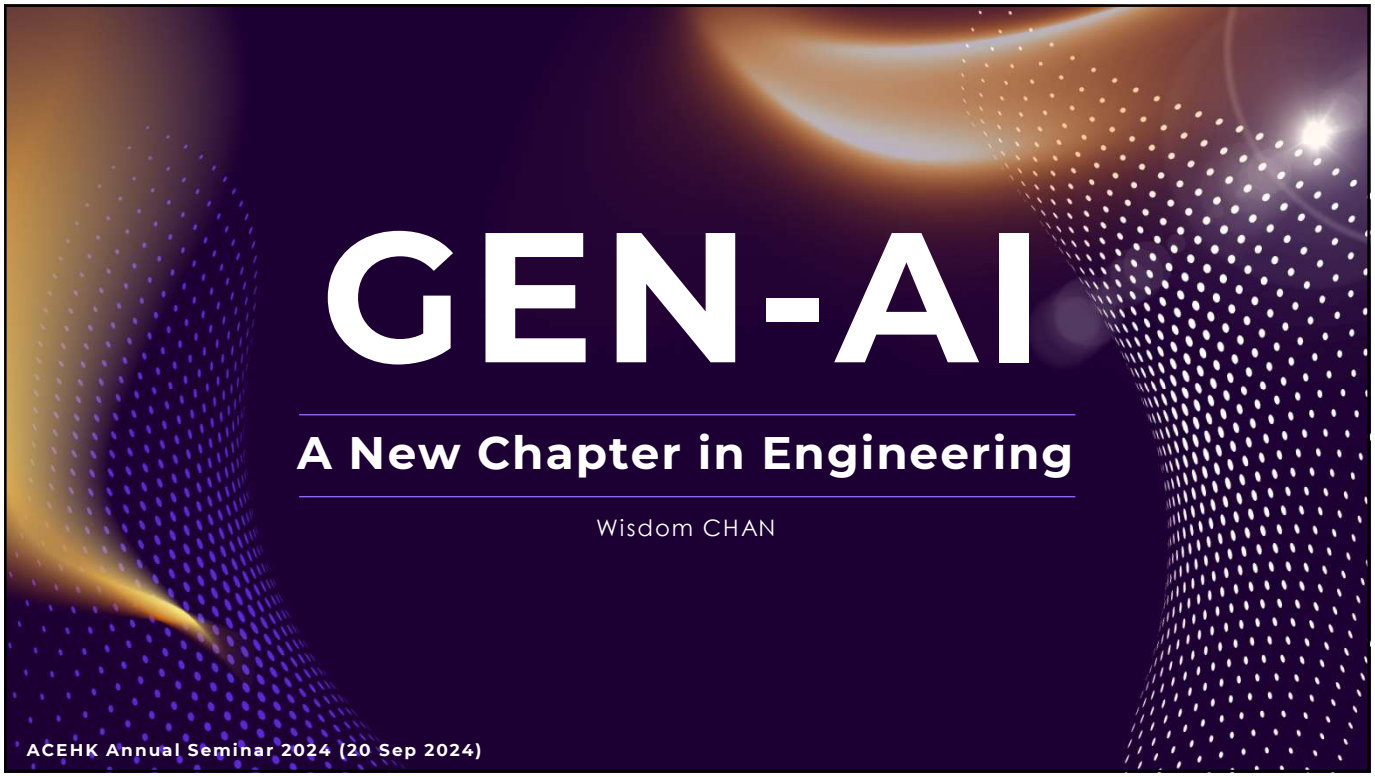

GEN-AI
A New Chapter in Engineering
Wisdom CHAN
ACEHK Annual Seminar 2024 (20 Sep 2024)

1


OUR FOCUS: THREE KEY AI ASPECTS
Specializes in integrating these three AI aspects to create powerful, accurate, and visually-enhanced solutions for the engineering industry. By combining the strengths of LLMs, RAG, and cutting-edge visual AI, we're opening new possibilities for AI-assisted engineering practices that span both textual and visual domains
01
Large Language Models (LLMs)
Large Language Models form the foundation of modern natural language AI. These sophisticated models are capable of understanding and generating human-like text, revolutionizing how we interact with and leverage AI in various applications.
02
Retrieval-Augmented Generation (RAG)
Retrieval-Augmented Generation enhances LLMs by incorporating external knowledge retrieval. This technique significantly improves the accuracy and relevance of AI-generated content, making it particularly crucial for domain-specific applications.
03
Visual AI for Engineering
Visual AI brings a new dimension to engineering with generative models for creating and manipulating images and designs. Pushing the boundaries of what's possible in concept visualization, design iteration, and even 3D modeling.
ACEHK Annual Seminar 2024 (20 Sep 2024)

