DATA SET GENERATION FUNDING PROGRAM (WSAI)

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Project Title: Monitoring Air Quality inside an Automobile.

Project Topic Smart cities:

Principal Investigator: Ramkrishna Pasumarthy.

Co-Investigator:

Summary of the project : People spend most of their times in an indoor environment, such as homes, offices etc. Indoor environments may sometimes contain high particle concentration as opposed to outdoor environments. Exposure to short periods of high pollutant concentrations could be potentially harmful. Vehicle interior is one such environment where occupants are exposed to several materials used in the interior, ambient conditions, emissions from surroundings, recirculation being on or off and general cleanliness of the cabin. Additional factors include stopping at red lights, intersections with heavy traffic which have significantly higher concentration of PMs and other pollutants .The inhalation exposure to certain PMs, VOCs in addition to CO, CO2 etc also depends also on the duration of a particular drive. Some studies suggest that the air inside the cabin can many a times be toxic, or in other cases can be a serious health concern, ranging from elevated heart rate and blood pressure to increased risk of driver drowsiness. While these factors can be monitored and controlled in a provate car, the same may not be true while hiring cab services. Due to lack of efficient public transport across the country, one is more likely to use cab services very often, thus exposing oneself to large times in an uncontrolled, sometimes ill maintained in cabin enviroments of an automobile. While most of the cab service providers/ aggregators maintain driver rating, (largely based on user experience), there is no measure to rate the in cabin condition of a particular cab. In measuring in cabin air quality, a user rating need not be the most accurate and one must device more appropriate scientific measure to measure the in cabin air quality. The aim of this project is to measure Air Quality across several cab services and provide an index for cab air quality, thus enhancing user experience while hiring a cab service.

Duration: 9 months.

Funding requested in INR: 14.78L

Methodology and Materials:
The below Figure 1 lists various pollutants in the car with their sources. This is in addition to other sources such as food-spill, "new car smell", mindless use of car perfumes, and factors unclean air filter, lack of periodic servicing etc. Via these sensor modules, we aim to generate a comprehensive data lake across 1000 cab rides covering the following: (i) data collected in at least two cities, (ii)across several cab services, (iii) several levels (mini-comfort).
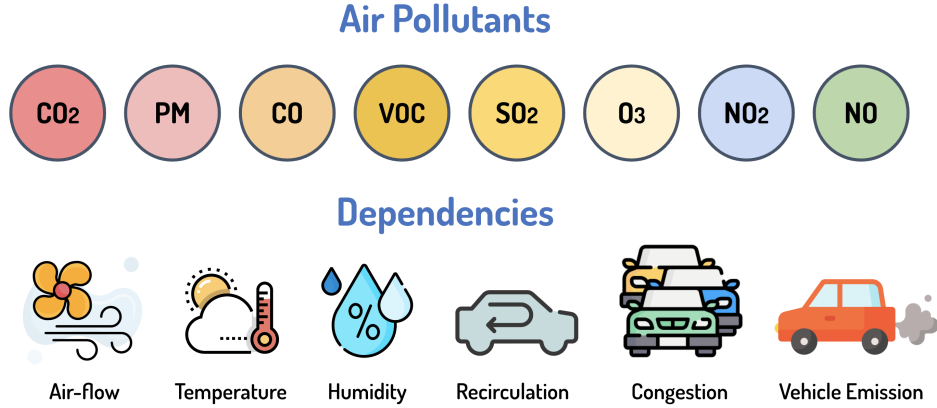
FIGURE 1. Various pollutants and their sources

With the collected data (and benchmarking with existing data) we aim to propose an CAQI (CabinAirQualityIndex), developed via data driven algorithms, which can be used to alert a driver/user under unsafe in cabin conditions.

