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Technology Empowering Insurance Transformation: The Evolutionary Path of Auto Insurance Claims System Driven by AI

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Abstract: AI is reshaping the auto insurance claims system. This article systematically reviews the current application status and development history of AI technology in auto insurance claims, analyzes various potential problems including data security risks, and proposes corresponding countermeasures. In the future, with the continuous advancement of technology, auto insurance claims will become more intelligent, but it is also necessary to strike a balance between technological innovation and risk management. This article provides a reference basis for the digital and intelligent transformation of auto insurance claims.

Keywords: Artificial Intelligence; Auto Insurance Claims; Technological Innovation.

1. Introduction

At every stage of human history, technological progress has driven changes and development in all walks of life. Since the beginning of the 21st century, the rapid development of information technology has injected new impetus into the insurance industry, gradually moving insurance services from offline to online. "Internet insurance" has also transformed from a concept into reality[1]. In recent years, with the concentrated breakthroughs in emerging technologies such as artificial intelligence, the global insurance industry is undergoing the most profound transformation wave since the establishment of actuarial models.

Foreign countries started applying new technologies to the insurance industry earlier. Although China started relatively late, it has also successively introduced a series of policies to provide guidance. In 2006, The State Council issued the "Several Opinions on the Reform and Development of the Insurance Industry", explicitly stating that modern technology should be integrated into the development of the insurance industry. In 2017, "digital economy" was written into the government work report for the first time, marking that China's insurance industry has entered a new stage of accelerating digital transformation. In 2019, the "Guiding Opinions on Promoting High-Quality Development of the Banking and Insurance Industries" was released, further emphasizing the need to adhere to technological empowerment to provide strong support for the innovative development of the banking and insurance industries[2]. At the end of 2021, the China Insurance Association released the "14th Five-Year Development Plan for Insurance Technology", clearly defining the direction and goals for the development of insurance technology in China by 2025[3].

Auto insurance, as an important component of property insurance, holds a pivotal position worldwide. In the United States, the auto insurance market is as large as 432 billion US dollars, accounting for approximately 41% of the entire property insurance market. Similarly, in China, auto insurance is not only the insurance product that consumers come into contact with most widely and use most frequently, but also the largest business segment in property insurance. According to McKinsey's prediction, within the next decade, the application of AI technology will save the global insurance industry over 180 billion US dollars in costs. Due to the high degree of standardization in the claims process and the large input of human resources, it has become one of the key directions for the implementation of technology. The traditional claims settlement model has problems such as low efficiency, high cost and many risks. Statistics show that in small claims cases alone, the annual losses caused by loopholes in claims settlement amount to as much as 50 billion yuan, accounting for 10% to 20% of the total claim amount. Although the digital transformation of the insurance industry in recent years has significantly improved the quality of claims services, it still faces many challenges in practical application. The "Report on the Digital Development of Insurance Claims Services in China" released in 2023 also pointed out that there are still many problems in current claims services that need to be urgently addressed [4].

In recent years, AI technologies represented by deep learning, computer vision and natural language processing have developed rapidly, bringing new vitality to auto insurance claims, but at the same time, they have also brought certain risks and challenges. For this reason, this paper systematically reviews the current application scenarios and technical principles of AI technology in auto insurance claims both at home and abroad, deeply analyzes the risks faced, and proposes corresponding countermeasures, aiming to promote the healthier and more orderly development of AI technology in the auto insurance claims service system.

2. Intelligent Reconstruction of Auto Insurance Claims under the Application of AI Technology

The application of AI technology in the insurance claims system has undergone a relatively long development process. From the 1990s to the present, it can roughly be divided into the following five stages. The first stage is the stage of technological germination and early exploration. For instance, around the year 2000, machine learning techniques began to be attempted to be applied in risk assessment models.