2

THE RISE OF GENERATIVE AI IN ENGINEERING

Generative AI is enhancing efficiency, accuracy, and innovation across various aspects of engineering projects.

01 Project Planning and Analysis

- Advanced tender proposal evaluation
- Automated compliance checking against standards and requirements
- Comprehensive summary generation for efficient decision-making

02 Contract and Document Management

- Automated contract analysis and requirement extraction
- Integration with BIM models and CAD data for holistic contract oversight
- Proactive identification of non-compliant elements

03 Advanced Visual and Technical Analysis

- AI-driven examination of construction diagrams and blueprints
- Identification of potential issues and discrepancies in visual data
- Correlation of visual data with contract specifications

3

CHALLENGES IN IMPLEMENTING GEN-AI FOR ENGINEERING

While Generative AI offers immense potential, its implementation in engineering faces several critical challenges:

01 Accuracy and Reliability

- Ensuring AI-generated outputs meet stringent engineering standards
- Validating AI solutions against real-world physical constraints
- Maintaining precision in complex calculations and design processes

02 Domain-Specific Knowledge Integration

- Training AI models to comprehend specialized engineering concepts
- Bridging the gap between AI capabilities and expert engineering judgment
- Adapting AI to diverse engineering disciplines (structural, electrical, mechanical, etc.)

03 Data Security and Intellectual Property

- Protecting sensitive project information and proprietary designs
- Ensuring compliance with data protection regulations
- Defining ownership and rights for AI-generated engineering solutions

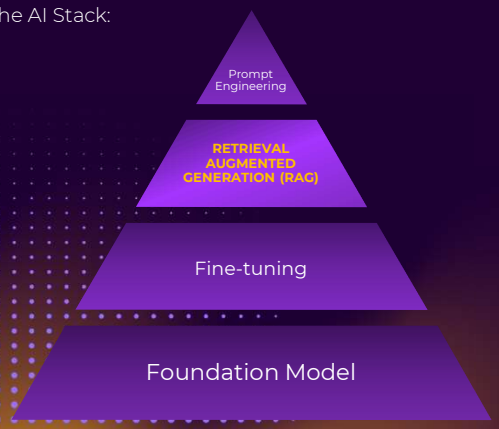
04 Seamless Workflow Integration

- Incorporating AI tools into existing engineering processes without disruption
- Ensuring compatibility with current CAD, BIM, and project management software
- Balancing AI assistance with traditional engineering methodologies

4

INTRODUCING RETRIEVAL-AUGMENTED GENERATION (RAG)

The AI Stack:



01

ENHANCING ACCURACY AND RELIABILITY

RAG grounds LLM outputs in verified engineering data and standards, incorporating up-to-date specifications and codes. This integration ensures accuracy, provides traceability, and builds trust in AI-assisted engineering processes.

02

BRIDGING DOMAIN-SPECIFIC KNOWLEDGE GAPS

LLM+RAG seamlessly integrates vast engineering knowledge bases, enabling real-time access to specialized literature and case studies. This adaptability makes it a versatile tool across various engineering disciplines.

