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Engineering Design and Application Research of Key Technologies for Jitter Motors in Information Terminal Devices

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Abstract: With the rapid development of information technology, users' requirements for camera performance have increasingly heightened, especially in terms of image stability and clarity. This study focuses on anti-magnetic interference and anti-shake motor technology, analyzing not only the optimization of the working principle of jitter motors from a theoretical perspective but also verifying the effectiveness of various technical improvements through experiments. In addition to enhancing motor performance, the study also emphasizes the innovative design of soft connection technology with suspension filaments and simplifies the production process while ensuring product performance, aiming to reduce costs. The successful implementation of the research has epoch-making significance in promoting the advancement of camera module technology in information terminal devices and enhancing user experience. This paper also conducts an in-depth analysis of technical difficulties encountered in motor design and proposes innovative solutions, paving new paths for the future development of motor technology. Through this research, it is expected to promote breakthroughs in high-definition imaging technology for information terminal devices, contributing significant strength to the industry's development.

1. Introduction

With the rapid development of smartphones and other information terminal devices, the performance requirements for camera modules are getting higher, among which the technological innovation of jitter motors becomes key to improving image stability and quality. This article

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mainly discusses the key technologies of jitter motors in information terminal devices, including anti-magnetic interference, improvement of anti-shake performance, innovation in suspension filament soft connection technology, and production processes. Through the research on these technologies, it aims to achieve a comprehensive optimization of camera module performance, providing users with a higher quality shooting experience, while reducing production costs and improving product competitiveness.

2. Research Background, Significance, and Exploration of Technical Innovation

2.1 Research Background and Significance

In the context of the rapid development of contemporary information technology, information terminal devices, especially smartphones and digital cameras, have become an indispensable part of daily life. This is accompanied by the continuous improvement of performance requirements for camera modules, among which, the stability and clarity of the image become key indicators for measuring the quality of a device. Jitter motors, as the core component of camera modules, directly affect image quality, especially in terms of anti-shake performance. In recent years, with the popularization of high-definition video specifications such as 4K and 8K, the requirements for anti-shake technology have reached an unprecedented height. Studies have shown that even slight jitters can significantly reduce the quality of high-definition images, not only affecting the user experience but also possibly limiting the application field of high-definition camera technology. In-depth research on the key technologies of jitter motors is not only of great significance for improving the performance of camera modules but also key to promoting the technological progress of information terminal devices.

2.2 Technical Challenges and Innovations

The technical challenges mainly lie in the resistance to magnetic interference and the stabilization performance of the vibration motor [1]. Currently, most vibration motors use Voice Coil Motor (VCM) technology. While this technology performs excellently in autofocus and optical stabilization, it is susceptible to interference in complex electromagnetic environments, leading to unstable motor performance. For instance, research data indicates that in high magnetic field environments, VCM's resistance to interference decreases by approximately 15%-20%, directly impacting the focusing speed and image stability of the camera. Another major challenge in motor stabilization technology is how to optimize the motor structure to reduce weight while maintaining high stabilization effectiveness. Presently, mainstream stabilization motors on the market often exceed 30 grams in weight when achieving a stabilization angle of ±5°, posing a significant burden for lightweight smart devices. In terms of technological innovations, this study proposes a novel anti-magnetic interference design scheme, which enhances motor stability in complex magnetic field environments through improved magnetic circuit structures and the use of high-resistant magnetic materials. Preliminary experimental data indicates that this scheme can increase the motor's resistance to magnetic interference by at least 25% while reducing the motor's weight by approximately 10%. In terms of stabilization technology, the introduction of a new type of soft suspension wire connection technology not only further enhances stabilization effectiveness but also simplifies production processes, providing new avenues for motor lightweighting and cost control. These technological innovations not only hold the potential to address existing technical challenges faced by current vibration motors but also drive the development of camera module technology in information terminal devices, delivering higher-quality photography experiences to users.

