

Research on the Application of Artificial Intelligence in Smart Home Systems and Its Impact on Privacy Protection

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Abstract: As artificial intelligence technology enters a new era, smart home systems are also entering a period of high-quality development. Smart home privacy protection proposals must be proposed with the human-centered development concept to meet people's needs better. Based on the dynamic evolution of smart home system development, we built a theoretical analysis framework for smart home development according to the inherent logic of privacy protection. We analyzed the privacy protection mechanism and user satisfaction of smart homes generated by artificial intelligence. We will explore the possibility of approaching the goal of high-quality smart home development from the perspective of privacy protection and the practical application of smart home system development. Developing a smart home system aims to provide people with services that meet the expected standards, improve service quality, and continuously enhance customer satisfaction. Therefore, data protection management should be strengthened based on the internal dissemination of data quality, a mechanism of interaction and trust among users, increased awareness of smart home quality, and a system for evaluating data protection and customer satisfaction. Finally, it will enable the high-quality development of smart homes, promote the sustainable and healthy development of the smart home industry, and truly meet people's expectations for a better life.

Keywords: Artificial intelligence; Smart home system; Privacy protection; Customer satisfaction

1. Introduction

Smart home systems are one of the main achievements of modern science and technology development, and they are also a vital expression of artificial intelligence applications [1]. It can be divided into essential home functions and advanced intelligent services, composed of traditional home equipment and intelligent systems. To improve the quality of life, people entrust the smart home system to carry out the intelligent management of living. Since artificial intelligence technology has been integrated into the home environment, intelligence has become the key to home systems. In addition, privacy protection has become an essential indicator for judging smart home systems. Unlike the traditional home system, smart home system emphasizes personalization, convenience and interactivity. Therefore, we put forward the issue of privacy protection, and artificial intelligence provides new technical support for smart home systems.

The smart home system originates from the human-centered design concept, and its development reflects the importance of privacy protection and is also a tool to improve the quality of life [2]. From the perspective of system structure, a smart home system pursues functionality and intelligence. It realizes home modernization through the combination of hardware equipment and software algorithms. However, this is only a technical pursuit. Today, the smart home system has implemented a unique user-centered development way. The all-round promotion of artificial intelligence not only rewrites the traditional definition of the home system and reflects the new trend of scientific and technological development but also changes people's living habits, posing a potential threat to personal privacy. In conclusion, we must have a forward-looking vision and an overall pattern to discuss smart home systems. Therefore, the proposition of privacy protection is put forward by integrating artificial intelligence and smart home systems.

In a word, privacy protection is a necessary condition and guarantee for the high-quality development of smart home systems [3]. Although technical progress has been made in developing smart home

systems, privacy protection still needs to improve. The researchers have yet to determine the practical path to take fully, and efforts are still being made. Therefore, the smart home system needs to constantly explore and improve privacy protection measures, which is the respect for users' privacy and the key to the sustainable development of the smart home industry.

Based on the above analysis, this paper puts forward a privacy protection framework combining technology, law, and ethics, aiming at solving the privacy protection problems in smart home systems and the problems of data security and user trust through theoretical analysis and empirical research. The main contents are data encryption and access control at the technical level, regulatory improvements at the legal and ethical level, and user training to effectively counter the risks of data loss. The research is significant in linking practice and theory.

2. Integration of Artificial Intelligence and Smart Home Systems

2.1 Current Application Status of Artificial Intelligence Technology in the Home Manufacturing

2.1.1 The Definition and Characteristics of Smart Home Systems

A smart home system is a concept developed with artificial intelligence technology [4]. It reflects intelligence, highlights the future orientation of scientific and technological development, and reflects the innovation strategy of the home industry since the 21st century. However, it isn't easy to get a unified understanding when we use some traditional household standards to construct the definition and essence of smart home. A smart home system is a system that integrates artificial intelligence technology into traditional home devices to provide intelligent management and control of the home environment. It has the following characteristics: Firstly, the smart home system can realize the remote control of home equipment so that users can manage the home anytime and anywhere. Secondly, smart home systems can learn user habits through artificial intelligence algorithms and provide personalized services. Finally, the smart home system can realize the interconnection between devices and create an intelligent home ecosystem. Figure 1 shows the integration of artificial intelligence and smart home systems.