However, due to the limited computing power and insufficient data resources at that time, the core links of the claims process still mainly relied on manual operation. The second stage is the stage of technological breakthroughs and pilot applications. In 2012, the world's first AI online claims settlement system was officially launched, marking the beginning of AI technology's entry into the insurance claims field and its entry into a small-scale application testing stage. The third stage is the commercialization implementation stage. In 2016, a domestic insurance company launched an intelligent claims settlement platform, reducing the processing time for auto insurance damage assessment by 40%. In 2018, Fudan University and the China Insurance Society jointly released the "AI Application Roadmap for the Insurance Industry", setting the development goal of achieving the "medium-intelligence stage" by 2020. The fourth stage is the full-process and efficiency revolution stage. This is a period when AI is developing rapidly in the field of claims. Due to the impact of the epidemic, the demand for contactless claims has soared. A certain insurance company has launched an "AI Intelligent automatic decision-making Model", increasing the proportion of AI automatic processing to 40%, achieving the elimination of manual review and marking a crucial step forward in unmanned claims settlement. The fifth stage is the stage of intelligent decision-making and ecological reconstruction. In 2023, with the accelerated advancement of AI technology worldwide, its scale in the insurance claims market has reached 20 billion US dollars. The rise of generative AI has transformed the traditional operation mode. It can automatically generate claims summaries, and humans only need to verify key information to complete the entire process.

Based on the above five development stages, this chapter focuses on the application of AI technology in the auto insurance claims system, and mainly analyzes its current situation in three core aspects, including the key technologies used, specific application cases, and the actual benefits brought.

2.1. Achieve Intelligent Loss Assessment Through Image Recognition and Automated Processing

The accuracy of image recognition directly affects the correctness of the damage assessment results. Whether the damaged parts and degrees in the pictures can be accurately identified has always been a difficult issue in the claims process. At present, the mainstream visual recognition systems adopt convolutional neural networks (CNNS) as the technical basis for intelligent loss assessment. By extracting the vehicle damage features in the image through multi-layer convolution and pooling operations and training the model with a large amount of historical damage assessment data, the system can determine the damage location and severity of the vehicle within seconds and automatically match the corresponding repair plan.

For instance, a regional insurance company in China has developed its own AI image recognition system, which can process over 50 million images every day, with an image plagiarism detection accuracy exceeding 90%. Another leading insurance company has developed an intelligent damage assessment platform. Users only need to upload photos of vehicle damage through a mobile APP. Under the guidance of the system, they can take panoramic and detailed damage pictures. Then, the background can identify the damaged parts through cloud algorithms and automatically generate maintenance suggestions. Meanwhile, the system can also calculate and feedback the possible changes in the premium for the following year in real time, helping customers understand the reasons for premium adjustments in advance. The most significant breakthrough of this system lies in solving the problem of identifying irregular damages. The accuracy rate of damage assessment for pure appearance damage cases is as high as 98%, reducing the traditional process that originally took half an hour to just three seconds. At present, this system has been applied to approximately 60% of private car claims cases, saving the industry about 2 billion yuan in costs annually.

Foreign insurance companies started earlier in the application of AI technology. For instance, a large insurance company in the United States uses AI to handle auto insurance claims, with an average processing time of only 3 seconds per claim. A certain European company has introduced blockchain technology into the AI loss assessment process, ensuring that the loss assessment data cannot be tampered with and further enhancing the credibility of the loss assessment results. A German insurance company has also developed a "virtual surveyor" system. By leveraging VR technology to reconstruct accident scenes, it has enhanced the accuracy of loss assessment for difficult cases.

From the above cases, it can be seen that by introducing AI technology and combining the intelligent recognition of vehicle damage images with the automation of the claims process, not only has the recognition accuracy been significantly improved, but also on the basis of traditional digital claims, the level of automation has been further enhanced, effectively solving the traditional claims pain points such as high labor costs and low efficiency. With the integrated application of technologies such as blockchain, virtual reality, and generative artificial intelligence, in the future, more precise functional modules can be developed for special scenarios and specific needs, promoting the loss assessment process to a higher level of intelligence.

2.2. Enhance Risk Prevention and Control Capabilities Through Machine Learning and Biometric Recognition

Insurance fraud has long been one of the significant risks faced by insurance companies. As early as the beginning of the 2000s, in a certain region of our country, the annual losses caused by auto insurance fraud were close to 1 billion yuan. In one typical case, four employees of an auto repair shop forged over 300 false claims cases within more than a year, defrauding more than one million yuan in insurance money [5]. These cases highlight the urgent need to enhance fraud identification and risk control in the auto insurance claims process.

Building an insurance fraud identification system based on artificial intelligence technology (especially machine learning) is one of the more effective coping strategies at present. Insurance companies have accumulated a large amount of user and claims data over a long period of time. Through in-depth mining and analysis of these data, they can establish a risk map covering characteristics such as abnormal claim frequency, claim time concentration, and frequent association with specific repair institutions. On this basis, they can develop multi-dimensional anti-fraud models. For instance, a domestic regional insurance company has introduced an AI-driven risk control system, which is capable of detecting

image plagiarism and identifying traces of tampering. It has successfully intercepted approximately 10% to 20% of suspected fraud cases. Through large-scale data analysis, the system compares the maintenance quotations with the average market level and identifies a deeply hidden insurance fraud gang.