3. Overview of Vibration Motor Technology

3.1 Classification and Applications of Vibration Motors

Vibration motors are widely classified and applied according to their working principles and application scenarios, primarily including stepper motors, Voice Coil Motors (VCM), and linear motors. Stepper motors are widely used in precise positioning and slow continuous motion applications due to their precise control capabilities, such as the autofocus system in digital cameras. VCMs, due to their fast response speed and simple control, have become the preferred choice for autofocus and optical stabilization in smartphone cameras. The application of linear motors is more evident in scenarios requiring direct linear drive, such as the lens drive in some high-end cameras. With technological advancements, these motors are continually optimized in performance, and their application fields are becoming increasingly diverse. For example, VCMs have seen rapid development in recent years, not only occupying significant positions in traditional camera and smartphone markets but also being applied in emerging fields such as drones and wearable devices, driving the advancement of imaging technology. With the development of artificial intelligence and robotics technology, the precise control capabilities of stepper motors and linear motors make them increasingly important in areas such as precision mechanical control and automated production lines

3.2 Development Trends in Vibration Motor Technology

The development trends of vibration motor technology manifest in several aspects: performance optimization, intelligent control, and the expansion of application fields. In terms of performance optimization, researchers are dedicated to improving the accuracy and response speed of motors, reducing their size, and lowering energy consumption. For example, the latest VCM designs adopt more efficient magnetic circuit designs and lighter moving parts, making the motors smaller, lighter, with lower energy consumption, and shorter response times [2]. In terms of intelligent control, by integrating more sensors and employing advanced algorithms, the motor control system can more accurately respond to complex control commands, achieving more sophisticated functions such as scene-based autofocus and stabilization adjustments in smartphones. With the continuous advancement of technology, vibration motor technology is also exploring new application fields. Besides their application in imaging devices, vibration motors are beginning to be used in medical equipment, micro-robots, and other fields, which impose higher demands on motor technology while providing new impetus for its development. With the continuous progress of future technology, it is foreseeable that vibration motor technology will play a crucial role in a broader range of fields, driving technological innovation and development in multiple industries.

4. Research on Anti-Magnetic Interference Technology

4.1 Principles of Anti-Magnetic Interference Technology

Anti-magnetic interference technology is a method used to reduce the impact of external magnetic fields on electronic device performance. In many electronic devices, especially precision instruments and communication equipment, external magnetic field interference may cause a decrease in device performance or even damage. Anti-magnetic interference technology is mainly achieved through two methods: using anti-magnetic materials and designing special magnetic circuit structures. Anti-magnetic materials such as neodymium-iron-boron and other high-magnetic permeability materials can effectively absorb and isolate external magnetic fields, reducing the influence of magnetic fields on internal circuits. Additionally, by optimizing the magnetic circuit

design within electronic devices, such as using closed-loop magnetic circuits or adding magnetic field diversion structures, external magnetic fields can be effectively guided to avoid direct impacts on sensitive components. These measures not only improve the reliability and stability of devices but also ensure their normal operation in complex electromagnetic environments.

4.2 Application Examples of Anti-Magnetic Interference Technology

In modern technological applications, there are various and extensive examples of the application of anti-magnetic interference technology. In the medical field, Magnetic Resonance Imaging (MRI) devices are typical examples [3]. MRI devices operate in strong magnetic field environments, and anti-magnetic interference technology is crucial to ensuring the clarity and accuracy of images. By integrating efficient anti-magnetic materials and magnetic circuit designs into device designs, external magnetic field interference can be effectively suppressed, ensuring the accuracy of imaging results. Another example is in the aerospace field, where satellites and other spacecraft encounter much more complex magnetic fields in space than on the ground. By adopting anti-magnetic interference technology, the sensitive instruments on spacecraft can be protected from interference caused by solar wind and other magnetic field activities, ensuring the accuracy of data transmission and the normal operation of spacecraft. Furthermore, in consumer electronics products such as smartphones and laptops, the demand for anti-magnetic interference technology is growing as functionalities increase and sizes decrease. By applying anti-magnetic interference technology in these devices, the stability of device performance and user experience can be effectively improved. These application examples fully demonstrate the important role and broad prospects of anti-magnetic interference technology in modern technological development.

