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Advanced Engineering and ICT-Convergence Proceedings (AEICP)

9th International Conference on
Advanced Engineering and
ICT-Convergence (ICAEIC-2022)

July 13-15, 2022

Organized by

**ICT - Advanced Engineering Society,
Seoul, Korea (ICT-AES)**

Bima Build. #525, 20 Kwangwoon-ro, Nowon-gu, Seoul
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July 13-15, 2022

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Publishing Chair:

Seongsoo Cho, Professor, Kongju National University, Korea

Welcome Address



Prof. Dr. Gi-Chul Yang
Conference Chair
Mokpo National University, Korea

I am honored to be here as a Conference Chair of the 9th International Conference on Advanced Engineering and ICT-Convergence 2022 (ICAEIC-2022) to welcome all distinguished guests and eminent speakers from various part of the world. This time, we are gathering here face-to-face for the conference. The ICAEIC-2022 is dedicated to the research and development of a broad range of Engineering and ICT-Convergence related topics, with focuses on theory, simulation, design, realization, measurement, and applications. We expect the ideas and technological solutions presented here will contribute to the field of Engineering and the ICT industry as the enabling force for positive development for the benefit of the society. We are conducting total 5 tracks. For this conference, the organizing committee has accepted 69 out of 110 papers (62.7%) excluding the keynote paper for the presentations. Some papers have been rejected to maintain the quality of the conference. In this conference, the papers from 9 countries (Korea, Nepal, Burundi, Australia, USA, India, England, China, Vietnam) will be presented. I fully believe that these presentations and the keynote speech will be highly interesting and interactive. I would like to express our sincere appreciation to all the committee members and many other helping hands behind the scenes who have significantly contributed to set-up this conference. My special thanks go to all committee members, session chairs and the eminent persons who are attending here. Next, I would like to announce the 10th international conference which will be held in Thailand on February 7-10, 2023. I hope, you will submit your research papers and present over there. Thank you and I hope you will have a good time in Jeju.

Thank you!

July 13, 2022.

Congratulatory Remarks



Prof. Dr. Bhanu Shrestha
Chairman of ICT-Advanced Engineering Society
Kwangwoon University, Korea

Ladies and Gentlemen,

First of all, I'd like to welcome all the distinguished guests and participants today for the 10th International Conference on Advanced Engineering and ICT-Convergence (ICAEIC-2022). We are happy to be here for the 10th international conference to conduct face-to-face. As we know that the technologies are rapidly increasing that makes the future society to facilitate the people. That means, as a researcher, as an academician, and as a scientist, we are actually, designing the future society for the human welfare. Therefore, we need such platform to change our society. At the same time, we are living in the era of the 4th industrial revolution where artificial intelligence, big-data, internet of things (IoT), augmented reality (AR), virtual reality (VR), and metaverse are included. These all are related to information and communication technologies (ICTs) and convergence technologies. Therefore, we have selected the emerging topic on artificial intelligence, big-data, AR / VR and convergence technologies for the conference. I hope that this platform will be helpful to understand recently developed technologies and their impact on human life and society.

On behalf of the ICAEIC-2022 Organizing Committee, we thank keynote speakers, all the session chairs, publication chairs / co-chairs, technical chairs / co-chairs, program chairs / co-chairs, international advisory board honorary chairs, and all presenters. We would like to extend our special thanks to Conference Chair, Prof. Dr. Gi-Chul Yang from Mokpo National University, Korea, Program Chair Prof. Dr. Youngman Kwon from Ulji University, Korea, International Co-ordinator Prof. Surendra Shrestha from Institute of Engineering (IoE), Pulchowk Campus, Tribhuvan University, Nepal, Publication chairs, Prof. Seongsoo Cho and Technical chair, Prof. Sunchul Kwon for their invaluable guidance in organizing the conference. I hope, this conference will be a success and fruitful and established a brotherhood relationship under Advanced Engineering and ICT-Convergence.

Thank you very much.