2.1.2 The Key Role of Artificial Intelligence Technology

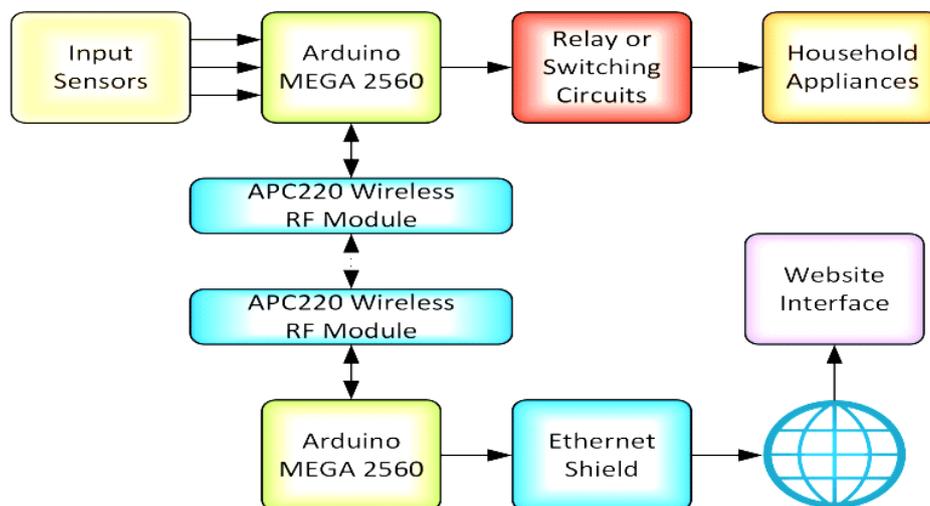


Figure 1: Integration of artificial intelligence and smart home systems

Artificial intelligence technology is an essential standard of smart home systems and an intelligent expression of home automation. Scholars have discussed various definitions of artificial intelligence technology from machine learning and natural language processing perspectives. In addition, some scholars believe that artificial intelligence technology shows the degree of computational intelligence or intelligent enhancement. Because artificial intelligence technology is more intelligent to some extent, it belongs to the applied science to improve the quality of home living. The development history of artificial intelligence technology can be traced back to the 1950s. Its principal activities include simulating human intelligence, processing big data, and providing intelligent decision support. In addition, the concept and implementation of smart home systems are closely related to the progress of artificial intelligence technology. With the upgrading of artificial intelligence, smart home systems have become essential to improving the quality of family life [5]. The main contribution of the smart home system theory in the

era of artificial intelligence technology is to provide personalized, convenient, and intelligent home services. Therefore, the concept of a smart home system initially focused on the measurement based on the attributes of artificial intelligence technology standards.

2.2 Challenges Posed by Artificial Intelligence Technology in Smart Home Systems

2.2.1 Technology Integration and Compatibility Issues

The issue of technology integration and compatibility in smart home systems focuses on how to integrate diverse artificial intelligence technologies into home devices perfectly. It is the application of intelligent thinking in the field of home manufacturing. To overcome the limitations of traditional home systems, it has entered the research field as a new alternative model-integration framework. The basic ideas of this framework are as follows. First, technology integration should ensure the effective implementation of smart home systems. Second, professional standards for home automation output should be set. Third, technicians use the Internet of Things and cloud computing technologies to 'capture' the data. Fourth, they use artificial intelligence to measure home environments. The integrated framework reconstructs the smart home system's technical architecture and improves the system's interoperability, flexibility, adaptability, and reliability.

2.2.2 User Acceptance and Habit Change

Changes in user acceptance and habits are the main obstacles to promoting smart home systems that focus on user adaptability to new technologies and directly reflect the market situation of smart home system design and functionality through user behavior [6]. Some elements of the development of smart home systems are gradually formed, and user feedback and various evaluation systems are gradually paid attention to. However, from the market feedback, the practice of some smart home systems is still in the initial stage of exploration, which is contrary to the user's daily habits and psychological expectations, resulting in low user acceptance.