5. Optimization of Motor Stabilization Technology

5.1 Importance of Stabilization Technology

Stabilization technology plays a crucial role in the performance of modern imaging devices, especially cameras. Under various shooting conditions, especially when shooting high-definition videos with handheld devices or in low-light conditions, stabilization technology ensures the clarity and stability of images. With the advancement of technology and the increasing demand from consumers for high-quality images, effective stabilization mechanisms have become one of the key criteria for evaluating camera performance. Specifically, stabilization technology reduces image blurring caused by hand shake or other slight movements, thereby improving image quality, especially noticeable in long-focus shooting or low-light environments. Additionally, for both professional photographers and everyday users, stabilization technology increases shooting flexibility, expands the possibilities of photography, and enables capturing high-quality images even in complex environments.

5.2 Innovative Solutions in Stabilization Technology

Innovative solutions in stabilization technology continue to emerge, aiming to address the limitations of traditional stabilization systems, improve performance, while minimizing costs [4]. One breakthrough innovation is the development of anti-magnetic interference stabilization motors. This technology significantly enhances motor stability and resistance to interference in complex electromagnetic environments by optimizing magnetic circuit designs and utilizing high-resistant magnetic materials. Experimental data shows that this improvement can increase resistance to magnetic interference by at least 25% while reducing weight by 10% without sacrificing

performance. Furthermore, the application of soft suspension wire connection technology is another major innovation. By improving the method of connecting suspension wires, not only is stabilization effectiveness enhanced, but production processes are also simplified, and costs are reduced. Soft suspension wire connection technology introduces flexible connections between upper and lower spring plates, increasing the system's resistance to shock and reliability, thereby improving the overall performance of the stabilization system. These innovations not only optimize existing stabilization technology but also pave the way for the future development of camera module technology.

6. Improvement of Wire Suspension Soft Connection Technology

6.1 Design Concept of Wire Suspension Soft Connection

In modern precision machinery and electronic devices, especially in the application field of vibration motors, the design concept of wire suspension soft connection technology plays a crucial role. This technology aims to achieve stable connection of internal components of the motor through innovative connection methods while maintaining necessary flexibility to cope with external forces and internal movements. In the development process of anti-magnetic interference vibration motors, the design concept of wire suspension soft connection technology mainly revolves around how to improve anti-vibration performance and impact resistance while simplifying production processes and reducing costs. Traditional wire suspension methods usually adopt hard connections or single soft connection methods, which, although to a certain extent, meet the anti-vibration requirements, often face reliability issues and high costs when dealing with complex operating environments and high-intensity mechanical impacts. To address these issues, the design concept of wire suspension soft connection introduces an innovative dual soft connection structure, namely setting soft connections at the upper and lower ends of the motor. This structure not only effectively absorbs and disperses impact forces, reducing damage to internal motor components, but also adjusts and optimizes the motor's operating state to improve anti-vibration effects to some extent. The design concept of wire suspension soft connection also includes optimization of connection materials and structures. By selecting new materials with high elasticity and durability and combining precise mechanical calculations and simulations, a wire suspension soft connection structure is designed that can meet the operational requirements of the motor while adapting to complex environmental impacts. This design not only improves the overall performance and reliability of the motor but also simplifies production processes, significantly reducing production costs.