03

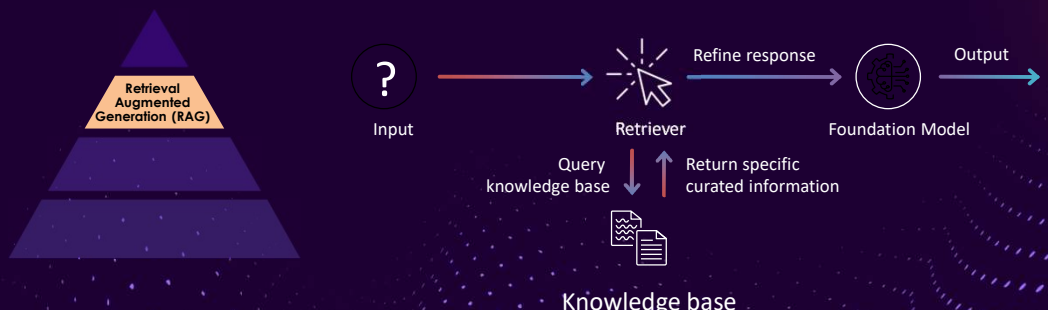
STRENGTHENING DATA SECURITY AND IP PROTECTION

The RAG architecture separates sensitive data from the core LLM, allowing fine-grained control over information access. This approach safeguards proprietary data while leveraging AI capabilities in engineering applications.

5

RAG PIPELINE: ENHANCING AI WITH CONTEXTUAL KNOWLEDGE

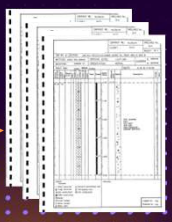
This diagram illustrates the seamless flow from user query to informed response:



6

CASE STUDY: ENGINEERING DOCUMENTATION ANALYSIS

01
DOCUMENTS UPLOAD



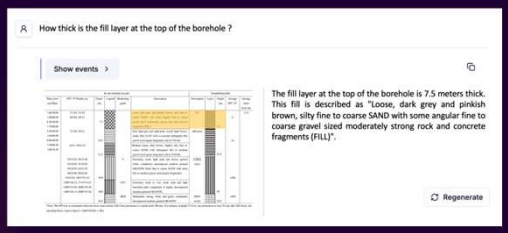
- Design Drawings
- O&M Manuals
- Code of Practice
- Specifications
- Borehole Records

02
AI PROCESSING

03
INTERACT WITH KNOWLEDGE BASE

Question: "How thick is the fill layer at the top of the borehole ?"

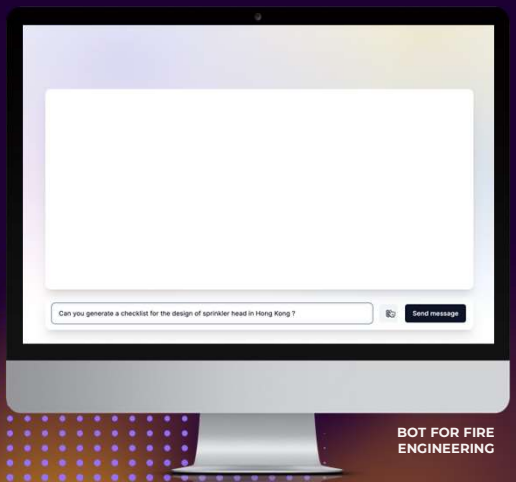
04
RETRIEVE ANSWER WITH REFERENCE



FEEDBACK LOOP

7

CASE STUDY: ENGINEERING DOCUMENTATION ANALYSIS



BOT FOR FIRE ENGINEERING

KEY FEATURES:

01
INTELLIGENT DOCUMENT PROCESSING

02
REAL-TIME QUERY RESOLUTION

03
CUSTOMIZABLE KNOWLEDGE BASE

04
MULTI-STANDARD COMPLIANCE CHECKING

05
INTERACTIVE LEARNING INTERFACE

06
DATA-DRIVEN INSIGHTS GENERATION

8

CASE STUDY: ENGINEERING DOCUMENTATION ANALYSIS

TRADITIONAL APPROACH

- Time-intensive manual review of technical documents
- Potential for human error in cross-referencing
- Limited ability to process large volumes quickly

GEN-AI APPROACH

- Automated analysis of thousands of documents in hours
- Accurate cross-referencing with up-to-date standards
- 50% reduction in review time, 35% increase in issue detection

90%

REDUCTION IN PROCESSING TIME

Analysis of 500 pages < 1 hour

17%

INCREASE IN ACCURACY

99.5% accuracy with automated cross-referencing

9

BEST PRACTICES FOR RAG IN ENGINEERING

Implementing Retrieval-Augmented Generation (RAG) in engineering requires careful consideration of data management, ethical use, and integration into existing workflows. These best practices ensure that RAG systems enhance engineering processes while maintaining high standards of accuracy, security, and professional responsibility.

