An Intelligent Transportation System for Air and Noise Pollution Management in Cities

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Introduction

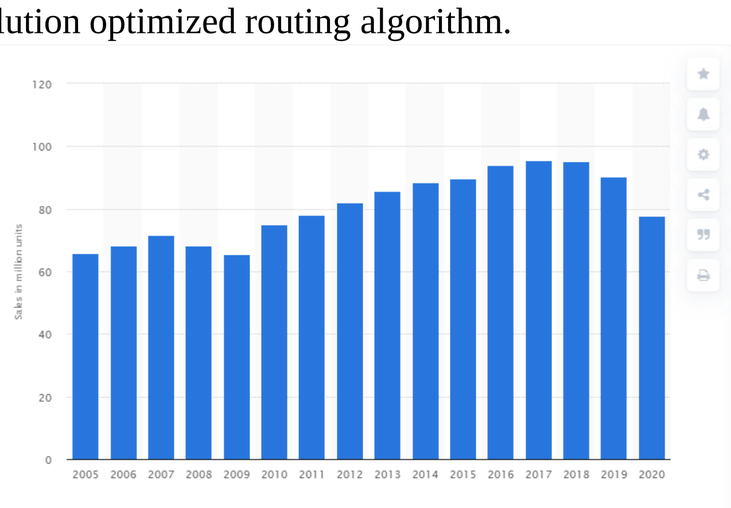
World's total number of vehicles 66 million vehicles in 2005 => 91 million vehicles in 2019.

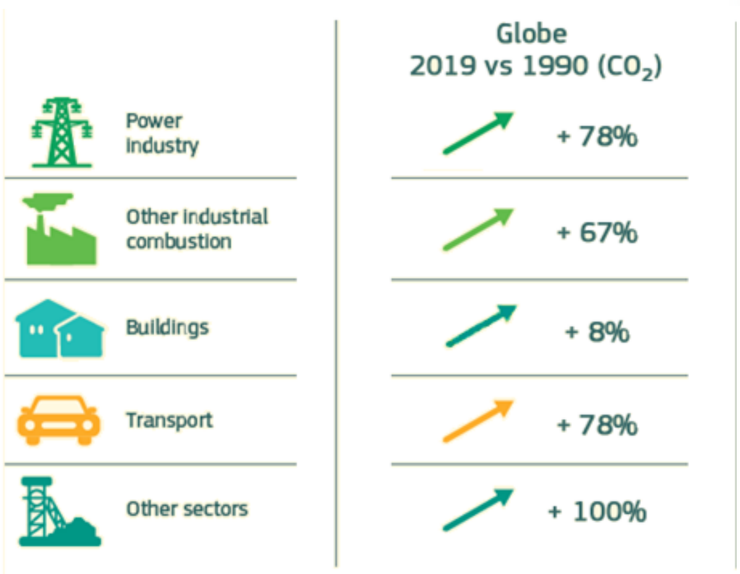
Many consequences on: traffic, economy, environment and notably on people.

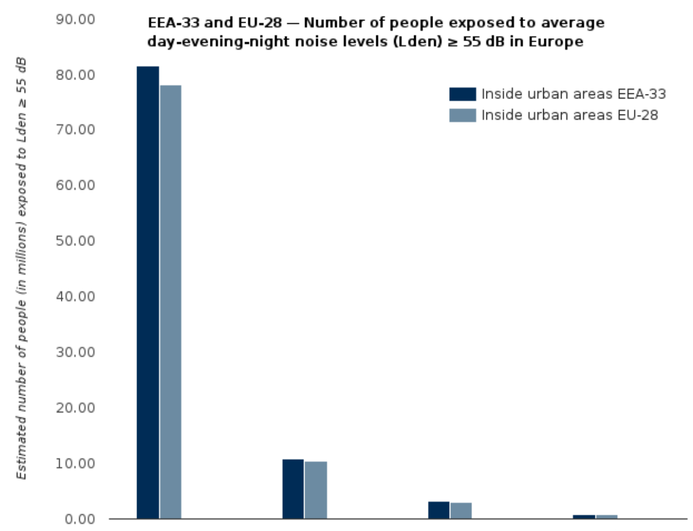
E.g.: vehicles caused 78% increase in the amount of CO2 in the environment since 1990. Increase in the noise pollution.

More than 80 million people in Europe are exposed to road traffic noise exceeding 55dB!

We propose an intelligent transportation system that aims to decrease both air and noise pollution levels in urban cities using cities segmentation and vehicles pollution optimized routing algorithm.







