ONYX

PERFECTUS ELITS

Vaibhav Jhangania (Mentor)

Mohammad Saad (Team Member)

Mehtab Aalam (Team Member)

RPVV YAMUNA VIHAR, DELHI

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ABOUT TEAM

MOHAMMAD SAAD:

A skilled programmer with a strong interest in physics. His deep knowledge of programming and significant experience make him a valuable asset in this project. Recently, in his role as a programmer, he played a crucial part in identifying the problem statement and developing the core idea. His contributions were essential in shaping the project's foundation, demonstrating his talent for both practical application and innovative thinking.

MEHTAB AALAM:

A individual with a strong background in designing structures and creating circuits for robots. As a experienced guy, he brings a unique perspective to his work. In this project, Mehtab was instrumental in identifying the problem and understanding its consequences. His ability to combine his technical skills with his knowledge allowed him to tackle challenges effectively and make significant contributions to the project's success. His proactive approach and dedication make him an indispensable asset to the project team.

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SUMMARY

Executive Summary:
The project aims to address the critical issue of air pollution, specifically targeting fine particulate matter (PM2.5 and PM10) which poses significant health risks globally. The proposed solution is a cost-efficient air purification system utilizing electrostatic forces generated through friction without high voltages. This system, incorporating sensors and a webpage for monitoring performance, aims to efficiently remove particulate matter from the air, offering a low-maintenance alternative to existing technologies such as HEPA filters. The project's success could lead to significant reductions in air pollution-related health issues and premature deaths.

Problem:
The project addresses the pressing global health concern of air pollution, which is responsible for an alarming 7 million premature deaths annually. This issue was chosen due to its profound impact on public health and its alignment with the United Nations Sustainable Development Goals, highlighting its urgency and significance.

Robotic Solution:
Our innovative robotic solution harnesses electrostatic force generated through friction to combat air pollution, specifically targeting fine particulate matter such as PM10 and PM2.5. Setting it apart from existing solutions, our method operates without the need for high voltages, thereby minimizing the risk of harmful ozone production. Furthermore, our solution boasts an efficiency monitoring system, providing valuable insights into maintenance requirements and overall performance, ensuring sustained effectiveness and durability.

Benefits:
The primary advantage of our robotic solution lies in its unparalleled effectiveness in reducing fine particulate matter in the air, mitigating major health risks associated with respiratory diseases and shortened life expectancy. Moreover, our solution offers substantial cost savings and requires significantly less maintenance compared to conventional HEPA filters, making it both economically viable and sustainable in the long term.

Impact:
Upon implementation, our robotic solution holds the promise of a transformative impact on public health by substantially lowering death rates and mitigating health issues linked to air pollution. By fostering cleaner air and a healthier environment, our solution has the potential to enhance the well-being of communities worldwide, marking a significant step towards achieving a sustainable and thriving future.

PROBLEM STATEMENT

Air pollution is currently the most significant environmental threat to public health, contributing to approximately 7 million premature deaths each year. Fine particulate matter (PM), such as PM2.5 and PM10, are the primary pollutants responsible for this crisis. These particles are capable of infiltrating deep into the lungs and bloodstream, leading to severe health conditions including stroke, heart disease, lung cancer, and respiratory infections.

PM2.5, with a diameter of 2.5 micrometers or less, and PM10, with a diameter of 10 micrometers or less, are particularly dangerous due to their small size, which allows them to penetrate deep into the respiratory system and enter the bloodstream. The sources of these particulates are diverse and include transportation, industrial processes, residential heating, construction sites, wildfires, and wind-blown dust.

The intersection of air pollution and climate change further complicates this scenario. Both issues share common sources and exacerbating factors, creating a vicious cycle that intensifies their respective impacts. Addressing air pollution, therefore, not only improves public health but also contributes to combating climate change. This makes air pollution a critical area for intervention, with dual benefits for public health and the environment.