DATA INTEGRITY AND QUALITY ASSURANCE

- Regular updates and peer review of knowledge base
- Rigorous source validation and version control
- Continuous performance monitoring and benchmarking

SECURITY AND PRIVACY SAFEGUARDS

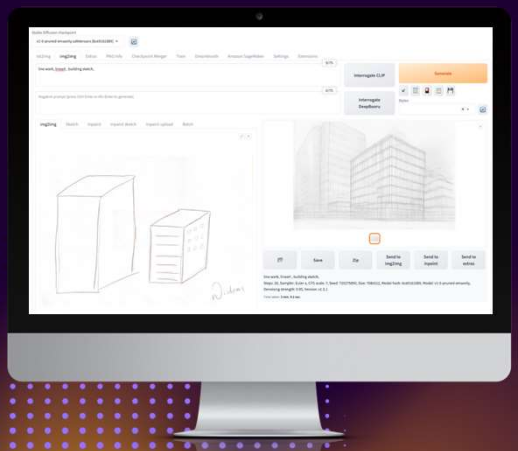
- Encrypted storage and secure, role-based access
- Data anonymization and compliance with industry regulations
- Regular security audits and updates

ETHICAL IMPLEMENTATION AND HUMAN OVERSIGHT

- Transparency in AI usage and decision-making processes
- Clear protocols for human review and final decision authority
- Ongoing bias detection and mitigation strategies

10

CASE STUDY: ARCHITECTURAL CONCEPT GENERATION



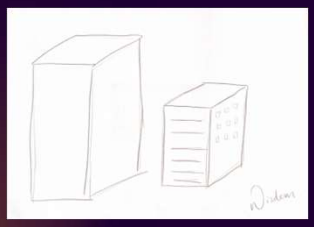
01

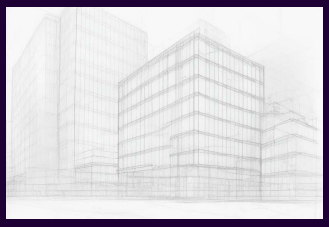
UPLOAD THE HAND-SKETCH DRAWING

02

ENHANCE THE IMAGE BY A SIMPLE PROMPT

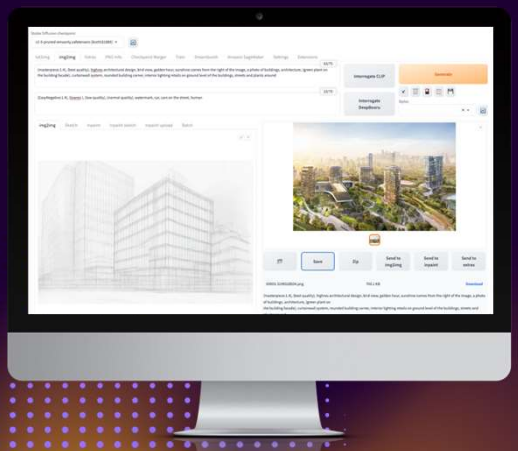
"line work, line art, building sketch, wireframe"





11

CASE STUDY: ARCHITECTURAL CONCEPT GENERATION



01

RE-UPLOAD THE ENHANCED DRAWING

02

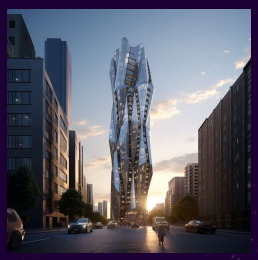
GENERATE A COMPREHENSIVE ARCHITECTURAL DESIGN

"(masterpiece:1.4), (best quality), highres architectural design, bird view, golden hour, sunshine comes from the right of the image, a photo of buildings, architecture, (green plant on the building facade), curtainwall system, rounded building corner, interior lighting retails on ground level of the buildings, streets and plants around"

12

CASE STUDY: ARCHITECTURAL CONCEPT GENERATION

Explore a vast array of design possibilities to achieve optimal outcome:

