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인공지능 및 커뮤니티 인텔리전스를 활용한 건축법령 해석 지원 시스템 개선 방안 연구

Developing the AI-based Law and Regulations Intelligence System for Building Codes: Incorporating Community Intelligence with AI

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Summary

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■ Background and Purpose of the Study

This study was conducted to address the chronic issues in the field of architectural administration, namely the complexity of regulations, excessive civil complaints, and resulting administrative inefficiency. The previously developed AI-based building code interpretation support system (Archilaw V2) demonstrated some potential but revealed clear limitations in terms of accuracy, currency, and reliability. Accordingly, this study aims to propose a method for advancing the existing system into a production-level, next-generation system (ALRIS: AI Legal and Regulatory Intelligence System). This is achieved by applying the latest Large Language Models (LLMs), introducing a 'Community Intelligence Framework' that utilizes the collective intelligence of users and experts, and incorporating a 'Hybrid Intelligence' strategy. The study also aims to empirically verify the performance of this new system.

■ Technology Trends for Building AI Legal Review Systems via Community Intelligence

As performance improvements in LLMs themselves encounter limitations related to data and computational resources (Scaling Law), new technological trends are emerging. First, 'Agentic AI' technology, which utilizes LLMs as a 'brain' to autonomously plan and use tools, is gaining prominence. Second, a 'Hybrid Intelligence' strategy, involving expert intervention to compensate for AI's limitations, is being emphasized. Third, the study confirmed the convergence potential between AI and 'Community Intelligence,' a concept where collective wisdom emerges from community interactions. Additionally, trends in domestic and international AI legal review systems, such as UpCodes, AutoReview.AI, and Building Regulation Copilot, were analyzed to derive implications.

Building the AI Building Code System (ALRIS V1)

The existing Archilaw V2 system was built on Retrieval-Augmented Generation (RAG), but it has clear limitations such as a lack of conversational context management, an inadequate quality verification system, and a static knowledge base. The new ALRIS system adopted an 'agent-based architecture' to overcome these limitations. The system was redesigned with a structure where independent agents—such as a Guardrail, Planner, Retriever, Response Writer, and Knowledge Manager—collaborate asynchronously. As a core strategy, a hybrid intelligence cycle was implemented, which automatically accumulates tacit knowledge generated from user interactions and expert reviews (Human-in-the-Loop) as 'Operational Knowledge' and reuses it for search and response generation. Furthermore, for production-level service, the backend (FastAPI) and frontend (React) were completely separated. It was converted to an asynchronous system capable of handling large-scale concurrent users, and a new JWT token-based user authentication system was built.

New System Performance Evaluation

To verify the performance of the new system, a comparative evaluation was conducted between the old system (Archilaw V2) and the new system (ALRIS V1) using a benchmark dataset of 1,205 Q&A log data entries from Archilaw V2. The evaluation results showed that, based on the entire dataset, the 'conclusion consistency rate' was 54.9% for the old system, while the new system showed an 8.6 percentage point (p) improvement at 63.5%. Notably, when limited to core data (n=580) where the answer keys provided clear conclusions, the new system's consistency rate was 73.4%, a 2.4%p improvement over the old system (71.0%). A key finding was that the new system maintained a high consistency rate of 73.5% even in cases where legal search failed and regulation changes were detected. This suggests that the query and response enhancement mechanisms via the Planning and Evaluation Agents are functioning effectively. However, the legal search success rate for both systems stagnated at around 61-63%, identifying the improvement of search algorithms, embedding models, and the Vector Index as short-term tasks.

Conclusion

This study's achievement lies in upgrading the existing streamlit-based prototype system to a production-level ALRIS system, featuring a separated FastAPI backend and frontend, asynchronous processing, and user authentication. Furthermore, it pioneeringly proposed a hybrid AI structure that enhances AI reliability by capturing expert feedback as 'Operational

Knowledge'. Future policy tasks include securing an operational foundation for a public ALRIS service linked to the Ministry of Land, Infrastructure and Transport's "Seumteo" system, promoting multimodal AI R&D for interpreting BIM data and blueprints, and introducing an "AI Architectural Administration Sandbox." Subsequent research is required to test domestic local LLMs for public administration integration, organically incorporate additional data such as local ordinances, and research a multimodal legal interpretation system linked with drawing information.

Keywords :
Large Language Nodel, Artificial Intelligence, Community Intelligence, Building Law, ALRIS system