How the Problem is Associated with the Theme:

As both air pollution and climate change are primarily caused by the burning of fossil fuels, actions taken to ensure clean air are often synonymous with climate action, aligning with Sustainable Development Goal (SDG) 13. Implementing solutions to improve air quality, such as transitioning to renewable energy sources and adopting cleaner transportation options, directly reduces emissions that contribute to both air pollution and climate change.

Moreover, reducing air pollution is essential for achieving SDG 12, which promotes responsible production and consumption. This involves minimizing emissions from transportation, waste burning, and industrial activities. Cleaner production methods and more sustainable consumption patterns can significantly reduce pollutants released into the atmosphere.

Clean air also supports SDG 15, which aims to protect and promote sustainable use of terrestrial ecosystems and halt biodiversity loss. Air pollution can severely damage ecosystems and biodiversity, affecting plants, animals, and microorganisms. By reducing air pollution, we help protect these species and maintain healthy ecosystems.

In summary, addressing air pollution is not only a matter of public health but also a crucial component of sustainable development. Efforts to improve air quality align with and support multiple SDGs, making it an essential area of focus for ensuring a healthier, more sustainable future.

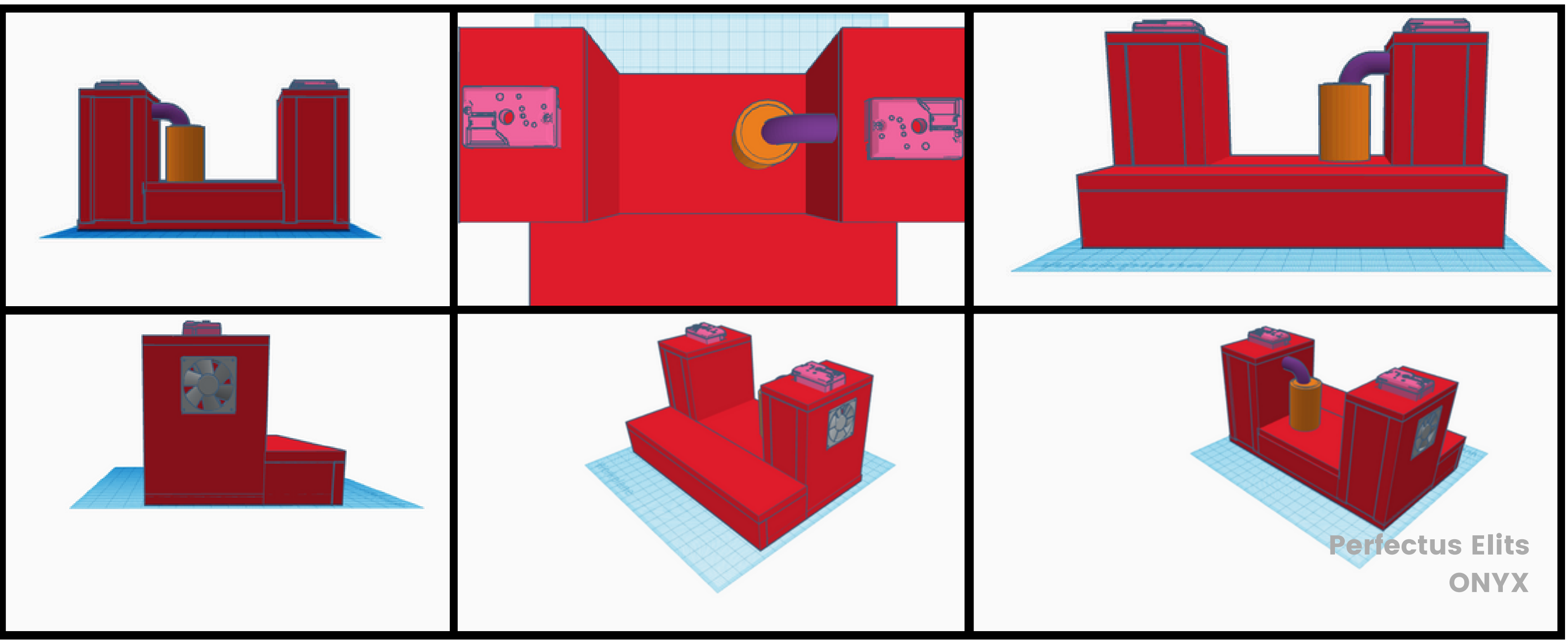
SOLUTION & DESIGN

The proposed solution involves the development of a cost-efficient air filtration system that utilizes electrostatic forces generated through friction, eliminating the need for high voltages and thus avoiding the associated risks of ozone production. This innovative system employs a motor to create a consistent electrostatic force between the nylon brush and friction plates, enabling the effective capture of fine particulate matter such as PM2.5 and PM10.

Key features of this system include the integration of sensors to measure the concentration of particulate matter at both the input and output, with data being updated to a webpage for performance analysis and visualization. Additionally, the system is equipped with controls for adjusting the motor's RPM to optimize efficiency. This allows for real-time adjustments to ensure the most effective filtration performance.