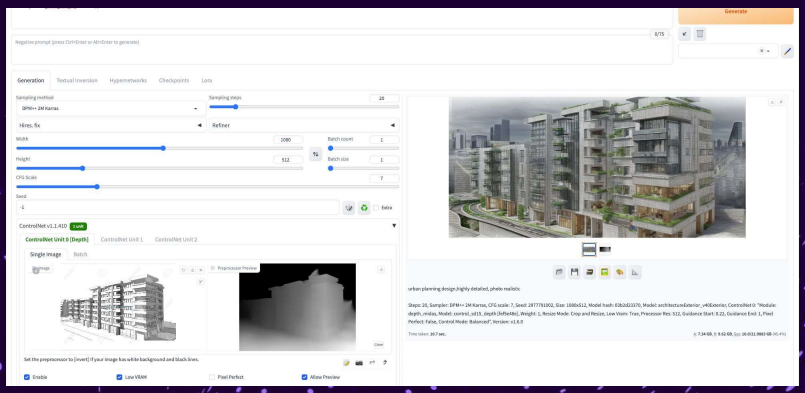

Final design:

13

14

CASE STUDY: ARCHITECTURAL CONCEPT GENERATION (2D TO 3D)

Transforms 2D architectural drawings into detailed 3D models using advanced depth mapping technology. By analyzing 2D images, the AI generates accurate depth maps, which are then used to construct 3D representations. This process drastically reduces modeling time, enhances design visualization, and improves client communication.



15

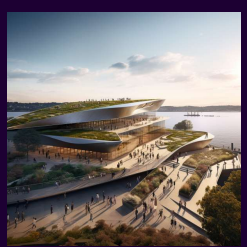
CASE STUDY: ARCHITECTURAL CONCEPT GENERATION (2D TO 3D)

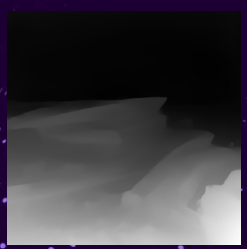
Transforms 2D architectural drawings into detailed 3D models using advanced depth mapping technology. By analyzing 2D images, the AI generates accurate depth maps, which are then used to construct 3D representations. This process drastically reduces modeling time, enhances design visualization, and improves client communication.

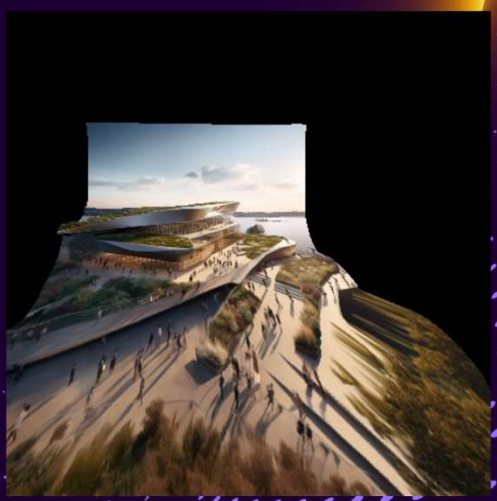
70%

REDUCTION IN 3D MODELING TIME

Integration with existing CAD and BIM workflows



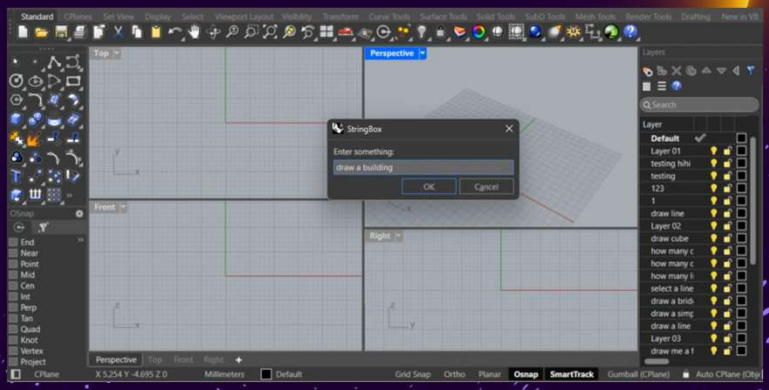




16

BUILDING AI-POWERED VIRTUAL AGENTS FOR ENGINEERING SUPPORT

AI-powered virtual agents represent the next frontier in engineering assistance, offering real-time support, knowledge retrieval, and task automation. These agents integrate advanced natural language processing, machine learning, and domain-specific knowledge to provide engineers with an intelligent digital assistant capable of enhancing productivity and decision-making across various engineering disciplines.



