

Method for Mission Analysis Using ToT-Based Prompt Technology Utilized Generative AI

Satellite Mission Analysis for SaganSat-0 of Remote Sensing Satellite

Kohei Arai

Dept. of Intelligent Information Science, Saga University, Saga City, Japan

Abstract—Method for mission analysis using ToT: Tree of Thought-based prompt technology utilized generative analysis AI is proposed. Mission analysis needs methods for simulation of the supposed images which will be acquired with the imaging mission instruments, and the other mission instruments. In order to create simulation images, ToT-based prompt technology utilized generative AI is used. An application of the proposed method is shown for a mission analysis for SaganSat-0 of remote sensing satellite which will carry three mission instruments, a 720-degree camera, a thermal infrared camera and a Geiger counter. The simulated images and the Geiger counter sounds created by the proposed method are shown here together with analyzed results.

Keywords—CoT; ToT; AI; Mission analysis; prompt technology; generative AI; SaganSat-0; remote sensing satellite; 720-degree camera; thermal infrared camera; Geiger counter

I. INTRODUCTION

In recent natural language processing, Chain-of-Thought (CoT) prompting for language models is a technique that includes a series of steps to solve a problem in the prompt (i.e., the text input to the language model) [1]-[10]. The basic CoT prompting mimics the "step-by-step thought process" and includes the flow of reasoning steps as examples/samples for few-shot learning. Namely, LLMs (large-scale language models) such as ChatGPT are not good at inference. If you want them to think logically, you have to ask them questions in a way that encourages logical thinking. This is called CoT prompting. Few-Shot prompting is a method of generating answers by giving a few examples. The idea is to lay the groundwork for thinking by giving examples and having ChatGPT think about it. Zero-Shot prompting is used for difficult questions, but in the sense of giving a few examples, CoT prompting is similar in some ways.

In problem solving, if questions are one of those of which someone has already answered, ChatGPT will give a clear answer. However, if the question has never been answered by anyone, ChatGPT will immediately give you an ambiguous answer. This is true not only for "unknown problems", but also for personal problems that cannot be generalized, such as your own or your company's. For such problems, we need to narrow down the scope of the problem and show the logical path. In short, if we can cover his weakness (inability to deduce or construct logic) on the human side, we can get a very useful answer because ChatGPT has knowledge from all over the world that we personally cannot have. This is the true meaning of "prompt engineering".

According to a paper published by a team at Google's AI research lab in January 2023 [11], "CoT prompts are a technique that does not immediately ask for the answer to a problem, but rather involves intermediate inference steps and then layering step-by-step inferences (chains of thought) to arrive at the answer." In this way, the CoT prompt shows the flow of thought to solve the problem logically and deductively, but because it is one-way, it may lead to the wrong answer in the case of more difficult problems. Therefore, the Self-consistency with CoT prompt was devised, which presents multiple answers and allows the user to choose the appropriate answer from among them. However, for problems that involve complex processes, verifying and evaluating all the answers one by one will not be enough resources no matter how many there are. The Tree of Thoughts (TOT) prompt, announced in May 2023 by a joint research team from Google's DeepMind team and Stanford University, is effective for problems that have multiple paths to the goal and are difficult to arrive at the correct answer [12]-[22].

Like COT, thinking deductively is desired, step by step, but in this case, it is unknown what order to do it in. Even with real problems, it's not uncommon to not know where to start. In such cases, we use the concept of "decision tree" to think about it. There are many options at each stage to get to the goal. This is a way to think about which route to take. This TOT prompt can be applied to solving complex problems. First, we ask participants to come up with some solutions in ChatGPT, and then we evaluate them based on criteria such as feasibility and budget. (For example, (certain/possible/impossible) or "on a 5-point scale.") Then, we dig deeper into the top ideas. A good question would be to ask participants to "dig deeper from a certain point of view." After that, we ask them to summarize their ideas in ChatGPT. "Based on your analysis so far, please rank your ideas in order of highest to lowest." This ToT prompt is close to human thinking, and as the DeepMind team suggested it, it is the logic used in games such as Go-play, Shogi, and autonomous driving.

The purpose of this paper is to present usefulness and effectiveness of the ToT for generation of images, moving pictures, and so on in comparison to the other CoT, plain generative AIs. By using ToT prompt technology, mission analysis (simulation of mission instrument data) is conducted. As an example, mission analysis for SaganSat-0 of remote sensing satellite which carries three mission instruments, 720-degree camera, thermal camera and Geiger counter is conducted. ToT prompts are used for creation of simulation

imagery data of the three mission instruments. Furthermore, mission analysis is conducted successfully. SaganSat-0 was launched in the midnight on 5 August 2024 and will be put into the orbit of ISS: International Space Station on 29 August 2024. Therefore, the simulation data will be verified after the SaganSat-0 data acquisition and also confirmed mission analyzed results after that.

