Title: "Chalk Dust Extraction and Cleaner: A Health-conscious Solution"

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Abstract: This paper endeavours to address the health risks associated with prolonged exposure to chalk dust by designing a device capable of efficiently cleaning blackboard dusters. While ingesting a piece of black chalk poses minimal health hazards, continual inhalation of airborne chalk dust can exacerbate respiratory issues. Employing principles of product design and development, this solution integrates automated duster cleaning and dust collection functionalities. Advancements in technology necessitate enhanced performance to meet market demands and alleviate human labour. By simplifying the cleaning process and facilitating proper disposal of chalk dust, this innovation aims to mitigate health risks associated with airborne dust particles, thus promoting a safer educational environment.

Keywords: Chalk, Health, Dust, Environment

Introduction:

Over the past few decades, there has been a surge in educational institutions and a push for comprehensive literature instruction, leading to increased usage of chalk and blackboards. While blackboard instruction remains effective in achieving learning outcomes, the traditional method of using a duster to clean the blackboard presents challenges. Although the duster effectively collects dust from the board, disposing of this dust poses a significant problem. Simply tapping the duster in an open area results in dust accumulation on surrounding surfaces, leading to allergies and skin conditions when inhaled.

While projectors have become more prevalent in classrooms, they are often impractical and require complex procedures. Therefore, a new device has been developed to provide the simplicity and convenience of a blackboard cleaner. However, a significant challenge arises when it comes to cleaning the duster rubber. While writing on the board is a straightforward process, erasing becomes increasingly difficult as the duster rubber becomes saturated with dust over time, necessitating cleaning.

Typically, the need to clean the blackboard arises during the instructor's lecture. However, traditional methods of cleaning, such as tapping the duster against a wall, generate a considerable amount of chalk dust. This not only creates noise and damages the texture of the wall but also makes the classroom dusty. Moreover, the inhalation of chalk dust can lead to respiratory problems such as bronchitis, asthma, and lung disorders, or cause eye irritation if it comes into contact with them. Thus, there is a pressing need for a more efficient and less hazardous method of cleaning the blackboard and maintaining a healthy learning environment.

Research indicates a higher incidence of respiratory problems among industrial employees involved in the production of limestone, the primary component of natural chalk. A study conducted in Spain found that frequent use of chalk or erasers, particularly when shaking them, was associated with an increased risk of respiratory issues. Chalk composition typically includes gypsum (dehydrated $CaSO_4$) and/or limestone ($CaCO_3$), whether in dusty or dustless forms. Additionally, trace amounts of substances like starch, polyvinyl alcohol, kaolinite (hydrated aluminum silicate), and CMC are present. In the case of coloured chalks, dyes and pigments, which may have toxic properties, are added to the mixture.

With this study, our aim to develop a practical method for effectively collecting duster dust and preventing its dispersion, thereby mitigating associated health risks.

Despite the evolving educational landscape, with advancements like digital tools and online learning, many schools and institutions still rely on traditional methods such as chalkboard instruction. According

to our survey, chalkboard instruction remains the preferred and most efficient method of teaching in the majority of institutions. However, there are concerns regarding health risks associated with traditional chalkboard cleaning methods. To address this issue, many schools may consider installing the device we are developing, which aims to efficiently collect duster dust and minimize health risks. While some countries offer advanced solutions such as automated board cleaners and hoover erasers, these options often come with high product costs and installation fees, making them less accessible in the Indian market.

To ensure competitiveness in the Indian market, our focus includes not only developing an effective product but also minimizing its cost. By prioritizing affordability without compromising quality, we aim to make our device accessible to a wide range of schools and institutions, thereby contributing to improved learning environments and overall educational development in the nation.

The primary objective of this project is to design a system capable of automatically removing chalk dust from a traditional blackboard duster, thereby protecting both instructors and students from harmful dust particles. Currently, manual methods such as tapping or cutting the duster are employed, which effectively remove the dust but disperse it into the air, posing health risks when inhaled or irritating the eyes upon contact.

The proposed solution involves developing an automated system that utilizes electrical mechanisms for duster cleaning. Once the duster is securely positioned within the system's holders, no further human intervention is required until the cleaning process is complete. The entire system is enclosed to prevent dust exposure to the environment.

The proposed system aims to achieve 100% efficiency in removing all dust particles from the duster and collecting them for disposal. This ensures thorough cleaning without leaving any residue behind. By automating the cleaning process and enclosing the system, it eliminates the need for manual handling of dust-laden dusters, thereby minimizing the risk of inhalation-related health issues for both instructors and students. The automated operation of the system reduces the time and effort required for duster cleaning compared to manual methods. Once the duster is placed in the holders, the system handles the rest of the cleaning process autonomously.

The main aims to develop an efficient, safe, and convenient solution for removing chalk dust from blackboard dusters, thereby improving the overall classroom environment and ensuring the well-being of instructors and students.

Literature:

In educational settings, blackboards serve as fundamental tools for instructional purposes and are integral to creating an effective learning environment. Traditionally, instructors use chunks of chalk to write on blackboards. The process of erasing the blackboard typically involves manual manipulation of a handheld instrument called a "duster." Alternatively, some utilize blackboard cleaning with a moist cloth, although this method is primarily reserved for situations where immediate reuse of the blackboard is unnecessary. Despite efforts to improve the materials used in erasers, the physical manipulation of the eraser remains necessary for erasing the blackboard effectively [1].

