

ISSN 2093-0542



ICONI



KOREAN SOCIETY FOR INTERNET INFORMATION

The 16th International Conference on Internet (ICONI 2024)

Dec. 16-19, 2024 Taipei International Convention Center (TICC)
Taipei, Taiwan
<http://www.iconi.org>

Proceedings of ICONI 2024

| Organized by |
Korean Society for Internet Information (KSII)

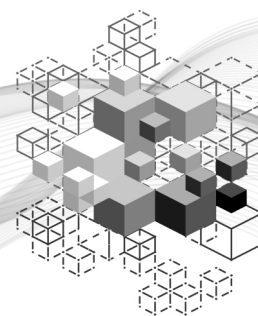
| Sponsored by |
INU Computational Research Center

Contents



1-1	An NLP Model to Predict the Ideological Orientation for the 22nd National Assembly (Polisay) and Associated Legal Issues Sang-Yeon Kim (Kwangwoon Univ., ROK), Heeyoon Yang (TVing, ROK), Junghoon Kim (CBS, ROK), Jiweon Seon (Hanyang Univ., ROK)	1-4
1-2	Between expectations and concerns: factors influencing Intention to use 5G-based immersive journalism Kyung Han You (Jeonbuk National Univ., ROK), Irkwon Jeong (Kwangwoon Univ., ROK)	5-7
1-3	The Role of Personalized Short-form Content on Media Consumption Patterns among University Students Hyun Jee Park (Hankuk Univ. of Foreign Studies, ROK), Eujong Kim (MBC, ROK)	8-11
1-4	From Likes to Action: How Clicktivism Mediates the Relationship Between Social Media Use and Political Participation Jaehyun Lee (Ewha Womans Univ., ROK), Yun-Kyoung Cho (Gachon Univ., ROK)	12-14
1-5	Analysis of Space Cybersecurity Strategy Trends in Advanced Space Countries Jungho Eom, Kyungil Kim (Daejeon Univ., ROK)	15-18
1-6	National Defense Space Cyber Threats and Response Measures for National Defense Space Security Jungho Eom, Sangpil Cheon, Kyungil Kim (Daejeon Univ., ROK)	19-22
1-7	Node Embedding Instability Problem when Using GNN for Detecting E-Commerce Malicious Fraud Janggun Jeon, Namgi Kim (Kyonggi Univ., ROK)	23-24
1-8	A Study on On-the-Fly Profiling Method using Prologue and Epilogue of Scheduler in HPC System Jae-Kook Lee, Do-Sik An, Min-Woo Kwon, Taeyoung Hong (KISTI, ROK)	25-28

Contents



1-9	Development of a Comprehensive Analysis and Evaluation Framework for ScienceON: Enhancing Quality and Enabling Digital Transformation Jinyoung Kim, Jeonghun Park, Suhyeon Yoo (KISTI, ROK)	29-30
1-10	A CCTV Active Contents Collection Method based on Location Kyunghee Sun, Kwanghoon Pio Kim (Kyonggi Univ., ROK)	31-34
1-11	A Study on the Exploration of Curriculum-Based Knowledge Map Construction Youngseok Lee (Seoul National Univ. of Education, ROK), Daehyup Park, Chigun Lee, Minyoung Hyun (i-Scream edu Corporation, ROK), Dukhoi Koo (Seoul National Univ. of Education, ROK)	35-37
1-12	Real-time Monitoring of Refrigerator Recycling Process Using YOLO and OpenCV Jun Seong Kim (East-North Resource Recycling Center, Inc., ROK), Yun-Seo Cho, Tae-Yeon Kim, Tai-Woo Chang (Kyonggi Univ., ROK)	38-39
1-13	The Classification of Electronic Wallet Types for Secure Digital Asset Management Moonseong Kim (Seoul Theological Univ., ROK), Woonchan Lee (Incheon National Univ., ROK), Hyung-Jin Lim (Financial Security Institute, ROK)	40-41
1-14	Scenario Design of a Disaster Warning Service utilizing FM RDS2 Dawoon Jeong, Younghun Kim, Heesang Eom, Jongho Paik (Seoul Women' s Univ., ROK)	42-43
1-15	Multi-modal Interaction for Virtual Pets Using Gesture, Voice, and Gaze Recognition Meejin Kim, Sung-Oh Jung, Byung-Ha Park (KETI, ROK)	44-45

Contents



2-1	Domain-Aware Semantics and Decaying Dependencies for Zero-Shot Log Anomaly Detection Lelisa Adeba Jilcha, Deuk-Hun Kim, Jin Kwak (Ajou Univ., ROK)	46-48
2-2	Design and Implementation of a Condition-Based Operation (CBO) using LLM-Based Multi-Agent Systems Joon Soo Jeong (Puzzlesystems Co., Ltd, ROK), Oakyoung Han (Sungkyunkwan Univ., ROK)	49-54
2-3	Performance Comparison of Transformer-based Process Instance Remaining Time Prediction Models Da-chan Jung, Eun-bi Jo, Jin-hyung Lee, Tsagaantsooj Batzaya, Kyoung-Sook Kim, Dinh-Lam Pham, Kwanghoon Pio Kim (Kyonggi Univ., ROK)	55-60
2-4	Real-World Reinforcement Learning for Real Environment Control: DQN vs. Advanced Dyna-Q Jinuk Huh, YongJin Kwon (ROK Aerospace Univ., ROK)	61-66
2-5	Semantic Positional Coordinate Embedding and LLM Feature Extraction-Based 3D Reconstruction Geon-Woo Kim, Woo-Hyeon Kim, Joo-Chang Kim (Kyonggi Univ., ROK)	67-70
3-1	NeRF-based 3D Reconstruction for Crime Video Gyu-Il Kim, Hyun Yoo, Kyungyong Chung (Kyonggi Univ., ROK)	71-73
3-2	Chest Multi-organ Segmentation with Pseudo X-ray Images Seonghyeon Ko, Huigyu Yang, Gyurin Byun, Juchan Kim, Hyunseung Choo (Sungkyunkwan Univ., ROK)	74-79
3-3	Design of Classroom Structures on the Metaverse for Public Education and Methods to Support Teaching and Learning Using 3D Objects Youngwoong Kim, Min Jeong Lim, Gyoung Mo Kim (Konkuk Univ., ROK)	80-84