This solution offers a lower maintenance and cost-effective alternative to traditional HEPA filters, which are expensive and require regular replacement. By utilizing friction-generated electrostatic forces, the system significantly reduces the operational costs and maintenance requirements associated with air filtration.

The implementation of this technology can have a substantial impact on reducing air pollution. By effectively capturing harmful particulates, the system helps improve public health by reducing the incidence of respiratory and cardiovascular diseases. Furthermore, by addressing a major source of pollution, this solution also contributes to climate change mitigation efforts. Overall, this innovative air filtration system presents a promising approach to tackling air pollution and its associated health and environmental challenges.



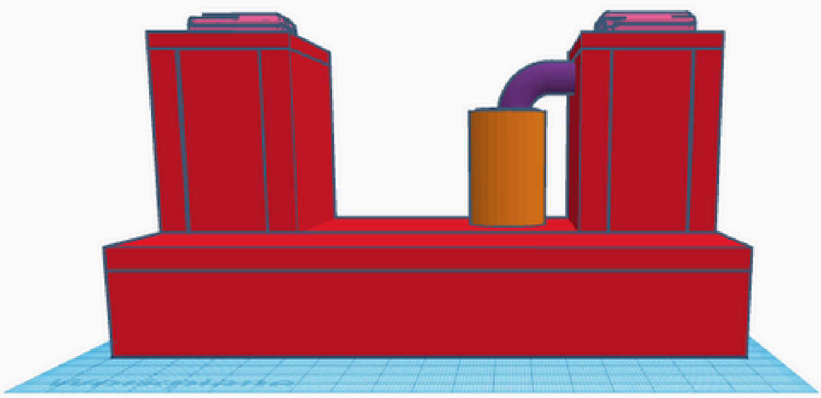
WORKING PRINCIPLE & PROGRAMMING

From the right inlet structure, air will enter the robot device where the concentration of particles will first be measured. This initial measurement establishes a baseline for the particulate matter present in the air. Next, a mist is introduced into the device through a pipe, transforming the air into an aerosol form, which is necessary for the filtration process. Once the air is in aerosol form, it will pass through the filter system. Here, a nylon brush rotates against a PVC frictional plate, generating electrostatic energy. This electrostatic energy is crucial as it effectively captures and filters out particulate matter from the air. As the air passes through this filtration stage, it becomes significantly cleaner.

After passing through the filter, the air will exit through the outlet structure. Before the air is released, the concentration of particulate matter is measured once more to ensure the filtration process's effectiveness. This updated data on particulate matter concentration is then transmitted to a webpage, allowing for real-time visualization and analysis of the air quality improvements achieved by the device. Additionally, users can control the motor's RPM to optimize the filtration performance, making adjustments as needed based on the data provided. This integrated approach ensures that the device operates efficiently, providing a cost-effective and low-maintenance solution for reducing air pollution and improving public health.

Programming of solution:

The coding involves C++, JS, HTML, and CSS. An access point server is set up to extract data from sensors, which is then sent to an endpoint via POST request. The data is visualized using Chart.js.