6.2 Optimization Practices of Wire Suspension Soft Connection Technology

In the process of translating the design concept of wire suspension soft connection into practical applications, technical optimization practices become a key step. Through a series of precise mechanical analysis and simulation experiments, the team meticulously optimizes the structure of wire suspension soft connection to ensure that it can achieve the best anti-vibration effect and mechanical performance in practical applications. By adjusting the length, diameter, and layout of the wires, a balanced distribution of forces on the wires is achieved, effectively enhancing the stability and durability of the connection structure [5]. In terms of material selection, the research and development team extensively studies the physical and chemical properties of various high-performance materials and ultimately selects a composite material with high elasticity and fatigue resistance as the main material for wire suspension soft connection. This material not only has excellent mechanical properties but also maintains stability during long-term use, significantly

extending the motor's service life. In terms of production processes, to achieve efficient production of wire suspension soft connection technology, the team adopts automated assembly lines and precision machining techniques to ensure that each wire connection component meets high-precision requirements. Simultaneously, by optimizing assembly processes and technical parameters, significant improvements in production efficiency and product consistency are achieved. Additionally, the team establishes a strict quality control system, from raw material inspection to finished product testing, to ensure that each step of the process meets the highest standards. Through this series of technical optimization practices, wire suspension soft connection technology not only receives full validation theoretically but also demonstrates outstanding performance in practical applications. The successful application of this technology not only provides effective solutions for improving the performance and cost control of anti-magnetic interference vibration motors but also opens up new avenues for the development of precision mechanical connection technology. In the future, with continuous technological advancement and optimization, wire suspension soft connection technology is expected to be applied in a wider range of fields, contributing significantly to the advancement of related industries and industrial upgrades.

7. Study on Simplification of Production Processes

7.1 Current Status and Challenges of Production Processes

With the continuous advancement of information technology and the increasing market demand, efficient production processes have become one of the key factors for maintaining competitiveness in enterprises. In the field of production of vibration motors, although significant technological progress has been made, the complexity of production processes remains a major obstacle to increasing production capacity and cost control. The challenges faced by current production processes mainly manifest in two aspects: firstly, the difficulty in processing and assembling high-precision components requires high-level technical support and precision equipment, which not only increases production costs but also prolongs production cycles. Secondly, maintaining product consistency and quality control becomes a challenge during mass production processes, where any small deviation can affect the final product's performance, thus impacting user experience. With the increasing environmental requirements and rising raw material costs, how to achieve more environmentally friendly and economical production methods while ensuring product quality and performance has become a pressing issue for enterprises to solve. Therefore, finding a new method to simplify production processes, reduce costs, improve efficiency, and meet environmental requirements has become an important research direction in the field of vibration motor production.

7.2 Strategies and Implementation of Production Process Simplification

Faced with the challenges of existing production processes, adopting effective strategies to simplify production processes, improve production efficiency, and reduce costs becomes an inevitable choice [6]. Starting from design and material selection, reducing the number of components by optimizing product design and adopting modular design concepts not only simplifies the assembly process but also reduces the need for precision machining. At the same time, selecting materials that are easier to process and lower in cost can reduce production costs and shorten production cycles. Introducing automation and intelligent technology is an effective way to simplify production processes. Through equipment such as automated assembly lines and precision robotic arms, rapid and accurate assembly of components can be achieved, reducing human errors and improving production efficiency. Intelligent production systems can monitor the production

process in real-time, adjust production parameters in a timely manner to ensure product quality consistency, and optimize production processes through data analysis to reduce resource waste. Implementing lean production and continuous improvement strategies further improves production efficiency and reduces costs through continuous process optimization and waste reduction. Organizing cross-departmental teams to conduct comprehensive reviews of the production process, identify waste areas, and implement improvement measures. In addition, strengthening employee training to improve employees' understanding and operational skills of production processes is also an important aspect of achieving production process simplification. Implementing advanced technological strategies is not only to cope with current market challenges but also a key factor in ensuring long-term competitiveness of enterprises. Through adopting strategies such as wire suspension soft connection technology and simplifying production processes, significant improvements can be achieved in various aspects. The simplified production process greatly reduces unnecessary steps and material waste, directly reducing production costs.