Contents



3-4	Comprehensive Tabular Data Analysis and Visualization for Registered Korean Fishing Vessels Juhyoung Sung, Kyoungwon Park, Kiwon Kwon, Byoungchul Song (KETI, ROK)	85-88
3-5	Devising an efficient routing protocol for vehicular delay tolerant networks Abdul Wahid (Univ. of Birmingham Dubai, UAE), Muhammad Sannan (NUST-SEECS, Pakistan), Muhammad U. Ilyas, Mian Hamayun, Nabeel Khan, Ahmad Ibrahim, Ahmad Ibrahim Kamel (Univ. of Birmingham Dubai, UAE)	89-91
4-1	Early Childhood Teachers' Discourse on the Development of an AI Model for Supporting Young Children's Social-Emotional Development Kyoungsook Kwon, Youngshin Ju, Inae Hwang (Sungshin Women's Univ., ROK)	92-97
4-2	Preliminary research to develop question scenarios to measure social-emotional in young children Sunok Min (Ai Joa Inc., ROK), Miseun Lim (MajuMom Care Psychological Research Institute, ROK), Yousun Cho, Heyjung Min (Ai Joa Inc., ROK)	98-103
4-3	A study on Adult Speech Data Augmentation Methods for Improving Child Speech Recognition WER JunHwi Moon (Vision21Tech, ROK), Jiyoung Choi (Pai Chai Univ., ROK), JeongRok Lee (AI Leader, ROK), Wonsun Shin (Vision21Tech, ROK)	104-109
4-4	Data Augmentation and Speech Recognition Improvement for Korean Children Speech Using Multimodal Speech Style Conversion Model Wonsun Shin (Vision21Tech, ROK), Yun-Kyung Lee (Soundustry Inc., ROK)	110-115

Contents



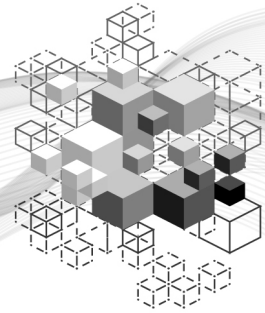
4-5	Parental Speech Patterns and Children' s Emotional Responses: A Study Using YouTube Vlog Data Sarah Choi, Keon Chul Park (Advanced Institute of Convergence Technology, ROK)	116-119
4-6	An Exploratory Analysis for Deriving Linguistic Factors for Children-AI Interaction Kwang Sik Jeong, Woomin Nam, Keon Chul Park (Advanced Institute of Convergence Technology, ROK)	120-122
4-7	Emotion Recognition in Child Speech through Multimodal Data: Considerations for Speech and Text Analysis Jaehoon Yang, Woomin Nam, Keon Chul Park (Advanced Institute of Convergence Technology, ROK)	123-128
5-1	Distributed Mesh Networks for Autonomous Coordination of Heterogeneous Unmanned Vehicles Sung-Chan Choi, Jong-Hong Park, Sungwook Jung, Ilyeop Ahn (KETI, ROK)	129-130
5-2	News Article Dataset for AI Generated Text Detection Yong-Suk Park, Yeon-Seung Choo, HyungSung Kim (KETI, ROK)	131-132
5-3	Implementation of Emotion Inference on Edge Devices Yong-Suk Park, Yeon-Seung Choo, Hyun-Sik Kim (KETI, ROK)	133-134
5-4	Research on heterogeneous GPU resource management and dynamic sharing and placement in cloud native environments Youngyoon Choi, Jaegi Son, Dongmin Kim (KETI, ROK)	135-138
5-5	Decentralized Pricing of Generative AI Model APIs via an Automated Market Maker HyungSung Kim, Hyun-Sik Kim, Yong-Suk Park (KETI, ROK)	139-140
5-6	Building AIOps Synthetic Datasets: A Framework for Resource Usage Optimization in Cloud ML Workloads Jonghwan Park, Geunmo Kim, Jaegi Son, Dongmin Kim (KETI, ROK)	141-144

Contents



5-7	Carton Box Volume Estimation based on ToF-RGB Fusion Sukwoo Jung, Youn-Sung Lee, KyungTaek Lee (KETI, ROK)	145-146
5-8	A Pose Estimation Method Utilizing 3D Spatial Map and Image Template Matching Sukwoo Jung, KyungTaek Lee (KETI, ROK)	147-148
5-9	Design of an AI-based Decision Support System Architecture through Knowledge Graph based Complex Threat Analysis Min Hwan Song, Sunghun Chae (KETI, ROK)	149-150
5-10	Development of an IoT-based Shipyard Welding Monitoring System and Algorithm Min Hwan Song, Sunghun Chae (KETI, ROK)	151-152
5-11	Classification of Emotional Expression in Metaverse for Visually Impaired Youngmin Kim, Seung Kyu Kang, Hyeonchan Oh, Yonghwa Kim, Jinsoo Jeong, Byounghyo Lee, Jisoo Hong, Sunghee Hong (KETI, ROK)	153-154
5-12	Multi-QR and 3D Model-Based Security Hologram Generation and Verification Technology for Anti-Counterfeit of Ticket YoungBeom Kim, Sunghee Hong (KETI, ROK)	155-156
5-13	Development of a 50-kVA Bidirectional PWM Converter for Reactive Power Compensation in Premises Systems Seunghyeon Park, Kiwoong Kwon, Yongho Kim (KETI, ROK)	157-158
6-1	Cross-Platform Parallel Processing of Intuitive Digital Focus Index for Autofocus Applications HyungTae Kim, Duk-Yeon Lee, Dongwoon Choi, Dong-Wook Lee (KITECH, ROK)	159-164
6-2	Attack Scenario-Driven Prediction and Mitigation of Blended Threats in IoBE Yu-Rae Song, Deuk-Hun Kim, Jin Kwak (Ajou Univ., ROK)	165-168