This literature review provides a foundation for exploring the development of a product aimed at automating the cleaning process of blackboard dusters. By examining current theories and technical data, it aims to identify opportunities for innovation and improvement, ultimately enhancing efficiency and convenience in classroom environments.

In addition to the task of erasing the blackboard, the conventional methods mentioned also result in the dispersion of chalk dust into the air, creating a messy classroom environment. The inhalation of chalk dust

particles, which are composed of tiny bits of chalk used during erasing, can pose risks to respiratory health, particularly for individuals with asthma or dust allergies. Consequently, students with such conditions are advised to avoid sitting near the chalkboard. A case study was conducted to highlight the adverse effects of chalk dust accumulation on respiratory health, including complications such as respiratory issues, hair loss, and eye-related disorders [2].

According to research and medical reports from specialists and physicians, many instructors are unaware of the health risks associated with chalk dust. Chalk generates airborne dust, including nanoparticles and submicron particles that can be inhaled into the respiratory system. As a precaution, it is recommended that both instructors and students wear face masks and maintain a safe distance from the blackboard while chalk is in use. Additionally, alternative teaching methods such as slides, videos, digital whiteboards, and electronic tools are suggested to mitigate air quality issues caused by chalk dust [3].

While dust-free chalk is available, it still produces some chalk dust compared to regular chalk, leading to the need for regular cleaning of the duster used for blackboard cleaning. Mechanical engineering controls, as described by Yang, S. Z., and Chong, Y. K., offer potential solutions to minimize chalk dust accumulation in classrooms. Ventilation strategies, such as keeping doors open and using ceiling fans, can help reduce dust levels during class sessions [4].

To address the challenges posed by chalk dust in classrooms requires a combination of awareness, precautionary measures, alternative teaching methods, and mechanical controls to ensure a healthier learning environment for both instructors and students.

In today's rapidly evolving world, various new technologies are being employed to enhance productivity in minimal time with high cost due to that many institutions will not afford for that. Thus, the proposed method will help with very minimal cost and saves valuable time of instructor in the cleaning process by contributing overall efficiency.

Methodology:

The designed system allows for the placement of the duster within a closed-loop mechanism, mimicking the manual dusting process while containing the dust within the system. By utilizing this closed-loop design, the system effectively collects and traps the dust inside a sealed box, preventing its dispersion into the atmosphere. This containment feature is crucial in mitigating health issues associated with dust allergies, as it ensures that dust particles do not escape into the surrounding environment. The proposed design structure is shown in fig 1.

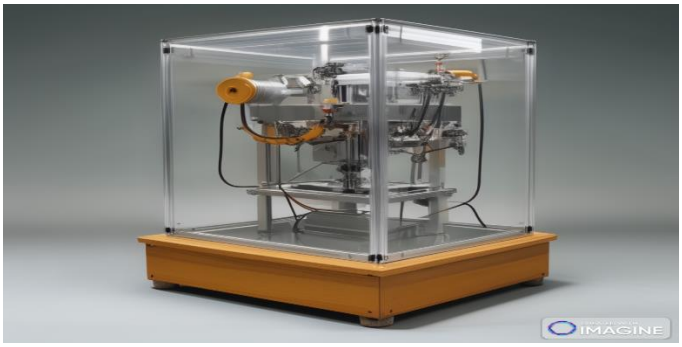

Fig1. 3D structure of proposed dust cleaner from the duster

Furthermore, by confining the dust within the system, the risk of respiratory irritation and other health concerns related to dust exposure is significantly reduced. This proactive approach to dust management promotes a healthier and safer learning environment for both instructors and students.

The designed closed-loop system not only streamlines the dusting process but also prioritizes health and safety by effectively containing and managing dust within the system, thereby minimizing the risk of adverse health effects due to dust allergies.

Results & Discussion:

Here proposed mechanism where the duster undergoes an automatic cleaning process, possibly involving a hammer-like action to dislodge accumulated dust. The conceptual design for the automated duster, outlining how the hammer-like mechanism will function to clean the duster and engage mechanical engineers to design the specific components needed for the self-cleaning mechanism, considering factors such as durability, efficiency, and safety. Integrate the self-cleaning mechanism into the overall design of the automated duster, ensuring seamless operation and compatibility with other components. The development of an automated duster with a hammer-like self-cleaning mechanism, ultimately creating a product that meets the needs of users while effectively removing dust from surfaces.

Conclusion:

The development of an automated duster that operates similarly to an automatic hammer for self-cleaning purposes represents a significant advancement in cleaning technology. By incorporating a hammer-like mechanism into the duster design, the system can effectively dislodge accumulated dust particles, ensuring efficient and thorough cleaning without the need for manual intervention.

Through conceptual design, mechanical engineering, prototyping, testing, and optimization, we have refined the concept of the automated duster to create a practical and effective solution for removing dust from surfaces. The integration of user feedback and safety considerations has further enhanced the usability and reliability of the automated duster, making it suitable for various applications in both residential and commercial settings.

The implementation of this innovative cleaning technology not only streamlines the cleaning process but also promotes a healthier and more hygienic environment by reducing the spread of dust particles. With proper documentation and training, users can easily operate and maintain the automated duster, ensuring long-term performance and satisfaction.

Overall, the development of an automated duster with a hammer-like self-cleaning mechanism represents a significant step forward in cleaning efficiency and convenience, offering a practical solution for maintaining cleanliness in homes, offices, schools, and other environments.

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