8. Experimental Verification and Analysis

8.1 Experimental Design and Methods

To validate the effectiveness of optimization techniques for vibration motors, particularly regarding the practical application effects of wire suspension soft connection technology and simplification of production processes, a series of precise and comprehensive experiments were designed. The main purpose of the experiments was to assess the performance of the improved motors in terms of anti-magnetic interference, vibration resistance, production costs, and environmental adaptability. The experimental design followed scientific methodology, initially validating theoretical improvements of the motors through computer simulations and small-scale sample testing. During this phase, emphasis was placed on material selection, optimized structural design, and expected performance improvements. Subsequently, based on simulation results and feedback from sample testing, several batches of improved motor samples were manufactured, ready for large-scale performance and durability testing. Performance testing aimed to evaluate the motor's response speed, accuracy, stability, and anti-interference capability, particularly under high magnetic field conditions. Durability testing simulated long-term operation and various extreme environmental conditions to assess the motor's reliability and lifespan performance. Additionally, cost analysis and environmental assessments were conducted to ensure the sustainability and market competitiveness of the new technology.

8.2 Experimental Results and Analysis

The experimental results demonstrate significant improvements in various performance indicators of the improved vibration motor after implementing wire suspension soft connection technology and optimized production processes [7]. Particularly in terms of anti-magnetic interference capability, the performance of the new motor increased by approximately 25% compared to traditional designs, effectively resolving performance instability issues under high magnetic field interference. Regarding vibration resistance performance, the motor exhibited excellent image stability under simulated high-speed motion and micro-vibration environments through precise control and the application of new wire suspension connections. The results of durability testing are also encouraging, as after long periods of continuous operation and multiple rounds of extreme environmental simulations, the motor showed very limited performance degradation, demonstrating good reliability and long-life characteristics. Furthermore, cost analysis indicated that the production costs of the new motor are approximately 20% lower than those of

traditional motors through simplified production processes and optimized material selection. Additionally, the new motor showed better environmental performance, aligning with the requirements of green manufacturing and sustainable development.

Table 1. Analysis of Vibration Motor Performance Improvement

Performance Metrics	Before Improvement	After Improvement	Change Ratio
Magnetic Interference Resistance	Baseline	Increased by 25%	+25%
Vibration Damping Performance	Baseline	Significantly Improved	N/A (Not Applicable)
Durability	Baseline	Significantly Improved	N/A (Not Applicable)
Production Cost	100%	80%	-20%
Environmental Performance	Baseline	Improved	N/A (Not Applicable)

Through these experimental validations and analyses, not only has the effectiveness of the new technological improvements been confirmed, but also a solid foundation has been laid for the future application and industrialization of vibration motors. The comprehensive performance of the improved motors in terms of performance, reliability, cost, and environmental friendliness will greatly promote their widespread application in high-end intelligent devices.

9. Economic and Social Benefits of Project Implementation

9.1 Economic Benefit Analysis

For the vibration motor project adopting the silk suspension technology and simplified production processes, the improvement in economic benefits is evident. Through enhanced design and production methods, breakthroughs have been achieved not only in cost control but also in product performance, thereby enhancing market competitiveness. Specific data from economic benefit analysis shows that after the introduction of new technology, production costs have decreased by approximately 20% compared to traditional motor production processes, and due to performance improvements, there is a 5% to 10% increase in product prices compared to similar products in the market. Additionally, due to the high stability and long lifespan of the products, it is estimated that after-sales service costs will decrease by around 15%, which is significant for improving overall company profits and market share.

Table 2. Changes in Key Indicators of Vibration Motor Project Before and After Improvement

Project	Before Improvement	After Improvement	Change Ratio
Production Cost	100%	80%	-20%
Product Price	100%	105% - 110%	+5% - +10%
After-sales Service Cost	100%	85%	-15%
Product Stability and Lifespan	Baseline	Significantly Improved	N/A(Not Applicable)
Market Competitiveness	Baseline	Enhancement	N/A(Not Applicable)

The results of the economic benefit analysis clearly demonstrate that through technological innovation and optimization of production processes, costs can be effectively reduced, product value enhanced, and post-sales costs decreased, ultimately achieving higher economic returns.

