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Carbon Dioxide Filtering Module

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***Abstract*: In this paper, we have designed a carbon-dioxide filtering module placed on the rooftops of private and public vehicles in order to purify the ambient air thereby reducing global warming and other pollution related health hazard. In this paper we plan to design and present a solidworks design of our prototype along with few of its applicabilities.**

***Keywords*: Carbon dioxide, filter, pollution, solidworks designing.**

1. Introduction

In this paper, we have designed a carbon-dioxide filtering module placed on the rooftops of private and public vehicles. The module would be adapted enough to filter out pollutants such as PM 2.5 and PM 10 and gases such as CO2 from the ambient air, thus reducing the CO2 levels. The module is designed to filter out a greater quantity of Carbon-dioxide than what is generated by the Vehicle. Once removed from the atmosphere, the carbon would be collected and could be used by ink and plastic manufacturing industries as raw materials.

The air suction inside the module would be carried out in 2 ways- Forced and Automatic. Forced suction would take place when the vehicle is at rest. The module would consist of twin propellers for letting the air into the filter assembly. When the vehicle is in motion, having a certain velocity, automatic suction would take place through the filters, thereby making our product fully energy efficient.

The primary feature of our module includes:

- Energy Efficiency: Our module would rely on its solar panels to power all its electronics
- Carbon Negativity: Since the vehicles equipped with our module would filter more CO2 than they produce, the filtered carbon would be reused.
- Live CO2 Level Monitoring: The CO2 sensors placed within our module would help govt. Monitor live CO2 levels using IoT.
- Easy to Implement: The module does not require any significant technological development and could readily be deployed with the help of major policymakers and companies.
- Low Cost: The module is designed to make it pocket-friendly for the user.

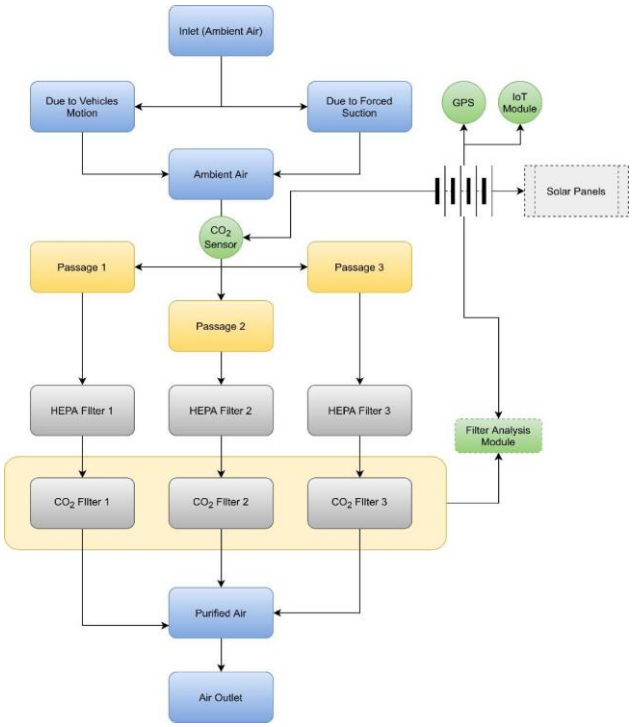

Fig. 1. Block diagram

2. Methodology

The module was designed considering several factors including,

1. *Ease of Integration:* To facilitate the deployment of our module on a large scale it was essential to design it in such a way that it could be used on vehicles of all shapes and sizes. Our module could easily be placed within the roof-top carriers hence eliminating the need of any special fixtures.
2. *Efficiency:* Prime focus was given to make our design highly energy efficient. We have also placed the solar panels on the top surface of the module, together with a battery for storing the clean source of energy. IMU was used to detect the motion of the vehicle, based on the data provided the speed of the suction fans was varied ranging from 0 (when the car vel > 10km/hr) to max (when the car was at rest). This optimized the consumption hence increasing the battery life per cycle
3. *Production Cost:* In order to make the product affordable several modern production methods were considered. We

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finally decided to use methods like vacuum molding and 3D printing to manufacture the module, as they cut down production time and cost while maintaining the quality.

4. *Serviceability:* Ease of servicing is a major factor when it comes to designing a product like this. We designed the module in such a way that all of its internal components could readily be accessed thereby reducing the service time.
5. *User Comfort:* The user could easily mount and dismount the module from the vehicle. Providing the user, a choice of using the module as and when he seems fit.

3. Modeling and Analysis

We have built a module that will be mounted on the roof of the vehicle and will have standard dimensions, allowing our product to be compatible with the majority of four-wheel vehicles.