Contents



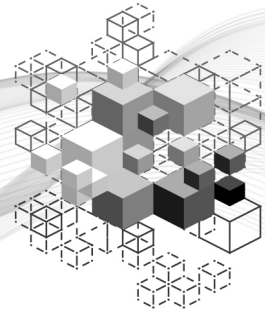
6-3	Design and Implement of a MAVLink-based UAV Control System Applicable to Safety Detection in Industrial Plants Seoyeon Park, Jiwon Ryu, Choonghwan Jung (Seoul Women' s Univ., ROK), Christian Lee (LOAS Inc., ROK), Jongho Paik (Seoul Women' s Univ., ROK)	169-173
6-4	Design and Implement of a Web Server/Client System for Long range UAV Control Jiwon Ryu, Seoyeon Park, Choong Hwan Jung (Seoul Women' s Univ., ROK), Christian Lee (LOAS Inc., ROK), JongHo Paik (Seoul Women' s Univ., ROK)	174-178
6-5	Electromagnetic Simulation Using FETI-based Domain Decomposition with Transmission Conditions Woonbin Park, Sunghan Lee (Incheon National Univ., ROK), Moonseong Kim (Seoul Theological Univ., ROK), Woochan Lee (Incheon National Univ., ROK)	179-183
6-6	Finite Element Method-based Waveguide Analysis Using a Sequential MUMPS Solver Sunghan Lee, Woonbin Park, Hyeonyeol Na (Incheon National Univ., ROK), Moonseong Kim (Seoul Theological Univ., ROK), Woochan Lee (Incheon National Univ., ROK)	184-185
7-1	A Multi-level Query Approach to Bibliometric Analysis of Internal Fraud Research: Macro and Micro Keyword Perspective Yuna Han, Jimin Lee, Yelim Jeon, Hangbae Chang (Chung-Ang Univ., ROK)	186-191
7-2	Comparative Analysis of Data Privacy Regulations for the Activation of Generative AI in Digital Finance Industry Yeji Choi, Jaewook Byun, Dabin Lee, Hangbae Chang (Chung-Ang Univ., ROK)	192-195
7-3	EGNN-Based Multi Class Attack Classification Jaeyeong Jeong, Dongkyoo Shin (Sejong Univ., ROK)	196-197

Contents



7-4	Data Analysis for Market Entry in the Personal Data Protection Technology Sector Donghwan Ko, Sumi Kim, Yeji Choi (Chung-ang Univ., ROK)	198-203
7-5	Preventing Prompt Leakage in Generative AI Applications by using Small Language Models Jung Hyun Yoon (Chung-ang Univ., ROK)	204-209
7-6	Analysis of Research Trends Technologies for Digital Financial Security Based on Keyword Network Analysis and Topic Modeling Sungyun Bae, Hangbae Chang (Chung-Ang Univ., ROK)	210-215
7-7	Enhanced mobile banking transactions security with the help of steganography and cryptography using QR code Soobia Saeed (Tayler' s Univ., Malaysia), Hassan Khan (EMIS Institute of Management and Sciences, Pakistan)	216-220
8-1	Real-Time Sequencing for Mixed-Model Assembly Line Using Q-Learning Minseok Kim, Jiyoun Song, Haejoong Kim (Kyonggi Univ., ROK)	221-222
8-2	Development of Digital Twin based Crowd Monitoring System Considering Privacy Protection Yerin Shin, Haelyn Kim, Gayeon Lee, Junghee Chae, Su Man Nam, Hyung-Jong Kim (Seoul Women' s Univ., ROK)	223-227
8-3	A Study on AI-based Supercomputer Job Submission Log Analysis Gukhwa Lee, Min-Woo Kwon, Do-Sik An, Taeyoung Hong (KISTI, ROK)	228-230
8-4	Analysis of high-performance computing technology capabilities Myoungju Koh, Jaegyeon Hahm (KISTI, ROK)	231-232
8-5	Teletraffic Engineering for Multi-Access Edge Computing Systems Vladimir Shakhov (Novosibirsk State Technical Univ., Russia), Olga Sokolova (Institute of Computational Mathematics and Mathematical Geophysics SB RAS, Russia), Ha Manh Tran (HCMC Vietnam National Univ., Vietnam)	233-235