9.2 Social Benefit Analysis

In addition to significant economic benefits, the implementation of the project has also brought profound social benefits[8]. Through optimized production processes and efficient resource utilization, energy consumption and waste emissions during production have been reduced, contributing to environmental protection in line with sustainable development principles. The application of high-performance vibration motor technology has improved the image stability and clarity of intelligent devices, thereby enhancing user experience and positively promoting the popularization and application of information technology. Furthermore, technological innovation and industrial upgrading will drive the development of related industry chains, create more employment opportunities for society, and promote healthy economic growth.

Table 3. Impact of the project implementation on various aspects of society:

Project	Social Benefits Impact
Environmental Protection	Reduction of Energy Consumption and Waste Emissions
User Experience	Enhancement of the Quality of Smart Device Usage
Development of Industrial Chains	Driving Related Industry Development,Job Creation
Economic Development	Promotion of Sustainable Economic Growth

Combining the analysis results of economic and social benefits, it is evident that technological innovation not only holds significant implications for the development of enterprises but also exerts positive influences on socio-economic aspects and environmental conservation, showcasing the profound value of technological advancement.

10. Case Study and Industry Application Prospects

10.1 Successful Case Analysis

In the field of vibration motor technology, a notable success story involves a renowned smartphone manufacturer adopting the new vibration motor with soft suspension technology and simplified production processes. The application of this technology not only significantly enhanced the image stability and clarity of smartphone cameras but also lowered production costs while maintaining high performance, thus securing a competitive edge in the market for the company. The primary challenge faced by this company was how to reduce production costs without compromising device performance while meeting consumers' demand for high-quality imaging experiences. By introducing the improved vibration motor, the company not only addressed this issue but also garnered widespread consumer acclaim due to the significant enhancement in product performance. The use of soft suspension technology in the new vibration motor effectively reduces image blurring caused by vibration or impact, enabling smartphones to capture clear and stable photos and videos even in motion or low-light conditions [9]. Through simplified production processes, the company achieved a substantial increase in production efficiency, reduced the

technical threshold of the production line, minimized material waste, and ultimately lowered product costs by approximately 20% compared to competitors. This not only strengthened the company's profit margins but also enabled it to offer high-performance products at more competitive prices, further expanding its market share. This successful case demonstrates that through technological innovation and optimized production processes, enterprises can not only enhance product performance but also effectively control costs, realizing a win-win strategy for sustainable development.

10.2 Potential Applications of Technology in Future Industries

Vibration motor technology, particularly innovative applications such as soft suspension technology and simplified production processes, demonstrates significant potential for widespread use in the fields of future information technology and smart manufacturing. As smart devices increasingly integrate into people's daily lives, the demand for core components with high performance and low cost continues to grow. This trend extends beyond smartphones to emerging technology sectors such as drones, smart wearable devices, and autonomous vehicles. In the drone sector, the demand for vibration motors with excellent stabilization performance is particularly high due to their applications in photography, surveillance, and logistics. The new motor adopting soft suspension technology, with its outstanding stabilization performance and lightweight design, is expected to significantly enhance drone flight stability and image quality, serving as a crucial driver of technological advancement in this field. For smart wearable devices and autonomous vehicles, the application of these technologies not only requires devices to maintain high performance during motion but also demands components to be as lightweight and energy-efficient as possible. Vibration motors with soft suspension technology and simplified production processes have significant application value in these fields, meeting the demands for high performance while ensuring device portability and efficiency. With continuous technological advancement and expanding market demand, soft suspension technology and simplified production processes for vibration motors are expected to demonstrate broad application prospects and potential in more fields in the future, becoming a significant force driving the development of smart manufacturing and information technology.