In the next section, SaganSat-0 mission is described together with three mission instruments. Then, simulation of these mission instruments data is described with the proposed ToT-based prompt technology. After that, some mission analysis results are described followed by conclusion with some discussions.

II. SAGANSAT-0

SaganSat0 is a small satellite of the CubeSat (1U) type supported by the Saga Prefectural Space Science Museum. Below is more information about SaganSat0:

Satellite details:

Name: SaganSat0 (SaganSat No. 0)

Type: CubeSat (1U)

Status: Not launched, scheduled for 2024

Launch rocket: Falcon 9 (Cygnus, NG-21)

Project overview: Three mission instruments, 720-degree camera, thermal infrared camera, Geiger counter

Support organization: Saga Prefectural Space Science Museum

Contact: a-ito@yumeinga.jp.nospam

Website:

SaganSat's website aims to develop nanosats and create support contacts

Japanese news:

The Saga Shimbun newspaper has extensive coverage of news about SaganSat0

From these information, SaganSat0 is a small satellite project led by the Saga Prefectural Space Science Museum, scheduled for launch on 5 August 2024 to ISS and will be released from the ISS and putted into ISS orbit in the near future (late of August 2024).

A. Mission Instruments

The SaganSat-0 satellite is equipped with three mission instruments. One of them (Mission 1) is two 360-degree cameras (720-degree cameras) that test the Earth-pointing direction and the deep space direction. The 360-degree cameras take images with a resolution of 800 by 600, and the image size of the two images is about 60 KB (0.45 degrees/pixel) in total. If the radius of the Earth is R , the satellite altitude (ISS altitude = 400km) is H , and the instantaneous field of view is θ , the resolution of the Earth's surface is expressed by Formula (1). The resolution of the Earth's surface is about 3142m.

$$R=H \cdot \tan(\theta) \quad (1)$$

The Earth's spheroid used here is the standard spheroid called GRS80, and the geodetic coordinate system using it has a polar radius of 6356.752 km in ITRF84. The infrared camera for Mission 2 will take images at a resolution of 800 by 650, with an image size of about 40KB; the resolution is 200m, and since the down-link is at 4.8kbps, one set of Mission 1 and 2 data can be down-linked in 21 seconds. Mission 3 data can be down-linked at 42B/21 seconds.

Since the altitude of the International Space Station (ISS) is about 400 km, the range over which a ground station can communicate with the ISS is affected by the curvature of the Earth and the characteristics of the antenna of the ground station, and an approximate method for calculating the basic range is expressed by Formula (2), which calculates the range over which a ground station can communicate with the ISS (line of sight).

$$d=\sqrt{(2hR+h^2)} \quad (2)$$

where: d is the distance above the horizon (km), h is the altitude of the ISS (km), and R is the radius of the Earth (about 6371 km). Therefore, the range over which a ground station can communicate with the ISS is about 2293 km. Within this range, direct communication with the ISS is possible, and since the speed of the ISS is about 28,000 km/h (7.8 km/s), the visible range is about 4.91 minutes = 294.6 seconds. Therefore, about 14 frames of Mission 1, 2, and 3 data can be downloaded.

B. 720-Degree Camera

The 720-degree camera is composed of two 360-degree cameras. Moving pictures and still pictures can be acquired with the different operation modes. Instant Field of View: IFOV of the camera is 0.45 degrees.

C. Thermal Infrared Camera

Arducam: 2MP Global Shutter OV2311 Mono Camera Modules Pivariety (NoIR), compatible with Raspberry Pi ISP, and Gstreamer Plugin-Arducam is used for mission #2 of thermal infrared camera. Moving pictures and still pictures can be acquired as well. Swath width is 163 km, Instantaneous field of view is 102m, Frame rate is 30fps for moving picture acquisition, The number of pixels can be selected (1) 1600 by 1300, (2) 800 by 650, Quantization bit rate is 8bit, Transmission bandwidth is 499.2 Mbps, Camera clock is 27MHz in maximum, and it can be transmitted one frame image in every 18.5 seconds for 1600 by 1300 mode, and in 4.6 seconds for 800 by 650 mode, respectively.