Contents



9-1	A 32-Gb/s Integrated Serial-Link Optical Receiver IC with Dual-Loop Clock and Data Recovery Circuits Kangyeob Park, Won-Seok Oh (KETI, ROK)	236-237
9-2	A 1-V 25-Gb/s CMOS Optical Receiver with Advanced Common-Gate Current Buffer in 45-nm CMOS Technology Won-Seok Oh, Kangyeob Park (KETI, ROK)	238-239
9-3	Design of a 4-Lane 25-Gb/s Directly Modulated Laser Driver Chipset in 45-nm CMOS Technology Won-Seok Oh, Kangyeob Park (KETI, ROK)	240-241
9-4	A Study on Data Interoperability of Video Surveillance System Sungjoo Park, Kyeongun Seo (KETI, ROK)	242-244
9-5	Comparison of HRV and EDR to Stress using an ECG patch Won Hee Hwang, Chan Hee Jeong, Hyuck Ki Hong (KETI, ROK)	245-246
9-6	Cloud-Based Multi-Edge Sensor Data Processing System for Enhanced Detection and Perception Jaewon Lee, Jongseol Lee, Dalwon Jang (KETI, ROK)	247-250
9-7	Experimental results of beat tracking based on music understanding model and feature selection Dalwon Jang, Jiyoung Beak, Jaewon Lee, JongSeol Lee (KETI, ROK)	251-253
9-8	Text based Domain Specific Image Retrieval using Image-Auxiliary Texts and Large Language Models Byunggill Joe, San Kim, Minyoung Jung, Jin Yea Jang, Chung-Il Kim, Saim Shin (KETI, ROK)	254-255
9-9	Evaluating Fine-Grained Visual Perception of Vision-Large Language Models on a Fashion Dataset Byunggill Joe, San Kim, Minyoung Jung, Jin Yea Jang, Chung-Il Kim, Saim Shin (KETI, ROK)	256-257
9-10	Evaluation of the knowledge value about code data: Dataset and model construction San Kim, Byunggill Joe, Jin Yea Jang, Chung-Il Kim, Saim Shin (KETI, ROK)	258-259

Contents



9-11	Improving Korean tool calling in large language models through a single tool calling dataset San Kim, Byunggill Joe, Jin Yea Jang, Chung-Il Kim, Saim Shin (KETI, ROK)	260-261
9-12	An Experimental Study on SemanticVQVAE in Co-Speech Gesture Generation Chungil Kim, San Kim, Jin Yea Jang, Byunggill Joe, Saim Shin (KETI, ROK)	262-263
10-1	Interactive Graph Convolutions for Bike Demand Forecasting Serin Kim, Seonghyeon Ko, Huigyu Yang (Sungkyunkwan Univ., ROK), Moonseong Kim (Seoul Theological Univ., ROK), Hyunseung Choo (Sungkyunkwan Univ., ROK)	264-269
10-2	Imaging the Respiratory Sound for Detecting Disease Symptoms Gyurin Byun, Huigyu Yang (Sungkyunkwan Univ., ROK), Moonseong Kim (Seoul Theological Univ., ROK), Hyunseung Choo (Sungkyunkwan Univ., ROK)	270-275
10-3	Multi-Labeling for Enhanced Object Tracking in Occlusion Scenarios Yumin Kim, Yunho Seo, Haejoong kim (Kyonggi Univ., ROK)	276-277
10-4	Generating 3D Models through Analyzing Natural Language Sentences with GPT API Ye Jin Jin, Chae Yun Seo, R. Young Chul Kim (Hongik Univ., ROK)	278-282
10-5	Automatic 3D Image Generation via UML Diagram based on Semantic Roles extracted with ChatGPT Hyuntae Kim (Hongik Univ., ROK), Kidu Kim (TTA, ROK), Jihoon Kong, R. Young Chul Kim (Hongik Univ., ROK)	283-286
10-6	Better Sentence Learning through Converting Simple Sentences based on C3Tree Model Janghwan Kim, Woo Sung Jang, R. Young Chul Kim (Hongik Univ., ROK)	287-290

Contents



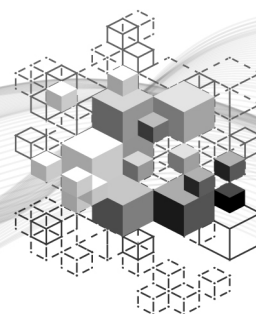
10-7	Analyzing Choice Overload Behaviors in AI-Generated Recommendations Chao-Chun Lee, Imran Ghani (Virginia Military Institute, United States)	291-293
11-1	The impact of elementary school teachers' perception of AI convergence education on their teaching capabilities Danheui Kang, Sunju Park (Gwangju National Univ. of Education, ROK)	294-296
11-2	The Effects of Problem-Solving Project-Based Learning Using Generative AI on Learners' Critical Thinking Hwieun Jang (Yeocheon Middle School, ROK), Sunju Park (Gwangju National Univ. of Education, ROK)	297-299
11-3	Study on the Design of Response-based Model using AI Tutor Jaekwoun Shim (Daegu National Univ. of Education, ROK)	300-303
11-4	A Study on the Design of Elementary Programming Education Platforms Using AI Jueun Shin, Youngkwon Bae (Daegu National Univ. of Education, ROK)	304-307
11-5	Current Status and Proposal of the Ministry of Education's Projects for Digital Education Transformation Daisung Ma (Gwangju National Univ. of Education, ROK)	308-310
12-1	VR Shopping, Fitting, and Recommendation Service Based on Interactive Interface Li Jar, Sook Youn Kwon (Jeonju Vision College, ROK)	311-313
12-2	Auditory Pitch Training by Providing Error Information with Haptic Feedback Jaeho Hwang, Jaeyoung Park (Hongik Univ., ROK)	315-317
12-3	Designing an Open Module Service for Knowledge Sharing Suhyeon Yoo (KISTI, ROK), Seokhyoung Lee (Chungnam National Univ., ROK)	318-321