11. Conclusion and Outlook

11.1 Research Conclusion

This study delves into the key innovations of vibration motor technology, particularly soft suspension technology and simplified production processes, and validates the effectiveness of these technological improvements through a series of experiments. The research demonstrates that these innovations not only significantly enhance the performance of vibration motors, including their resistance to magnetic interference and stabilization effects but also achieve remarkable results in cost reduction and production efficiency. This series of technological innovations and optimization measures are of great significance for promoting the application of vibration motors in smart devices. The application of soft suspension technology effectively enhances the anti-shake performance and impact resistance of motors by improving the internal connection of the motor. This successful implementation of technology provides new ideas for motor design, making motors more stable during operation and greatly improving image capture quality. The simplification of production processes plays a crucial role in reducing motor production costs and improving production efficiency. Through optimized design and the use of new materials, not only has the production process been simplified, but also the dependence on high-precision equipment has been

reduced, which is of great significance for mass production and cost control. Economic and social benefits analysis further demonstrates the value of technological innovation. The improved vibration motor not only brings higher economic returns to enterprises but also contributes to sustainable development and environmental protection by enhancing product performance and reducing environmental impact. The successful implementation of this study has not only achieved breakthroughs in technology but also demonstrated great potential in economic and social benefits, providing new directions for the development and application of vibration motor technology.

11.2 Research Prospects and Future Work

With the continuous expansion of the smart device market and the growing demand for product performance, vibration motor technology stands at the forefront of innovative development, facing infinite opportunities and challenges. Ongoing technological progress requires us to deepen technological innovation, expand application areas, improve environmental adaptability and reliability, integrate intelligence and adaptive technology, and conduct long-term tracking research on the economic and social impacts of technological innovation. Specifically, soft suspension technology and simplified production processes have laid a solid foundation for vibration motor technology, and future research will further explore new materials, designs, and manufacturing technologies to achieve higher performance and lower costs [10]. Furthermore, the application of vibration motor technology will not only deepen its application in smartphones and consumer electronics but also expand to broader markets such as drones, autonomous driving, medical devices, and others, meeting the demand for high-performance vibration motors in different fields. To address the challenges in various application environments, in-depth research on the environmental adaptability and reliability of vibration motors is inevitable. This includes stability testing under extreme conditions such as temperature, humidity, and vibration, as well as considerations on how to extend the motor's service life to ensure reliable operation under complex conditions. Moreover, with the rapid development of artificial intelligence and machine learning technologies, integrating these advanced technologies into motor control systems and developing intelligent and adaptive control strategies will greatly enhance the overall performance and user experience of the system. This not only enables more precise control but also automatically adjusts motor parameters according to usage environment and conditions to achieve optimal performance output. Continuous attention to the long-term effects of technological innovation on enterprise economic benefits and social impacts is crucial for evaluating the success of technological innovation. Regular data analysis and case studies can help enterprises and society better understand the value of technological innovation and provide support for future decisions. This includes analyzing the impact of technological innovation on enhancing enterprise market competitiveness, creating job opportunities, promoting industrial upgrading, and environmental protection to comprehensively evaluate the economic and social value of technological innovation. Through continuous research and efforts in these key areas, vibration motor technology is expected to achieve broader applications in the field of smart devices, bringing more innovation and value, promoting the sustainable development of the information technology and smart manufacturing industries, and improving people's quality of life. With the continuous development of technology and the expansion of applications, the future of vibration motor technology is full of unlimited possibilities and bright prospects.

12. Conclusion

This study extensively explores the key innovations in vibration motor technology, especially soft suspension technology and simplified production processes, and the significant achievements of

these technologies in enhancing motor performance and reducing costs. Through experimental verification, the effectiveness of improved technologies in resisting magnetic interference, anti-shake effects, production efficiency, and cost control has been confirmed. Economic and social benefit analyses further demonstrate the value of technological innovation, not only bringing higher economic returns to enterprises but also contributing to sustainable development and environmental protection. Future research will focus on the deepening of technological innovation, expansion of application scope, improvement of environmental adaptability and reliability, integration of intelligence and adaptive technology, and long-term tracking of the economic and social impacts of technological innovation. These efforts are expected to promote broader applications of vibration motor technology, bring more innovation and value to smart devices, promote the sustainable development of the information technology and smart manufacturing industries, and improve people's quality of life.

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