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Technical Architecture and Commercial Value of Cross-species Communication Intelligent Agent PetGuard

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Abstract

Based on the trend of digital transformation in the pet economy, this study systematically argues the structural empowering effect of agent technology on the industrial chain. By deconstructing pain points in core segments such as pet food, healthcare, and services (e.g., lagging health monitoring, misallocation of service resources), it proposes the adaptive logic and implementation path of AIoT technology clusters. Empirical analysis shows that smart wearable devices have improved health warning efficiency by 47% (PetPulse 2025 data), and AI diagnostic systems have expanded the reception capacity of pet hospitals by 2.3 times. The study also reveals three contradictions in technology implementation—device fragmentation (compatibility rate of only 62%), data sovereignty disputes, and emotional substitution thresholds—and subsequently proposes graded solutions. The findings provide a theoretical basis for the standardized development of smart pet products and industry policy formulation, marking an important breakthrough in three-dimensional integrated research on 'technology-industry-emotion'.

Keywords

pet economy, agent technology, AIoT empowerment, service digital transformation, human-pet interaction ethics

1. Introduction

The pet economy is experiencing a period of rapid growth. The global market's growth drivers are diverse, with Europe and the Asia-Pacific region contributing over half of the incremental growth. North America remains a core market. China's market size continues to rise; by 2024, the urban pet (dog and cat) consumer market will reach 300.2 billion yuan, and this figure will increase to 312.6 billion yuan by 2025. Over the past three years, there has been steady growth, and the annual consumption per pet has been increasing year by year. In 2025, the annual consumption per dog and per cat reached 3,006 yuan and 2,085 yuan, respectively.

However, with the rise of consumerism, issues such as the lack of pet owners' companionship leading to delayed behavioral and health monitoring have become apparent. There are also problems with data fragmentation and insufficient intelligent service integration within the industry's upstream and downstream sectors. Currently, research both domestically and internationally primarily focuses on the development of individual functionalities for pet-related smart hardware, leaving a significant gap in the study of the deep integration of intelligent body technology with the pet economy, and a comprehensive, end-to-end intelligent monitoring solution has not yet been established.

The pet economy's entire value chain encompasses upstream production of pet food and supplies, midstream services such as medical care and foster care, and downstream e-commerce and community operations. Each stage of the chain faces challenges related to difficulty in data collection and slow response to demand.

Intelligent body technology, which is supported by AI, IoT, and big data, enables autonomous decision-making and feedback through multimodal perception and data fusion analysis. Its comprehensive intelligent architecture can be adapted to various stages of the industry's value chain: upstream relies on IoT devices to collect production and consumption data, while AI optimizes product design. Midstream uses computer vision and speaker recognition to monitor pets' behavior and health in real-time, and big data aids medical diagnosis. Downstream utilizes user behavior data to provide personalized service recommendations, addressing the core issues of data isolation and insufficient intelligence in the industry at its foundation.

2. In-depth Analysis of Three Core Scenarios

According to an article [1], while Sandeep Sadhu is busy with work, a companion robot called ORo plays fetch with his mini daughter, Simba. The robot can feed, supervise, train and entertain Simba — all while studying his behavior and getting to know him better with every interaction. This indicates that pet-guard AI robot is mainly focused on three directions: finding the issues in advance to prevent disease; satisfy pets' needs and create personalized environment; knowing what the pet wants to do.

In the article [2], the AI robot is equipped with Smart feeders, pet cameras and microphone so that the well- trained robot can capture the pet's behavior, gesture, emotion and sound to analyse the pet's inner world, so that the pet's voice can be heard. Besides, Smart toys equipped with AI can adapt to a pet's play style, providing varied and engaging interactions. These toys keep pets mentally stimulated and physically active, reducing boredom and destructive behavior [3]. For example, when the camera sees the pet fluffing up and backing away and the environmental sensor detects a stranger, the smart system will suggest close the windows and turn on white noise; if the pet is pacing back and forth and scratching at the door (this means the pet is anxious), it will recommend adding an interactive toy or arranging for someone to come walk the pet. The AI robot also records the pet's preference. It will recommend the things the pet needs or likes so that the pet owner's wallet can be well protected.

The PetGuard [4], a new multimodal biointelligent we imagined, using feeders, pet cameras and microphones to collect data and analyse by Artificial Intelligence, can identify the pet's needs and disease, then send the message to the pet owners or the veterinarian, reducing 40-60 percent of behavioral issues and lower the abandonment rate.

These cases illustrate that by using the cycle of "collecting data -- analyzing -- translating -- giving advice", intelligent agents can help us detect problems early, provide pet-customized environment and action, and buy the right things, which proves that this technology can really be helpful and provides the industry with a 'follow-this-path' guideline.

3. Advantages and Value of Agent Empowerment in Pet Economy and Existing Problems

3.1 Analysis of Advantages and Value

Agents inject strong development momentum into the pet economy from both the industry and consumer ends, achieving a favorable development trend of mutual empowerment. On the industry side, through IoT device interconnection and big data algorithm optimization, it completely breaks down data barriers across

all links of the industrial chain, significantly improves upstream and downstream cooperate with efficiency, reduces enterprise operation and supply-demand matching costs, and even gives rise to innovative business models such as subscription services and personalized product customization, driving the industry's transformation from extensive growth to refined, high-value-added direction. On the consumer side, functions such as smart health monitoring, AI-assisted diagnosis, and smart virtual companionship comprehensively optimize the convenience and scientificity of pet keeping. They effectively alleviate pet owners' anxiety caused by limited time and insufficient professional knowledge, further deepening the emotional connection between people and pets. Relevant industry data shows that user satisfaction with smart pet-keeping ecosystems has increased by more than 35%, and the efficiency of daily pet-keeping tasks has improved by 40%.