Contents



12-4	A Theoretical Approach for Automatic Textual Data Processing Incorporating Prompt Engineering Jinmo Yang, Janghwan Kim, Chaeyun Seo, R. Young Chul Kim (Hongik Univ., ROK)	322-327
12-5	Statistical Distribution Study of Dynamic Vision Sensor Data Nabeel Khan (Univ. of Birmingham Dubai, UAE), Maria G. Martini (Kingston Univ., UK), Muhammad U. Ilyas, Abdul Wahid (Univ. of Birmingham Dubai, UAE)	328-333
12-6	Reliability Issues of Linear Wireless Sensor Networks for Structural Health Monitoring Vladimir Shakhov, Anastasia Yurgenson (Institute of Computational Mathematics and Mathematical Geophysics SB RAS, Russia)	334-335
13-1	Predicting the yield of field vegetables using a functional regression model and deep learning algorithm Jinho Kang, Zhoulin Liu, Wanhyun Cho, Myung-Hwan Na, Inseop Na (Chonnam National Univ., ROK)	336-339
13-2	A Comparative Analysis of Over sampling, Under sampling, and Hybrid Methods for Imbalanced Data Yunsu Koo, Heeyeong Yang, Haje Park, Donghwi Cho, Woochang Shin, Choonsung Nam (Inha Univ., ROK)	340-344
13-3	Study on measuring pulse transit time using radar technology Hui-Sup Cho, Young-Jin Park (DGIST, ROK)	345-350
13-4	Energy Efficient 5G & 6G eMBB Multi-RAT Dynamic Offloading via Wi-Fi using Deep Reinforcement Learning Control Dongjun Jung, Jong-Moon Chung (Yonsei Univ., ROK)	351-352
13-5	UAV Supported Real-time EO and IR based Illegal Parking Augmented Reality AI Detection System Sangdo Kim, Byounghoon Son, Juyeong Hwang, Jong-Moon Chung (Yonsei Univ., ROK)	353-354

Contents



13-6	Design of an Early Childhood Safety Management System Using LE Audio Technology Sook Youn Kwon (Jeonju Vision College, ROK)	355-357
13-7	A Study on the Development of Contents Based on Virtual Reality for Early Childhood Teachers Yang Si Nae (Vision College of Jeonju, ROK)	358-359
13-8	A Machine Learning based Health Monitoring System for Internet of Medical Things Application Mohammad Akbar Mureed Bhutta, Chaehyun Kim, Youngwoo Yoo, Young-Joon Kim (Gachon Univ., ROK)	360-362
13-9	Energy Saving Methods Based on Influence between Light Sources Sehyun Lee, Seungtaek Oh, Jaehyun Lim (Kongju National Univ., ROK)	363-364
13-10	A Study on Intelligent IoT Sensor Device and AI Chatbot Integration for Air-Conditioner Remote Control Yeon-Jin Ju, Tea-Youn Kim (AirDeep, ROK), Junhyeok Lee, SuHyenon Hong (Jeju National Univ., ROK), Yoosin Kim (AirDeep, ROK)	365-366
13-11	A Study on Vehicle Acoustic Characteristics for Utilizing Audio Systems for in-Vehicle Acoustic Experiences Hyungwoo Park (Dong-Seoul Univ., ROK), Hyojin Jin (SRG SOUND, ROK)	367-369
13-12	A Case Study on the Establishment of Work Environment for ME Equipment Operation Training Cheon Whan Kim, Min Ji Song, Gyoung Mo Kim (Konkuk Univ., ROK)	370-375
13-13	The Case Study on the Development of an Educational Program for Prototype Production Using 3D Printing: Focusing on Outcomes Related to Startups and Employment Bong Won Han, Min Jeong Lim, Gyoung Mo Kim (Konkuk Univ., ROK)	376-380

Contents



14-1	A Deep Learning-Based Strategy for Crime Script Analysis: Unveiling Patterns and Predicting Criminal Behavior Myeonggi Hong, Eunbi Cho, JeongHyeon Chang (Kyonggi Univ., ROK)	381-386
14-2	An Empirical Study of the Spatiotemporal Distribution of Terrorism by Attack Type in Western Europe Junho Park, Euigab Hwang (Kyonggi Univ., ROK)	387-392
14-3	An Architecture for Smart Incident Reporting and CCTV Management in Public Safety Operations Dinh-Lam Pham, Jeong-Hyun Chang, Sang-eun Ahn, Kyunghhee Sun, Kyong-Sook Kim, Kwanghoon Pio Kim (Kyonggi Univ., ROK)	393-397
14-4	YOLO based CCTV video risk situation analysis Tsagaantsooj Batzaya, Eunbi Cho, Jeong-Hyeon Chang, Kyung-Hee Sun, Dinh-Lam Pham, Sang-Eun Ahn, Kyoung-Sook Kim, Kwanghoon Pio Kim (Kyonggi Univ., ROK)	398-400
15-1	A Study on Public Perception of AI Digital Textbooks through Big Data Analysis Eunsun Choi, Sunju Park (Gwangju National Univ. of Education, ROK), Namje Park (Jeju National Univ., ROK)	401-403
15-2	Verifiable Certificate Propagation Mechanism in an Authentication Token-Based Block Generation Distributed Network Environment Jinsu Kim, Ikseo Choi, Hyunjeong Lim, Pureum Kim, Namje Park (Jeju National Univ., ROK)	404-407
15-3	A Study on the Current Status and Cause Analysis of Cyberbullying in Korean Children Woochun Jun (Seoul National Univ. of Education, ROK)	408-409
15-4	A Method of Spreadsheet Education Using LLM AI in ODA Country Teacher Training Byoung Rae HAN (Chinju National Univ. of Education, ROK)	410-413
15-5	Analysis of the Educational Impact of AI Courseware Utilization on Elementary School Students Youngsik Jeong (Jeonju Univ. of Education, ROK)	414-416

Generating 3D Models through Analyzing Natural Language Sentences with GPT API

Ye Jin Jin, Chae Yun Seo, and R. Young Chul Kim*

Software Engineering Laboratory, Graduate School, Hongik University
Sejong, South Korea

[e-mail: yejin_jin@g.hongik.ac.kr, chaeyun@hongik.ac.kr, bob@hongik.ac.kr]

*Corresponding author: R. Young Chul Kim

Abstract

As the 3D market expands, the cartoon industry is using 3D technology to produce 3D cartoons. Recently, AI image tools that generate background props or characters necessary for cartoons using only natural language input using AI technology have emerged. Background props can be used in various cartoons, but characters cannot be because of the author's intended style. To solve this, we propose an automatic mechanism for how to represent a facial emotion expression in a 3D object created. That is, we can make it possible for the emotional state of the main character in the cartoon to be reflected in the facial expression of the 3D character entity. The previous AI Text_to_3D (TT3D) tools generated various models for querying with each natural language, which cannot guarantee the accuracy of the results because the whole generation process is operated as a black box. To overcome these limitations, we try to perform a systematic natural language analysis and then visualize UML diagrams to copy with low visibility of natural language. We input natural language sentences and analyze them using the procedure through the GPT API. We apply software engineering to provide reusability, consistency, and traceability. With this, we expect to improve productivity and convenience in 3D cartoon development.