July 13-15, 2022

Conference Program (9th ICAEIC-2022)

Day 1 / Wednesday, July 13, 2022

10:00 – 11:30	Paper Registration & Meeting	
10:00 – 10:15	Organizing Committee Meeting	
10:00 – 11:30	Paper Registration / Name Tag Distribution	
11:30 – 13:00	Lunch Break	
13:00 – 13:30	Opening Ceremony	Main Hall
13:00 – 13:10	Welcoming & Opening Remarks by Conference Chair, Mokpo National University	
13:10 – 13:15	Greetings from Representative of BonC Innovators Company	
13:15 – 13:20	Greetings from Representative of Tracom Company	
13:20 – 13:25	Congratulatory Remarks by Chairman of ICT-AES	
13:25 – 13:50	Keynote Speech by Prof. Dr. Sukhwa Hong, USA	Main Hall
13:50 – 14:00	Break Time	
14:00 – 17:30	Technical Session (Oral Session) 1	Main Hall
	Session Chair: Prof. Dr. Yeonwoo Lee,	
14:00 – 17:30	Technical Session (Oral Session) 2	Hall A
	Session Chair: Prof. Dr. Surendra Shrestha,	

Day 2 / Thursday, July 14, 2022

09:00 – 13:30	Technical Session (Oral Session) 1-1	Main Hall
	Session Chair: Prof. Dr. Sun Park,	

09:00 –12:30	Poster Session	Hall A
	Evaluation Committee:	Prof. Dr. Surendra Shrestha, Prof. Dr. Yeonwoo Lee, Prof. Dr. Youngman Kwon, Prof. Dr. Jinho Han, Prof. Dr. Soonchul Kwon
12:30 –14:00	Lunch Break	
14:00 –17:30	Technical Session (Oral Session) 1-2	Main Hall
	Session Chair:	Prof. Dr. Youngman Kwon,
14:00 –17:30	Technical Session (Oral Session) 2	Hall A
	Session Chair:	Prof. Dr. Jinho Han,
15:30 – 15:40	Break Time	
 Closing Ceremony Time : 17:40 – 18:10		
<ul style="list-style-type: none"> ▪ Certificate Distribution Announcement (Certificates + Best Paper Awards): One winner will be selected from each session for the best paper award based on the evaluation of each session chair (by Prof. Dr. Yeonwoo Lee). ▪ Closing Remarks : Prof. Dr. Bhanu Shrestha, Chairman of ICT-AES, Korea. 		
17:40 – 18:10	Award Ceremony and Photo Session	Main Hall
18:10 – 20:10	Banquets	

Day 3 / Friday, July 15, 2022

10:00 –11:00 Organizing Committee Meeting

11:00 –17:00 Individual Technical Tour & Jeju Island Tour

Preparation for Presentation

- All registered presenters are requested to attend the opening ceremony.
- Please confirm the room number you have assigned in terms of a poster and oral sessions.
- Each presentation will have 20 minutes for presentation including 5 minutes Q/A time.
- Each presenter must copy your presentation files to the computer guided by the volunteers

Session in Details

Day 1 / Wednesday, July 13, 2022

Time: 13:00 – 13:30

Plenary Session

Room- Main Hall

MC: Prof. Dr. Yeonwoo Lee, Department of Information Communication Engineering,
Mokpo National University, Korea

13:00 – 13:10 Welcome Remarks

Prof. Dr. Gi-Chul Yang, Conference Chair, Mokpo National University, Korea

13:10 – 13:15 Greetings from Representative of BonC Innovators Company

13:15 – 13:20 Greetings from Representative of Tracom Company

13:20 – 13:25 Congratulatory Remarks

Prof. Dr. Bhanu Shrestha, (Professor, Kwangwoon University, Korea, and Chairman of ICT-AES, Korea)

Time: 13:25 –13:50

Keynote Speech

Room- Main Hall

Keynote Session Chair: Prof. Dr. Surendra Shrestha

Keynote Speaker : Prof. Dr. Sukhwa Hong, University of Hawai'i Data Science, USA

Title: A Network-based Text Visualization Model for Online Crowdfunding Analysis

Time: 13:50 – 14:00

Break Time

Time: 14:00 – 17:30 PM

Presentation (Oral) Session 1

Room - Main Hall

Session Chair: Prof. Dr. Yeonwoo Lee

ICAEIC-2022-129

Design of Intelligent BoP-based Flexible Hydrogen Power Pack
(Sun Park, Byung-joo Chung, ByungRea Cha, JongWon Kim)