D. Geiger Counter

The ISS is located at an altitude of about 400 km, outside the Earth's magnetosphere, making it an environment that is easily affected by cosmic rays: a Geiger counter makes a "click" sound each time it detects radiation (alpha particles, beta particles, gamma rays, etc.). On Earth, the amount of radiation is low, so the sound is heard sporadically, but on the ISS, the intensity of radiation is much higher, so the detection sound is more frequent. For example, natural radiation levels on Earth would make a Geiger counter click a few dozen times per minute, but on the ISS, hundreds to thousands of clicks per minute would be heard.

III. SIMULATION OF MISSION INSTRUMENT DATA WITH A SIMPLE PROMPT OF THE GENERATIVE AI

A. 720-Degree Camera Images

360-degree camera images which will be acquired with 720-degree camera of Mission #1 are tried to create with a simple prompt of the generative AI (ChatGPT, for instance). Two examples are shown in Fig. 1. The prompt is as follows, "Please create 360-degree camera image of the Earth from the altitude of ISS (400km)". As is shown in Fig. 1, it seems like nighttime scenes of cloudy South American continent with the thin atmosphere and shining the sun.



Fig. 1. Two example images which will be acquired with 720-degree camera of Mission #1 created with a simple prompt of the generative AI (ChatGPT).

The following ToT of prompt ("Please decide to choose the Pika¹ generated images or Tenbin AI generated images for creation of 360-degree camera image of the Earth from the altitude of ISS (400 km)") is attempted to the creation of 360-degree camera images. Tenbin AI is created by GMO², Japan which allows the use of more than six generative AI at once free of charge. Such that the decision tree selection of the prompt does work to generate many appropriate images. Fig. 2 shows the images created by the ToT prompt proposed here.

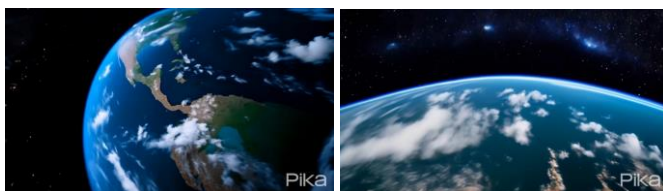


Fig. 2. Two example images which will be acquired with 720-degree camera of Mission #1 created with the proposed ToT prompt of the generative AI (ChatGPT).

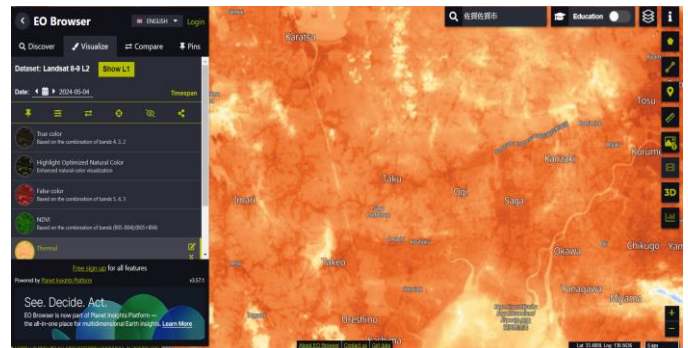
Curvature of the Earth can be seen. At an altitude of 400 km, the curvature of the Earth is clearly visible. The curved horizon is a distinctive feature. Continents and the oceans can also be seen. The vast oceans can be seen together with the spreading continents and their boundaries. During the day, the sunlight reflects beautifully off the land and water surfaces. The thin blue layer of atmosphere that surrounds the Earth can be seen as well. This is the Earth's atmosphere. On the night side of the Earth, scattered city lights can be identified. The boundary between day and night (terminator) divides the Earth

1 <https://pika.art/>
2 <https://tenbin.ai/>

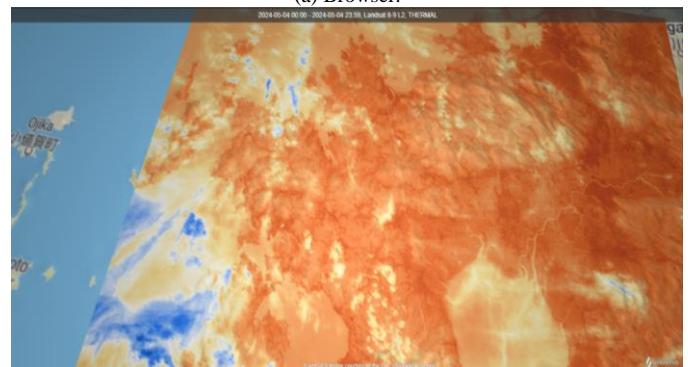
into two halves. The night sky features a large number of stars and a clear view of the Milky Way.

