Research in Health Science
ISSN 2470-6205 (Print) ISSN 2470-6213 (Online)
Vol. 10, No. 1, 2025
www.scholink.org/ojs/index.php/rhs

Original Paper

Stm32-based Mask-assisted Respirator - Portable Ventilated and Scented Masks

Hongtao Deng[1]

[1] Faculty of Petroleum Engineering, Xi'an Shiyou University, Xi'an, China

Received: January 13, 2025 Accepted: February 12, 2025 Online Published: February 20, 2025

doi:10.22158/rhs.v10n1p40 URL: http://dx.doi.org/10.22158/rhs.v10n1p40

Abstract

The STM32-based portable ventilated and scented mask is an innovative respiratory aid designed to enhance the comfort and breathing efficiency of the wearer. Adopting independent separated design, the core components include air dispenser and air inlet to realize intelligent air control. The air dispenser detects breathing speed and frequency, and the air inlet adjusts the air flow according to the analyzed results to ensure smooth breathing. The device adopts a multi-layer structure to provide multiple protection: the filter cover is used to initially block dust, the filter mesh enhances the filtration effect, and the intelligent fan adjusts the wind speed to realize auxiliary air exchange. The housing is equipped with an indicator light to show the status of the device, a lithium battery to provide long-lasting power, a circuit board that integrates a variety of intelligent functions, and a connector to ensure air circulation. The device is lightweight and the snap-on design makes installation quick and easy, taking less than 10 seconds. Compared with other smart masks, this product is affordable and aims to let more people enjoy the convenience of technology. The design not only improves wearing comfort, but also potentially extends wearing time. With the intelligent wind control function realized by STM32 microcontroller, the device is equipped with efficient computing power and stability performance. The power management system is optimized to provide powerful functionality while keeping power consumption low. With significant advantages in design, functionality and affordability, the device will provide users with an efficient, comfortable and intelligent breathing assistance solution.

Keywords

portable, mask, respiratory assistance, innovative design

1. Introduction

In today's market system, protective equipment has become a huge demand point, with a vast sales market, so the new intelligent protective products have a good space for development. With the continuous development of the current situation, the demand for intelligent protective products will continue to increase, which will make the sales market of intelligent protective products become more and more broad. In the past, masks were nothing more than a non-essential item for a few people, but with the normalization of epidemic prevention and control, masks have become a necessity for every household in China. Since 2017, the national annual mask usage has climbed year after year and has seen a super-substantial increase in the aftermath of the epidemic in late 2019. Masks are mass-produced and in short supply, and the problems of mask use method, use time, use effect, and use experience have become increasingly serious, and it is for this reason that the country is in urgent need of auxiliary-type products used to assist mask use, in order to solve the supply problem of masks and the demand problem of masks.

With the gradual emergence of the problem of traditional masks, caused a lot of enterprises and companies to pay attention to, which makes a lot of companies put their energy into the development and production of new masks, however, compared to the traditional masks, the price of new masks is much higher than the traditional type of masks. In contrast, the new masks on the market can solve some of the problems of traditional masks, but still can not make up for the inherent disadvantages of many masks. Although the new masks are better than ordinary masks in terms of performance, but the price is high, which has caused a series of problems such as narrow market and difficult to sell. In the past few years, although the demand for masks has increased with the development of the epidemic, however, most of the new masks are still difficult to sell because of the high price.

To solve this problem, a portable ventilated and scented mask based on STM32 has been created, aiming to enhance the comfort and breathing efficiency of the wearer. The device realizes the intelligent wind control function by combining the air dispenser and air inlet through an innovative independent separation design. The air dispenser detects the wearer's breathing speed and frequency and transmits the data to the analysis module, while the inlet air dispenser adjusts the air flow according to the analysis results to ensure smooth breathing. The device utilizes a multi-layer structure, including a filter cover, filter and smart fan, providing multiple protection and functional support. Equipped with an indicator light and lithium battery, the device further enhances its practicality and convenience. With the efficient computing power of STM32 microcontroller and optimized power management system, the device achieves low energy consumption while maintaining powerful functions. This project not only has significant advantages in design and functionality, but also allows more people to enjoy the convenience of technology through its affordable cost. This paper will explore the design concept, technical realization and potential impact of this device in detail.

2. Method

2.1 System Design

The STM32-based portable ventilation and scenting mask is an innovative respiratory support device that combines modern technology with a system designed to enhance the wearer's comfort and breathing efficiency through intelligent means. The whole system revolves around the STM32 microcontroller and integrates several modules such as sensing, control, ventilation and power management, which work in concert with each other in order to realize efficient and intelligent breathing support.