Important facilities required for data generation and curation (include those available and those to be acquired with project funds):
We have developed and rigorously tested a hardware module, for a related project, with specific sensing capabilities as shown in Figure 2
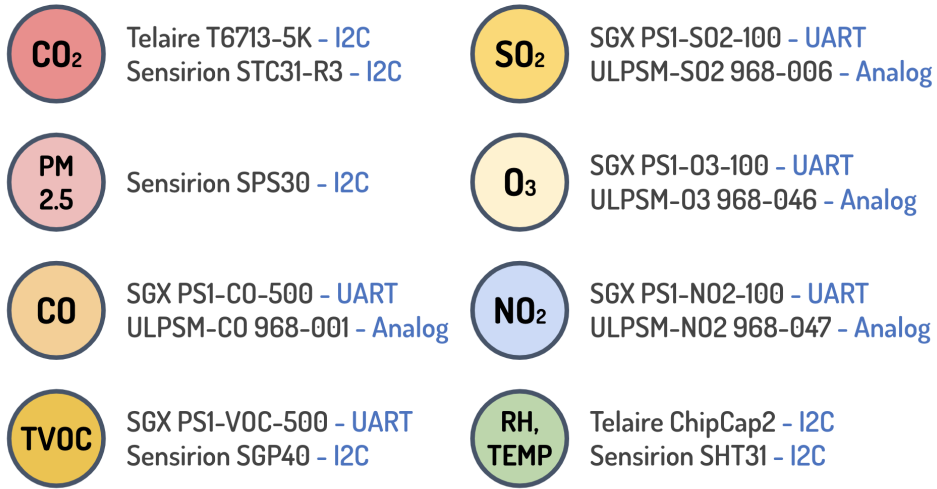

FIGURE 2. Sensing Capabilities

What has driven or motivated this project?
First motivation was a project from a car company Stellantis, whose objective was generate a data lake and develop data driven algorithms for In-cabin condition monitoring, which is crucial with regards to the Safety, Health and Comfort of the driver and occupants. While

a large part of the project was devoted to being able to accurately detect driver state of mind and health can prevent serious accidents, another important aspect was to measure and thus provide in cabin climate comfort and infotainment personalisation for better driving experience and safety. While conducting related literature survey on the project we found that although numerous research studies have been conducted on determining gases that affect humans, more conclusive work was needed to specify the gases and air quality parameters within road vehicles affecting the driver and other passengers. Therefore, it is necessary to identify the air quality parameters and gases in a car's cabin and their variations under different ambient and interior conditions. Some studies (3) found that only 24% of the cars passed the AQI test. This motivated us to deploy and test these platforms across several cab service providers/ aggregators.

On similar lines our initial findings show large concentrations of CO_2 and PM2.5, inside the cabin which can impact driving behaviour. Additionally the measured concentrations of VOC and CO indicate measuring them is necessary in derviring an over all AQI for in cabin conditions. These findings motivated the need for the need for further studies related to interior air hygiene in cabs.

Has any such/similar work/kind of been carried out by the investigators or elsewhere?
A project by a car company called Stellantis, as mentioned above. In this particular project, we pick on a small module of the project related to in cabin air quality under different driving conditions, with particular focus on can services within a city.

What is the risk involved in such a project? There is no physical risk involved in the project. We are not sure if we need to get prior permissions of the cab service providers/ aggregators in conducting such an exercise. We however, expect to overcome this possible hurdle.

What could be the possible outcomes or breakthroughs (though there could be uncertainties)? If the study is successful, one can aim to sell such devices to cab service providers/ aggregators and help them deliver better service to customers, in terms of better in cabin climate comfort.

Can further research/funding be expected based in this work? The developed sensor modules can be further applied to study conditions in other indoor environments such as office spaces, cinema halls, shopping malls, restaurants, airports, metro trains among several others.

Budget for the project:
Sensor Modules (3): INR 4.5L
1000 cab rides (@500 per ride): 5L
Project Staff (@42k per month) 3.78L
Contingencies and Consumables: 1.5L
Total: 14.78L

References

(1) Joanna Faber, Krzysztof Brodzik, "Air quality inside passenger cars", AIMS Environmental Science, 4(1), pp. 112-133, 2017.

(2) Tartakovsky, L., V. Baibikov, J. Czerwinski, M. Gutman, M. Kasper, D. Popescu, M. Veinblat, and Y. Zvirin , " In-vehicle particle air pollution and its mitigation. Atmospheric environment", 64, 320–328, 2013.

(3) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6650813/