ICAEIC-2022-151

Efficient Beaver Triple Generation for Privacy-preserving Collaborative Machine Learning
(Zhaohui Tang)

ICAEIC-2022-126

Mixup Methods in Low Resource Multi-Label Classification
(Minkyu Park, Juntae Kim)

ICAEIC-2022-124

A Study on a Cloud-based Smart Farm Capable of Real-time Monitoring and Remote Control
(Seung Jin Oh, Min Jae Kim, Jong Eun Lee, Chaewon Lee, Sejong Oh, Ilchul Doo)

ICAEIC-2022-128

A Machine Learning Approach to Predict NFT Price
(ZiXiong Wang, QiuYing Chen, Sang-Joon Lee)

ICAEIC-2022-174

Crosswalk Pedestrian Situation Recognition System
(Sac Lee, Jaemin Hwang, Jinho Han)

ICAEIC-2022-125

A Study on the Development of an AI-Based File Organization Automation System
(Dain Kang, Nakyung Im, Hyeongcheol Shin, Sejong Oh, Ilchul Doo)

ICAEIC-2022-183

Nepali Number Plate Recognition using YOLOv4
(Kripesh Shrestha, Manisha Adhikari, Monika Bakhunchhe, Ranjeev Shrestha, Rabindra Phojju)

ICAEIC-2022-144

Performance Comparison Evaluation of Cloud Rendering and Model-Based Method
(Gyubeom Lim, Sukjun Hong, Youngseo Baik, Junyoung Park, Seyun Choi, Woosung Shim, Jisang Yoo, Seunghyun Lee, Soonchul Kwon)

ICAEIC-2022-119

Automatic Asymmetric Routine Generator using Genetic Algorithm
(Anup Kafle, Anushil Timsina, Rochak Sedai, Sandeep Subedi)

Presentation (Oral) Session 2**Room – Hall A**

Session Chair: Prof. Dr. Surendra Shrestha

ICAEIC-2022-182

On the Derivation of Keywords Clustering based Machine Learning for Urban Railway Logistics System
(Sunwoo Hwang, Jaemin Hwang, Younghoon Kim, Joouk Kim)

ICAEIC-2022-192

Towards In-network Computing for Metaverse: Communication, Computing and Cost Modeling
(Ibrahim Aliyu, Hyeju Shin, Sang-joon Lee, Tai-Won Um Jinsul Kim)

ICAEIC-2022-113

Brain-Computer Interface: Application Area and Obstacles
(Gi-Chul Yang, Sukhwa Hong)

ICAEIC-2022-177

Cost Extraction with Reverse Engineering Approach
(So Young Moon, R. Young Chul Kim)

ICAEIC-2022-203

Trapezoidal Uncertainty Estimation for Failure Rate Data in Safety Instrumented Systems
(Ngoc-Tung La, Gihwon Kwon)

ICAEIC-2022-130

Designing Marine Data Lakehouse Architecture for Managing Maritime Analytics Application
(Sun Park, ByungRea Cha, JongWon Kim)

ICAEIC-2022-122

Performance study of Visual Image Data Processing Embedded Hardware Platforms
(Wooyoung Kang, Seohyeon Park, Sejong Oh, Ilchul Doo)

ICAEIC-2022-186

Vehicle Detection and Counting Using YOLOv3
(Avishek Luitel, Manita Dangol, Prasanna Dahal, Rajan Shrestha, Krishna prasad Gaihre)

ICAEIC-2022-191

Identification of Factors for Verification of SOTIF Safety Analysis of Variable Focus Function Cameras based on RSS Model
(Min Joong Kim, Myung Sung Kim, Young Min Kim)

ICAEIC-2022-161

Hybrid Beamforming Optimization for Millimeter Wave Massive MIMO System Using Deep Learning
(Om Nath Acharya, Surendra Shrestha, Ram Krishna Maharjan)

Day 2 / Thursday, July 14, 2022**Time: 09:00 – 12:10****Presentation (Oral) Session 1-1****Room - Main Hall**