In addition, the application of biometric recognition and user behavior verification technologies also helps to enhance the accuracy of risk prevention and control. Facial recognition, voiceprint recognition and other means can be used to verify the identity of applicants, effectively reducing the possibility of identity fraud. Meanwhile, by continuously monitoring user behavior patterns, insurance companies can set reasonable permissions and compensation limits based on user profiles, thereby achieving early intervention in risks. For instance, a major insurance company sets credit limits for users based on a driving behavior scoring mechanism and requires users to complete specified actions during the remote loss assessment process to verify the authenticity of the accident.

The application of artificial intelligence in the field of auto insurance risk control is far from limited to this. With the introduction of emerging technologies such as blockchain, the security and credibility of claims data have been further enhanced, providing a more solid technical support for anti-fraud work. Although some innovations are still in the exploratory stage and have not yet been widely implemented, the potential of AI in enhancing the risk management and fraud detection of auto insurance claims has already begun to emerge.

2.3. Optimize the Full-Process Customer Service Experience through NLP and UBI Technologies

The claims experience of customers largely determines their satisfaction with the claims outcome and further influences their future choice of the insurance company. Therefore, the customer experience is directly related to the core competitiveness of the insurance company.

The full name of NLP technology is Natural Language Processing Technology. Its core principle is to understand the user's text through pre-trained language models and extract key information from cases. For instance, through the recognition technology of named entities, important information such as the type of accident and the responsible party can be automatically identified. By integrating sentiment analysis and semantic rules, the rationality of the user's description is judged, and ultimately, unstructured language is transformed into processable claims data. A leading domestic insurance company has applied NLP technology in its intelligent customer service system, which can identify over 200 types of claims related consultation questions. This has increased the efficiency of claims case sorting by 70% and customer satisfaction by 25%.

UBI technology (insurance based on usage behavior) first emerged abroad. In 2016, a large insurance company in the United States was the first to innovatively apply the UBI model [6]. This technology collects driving behavior data in real time through on-board sensors, such as obtaining driving information through OBD devices or mobile phone GPS, and uses machine learning algorithms to analyze these data to establish personalized risk assessment models, thereby achieving dynamic assessment of users' driving risks and having the ability to automatically identify accidents. UBI technology makes personalized claims services possible, making "dynamic claims" a reality. A domestic insurance company has begun to dynamically adjust the deductible based on historical accident data. Users need to complete online safety learning before they can enjoy the fast claim settlement channel.

To sum up, the advantage of UBI technology is that it can provide dynamic, objective and detailed factual data, while NLP technology is good at processing users' subjective descriptions through intelligence. If the above two can be combined, it will not only enhance the efficiency and accuracy of claims settlement, but also optimize the customer experience throughout the claims process.

3. Risk Analysis of Auto Insurance Claims Empowered by AI Technology

3.1. Data Security and Privacy Leakage Risks

In the process of applying AI technology to auto insurance claims, it often relies on a large amount of data support. However, in the process of data collection and storage, the risk of information leakage has become increasingly prominent.

Firstly, when using UBI technology for data collection, if the system malfunctions or encounters other issues, sensitive information such as users' whereabouts and driving habits may be leaked and then exploited by lawbreakers. For instance, in 2020, a certain foreign auto insurance company caused the leakage of driving records of hundreds of thousands of users due to incorrect database configuration, which eventually led to a class-action lawsuit.

Secondly, third-party companies also face the risk of abuse in the use of data. As the process of auto insurance claims involves third-party institutions such as repair shops, when insurance companies share vehicle owner information and historical accident data with these cooperative units, it actually constitutes an indirect leakage of user information, bringing about potential risks in terms of privacy and security. For instance, a major domestic insurance company once opened up users' claim data to its partners, which led to users questioning that it violated users' privacy.

3.2. Algorithmic Bias and Fairness Risk

Apart from the issue of data security, the application of AI technology also faces challenges in terms of fairness, especially in the two links of auto insurance pricing and claims settlement.