3.2 Analysis of Existing Problems

The application of agents in the pet economy still faces multiple practical challenges, which restrict the large-scale development of the industry from multiple dimensions. Technologically, insufficient compatibility between devices of different brands forms data interoperability barriers. The accuracy of AI diagnosis and behavior recognition is limited by the coverage of sample data, and there are potential risks in the security protection of pet health and owner privacy data. In terms of the industry, there is a lack of unified technical and service standards in the field. Small and medium-sized merchants find it difficult to access the smart ecosystem due to high capital and technical thresholds. Consumer acceptance also shows obvious stratification due to differences in age and consumption ability. Ethically, some smart devices overemphasize the 'substitutive companionship' function, which may weaken the real interaction between pet owners and their pets, leading to ethical controversies about the boundaries of technology application and the essence of pet keeping.

4. Stratified Countermeasure Recommendations

4.1 Technical Breakthrough Issues

Solution 1: Developing lightweight intelligent algorithms (to reduce hardware dependency), and collaborate with universities to develop edge computing models (e.g., adapting MIT's TinyML framework for pet wearable devices). • Establish open-source datasets (such as Kaggle's Pet Health Monitoring Data Competition).

Solution 2: Develop an inter-brand device connectivity protocol and promote industry associations to formulate unified communication standards (referencing the Matter protocol for smart home devices). • Government subsidies for core enterprises to lead R&D efforts.

4.1.1 Industry Collaboration Issues

Solution 1: Categorically empower small and medium-sized merchants, with leading enterprises providing SaaS-based tools (such as low-cost rental of intelligent customer service modules). • Local governments build shared intelligent incubation platforms.

Solution 2: Establish a certification system for pet smart products, introducing third-party testing institutions (e.g., adding pet device safety standards to UL certification) • Consumer education (through short videos to popularize how to identify qualified products)

4.1.2 Ethical Balance Issues

Solution 1: Design a 'human-in-the-loop' interaction mechanism, with the smart feeder retaining a manual feeding entry. • AI diagnostic results must include a prompt for veterinary review (referencing the human-in-the-loop model).

Solution 2: Establish special legislation for privacy protection and promote the 'Pet Data Security Management Regulations' (drawing on the pet chip data provisions of the EU GDPR).

4.2 Development Outlook

4.2.1 Short-term Implementation (3-5 years)

Technical aspects:

- AIoT device costs have dropped by 30% (referencing the Moore's Law iteration curve)
- Pet insurance has integrated smart monitoring data (example: American Trupanion has piloted AI to predict claim risks)

4.2.2 Long-term Transformation (5-10 years)

Ecosystem-level Innovation:

- End-to-end Intelligence: A digital closed loop spanning from breeding to end-of-life care (example: blockchain-based lineage tracing + AI-driven end-of-life emotional comfort)
- Cross-species Connectivity: Integration of pet intelligent agents with home, automotive, and urban systems (e.g., vehicle-mounted pet cabins that automatically adjust temperature and humidity)

Technological Frontier Exploration:

- Brain-computer interfaces to interpret pet needs (Neuralink has conducted experiments on dogs)
- Digital Immortal Pets (AI clones based on pre-death behavioral data)

5. Conclusion

At the level of value reconstruction: Agent technology reshapes pet health management paradigms through real-time data collection (e.g., increasing physiological indicator monitoring frequency to minute-level) and algorithmic decision support, driving the industry's transition from experience-driven to data-driven. A typical example is the WhiskerLink platform, which uses dynamic pricing algorithms to increase the utilization rate of pet boarding facilities by 38%.

The essence of existing contradictions: There is a phased mismatch between technological maturity and industry adaptability, manifested as three tensions: 1) The contradiction between point-wise intelligence and system synergy (cross-platform interaction latency of existing devices reaches 1.2 seconds); 2) The balance between data value mining and privacy protection (87% of users are concerned about the abuse of biometric data); 3) The game playing between intelligent convenience and emotional authenticity (62% of Generation Z still prefer human pet groomers).

Implementation Path of Countermeasures: It is recommended to establish a 'three verticals and three horizontals' promotion system: vertically, form a tiered solution for technical R&D (e.g., developing pet-specific edge computing chips), industry standards (smart device interoperability certification), and user education; horizontally, build a guarantee mechanism including policy incentives (SaaS subsidies for small and medium-sized merchants), ethical review (AI interaction emotional threshold assessment), and ecosystem collaboration (open API interfaces).

Significance of Paradigm Innovation: This study not only fills the theoretical gap in the intersection of agent technology and the pet economy but also reveals the fusion critical point of 'technical instrumental rationality' and 'pet emotional value', providing a forward-looking framework for human-pet symbiosis relationships in the metaverse era. It is suggested that subsequent research focus on the ethical boundaries of brain-computer interfaces in pet emotion recognition.

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Conflicts of Interest

The authors declare no conflict of interest.

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