Session Chair: Prof. Dr. Sun Park

ICAEIC-2022-158

Super Resolution by Using Sub-pixel Convolution
(Young-Man Kwon, Kyo-Seok Lee, Won-Mo Gal, and Myung-Jae Lim)

ICAEIC-2022-127

Customer Analysis of Luxury Brand NFT
(QiuYing Chen, Sang-Joon Lee, Kyeong-Rak Lee)

ICAEIC-2022-176

Reducing Dependence on Superficial Patterns of CNN using Shape Based Images
(Junbeom Kim, Jinho Han)

ICAEIC-2022-205

SIL Verification of Safety Instrumented System with Variance Contribution Analysis
(Jiyoung Chang, Ngoc-Tung La, Gihwon Kwon)

ICAEIC-2022-166

Analysis of Discrete Wavelet Transform based on OFDM
(Nischal Maharjan, Surendra Shrestha)

ICAEIC-2022-194

Development of Robot-based Loading System using Automation Technology to Improve Cargo Loading Efficiency
(Jae Min Park, Sang Min Lee, Young Min Kim)

ICAEIC-2022-188

Initial Design of Self Learning Robot for Unknown Environment
(Jong-Won Kim, Hee-Young Park, Hyein Jo, Ayeon Han, Bongseog Jang)

ICAEIC-2022-153

Super-Resolution Using Multi-Scale Dense Block and Chanel Attention

(Dongwoo Lee, Kyeongseok Jang, Hoijun Kim, Soowook Lee, Kwang Chul Son)

ICAEIC-2022-167

Fake News Detection Using Machine Learning

(Ronish Shrestha, Roshan Shrestha, Rubin Baidhya, Sairush Tamang)

Poster Session**Hall A**

Evaluation Committee: Prof. Dr. Surendra Shrestha,
Prof. Dr. Yeonwoo Lee / Prof. Dr. Youngman Kwon
Prof. Dr. Jinho Han / Prof. Dr. Soonchul Kwon

ICAEIC-2022-112

Design and Implementation of Visualization for Flight Control using Airsim Simulator

(Gi-Seok Lee, Sang-Hyun Lee)

ICAEIC-2022-132

A Study on the Care of Pregnant Women's Seat Using Android App in IoT Environment

(Dong-Jin Shin, Jeong-Joon Kim)

ICAEIC-2022-115

Draft Design of Technology for DX and Safety Support of Tower-Crane

(SeongYeol An, YoonSeok Cha, EunJin Jeon, ChaeYun Kim)

ICAEIC-2022-156

Acceleration Factor of OLED Dark Spot by Humidity and Prediction of black spot growth through Artificial Intelligence

(Dong-Hun Han, Kyung-A Kim, Myung-Ae Chung, Min-Soo Kang)

ICAEIC-2022-208

Study on Refrigeration Unit for Ice-rated Condition

(Zhen-Huan Wang, Youn-Sung Choi, Jin-Mook Kim, Youngchul Kwon)

ICAEIC-2022-157

Education Attendance Management System through Real-time Online Face Recognition

(Seongsoo Cho, Bhanu Shrestha)

ICAEIC-2022-117

A Study on Drift Phenomenon of Trained ML

(SeongYeol An, JinYoung Park, Sun Park, JongWon Kim, ByungRae Cha)

ICAEIC-2022-134

AI based Language Pronunciation Evaluation System

(Seung-Yeon Hwang, Jeong-Joon Kim)

ICAEIC-2022-159

Manufacturing of Arduino-based ECG Measurement Device and Method of Determining Normal State using Deep Learning

(Geonu Kim, Jaehyuk Cho)

ICAEIC-2022-187

Preemptive Channel Access Scheme for Assuring Transmission Priority in IEEE 802.11ah WLAN-based IoT Environment

(Youngboo Kim, Junho Jeong, Gayoung Kim)

ICAEIC-2022-133

A Study on the Remote Electric Fan Operation Using Android App in IoT Environment

(Dong-Jin Shin, Jeong-Joon Kim)

ICAEIC-2022-142

Identification Of Workers Wearing Mask and Hard Hat Using Deeplearning

(NaeJoung Kwak, DongJu Kim)