Literature Review

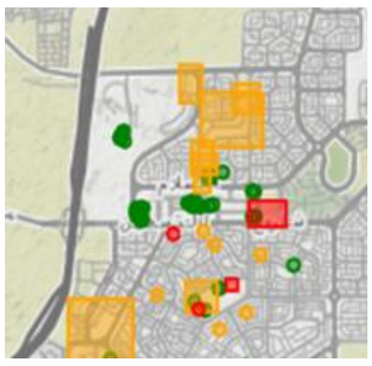
Air Pollution
- Asthma & Allergies
- Heart diseases
- Pre-mature deaths

Noise Pollution
- Stress & Sleep disturbance
- High blood pressure
- Hyperactivity & Fatigue

The related work mentioned in the literature was mainly focusing on measuring air pollution, using deep learning on real-time images, or sensors connected to the vehicle or the city infrastructure.
A few studies focused on noise pollution measurement due to its difficulty.
Ideas for reducing pollution were either using warning messages to the driver, fine payments, less speed limits, or decreasing number of vehicles travelling.
There is no ITS that aims at reducing air and noise pollution in cities via routing decisions based on city segments, pollution indicators, fixed thresholds, and real-time pollution level readings from both the vehicle and the city sides.

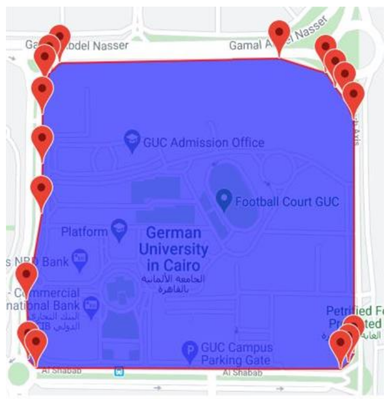
Methodology

1



Segmentation of city into 3 categories

2



A closer view of one of the segments, its borders and its different entry-exit points

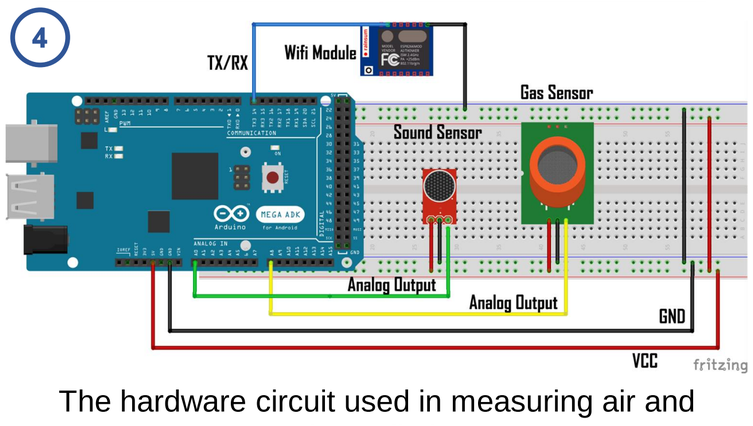
3

Algorithm 1: Routing Algorithm to get out of the city.

Input: Car's ID *uid*, Start Point *start*, Destination Point *dest*, Car's Pollution Level *carPoll*, City's Pollution Level *cityPoll*, City's Pollution Threshold *cityThresh*
Output: Routes *R*1, *R*2

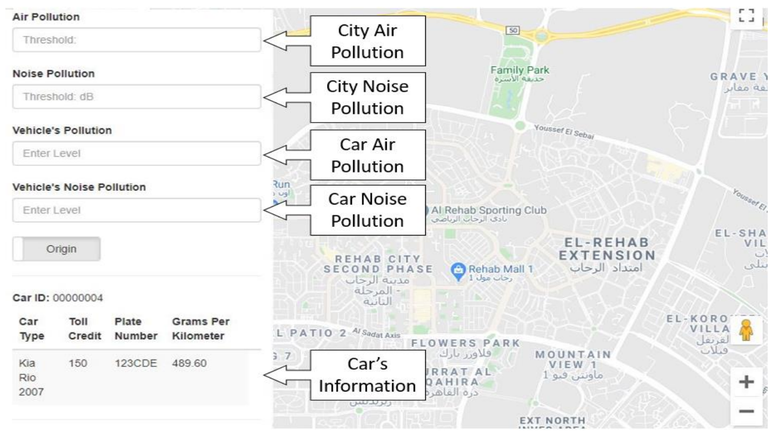
```
if (start inside city) then
    if (carPoll + cityPoll > cityThresh) then
        for Gate g in cityExitGates do
            Distance d = Distance between start and g
            Add Gate g with the minimum d to the Route R1 Way Points
        end for
    else
        R1 = Shortest Path
    end if
    R2 = Shortest Path
end if
return R1 and R2
```

4



The hardware circuit used in measuring air and noise pollution.