3. Privacy Protection in Smart Home Systems

3.1 The Connotation and Importance of Privacy Protection

3.1.1 Definition of Privacy Protection

From the perspective of privacy protection, data security is the essential link between smart home systems and the core embodiment of user trust [7]. Therefore, the smart home system protects user privacy as the leading generation logic. Privacy protection is the primary task of smart home systems and the key to safeguarding user rights. At this stage, the smart home system strengthens privacy protection control from technology. There are three primary forms. The first is data encryption. The data is securely protected during transmission and storage. Second, pay attention to access control. The standardized control of access rights is realized by formulating user authentication and rights management standards and disclosing privacy protection standards to users. The third is the internal process reengineering of the privacy protection policy. In recent years, smart home systems have improved privacy protection and user satisfaction using technological innovation. However, compared with the ideal state, the privacy protection of the smart home system still needs to be further improved.

3.1.2 The Special Significance of Privacy Protection in Smart Homes

The difference between privacy protection and other functions in the smart home system lies in its ethical attributes. The technical standards and operating guidelines of smart home systems are aimed at improving the convenience of life, and their development is mainly reflected in technological innovation and market-driven. In the ethical framework of smart home systems, respecting and protecting user privacy is the core value and the highest criterion for the development of smart home systems. At present, the diversity of smart home devices and the differences in user needs lead to a complex situation of privacy protection. Although smart home systems are constantly improving technologically, privacy protection measures are still imperfect and need to be improved, and the system also requires self-regulatory mechanisms. Therefore, they are the "shortcomings" in privacy protection of smart home systems, which affects users' trust and the system's sustainable development.

3.2 Potential Threats to Privacy Protection from Artificial Intelligence

3.2.1 Risks in Data Collection and Processing

From the perspective of privacy protection, smart home systems cannot accurately provide the privacy protection that users need. The main form is the evaluation of users' satisfaction with smart home systems. However, the system lacks the relevant information and protection mechanism of user privacy, so data collection and processing are risky. In smart home systems, user privacy is usually described as "sensitive information", and the scope and depth of data collection directly reflect the degree of privacy protection. However, most of the data the system collects is about user behavior, and there are few measures to respect and protect user privacy. The effect of user privacy protection is difficult to measure. Asymmetric information and imperfect protection mechanisms have caused obstacles to users' trust.

3.2.2 The Conflict between Intelligent Monitoring and Personal Privacy

From the perspective of privacy protection, the development of intelligent monitoring technology has restricted personal privacy protection for a long time. Since the 21st century, intelligent smart home systems with built-in intelligence have re-engineered family security through perfect surveillance, but the shortcomings of traditional surveillance technologies limit privacy protection. Due to the limitations of the technology itself and the user's awareness of privacy protection, intelligent surveillance needs to be improved. On the premise of ensuring family safety, intelligent surveillance is regarded as one of the ways to improve the quality of life. However, the actual protection of personal privacy by the surveillance-based smart home system remains to be discussed. At the same time, technical difficulties lead to a lack of effective implementation means for privacy protection. Therefore, intelligent surveillance fails to achieve the desired privacy protection goals. In conclusion, intelligent surveillance is not only a technical problem but also faces the problem of privacy ethics.

4. Privacy Protection Strategy of Artificial Intelligence in Smart Home

4.1 Technical Privacy Protection Measures

4.1.1 Data Encryption and Anonymization

The smart home system cannot avoid data security issues as the core regarding privacy protection. Data encryption and anonymization are standard and effective technical tools in the privacy protection mechanism, which play an essential role in protecting user privacy. Therefore, data security is connected not only to technology but also to ethical concepts. Data encryption focusing on "protecting user privacy" has become the primary protection mechanism of smart home systems. The practical deduction of data encryption and anonymization processing is generally a protection gradually formed based on technical protection, which contains ethical attempts. Whether it is data collection or processing, privacy protection is closely related to user privacy. Researchers should focus on improving technology to improve the level of privacy protection to meet the requirements of smart homes. However, in the case of too much data, this also brings a problem, that is, the phenomenon of privacy leakage. In general, about protection mechanisms, there is room for improvement in data encryption and anonymization processing, and further improvements in effectiveness are also required. It is also an essential task for smart home systems.

4.1.2 Access Control and Authentication

For privacy protection, the smart home system cannot accurately provide the privacy protection that users need. Users' satisfaction evaluation of smart home systems is the main form, but the system lacks relevant information and protection mechanisms for user privacy. The solution to this problem may be to improve access control and authentication. In smart home systems, user privacy is usually described as sensitive information, and the strictness of access control directly reflects the level of protection. However, most of the access control in the system involves user behavior, so some respect and protection measures for user privacy are needed. Typically, the effect of user privacy protection is difficult to obtain or measure. As a result, information asymmetry and imperfect access control mechanisms lead to user distrust.