ICAEIC-2022-207

Walking Behavior Recognition Platform

(Seok-Jae Moon, Min A Jeong, Jin-Mook Kim, Jeong-Kyung Moon)

ICAEIC-2022-118

Fused Spatial Map for Path-planning of Autonomous Robot

(Junghwan Ko)

ICAEIC-2022-135

Healthcare SNS Application Using Cloud and Google Maps

(Seung-Yeon Hwang, Jeong-Joon Kim)

ICAEIC-2022-180

Development of Indoor Air Quality Measurement and Notification Device

(Sungmin Kang, Jaehyuk Cho)

ICAEIC-2022-184

Deep Learning Techniques for Robotic Vision: A survey

(Chris Gislain Austin Kimenyi, Lewis Nkenyereye)

ICAEIC-2022-198

GAN-based Area Restoration Technique for Recognizing Partially Occluded Objects

(Jesung Lim, Chung-Pyo Hong)

ICAEIC-2022-202

Spam Detection in Chat Application

(Aakash Shrestha, Ankit Pradhan, Prasanna Adhikari)

ICAEIC-2022-206

Intelligent EMRA Protection Access Control

(Seok-Jae Moon, Jong Sup Lee, Jin-Mook Kim)

ICAEIC-2022-196

A Study on Composable Infrastructure Systems based on Ensemble Architecture
(Seung-Won Cho, Seunghyun Lee, Kwangchul Son)

Time: 12:10 – 14:00**Lunch Break****Time: 14:00 – 17:30****Presentation (Oral) Session 1-2****Room - Main Hall**

Session Chair: Prof. Dr. Youngman Kwon

ICAEIC-2022-152

Federated Learning with Real-world Datasets: Compliance with the Privacy Act
(Zhaohui Tang, Sye Loong Keoh)

ICAEIC-2022-120

Monitoring Electronic Charge and Distinguish Outlier
(Eun chan Jeong, Jae won Jeong, Un mun Lee, Dong hyeon Song, Sejong Oh, Ilchul Doo)

ICAEIC-2022-131

Data Concentrator Unit Supported with Intelligent Video Analytical Data Pipeline for Autonomous Vehicles
(Anvarjon Yusupov, Sun Park, JongWon Kim)

ICAEIC-2022-190

A New Data Augmentation Method for Generate Time Series Data using Time Series Image-based SRGAN
(Sangwon Oh, Seungmin Oh, Sang-joon Lee, Tai-Won Um, Jinsul Kim)

ICAEIC-2022-209

SIL Verification with Uncertain Down Time of Failure
(Sohee Park, Ngoc-Tung La, Gihwon Kwon)

ICAEIC-2022-189

A Comprehensive Survey on application of Internet of Medical Things in Smart Cities
(Thierry Ndayiragije, Lewis Nkenyereye)

ICAEIC-2022-195

Salient Object Detection in Parallel Networks using Multi-Scale Convolution and Attention Mechanisms
(Kyeongseok Jang, Dongwoo Lee, Jeseung Kim, Chaebong Sohn, Soo Young Cho, Kwang Chul Son)

ICAEIC-2022-168

Spectrum-Sliced WDM PON with 25-GHz Spacing using 50-GHz AWGs
(Dipen Manandhar, Surendra Shrestha)

ICAEIC-2022-175

Social Distancing Violation Detection
(Niruta Dhimal, Sujan Karki, Pradip Sapkota, Anish Joshi, Sabin Kafley)

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Session Chair: Prof. Dr. Jinho Han

ICAEIC-2022-143

Active Power Offering Strategies in the Virtual Power Plant
(Yeonwoo Lee)

ICAEIC-2022-121

Cryptocurrency Price Prediction via Sentiment Analysis on Twitter
(Juwon Kim, Doyoung Kim, Taewoo Kim, Seoyoung Jeong, Sejong Oh, Ilchul Doo)

ICAEIC-2022-185

Application of Internet of Drones in Smart Cities: A Brief Survey
(Blaise Ndikumagenge, Lewis Nkenyereye)

ICAEIC-2022-193

Towards Joint Optimization Problem for Computing and Resource Allocation in In-network Computing for Metaverse
(Ibrahim Aliyu, Ibrahim Mohammed Abdullahi, Sang-joon Lee, Tai-Won Um, Jinsul Kim)