The sensing module is the foundation of the system and is responsible for monitoring the respiratory parameters of the wearer in real time. Breath detection sensors are primarily used to capture data such as breathing rate and frequency. This data is received and processed by the STM32 microcontroller through analog-to-digital conversion, ensuring accurate analysis of breathing patterns. In addition, the system can be equipped with an optional air quality sensor for detecting the air quality of the surrounding environment. This feature not only optimizes air flow and filtration, but also alerts the user to replace filter components or adjust settings when necessary.

The control module is dominated by the STM32 microcontroller, which acts as the brain of the system and is responsible for data processing and command delivery. The microcontroller runs a set of complex algorithms that analyze the data provided by the breathing sensors and adjust the operation of the air outlet and air inlet in real time. Through this intelligent air control mechanism, the system can dynamically adjust the air speed according to the user's breathing pattern, ensuring smooth and natural breathing. The control module also manages the status of the entire device, including start, stop and mode switching operations, to ensure stable operation under various conditions.

The ventilation module is a key part of the system design and is responsible for the actual air flow and filtration. The module's built-in outlet and inlet ventilators adjust the air flow under the command of the microcontroller to ensure that the user has an optimal air circulation experience both during inhalation and exhalation. Air quality is further enhanced by a multi-layer filtration system, with the outermost filter cover used to initially block dust and particulate matter, and an internal high-efficiency filter to further purify the air and ensure the cleanliness of the inhaled air. The smart fan design not only adjusts the air speed as needed, but also maintains low noise operation during use, enhancing the overall wearing experience.

The power management module provides stable energy support for the entire system. The device's built-in Li-ion battery has been carefully designed to support fast charging while providing long battery life. The power management circuitry optimizes the efficiency of energy usage and ensures that the device maintains low power consumption in different modes, which is especially important for portable devices. Users can replenish power to the device through a simple charging port to ensure it is always available.

The user interface is designed to be simple and intuitive, mainly through the indicator lights on the

device to show the current working status and mode. These indicators provide clear feedback on the device's operation, including power status, wind speed mode, etc., making it easy for users to quickly understand the status of the device and make necessary adjustments. Future versions can connect to mobile apps via Bluetooth to provide more intuitive control and monitoring features, allowing users to view detailed breathing data and device status and even control and set up remotely from their phone.

The connection and mounting design of the device is also well thought out and utilizes a snap-on design to ensure a tight fit between the device and the mask. This design not only makes the installation process easy and quick, but also keeps the device stable during wear, preventing it from loosening or falling off due to movement or other factors. The lightweight design of the device ensures that the wearer will not feel any extra burden during prolonged use.

The STM32-based portable ventilation and scenting mask strikes a good balance between functionality, portability and economy by integrating several advanced technologies. The device not only improves wearing comfort and breathing efficiency, but also provides users with an efficient, comfortable, and intelligent breathing assistance solution through intelligent system design, adapting to the dual needs of health and convenience in modern society.

2.2 Testing and Evaluation

The testing process of STM32-based portable ventilated and scented masks involves several aspects, including functionality, reliability, user comfort, energy efficiency, and safety. Through systematic testing and evaluation, potential problems can be identified and solved to ensure the stability and effectiveness of the device in various usage environments.

Functionality testing is designed to verify that the core functions of the device meet the design requirements. By simulating different breathing patterns, the team evaluated the response speed and accuracy of the air dispenser and air inlet under various conditions. The use of a standardized breathing simulator enables effective testing of the device's performance under different breathing frequencies and intensities. By analyzing the sensor data, it ensures that the STM32 microcontroller can accurately process and adjust the wind speed to ensure smoothness and a natural feeling of breathing.

Reliability testing is designed to evaluate the stability of equipment over extended periods of time. Durability and stability are tested by running the equipment under simulated real-world environmental conditions for an extended period of time. This includes performance under different temperature, humidity and air quality conditions. Reliability testing also addresses the physical durability of the device, ensuring that the snap-on design maintains its tightness and functionality after multiple installations and removals.

The user comfort test looks at the user experience of the device during actual wear. Through feedback from the wearer, the device is evaluated for weight, wearing comfort, noise level, and comfort with wind speed adjustment. The user test team can wear the device during daily activities and provide subjective ratings on wearing comfort and respiratory support effectiveness. This feedback is used to make further adjustments to the design of the device, such as optimizing weight distribution or

reducing fan noise, to improve the overall user experience.

Energy efficiency testing is an important part of evaluating the performance of a power management system. The team measures the energy consumption of the device in different modes, including standby, low-speed and high-speed operating modes. By recording the rate of battery consumption, the efficiency of the power management circuitry and battery life were assessed. It was concluded that efficient energy management not only extends the life of the device, but also improves user satisfaction and the competitiveness of the device in the market.