4.2 Privacy Protection Measures at the Legal and Ethical Levels

4.2.1 The Establishment and Improvement of Relevant Laws and Regulations

Smart home systems need to face the problem of laws and regulations when it comes to privacy

protection. In the privacy protection mechanism, establishing and improving relevant laws and regulations are standard and effective and play an essential role in protecting user privacy. Therefore, laws and regulations are not only related to policy but also to ethics. Laws and regulations focusing on "protecting user privacy" have become the primary protection mechanism for smart home systems. Its practical deduction is generally a protection approach gradually formed based on policy protection, and this way contains some attempts. Privacy protection is closely related to user privacy, from data collection to processing. Relevant managers should be committed to improving the level of privacy protection to adapt to the requirements of smart homes. However, the case of too much data also brings a problem, that is, the phenomenon of privacy leakage. To sum up, there is still room for improvement in the protection mechanisms of related laws and regulations, and the protection effect needs to be further improved, which is also an essential issue for smart home systems.

4.2.2 Ethical Guiding Principles for User Privacy Protection

From the perspective of privacy protection, smart home systems can't fully protect users' privacy. Users' evaluation of smart home systems takes satisfaction as the main form. However, the system needs the relevant information protection mechanism for user privacy, and the core of this problem may be the need for ethical guiding principles for user privacy protection. In smart home systems, user privacy is usually described as "sensitive information", and its compliance with ethical guiding principles directly reflects the level of privacy protection. However, most of the information in the system is about user behavior, and there are few measures to respect and protect user privacy. Usually, the effect of user privacy protection is difficult to obtain or evaluate. Therefore, information asymmetry and the imperfection of ethical guiding principles directly lead to users' distrust.

5. Conclusion

Artificial intelligence technology has been closely related to smart home systems, which puts forward new challenges and requirements for user privacy protection. Privacy protection symbolizes the "intelligence" of smart home systems and is essential to protecting users' rights and interests. In addition, it meets the needs of realizing high-quality development of smart home systems and maintaining users' trust. It embodies the inherent requirement of respecting and protecting users' privacy. This study constructs the theoretical analysis framework and practical mechanism of smart home system privacy protection in this context. In recent years, modern information technologies such as artificial intelligence have promoted the development of smart home systems. Data analysis and intelligent decision-making empower household equipment and improve the accuracy and scientificity of the system. The research value accords with the internal logic of smart home systems. Therefore, measures based on privacy protection have also improved the smart home system. In summary, the privacy protection of smart home systems can be improved and developed continuously, which will help to meet users' needs and promote the sustainable and healthy development of the smart home industry.

References

- [1] Hasan M, Biswas P, Bilash M D T I, et al. Smart home systems: Overview and comparative analysis[C]//2018 Fourth International Conference on Research in Computational Intelligence and Communication Networks (ICRCICN). IEEE, 2018: 264-268.
- [2] Auernhammer J. Human-centered AI: The role of Human-centered Design Research in the development of AI [C]. Synergy - DRS International Conference 2020, 11-14 August, Held online. <https://doi.org/10.21606/drs.2020.282>.
- [3] Yuan M, Chen L, Yu P S. Personalized privacy protection in social networks [J]. Proceedings of the VLDB Endowment, 2010, 4(2): 141-150.
- [4] Zaidan A A, Zaidan B B. A review on intelligent process for smart home applications based on IoT: coherent taxonomy, motivation, open challenges, and recommendations [J]. Artificial Intelligence Review, 2020, 53(1): 141-165.
- [5] Sepasgozar S, Karimi R, Farahzadi L, et al. A systematic content review of artificial intelligence and the internet of things applications in smart home [J]. Applied Sciences, 2020, 10(9): 3074.
- [6] Aldossari M Q, Sidorova A. Consumer acceptance of Internet of Things (IoT): Smart home context[J]. Journal of Computer Information Systems, 2020, 60(6): 507-517.
- [7] Abdulla A I, Abduraheem A S, Salih A A, et al. Internet of things and smart home security[J]. Technol. Rep. Kansai Univ, 2020, 62(5): 2465-2476.