ICAEIC-2022-123

Cryptocurrency Trading Timing Search Service using Statistical Arbitrage Algorithm
(Haneul Lee, Yeongseon You, Suyeon Kim, Hyunjung Lee, Sejong Oh, Ilchul Doo)

ICAEIC-2022-181

Applying Code Visualization into Solidity for Auditing of Smart Contract
(Chansol Park, Bokyung Park, Soyoung Moon, R. Young Chul Kim)

ICAEIC-2022-199

A Network Model to Improve the Accuracy of Detecting Black Ice Regions in Images
(Jae-Yong Hwang, Sun-Kyoung Kang)

ICAEIC-2022-197

Digital Image Inpainting Technique
(Dipinti Manandhar, Sumit Keshari)

ICAEIC-2022-210

Analysis of Students Term Project with Scrum Software Process
(Suhee Jo, Ngoc-Tung La, Gihwon Kwon)

ICAEIC-2022-179

Characterization of Activated Carbon Prepared from Peach (*Prunus persica*) Stone
(Vasanta Gurung, Rinita Rajbhandari (Joshi), Rajeshwar Man Shrestha)

Time: 17:30 – 17:40

Break Time

Time: 17:40 – 18:10

Closing Ceremony

- Certificate Distribution Announcement (Certificates + Best Paper Awards: One winner will be selected from each session for the best paper award based on the evaluation of each session chair.
- Closing Remarks : Chairman of ICT-AES, Korea: Prof. Dr. Bhanu Shrestha

Time: 18:10 – 20:10

Banquets

Day 3 / Friday, July 15, 2022

10:00 –11:00 Organizing Committee Meeting

11:00 –17:00 Individual Technical Tour & Jeju Island Tour

Preparation for Presentation

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- Each presentation will have 20 minutes for presentation including 5 minutes Q/A time.
- Each presenter must copy your presentation files to the computer guided by the volu

NOTE:

- The presentation time is 20 minutes (15 min-presentation and 5 min-Q&A) for each presenter except Keynote speakers (25 minutes 5 min-Q&I).
- This program can not be changed but if there are some problem to make presentation by authors, the presentation can be slightly changed on authors' request.
- All authors are requested to join in the conference on the given time.

Contact:

Bima Build. #525, 20 Kwangwoon-ro, Nowon-gu, Seoul, Korea (01897). Email: info@ictaes.org, Tel.: +82-2-940-8626 / 8637 | Website: <https://ictaes.org>

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Keynote Speaker



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Applying Code Visualization into Solidity for Auditing of Smart Contract

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Abstract

In near future, it will expect to rapidly be increasing Audit demand for Smart Contracts containing the core logic of DApp, but still manual or partially automated. This audit process has a limit to meet all demands. Therefore, we propose Code Visualization for the automatic audit process. Through this, it is expected to be able to produce an audit report rich in evidence and contents by melting the audit elements into the call graph.

Keywords: *Code Visualization, Smart Contract, Solidarity, Audit process, DApp.*

1. Introduction

As DApp services on blockchain networks is increasing, there are also increasing demand for Audit services for Smart Contracts containing Core Logic. However, most of the Audit processes currently in service are either manual or limitedly automated. In addition, it detects only vulnerabilities such as Smart Contract Weakness Classification (SWC) during Audit for source code. Auditing and generating reports through these non-automated processes is time consuming and inevitably increases the cost of auditing services. In addition, when only analyzing vulnerabilities, it is difficult to analyze the overall flow and content of the source code through an audit report. To solve this problem, we are conducting research on automating the audit process by applying the Our 'Software Architecture Visualization for Object-Oriented Programming' research. Among them, this paper mentions a study to derive code complexity by extracting Call Graphs for Solidity. With applying code visualization to Solidity, we can visualize the complexity inside the Solidity code and guide it to the problematic areas. Chapter 2 describes code visualization as a related study. Chapter 3 discusses code visualization of solidarity such as call graphs. Chapter 4 describes the output of the Call Graph Visualization tool. Finally, Chapter 5 describes the conclusion and future research.