17

CONCLUSION AND KEY TAKEAWAYS

Generative AI is not just a tool, but a collaborative partner in engineering innovation. By fostering effective human-AI synergy, we can unlock unprecedented levels of creativity and efficiency, pushing the boundaries of what's possible in engineering and creating a smarter, more sustainable future.

18

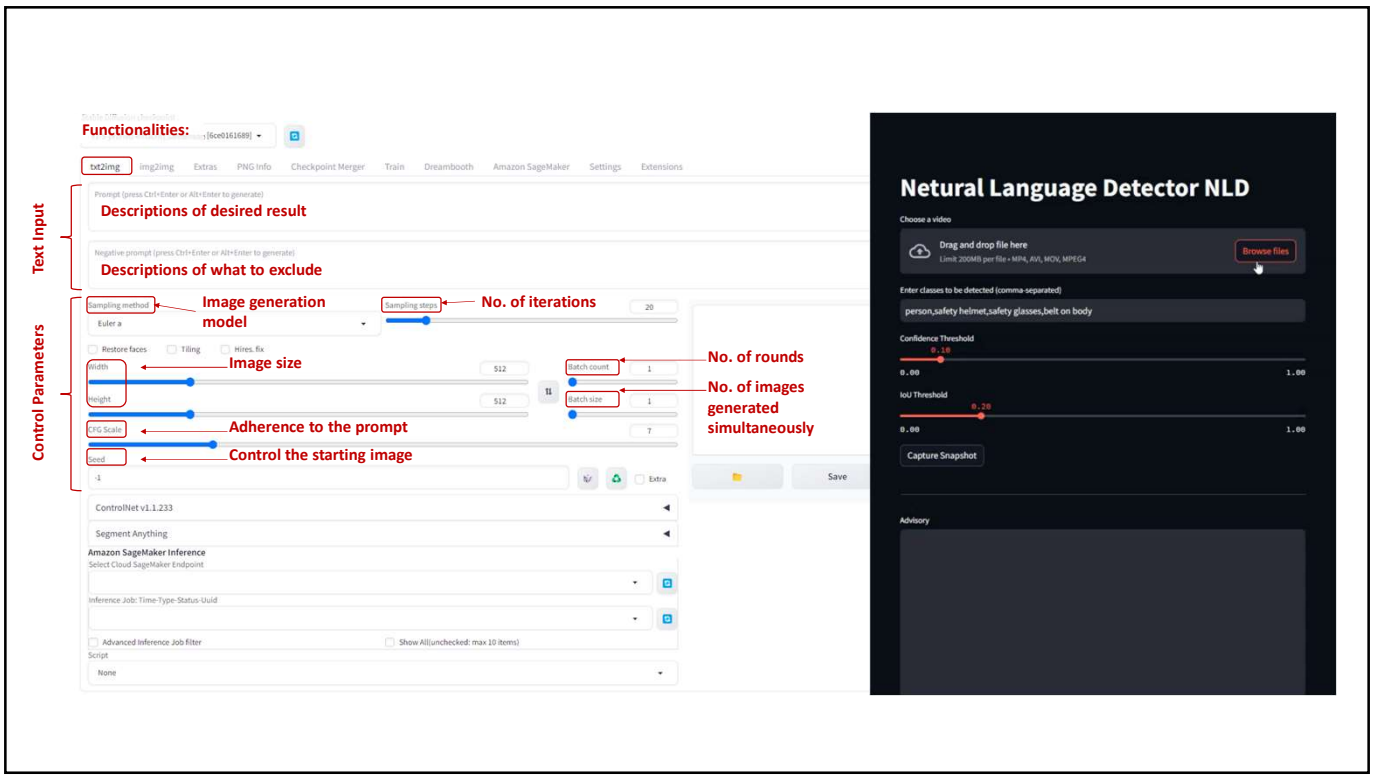
Thank You!

Get in touch with us

LinkedIn :
https://www.linkedin.com/in/wisdomchan/

ACEHK Annual Seminar 2024 (20 Sep 2024)

19



20

CASE STUDY: ENGINEERING DOCUMENTATION ANALYSIS

01
HARDWARE REQUIREMENTS

02
TRAINING PROCESS

03
PERFORMANCE BENCHMARK