Keywords: GPT, Natural Language Processing, State Diagram, 3D Modeling, Cartoon Engineering

1. Introduction

The 3D Modeling Market Size has been gradually increased recently[1]. The market growth is accelerating as 3D modeling is used in various industries such as architecture, construction, and games. In particular, the trend in the comics industry is to create webtoons through 3D modeling. 3D webtoons are characterized by realistic expressions compared to existing 2D methods, high quality, and fast work speed[2]. In general, 3D technology utilizing AI is mainly used for background design rather than character design. This is, because in

comics, the same background or prop assets can be downloaded and used. However, it is difficult to apply this to characters. This is because a 3D model that reflects all changes in the character's facial expressions or behaviors depending on the scene is required. Since this process must reflect all the complex characteristics of the character, it is costly and time-consuming and requires expert-level skills.

Therefore, we systematically create 3D character entity from natural language. AI tools that create 3D models from natural language are already available, but they have limitations because they are difficult to satisfy detailed

requirements. In addition, AI technology has problem with low maintenance and reusability because internal mechanisms cannot be confirmed. To solve this problem, we improved the existing mechanism and implemented it procedurally. We analyze the input natural language using GPT API, visualize it as UML, and then generate a 3D model containing the properties of the UML. This method enables tracking between natural language and models through UML as a middle step, and clearly understands the implementation process through a procedural approach.

The paper is organized as follows: Chapter 2 introduces the 3D modeling process and the existing proposed mechanism. Chapter 3 describes this research. Finally, Chapter 4 discusses the research and discusses future research directions.

2. Reconstruction of Volumetric Models

2.1 3D Modeling

3D character models are mainly used in the game industry, and recently, they are being applied to the cartoon industry. Character modeling involves many detailed steps, but broadly, it can be divided into six steps[3].

1) *Conceptual Design*: Determining the character's basic form and style. Establishing modeling plans by considering the character's personality and distinct features.

2) *Modeling*: Building the 3D form based on 2D designs. Visualizing the character's structure and expressing detailed features.

3) *Texturing and Rendering*: Visualizing the 3D model with textures and lighting. Adding color and texture to the character through texturing.

4) *Rigging*: Adding skeleton and joints to the 3D model. Configuring the character for natural movement.

5) *Animating*: Applying expressions and motions to the 3D model. Conveying the character's personality and emotions.

6) *Exporting*: Preparing the completed character for export in formats compatible with the target environment. Enabling integration with game engines or other 3D software.

In this study, we intend to perform steps 5 (Animating) and 6 (Exporting) using a 3D model

that has already been completed from step 1 (Conceptual Design) to step 4 (Rigging). Through this, we study the process of adding emotional expressions and motions to an existing model and exporting it in a file format that can be utilized within a web environment.

2.2 Our Previous Mechanistic Study

In our previous study, we proposed a mechanism to generate 3D models from natural language[4]. Fig. 1 shows the process of the previous study.

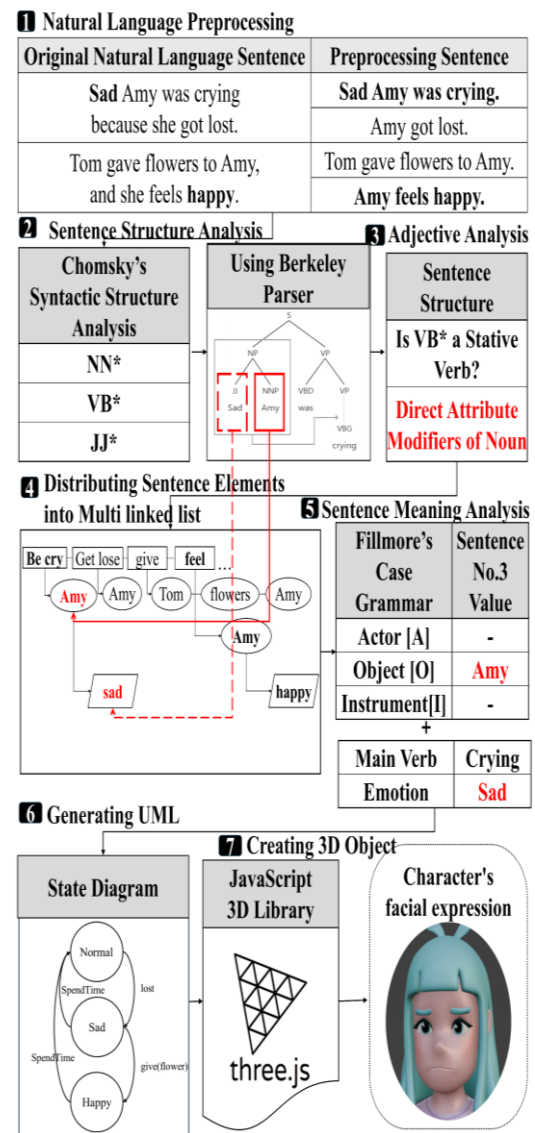


Fig. 1. Previous Study Process

We systematically analyzed natural language sentences, visualized them as UML, and generated 3D models based on the information to ensure traceability and consistency between natural language, UML diagrams, and 3D models.