2. Related Works

With our code visualization technique, we extract information about source code through reverse engineering on software, and then visualize the design extraction and complexity of source code.[1] We can extract designs such as Class Diagram, Sequence Diagram, and Call Graph, and measure Complexity of various indicators such as Coupling, Cohesion, and MCC Metrics.

Regarding the quality of Solidity, the most representative indicator and most used indicator by Audit is SWC. SWC implements the vulnerability classification scheme proposed in Ethereum Improvement Proposal (EIP)-1470.[3] Each SWC item is associated with a Common Weakness Enumeration (CWE) items. The SWC includes a description of the vulnerability and an example code and an improved code.[4]

3. Our Code Visualization for Solidity

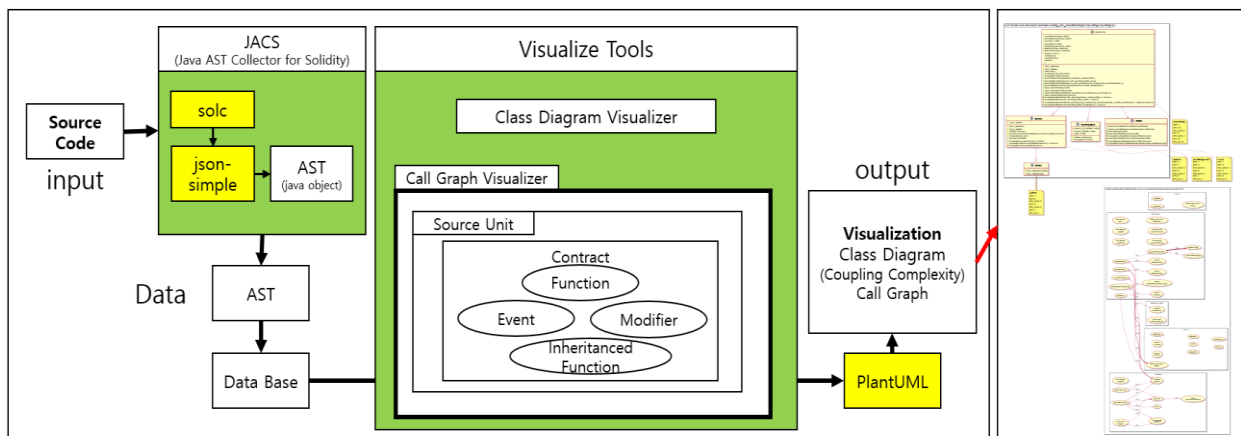


Figure 1. Solidity Visualization Toolchain.

The Solidity Visualization Toolchain receives the Solidity source code as inputs, extracts the AST into the JAVA object structure through the JACS(Java AST Collector for Solidity), and stores it in the local DB. Each visualization tool extracts and processes information DB information, and creates diagrams and graphs as outputs via Plant UML. Currently, the Solidity Visualization Toolchain can be automatically visualized for 'object-oriented complexities and class diagram' and Call Graph. We describe Call Graph among them.

The Call Graph Visualizer is a tool that extracts and processes information from DB, and generates PlantUML scripts as an output. The Call Graph Visualizer groups each function type in units of contract. At this time, the function type includes not only modifier and event, but also functions that included in the parent contract. The Contracts are then grouped in units of source code, and arrows are connected for all function calls.

4. Case Study

We explain our approach with the case study. Figure 2 is a part of the Extracted Call Graph for Sample code. An elliptical object in number 1 is a function. If the type of function is Modifier or Event, we state the

type of function above the function name. Also, we state ‘inherited’ above the function name for function that are inherited from the parent. Number 2 is Contract. Number 3 is Source Code. Finally, arrows in number 4 are function calls. In number 4, the left function (Caller Function) calls the right function (Callee Function). The number of calls is specified at the top of the arrow, and the arrow line becomes thicker as the number of calls increases. Through the Call Graph, various complexities such as counting for simple function calls or MCC can be applied in the future