During the testing and evaluation process, the data and feedback collected is used to optimize the design and functionality of the device. The iterative testing process allows for continuous improvement of device performance and resolution of issues identified during initial testing. Upon completion of testing, the device is certified by an independent third party to ensure that it meets industry standards and regulatory requirements. This not only enhances the trust of the device in the marketplace, but also provides additional security for the user.

2.3 Challenges and Responses

Multiple challenges were faced during the development of the STM32-based portable ventilated and perfumed mask. These challenges were mainly related to technical implementation, user experience, market demand and safety compliance.

Challenges in the technical implementation focused on system integration and performance optimization. The STM32 microcontroller needs to process complex sensor data and control the precise operation of the fan. This requires high efficiency and accuracy of the software algorithms to achieve real-time response to breathing patterns. To meet this challenge, advanced signal processing techniques and optimized control algorithms are used to ensure that the system operates efficiently at low power consumption. At the same time, extensive simulation tests can be performed to verify the reliability and robustness of the algorithm.

In hardware design, it is also a challenge to integrate multiple functional modules in a limited space. Devices need to contain sensors, fans, filtration systems and power management modules, and these components must be compactly designed to ensure portability. For this, a modular design can be used to optimize the layout using 3D modeling and simulation tools. In addition, the selection of energy-efficient components can help reduce the size and weight of the device and improve user comfort.

Challenges in the user experience lie primarily in the comfort and ease of use of the device. The discomfort that may result from prolonged wear, as well as the complexity of device operation, may affect user acceptance. For this reason, extensive user testing can be conducted to gather feedback to improve product design. For example, optimize the wearing structure of the mask to improve comfort and simplify the user interface for easier operation. At the same time, ensure that the noise level is kept low when the device is in operation to enhance the user experience.

Security compliance is another key challenge. Devices must comply with relevant safety standards and

regulatory requirements to ensure user safety. This can be accomplished by conducting comprehensive safety testing, including electrical safety, material safety and biocompatibility testing, to ensure the safety of the device under all conditions of use.

In the face of the multifaceted challenges of developing a portable STM32-based ventilated and perfumed mask, it also requires an effective response through technology optimization, user feedback, market research, and safety compliance strategies. Through continuous improvement and innovation, the device will not only be able to meet the needs of users, but also be able to occupy a place in the competitive market.

3. Result

The new mask-assisted ventilator is bound to have an immeasurable role in the future development. Mask-assisted ventilators will not only prevent lung lesions in the future, but all other types of functional masks will become more and more common, and the product layout will also change, which will certainly provide brand new manufacturing opportunities for the world's largest mask manufacturers and exporters. In addition, the mask-assisted ventilator can provide a new technology for the development of more intelligent masks in the future to lay the foundation, but the implementation of mask-assisted ventilator has a certain degree of difficulty, the cost of the problem has yet to be resolved, there are many difficulties in the future, the most important thing is still to bring down the cost to achieve the goal of this goal still requires more efforts.

Fund Project

Supported by Chinese College Students' Innovation and Entrepreneurship Training Program Project: 202310705028

References

Chen Dalei. (2023). *Evaluation and analysis of graphene medical mask application*. Gansu Province, Gansu Medical Device Inspection and Testing Institute, 2023-09-08.

Feng Yuxiao, Guo Jiawen, Xiao Qing, et al. (2023). Progress of research on materials and application efficacy of medical masks. *China Medical Equipment*, *20*(01), 153-157.

Huo, S. (2021). Granted. *Research on the protection performance and comfort of ventilated masks*. Tianjin University, 2021.

Jiang Bo, Liu Hongsheng, & Liu Yuliang. (2024). Research on breathing automatic adjustment technology of intelligent mask. *Mechanical Engineer*, *2024*(06), 11-14.

Jiang Jinping, Zhang Huimin, Ren Yijia, et al. (2024). Analysis of factors affecting the protective effect of masks. *China Fiber Inspection*, *2024*(09), 108-110.

Li Na, Wei Changchang, Fang Qingfei, et al. (2023). Design of new intelligent mask technology system. *Electronic Product World*, *30*(05), 51-53.

Lin Fangbing. (2022). Performance analysis of 8 types of protective masks. *Shanghai Textile Science and Technology*, *50*(07), 1-4.

Wang Xu, Zhang Qiaoling, Feng Xiangwei. (2015). Portable mask filtration test device and comparison of filtration of commonly used masks. *China PPE*, *2015*(06), 32-36.

Wang Ji. (2023). *Research on filtration and comfort performance of multilayer combined fiber materials for mask application*. Qingdao University, 2023.

Zhang Tinglu. (2022). *Research on the protection and comfort performance of modified medical masks*. Tianjin University, 2022.

Zou Xiaoyue, Xu Jiahui, Chen Zhenshu, et al. (2024). Research progress of mask filtration materials and their electret technology. *China Plastics*, *38*(09), 47-53.