It primarily consists of filters, rotors, vibration setup, residue collection section, among other things.

Our module is equipped with 2 modes of suction- forced and automatic. We have added twin propellers for when the vehicle is at rest, they would force in air from the atmosphere to pass in the filter assembly. When the vehicle is in motion, having some certain velocity, the air from the atmosphere would automatically go through the filter, thereby making our module energy efficient and independent.

We have also placed the solar panels on the top surface of the module, together with a battery for storing the clean source of energy, in order to achieve a NET ZERO INITIATIVE, which is a net zero energy initiative.

The rotors will come into action during stationary conditions, and while moving, the rotors slow down there

During the working condition, the carbon residue stuck on the surface of the Carbon filters will be removed with the help of a vibratory setup that uses to and fro motion, and at the end of the process, the sliding collection section located just below the filter will collect the residue with ease, as shown in the diagram. At the end of the process, the waste will be recycled as a raw material for road construction and other uses.

The overall electronics of Breathe is based on the ESP32 module through our custom built PCB. It is connected to the google cloud via Wifi and to our mobile phones via bluetooth. Propeller speed monitor and filter health data is published on the cloud along with vehicle speed and location. This enables us to implement ML models on our custom Firebase server predicting user behavior.

Solar panels provide 50 Watts per hour of energy which is stored in our 7.4V LiPo batteries providing a continuous runtime of more than 10 hrs per charge. The propellers run at a high speed of 20 thousand RPM providing great suction power. The IMU and GPS integrated module provide precise speed and location of our vehicles to be sent to the cloud. Modularity is achieved by using dual CO2 sensors one for Ambient air and the other for Filter health.

1. This is our sensor setup for the initial iteration.
2. The sensor data is published on the cloud using the module.
3. Here is a snip of our code base of sensor and the website.
4. The GUI of our website can be seen here, the graphs and charts provide better readability.

We in our project plan to use a single compound filter with HEPA filter on one side and activated carbon filter on the other. High-efficiency HEPA filter that removes any microscopic pollutant and allergen above 0.3 microns including PM 2.5 and pollen. Activated carbon filter that removes formaldehyde, toxic gasses, VOCs and odor. Activated carbon acts as a carbon dioxide scrubber. Environments with high levels of carbon dioxide benefit from using an air purifier with an activated carbon filter.

We intend to use XAMPP and phpMyAdmin to deliver our co2 sensor data to a MySQL database, from which we will develop a full-fledged web application informing the administrator about the co2 level in a certain area. They can use this data to develop long-term strategies such as increasing public transportation or installing co2 scrubbers in areas with high co2 concentrations.

As a short-term solution, we can connect the traffic signals to a central server using IoT, which can access the sensor's data. When a certain location detects excessive CO2 concentrations, the signals following it might be set red to relieve traffic first, which would enhance air quality.

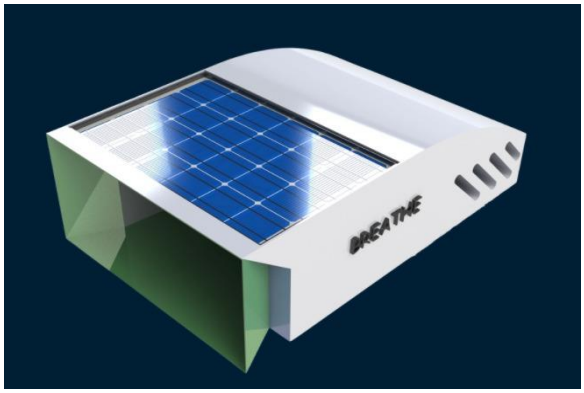

Fig. 2. Breathe

4. Results and Discussion

Whenever the product enters a market, it has several competitors to face and amidst the competitors, the product has to position itself in such a manner that it holds some part of the market share.

Our model can refresh stale air, reducing the chances of health issues caused by outdoor pollutants.

In this project we plan to target:

- Government
- Private companies
- And potential customers.

After evaluating all the necessary steps, we now take a look at the budget. So, the Overall budget of our product is approximately 12,000 which comprises of 3,000 for battery and Solar panels, 3500 for filters, 2500 for 3d printing, 1000 for sensors, 500 for propeller and 400 for microcontroller and 1000 miscellaneous.

5. Conclusion

Creating a vision and mission allows your team to take a top-down approach to your product's development.

Our vision is to reduce carbon dioxide from the atmosphere.

Our mission is to protect people, processes and environment be defining and delivering solutions that combine clean air with energy efficiency in sustainable and profitable way.

References

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