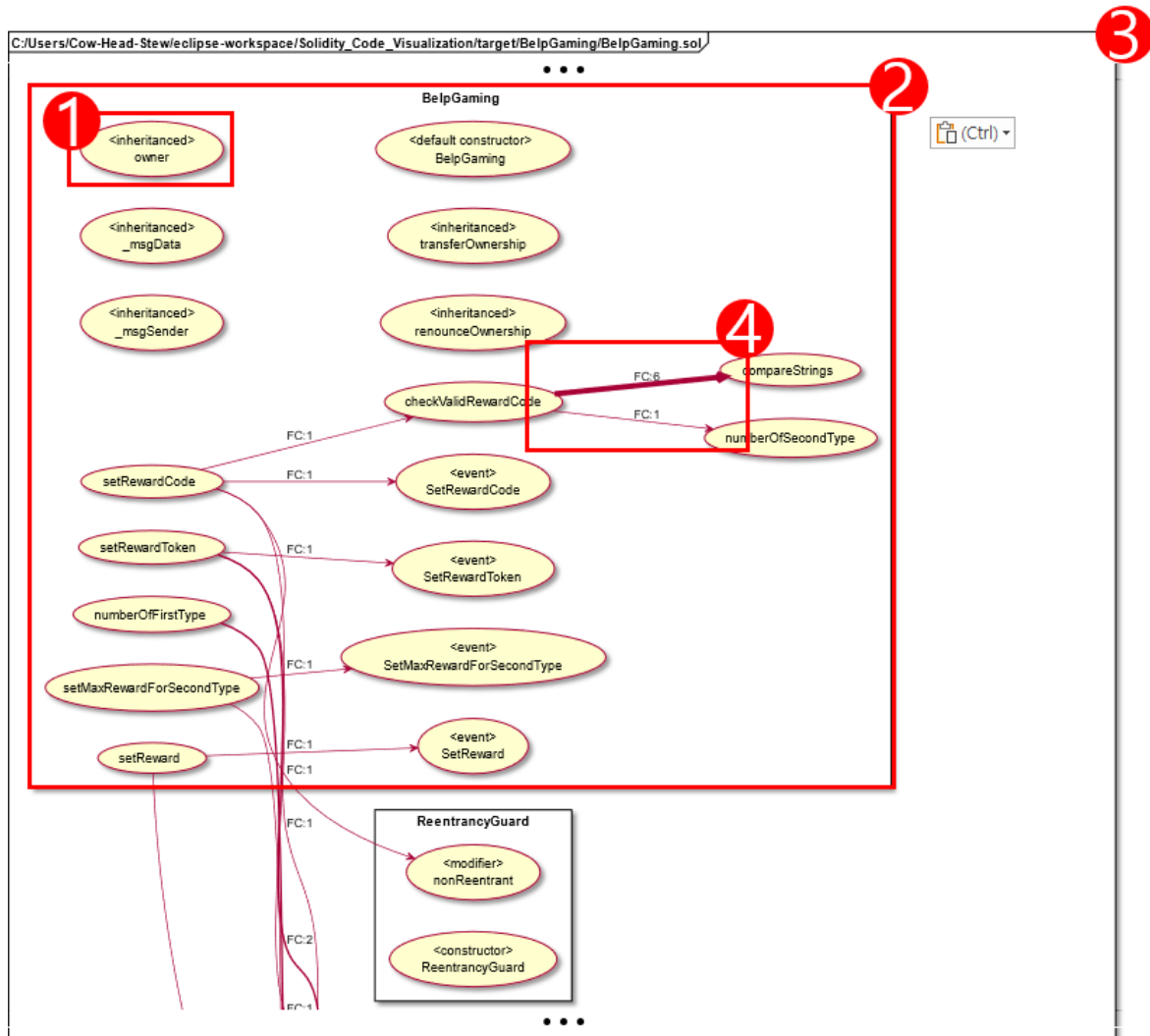


Figure 2. Part of Extracted Call Graph for Sample code.

5. Conclusion

In this paper, we add the Solidity Call Graph Visualizer to the Solidity Visualization Toolchain. In the future, we will analyze the correlation between Solidity and Smart Contract Audit elements (SWC, Gas Consumption, etc.) and the complexity we extracted. After this correlation is proven, we will study the improvement of Solidity Code Quality through complexities and our Software Architecture Visualization study.

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