EXISTING SOLUTIONS & DIFFERENCES

High-efficiency particulate air (HEPA) filters are considered among the best solutions for air purification, capable of eliminating no less than 99.97 percent of particles in the 0.3 micrometer-diameter-and-above range, with even higher efficiency for larger or smaller particles. This ensures an exceptional level of air purification by trapping various particulates effectively. However, despite their high performance, HEPA filters have notable drawbacks. They are expensive and require regular replacement, leading to high maintenance costs. Additionally, HEPA filters cannot remove volatile organic compounds (VOCs), which are airborne chemicals often derived from building materials and cleaning products, some of which are known carcinogens. HEPA filters also fail to capture ozone (O3), a harmful gas that can react with VOCs to form extremely small particles capable of penetrating deep into the lungs and bloodstream. Moreover, while HEPA filters are effective against many allergens like pollen and pet dander, very small allergenic fragments can still penetrate the filter and remain in the air, potentially triggering allergies and asthma.

Differences:

Our solution offers a cost-efficient approach to air purification by using electrostatic energy to remove particulate matter. It includes an efficiency monitoring system that allows users to track and optimize performance, with efficiency varying based on factors such as the motor's RPM. This solution requires low maintenance, with maintenance costs kept to a minimum. However, it does necessitate a manual filter brush change every 2-3 months to ensure continued effectiveness.

In contrast, HEPA filters are high-cost products that utilize methods such as inertial impaction, interception, diffusion, and sieving to remove particulate matter. HEPA filters do not include an efficiency monitoring system and maintain a typically constant efficiency of about 99.7%. Although they are highly effective, HEPA filters require periodic maintenance, which can be costly. Unlike our solution, HEPA filters do not need frequent filter changes, offering a longer service interval between replacements.

DEVELOPEMENT

Material	Price
ESP8266 NodeMCU x1	285.00
BO Motor x1	57.00
L298N Motor Driver Module x1	101.00
PVC Friction Plate x2	100.00
Nylon Brush X1	229.00
Mist Generator x1	299.00
DSM501A Sensor x2	914.00
Fans x2	100.00
Building Material Such As Wood Or Aluminium	200.00
Total	2355.00

Our solution is cost-efficient at approximately 2355 Rs, less than one-fourth the price of a HEPA filter.

SOCIAL IMPACT

Impact of the Solution for Society:

The implementation of the proposed air filtration system can have a profound impact on society by significantly improving air quality and public health. By effectively removing harmful particulate matter such as PM2.5 and PM10 from the air, the system can reduce the incidence of respiratory and cardiovascular diseases, lung cancer, and other health issues associated with air pollution. This reduction in health risks can lead to fewer hospital visits, lower medical costs, and increased life expectancy. Moreover, cleaner air can enhance overall quality of life, contribute to environmental sustainability, and support efforts to combat climate change by addressing common pollution sources .

Who Will Help & How Important Is It:

The development and deployment of this air filtration system will require collaboration between various stakeholders, including environmental organizations, public health agencies, government bodies, and the private sector. Environmental organizations can provide expertise and advocacy, while public health agencies can offer data and insights on pollution-related health impacts. Government bodies can support through funding, regulations, and policies that promote clean air initiatives. The private sector, including companies specializing in air purification technologies, can contribute through research, development, and commercialization efforts. The importance of this collaboration cannot be overstated, as it ensures a comprehensive approach to addressing air pollution, leveraging diverse expertise and resources to maximize the solution's effectiveness and reach .

Concrete Example of Use:

A concrete example of how and where this air filtration system could be used is in urban areas with high levels of air pollution, such as major cities in developing countries. For instance, in cities like Delhi, India, where air quality frequently reaches hazardous levels, the system could be installed in public buildings, schools, hospitals, and residential complexes. By doing so, millions of residents, including vulnerable populations such as children, the elderly, and individuals with pre-existing health conditions, would benefit from cleaner air. Additionally, workplaces and commercial spaces could adopt the technology to protect employees and customers, thereby improving productivity and public health on a broader scale .

LIST OF SOURCES

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