk a unit more in the path suggested the air quality experienced is significantly higher and therefore more desirable.

System Design

4.Proposed system

The system uses carbon dioxide, carbon monoxide, nitrogen dioxide, and noise sensors. The microcontroller takes input from these sensors. The microcontroller used is Atmega 328P. The module consisting of these sensors is mounted on the city bus. The readings from these sensors are displayed on the display device which is LCD. Further analysis of the data is performed to provide the cleanest route to reach the destination.

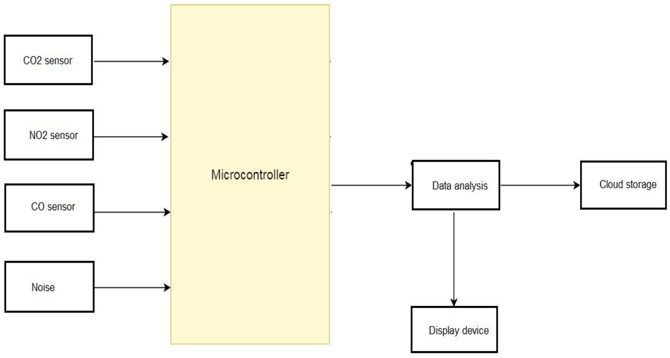

Fig -4: Figure

Fig -5: Figure

Algorithm steps

1. The system will start when it gets key from the user.

2. The sensor connected to the system will be read by the micro-controller.

3. Different sensors will collect the data.

4. The collected data will be passed through the data analysis algorithm.

5. The data will get stored on the cloud.

6. A display device is used to display the values.

Result analysis

The following results were obtained while taking readings of different gases.

Pollutant	Value on display	Expected value	Time	Route
Nitrogen dioxide	14.24 ug/m3	20.67 ug/m3	5.15 pm	karve nagar-pashan
Carbon monoxide	1.90 mg/m3	1.99 mg/m3	5.15 pm	karve nagar-pashan
Sulfur dioxide	12.07 ug/m3	17.07 ug/m3	5.15 pm	karve nagar-pashan
PM 10	76.23ug/m 3	89.86ug/m3	5.15 pm	karve nagar-pashan
Nitrogen dioxide	9.4ug/m3	12 ug/m3	1.pm	karve nagar-kothrud
Carbon monoxide	2.2mg/m3	3mg/m3	1.pm	karve nagar-kothrud
Sulfur dioxide	20.22ug/m 3	24.5ug/m3	1.pm	karve nagar-kothrud
PM 10	78.22ug/m 3	87ug/m3	1.pm	karve nagar-kothrud
Nitrogen dioxide	16.5ug/m3	18ug/m3	3.pm	karve nagar-bavdhan
Carbon monoxide	2.5mg/m3	4mg/m3	3.pm	karve nagar-bavdhan
Sulfur dioxide	30.2ug/m3	34.20ug/m3	3.pm	karve nagar-bavdhan
PM 10	91.22ug/m 3	94ug/m3	3.pm	karve nagar-bavdhan

Fig -6: Table

5.Result accuracy:

1.Karve Nagar-Pashan:

Nitrogen dioxide:68%, Carbon monoxide:95.4%, Sulphur dioxide:70%, PM10:88%

2.Karve Nagar-Kothrud

Nitrogen dioxide:78%, Carbon monoxide:73.3%, Sulphur dioxide:82.50%, PM10:89.90%

3.Karve Nagar-Bavdhan

Nitrogen dioxide:91.6%, Carbon monoxide:62.5%, Sulphur dioxide:88.30%, PM10:97%

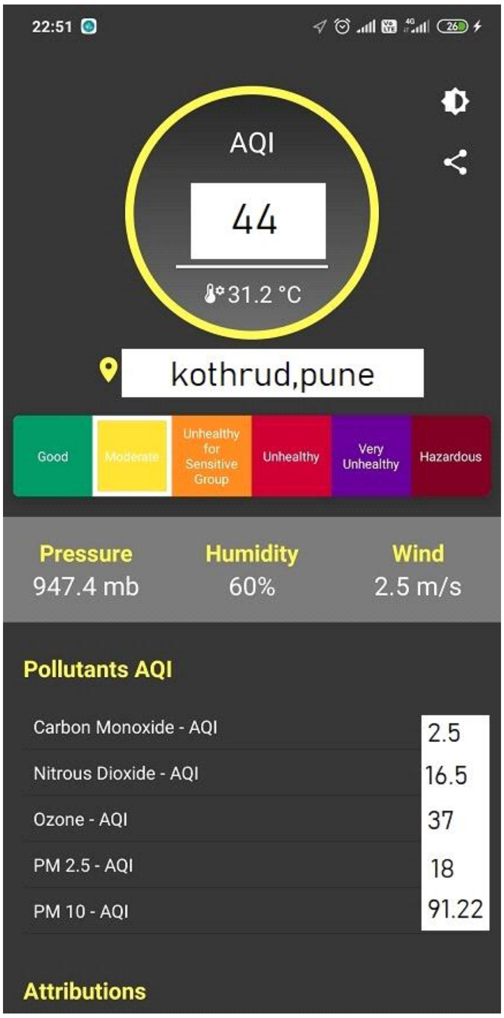

Fig -7: Figure

6. CONCLUSIONS

The proposed system design attempts to reduce the cost of the current air pollution system making it portable and using the data acquired to provide real-time analysis of routes to the user's destination using Dijkstra's algorithm.

The app provides an accurate result of the air pollutants along the route taken by the user.

ACKNOWLEDGEMENT

It is our immense pleasure to express our sincere gratitude and thanks to all our teachers for their help and encouragement.

We would like to express our sincere gratitude towards our Head of Department, Prof. S. B. Somani, and our project coordinator, Prof. R. D. Komati for their encouragement and mentorship in carrying out this project.

We are very thankful to our project guide, Prof. G.G.Narkhede for his valuable guidance and unflinching help during the project work.

We wish to extend our sincere thanks to the various laboratory assistants; teachers and all our committee members for their contribution towards making this project a success.

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