On the one hand, due to the significant regional differences in the auto insurance industry, the training data may contain some individual cases or biased data, such as certain regions that have long been regarded as regions with high claim rejection rates. A study abroad in 2022 found that a certain UBI auto insurance model charged higher premiums for night drivers. However, further investigation revealed that this group was mainly low-income individuals, and there was no sufficient evidence to suggest that their risks were higher. In addition, the recognition accuracy of NLP technology has significantly declined when dealing with non-standard languages such as dialects, which may lead to misjudgment of claims descriptions and thereby exacerbate the unfairness of services.

On the other hand, insufficient algorithmic transparency may also magnify the unfairness in the claims process. Deep

learning models usually have a "black box" feature, making it difficult for users to understand the specific basis on which AI makes a decision to reject claims. For instance, a foreign insurance company once adopted neural network technology for claims review. However, it was found that the system could neither explain its own judgment logic nor provide clear reasons for decision-making. Eventually, it had to suspend the use of the relevant AI system.

3.3. Risk of Lagging Responsibility Definition and Supervision

With the rapid development of AI technology, the current legal system and regulatory mechanism are also facing the problem of insufficient adaptability.

One situation is that when an accident occurs in an autonomous vehicle, the vehicle owner, the car manufacturer, the algorithm provider and the insurance company may all be held responsible. However, the autonomous decision-making process of AI systems often makes it difficult to clearly define the boundaries of responsibility. For instance, in an autonomous driving accident that occurred abroad in 2022, the insurance company refused to pay out, but the court was unable to determine whether the insurance company or the technical service provider should be held responsible for the accident.

In addition, the lag in regulation also brings risks in terms of technical compliance. AI systems have the ability to continuously learn, which may cause changes in originally certified models during operation. For instance, after a certain model is trained on a large amount of new data, it may automatically develop a discriminatory tendency towards a certain type of vehicle during the claims process. However, the regulatory authorities fail to detect this in time and still use the old standards for auditing. A study by a foreign financial institution in 2023 pointed out that there is still a lack of an effective real-time monitoring mechanism for dynamic AI systems at present.

4. Strategies for Dealing with Risks in Auto Insurance Claims under the Application of AI Technology

As mentioned in Chapter Three, the application of artificial intelligence technology has brought about significant technological innovations to the auto insurance claims service system. However, at the same time, it has also triggered a series of new risk challenges, including data leakage, algorithmic bias, and unclear liability attribution issues. This chapter will focus on the three main risks that AI faces in the field of auto insurance claims as mentioned earlier, and respectively explore the corresponding response strategies and optimization paths.

4.1. Build a Data Full Life Cycle Protection System

In response to the issue of data leakage, insurance companies should establish a multi-level data protection system. Firstly, during the data collection stage, differential privacy technology can be adopted to desensitize the information collected by UBI (Insurance Based on Usage) sensors, thereby ensuring that even if the data is leaked, the user's sensitive information cannot be restored. Secondly, in the data sharing stage, access rights should be strictly controlled, and the acquisition of key data by third-party institutions such as repair shops should be restricted. Moreover, blockchain technology should be combined to record the data flow path, enhancing the traceability and security of data usage.

In addition, it is also necessary to strengthen compliance management at the technical level. For instance, regularly conduct penetration tests and data security audits to promptly identify and fix system vulnerabilities; Strengthen the awareness training of employees in data protection to prevent the risk of data leakage caused by improper human operation. Meanwhile, privacy computing technologies such as federated learning can be introduced to enable the model training process to be completed on the user's local device, with only model parameters uploaded instead of the original data, fundamentally reducing the possibility of data leakage.

4.2. Establish and Improve the Mechanism for Ensuring Algorithmic Fairness

To reduce algorithmic bias, optimization should be carried out from both data and model dimensions.

In terms of data, adversarial de-bias techniques can be introduced to clean the training dataset, eliminating features that are strongly related to protected attributes (such as gender and region) or have a discriminatory tendency, thereby reducing the bias generated during the model training process. In terms of models, AI tools with strong interpretability should be adopted to clearly display the decision-making logic of AI and provide users with detailed judgment basis, enabling users to "understand" how AI makes claims decisions and achieve visual supervision of the AI service process.

At the same time, a dynamic fairness monitoring mechanism should be established to prevent possible bias issues that may arise from AI systems during the claims process. For instance, an interdisciplinary ethics committee composed of experts from multiple fields such as law, ethics, and technology can be established to regularly evaluate the output results of AI models, analyze their potential impacts on different groups of people, and promptly adjust model parameters or data composition to ensure the fairness of algorithmic decisions. In addition, the model of "completely relying on AI for decision-making" can be transformed into a mechanism of "human-machine collaborative decision-making", especially when dealing with high-risk or controversial cases, introducing a manual review process can jointly ensure the rationality and transparency of decision-making at both the technical and institutional levels.