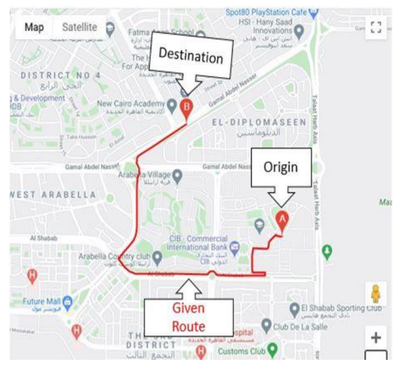
5

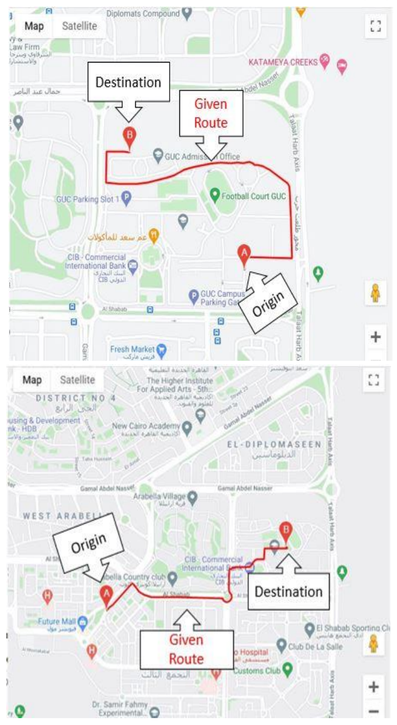


User Application

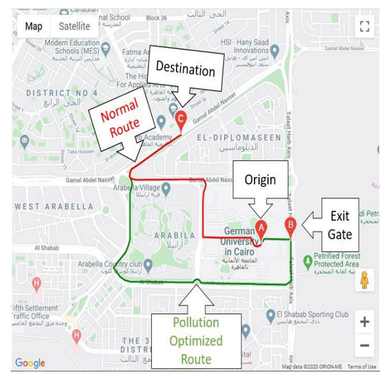
Results

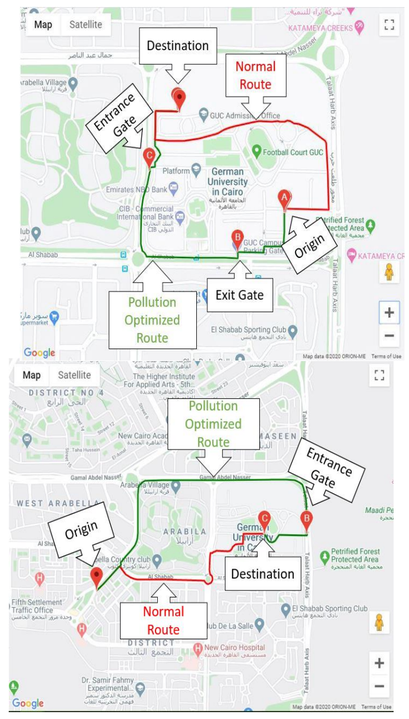
- Cases with low pollution levels





- Cases with high pollution levels





City was segmented into 3 categories:
1- Medical – with noise threshold of 30 dB
2- Education – with noise threshold 35 dB
3- Entertainment – with noise threshold of 85 dB
And all with the same air pollution thresholds, according to the WHO threshold for each of the emitted gases.

Conclusion

Because air quality and noise levels in urban cities have become major environmental concerns worldwide, managing road vehicles which are considered a primary source of air pollution and also a considerable source of noise pollution in urban cities becomes crucial. In this project, an ITS for Air and Noise pollution management in cities is proposed. Our ITS uses real-time pollution data to route cars based on the measured particle emissions and noise levels. Our system is divided into two layers: software and hardware. The software layer includes two different parts: the server side which is managed by an admin and where the city is segmented with air and noise pollution thresholds; and the user side which informs the driver about the pollution levels and the possible routes: city-pollution optimized and "normal" shortest route. Our system aims at helping in keeping the pollution of areas inside a city under a predefined threshold. To verify the feasibility of our approach, six different test scenarios were simulated and their outcomes were verified for one defined category.

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