We presented a comparison between the proposed mechanism and commercial AI Text_to_3D(TT3D) tools. The AI tools could not generate identical characters or accurately express facial emotions. To solve this problem, we effectively analyzed the emotional state of the main character from natural language using state diagrams and expressed it as a 3D character entity. However, in previous studies, humans had to process this process manually. Therefore, we improved this and developed an automated tool through the LLM API.

3. Generating 3D Models from Text with GPT API

Our study improves the previously proposed mechanism from an implementation perspective. The research process is largely divided into three parts: 1) Natural language analysis, 2) UML diagram generation, and 3) 3D Character Entity generation. We apply LLM to the natural language analysis process to automate this process. The environment of the research that was performed is as shown in [Table 1](#).

Table 1. Development Environment and Tools

Component	Version	Description
Node.js	20.14.0	JavaScript Runtime
Three.js	0.167.1	3D Library
Express	4.19.2	Web Framework
NLTK	3.5	NLP Library
OpenAI	1.15.2	GPT API

3.1 Natural Language Analysis

When a natural language sentence describing a cartoon scene is input, it is processed in three ways. First, the natural language sentence is preprocessed. Sentences consisting of complex and compound sentences are generally long, and the results of analyzing them are also extended. Therefore, complex sentences are converted into simple sentences. Simple sentences refer to sentences consisting of one subject and one verb.

Simple sentences are structurally analyzed using Chomsky's syntactic analysis theory[5]. Since it is essential to distinguish key morphemes in a sentence, the NLTK library is used to analyze the morphemes and part-of-speech tagging of the sentence. In addition, we analyze the type of structure the sentence exhibits. We analyze sentences into five structures, as shown in [Table 2](#)[6].

Table 2. Types of Sentences Structures

Sentence Type	Sentence Structure
Type 1	S+V
Type 2	S+V+C
Type 3	S+V+O
Type 4	S+V+I.O+D.O
Type 5	S+V+O+O.C

In [Table 2](#), 'S' represents 'Subject,' 'V' for 'Verb,' 'O' for 'Object,' 'I.O' for 'Indirect Object,' 'D.O' for 'Direct Object,' 'C' for 'Complement,' and 'O.C' for 'Objective Complement. After completing the structural analysis of all sentences, a JSON file is generated. This file contains the analyzed sentence, its order number, sentence structure type, morphemes, and parts-of-speech.

Based on the results, we analyze the sentence semantically. For semantic analysis, Fillmore's Sematic Roles theory is applied. Fillmore's theory analyzes the relationship between verbs and nouns and assigns appropriate roles to nouns[7]. The roles defined in the existing Fillmore theory have various interpretations[8]. Our study is to generate state diagrams through natural language in the cartoon domain. Therefore, we reduced the types of roles proposed by Fillmore and redefined the meanings as shown in [Table 3](#).

Table 3. Redefined Fillmore's Semantic Roles for State Diagram Generation

Semantic Roles	Definition
Actor	The instigator of the event/action.
Object	The entity which changes or existences is in consideration.
Instrument	The implement used in carrying out an event/action.

In order to assign a role to a noun, check the JSON file of the structural analysis result to see what kind of structure the sentence has and what the main verb is. As shown in [Table 3](#), you can assign an appropriate role to the noun in the subject, object, etc. position depending on the structure and verb type. Once the semantic analysis is complete, it is returned as a JSON file. The JSON file consists of the analysis target sentence, the sentence order number, and the Main Verb, Emotional Adjective, and Fillmore Roles, which are the analysis results. [Fig. 2](#) shows the entire process of analyzing natural language. We applied the GPT API in the natural language analysis step and outputted the results in JSON format for each step.

Diagram. Since we create diagrams using sentence analysis results, we map them.

In comics, since the character's emotions change depending on certain actions, 'Action Verb' is used as the 'Event' of the state diagram. The diagram is completed by writing 'Instrument' used for actions as 'Event's Parameter' and adjectives expressing emotions as 'State'. **Fig. 3** shows the process of generating a State Diagram from natural language.

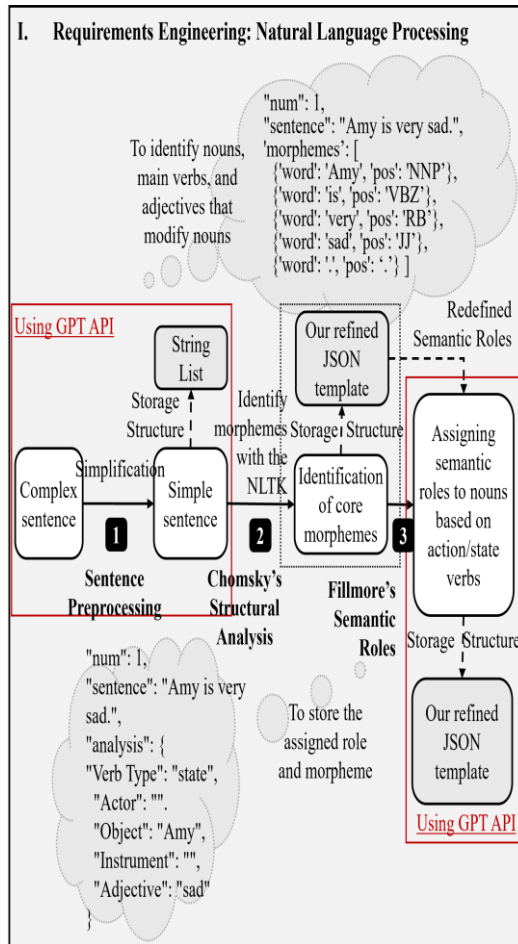


Fig. 2. Natural Language Analysis Process

3.2 UML State Diagram Generation

In order to analyze the emotional state changes of the main character, we create a UML State