4.3. Innovate the Model of Shared Responsibility and Regulatory Collaboration

To address the issue of unclear responsibility attribution, efforts should be made in a coordinated manner from both the legal contract and technical filing levels to establish a scientific and reasonable framework for responsibility division. On the one hand, before the product is officially launched, insurance companies can negotiate and sign multi-party liability agreements with relevant entities such as car manufacturers and AI algorithm providers, clearly defining the rights and obligations of each party and the responsive-sharing mechanism in different scenarios, providing a system basis and handling foundation for possible disputes in the future. On the other hand, relying on the advantages of immutability and traceability of blockchain technology, the

system records the operation process of the AI system and its key decision-making nodes, forming a complete and reliable technical evidence chain, thereby enhancing the transparency and execution efficiency of accident liability determination.

Given the current situation where regulation lags behind technological development, it is urgent to explore a more forward-looking and adaptive collaborative governance model. On the one hand, enterprises can actively participate in innovative mechanisms such as regulatory sandboxes, carry out pilot applications of new technologies in a controlled environment, and feed back the problems found in actual operation to the regulatory authorities, promoting the dynamic optimization and improvement of relevant rules. On the other hand, supporting regulatory tools can be developed, such as AI model early warning systems with real-time monitoring capabilities, to track algorithm changes and their potential impacts, thereby enhancing the response speed and intervention capabilities of regulatory authorities to technological evolution. Through the dual drive of institutional design and technological means, the problem of lagging supervision in the application of artificial intelligence in the insurance field will be gradually alleviated.

5. Conclusion and Prospect

This study systematically reviews the current application status of artificial intelligence technology in the auto insurance claims industry and deeply analyzes the process of intelligent reconstruction of the claims system driven by AI, as well as the main risks and response paths it faces. Research has found that the role of AI in the field of auto insurance claims has undergone a fundamental transformation - from an initial tool to assist manual operations, it has gradually evolved into a core driving force for promoting full-process intelligence. Whether in image recognition, risk prevention and control, or customer service optimization, AI has demonstrated significant technological advantages. Through the integrated application of multiple AI technologies, the processing efficiency, decision-making accuracy and user experience of auto insurance claims have all been significantly improved. However, with the rapid evolution of technology, a series of new problems and challenges have also been exposed. Among them, data security risks, algorithmic bias issues, and unclear definition of accident liability have become key issues that the current industry urgently needs to address. The resolution of these issues not only requires continuous optimization at the technical level but also relies on the collaborative innovation of institutional design and regulatory mechanisms.

The effective implementation of AI technology not only depends on the maturity of the technology itself, but also relies on the improvement of the supporting governance system. To this end, this paper puts forward specific suggestions from three aspects: data full life cycle management, algorithm fairness guarantee, and multi-party responsibility sharing mechanism, and clarifies the key path to ensure the stable operation of AI technology. In the future, with the continuous evolution of emerging technologies, the auto insurance claims system is expected to achieve a higher level of dynamic balance between efficiency and fairness, innovation and compliance. Meanwhile, regulatory authorities and industry entities should also enhance coordination to promote the continuous update of relevant standards, so as to better adapt to the development pace of AI technology.

Looking ahead, the auto insurance claims service system driven by AI will evolve towards a more intelligent, personalized and ecological direction. On the one hand, cutting-edge technologies such as generative AI and the metaverse may reshape the claims process, offering a more natural human-computer interaction experience and more precise decision support. On the other hand, with the deep integration of the insurance technology ecosystem, the collaboration among automakers, technology enterprises and insurance companies will become closer, jointly building a transparent, efficient and trustworthy claims service network. This research provides theoretical support and practical reference for the development of the industry. However, it must be recognized that the in-depth application of AI in the insurance field still faces many practical challenges. Subsequent research can further focus on issues such as technical ethics norms and cross-border data governance to promote the development of the auto insurance claims system towards high quality and sustainability.

In conclusion, technology empowerment has brought unprecedented development opportunities to auto insurance claims, while also putting forward higher requirements for system construction and risk governance. Only by adhering to the "dual-wheel drive" of technological innovation and risk prevention and control can the high-quality development of the insurance industry be achieved in the wave of digital and intelligent transformation.

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