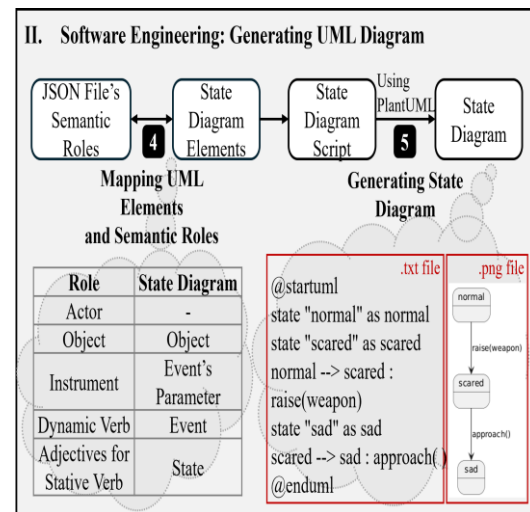


Fig. 3. Generating State Diagram from Semantic Roles

Using the Plant UML library, the diagram script (.txt) and diagram picture (.png) files are generated.

3.3 3D Model Generation in a 3D Environment

In order to express the emotional state of the 3D model from the state diagram, we load the generated diagram script file. We extract the diagram information from the file and apply it as the character's expression. There are five expressions: Normal, Joy, Sadness, Anger, and Fear, and they are indexed in order. The emotional expressions are stored as morph targets transformed from the original shape of the 3D model, and the degree corresponding to each emotional state can be adjusted from '0' to '1'. '0' means not applied at all, and '1' means fully applied. By adjusting this, various expressions corresponding to the emotional state can be implemented. **Fig. 4** shows this process.

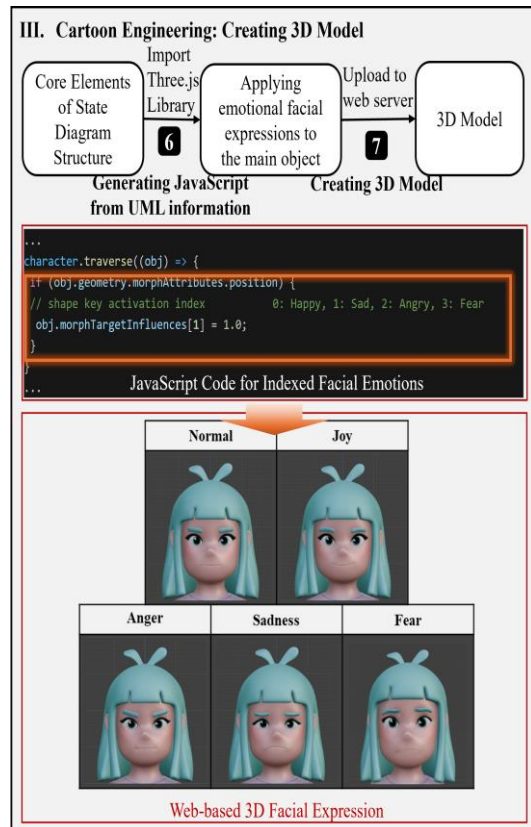


Fig. 4. Import 3D Models from the Web

4. Conclusions

This study improves the previously proposed mechanism for generating 3D models from natural language and attempts automation. We systematically analyze the natural language of comic scenes and convert them into 3D models. We analyze natural language analysis, which is difficult to process by rule-based method, using the GPT API. We generate state diagrams to make natural language sentences with low visibility easier to understand visually. In this process, we maintain consistency between natural language and 3D models by applying the information from the generated diagram to the expression of the 3D character entity. In addition, we automate some of the 3D modeling processes to provide that increases accessibility for non-experts in 3D modeling.

However, this study has several limitations. First, it requires a rigged 3D character entity. Second, we could only consider some sentence structures because natural language is diverse. Thus, our natural language analysis is limited. In

future studies, we plan to improve natural language processing technology to process various sentence structures to overcome these limitations. In addition, we aim to completely automate the 3D model generation process so that 3D models can appear with only natural language input.

Acknowledgements

This research was supported by Korea Creative Content Agency (KOCCA) grant funded by the Ministry of Culture, Sports and Tourism (MCST) in 2024 (Project Name: Artificial Intelligence-based User Interactive Storytelling 3D Scene Authoring Technology Development, Project Number: RS-2023-0022791730782087050201) and National Research Foundation (NRF), Korea, under project BK21 Four.

References

- [1] Fortune Business Insights. (2024, October 21). 3D Mapping & 3D Modeling Market Size, Share & Industry Analysis, 2024-2032. Retrieved from <https://www.fortunebusinessinsights.com/3d-mapping-and-modeling-market-106003>
- [2] M.H Jeoung, "A Study on the 3D Computer Graphics Application in Webtoons," *Smart media journal*, Vol.4, No.3, pp.31-37, 2015.
- [3] Kovanen, S., Functional Workflow in 3D Character Design, Karelia University of Applied Sciences, 2015.
- [4] Y.J. Jin, C.Y. Seo, J.H. Kong, R. Y. C. Kim, "3D Object State Extraction Through Adjective Analysis from Informal Requirements Specs," *The Transactions of the Korea Information Processing Society (TKIPS)*, Vol.13, No.10, pp.529-536.
- [5] N. Chomsky, Syntactic structures, USA: Mouton de Gruyter, 2002.
- [6] Betti, M. J., Sentence Patterns in English, University of Thi-Qar. 2021.
- [7] C. J. Fillmore, The Case for Case, New York: *HR&W*, 1968.
- [8] B. Park, and R. Y. Kim, "Effort estimation approach through extracting use cases via informal requirement specifications," *Applied Sciences*, vol.10, No.3044, pp.1-15, 2020.