B. Thermal Infrared Camera Images

Landsat-9/TIRS-2(Thermal Infrared Sensor-2), OLI-2(Operational Land Imager-2) can be used to simulate the mission #2 of thermal infrared camera images. By using EO (Earth Observation) Browser³ provided by European Space Agency, simulation images can be simulated. Fig. 3 shows an example of the simulated thermal infrared images with 200 m spatial resolution of Saga city and its surroundings which was acquired on 4 May 2024.



(a) Browser.



(b) 200m resolution of the simulated thermal infrared camera image.

Fig. 3. EO browser and example of the simulated thermal infrared camera image.

The following ToT of prompt ("Please decide to choose the EO browser derived Pika generated images or Tenbin AI-generated images for creation of thermal infrared camera image of a land containing flooding areas are included from the altitude of ISS (400km)") is attempted to the creation of thermal infrared camera images. Such that decision tree selection of prompt does work to generate many appropriate images. Fig. 4 shows the image created by the ToT prompt proposed here.

3 https://apps.sentinel-hub.com/eo-browser/?zoom=11&lat=33.29182&lng=130.03693&themeId=DEFAULT-THEME&visualizationUrl=https%3A%2F%2Fservices.sentinel-hub.com%2Fogc%2Fwms%2Ffa073661-b70d-4b16-a6a9-e866825f05fd&datasetId=AWS_LOTL2&fromTime=2024-05-04T00%3A00%3A00.000Z&toTime=2024-05-04T23%3A59%3A59Z&layerId=THERMAL&demSource3D=%22MAPZEN%22



Fig. 4. Example of the simulated thermal infrared camera image.

C. Geiger Counter Sounds

The sound of natural radiation levels on Earth would be tick... tick... tick... tick... tick... tick... whereas the sound of cosmic rays on the ISS would be tick-tock-tock-tock-tock-tock-tock... Thus, while on the ISS in orbit, the sound of the Geiger counter can be heard very frequently, and almost continuously, due to the frequent detection of high energy particles.

Famous links to actual audio data recording the sounds of cosmic rays in ISS orbit are (1) JAXA Kibo Public Relations and Information Center⁴ and (2) NASA Glenn Research Center⁵. Listening to these audio recordings gives you an idea of what life is like on the ISS and makes the presence of cosmic rays seem more familiar to you. Geiger counters can detect not only cosmic rays but also other types of radiation such as beta rays and gamma rays, so not all sounds are necessarily caused by cosmic rays.

By using ToT-based prompt technology, the sound of cosmic rays detected by a Geiger counter at an altitude of 400 km on the ISS can generally be simulated with the following prompt. "Choose the generate sounds as a quiet crackling when the satellite altitude is low or popping sound for the relatively higher satellite altitude". Like a crackling, similar to a light sound like a spark flying. It occurs every time a cosmic ray strikes the detector of a Geiger counter. As a popping sound, a sound similar to a small popping sound (occurs every time a high-energy cosmic ray strikes the detector) is heard. The loudness of the sound depends on the energy of the cosmic ray and the sensitivity of the detector, but generally, the more energetic the cosmic ray, the louder it will be. Also, a more sensitive detector can detect even weaker cosmic rays.

IV. MISSION ANALYSIS WITH THE SIMULATED IMAGES AND THE SOUNDS

A. 720-Degree Camera Images

By using generative AI (Tenbin AI) with the following simple prompt of "What insights can you glean from the images you've uploaded?" the following response is obtained.

The uploaded image shows the Earth from space, particularly the North American continent. Key insights from

the image include are as follows, (1) Roundness of the Earth: From space, the Earth is clearly spherical. (2) Atmosphere: The atmospheric layer surrounding the Earth is depicted as a beautiful blue atmospheric color. (3) Clouds: Clouds of various shapes are spread across the Earth's surface, indicating the movement of the atmosphere. (4) Land and Ocean: The land of North America and the ocean surrounding it are clearly distinguishable. (5) Stars in the night sky: Countless stars shine against the background of the Earth. (6) Word "Pika" in the bottom left of the image: The word "Pika" is written in the bottom left of the image, which may indicate that the image is part of some kind of content.

B. Thermal Infrared Camera Images Containing Flooding Areas

Thermal infrared imagery creates images based on the temperature of objects. Flooded or submerged areas have a lower temperature than the surrounding land, and therefore appear darker in thermal infrared imagery. For this image, the following methods are used to detect flooded or submerged areas: Simple thresholding method compares the brightness values of all pixels in the image and considers pixels that are lower than a certain threshold as flooded or submerged areas; Object-based segmentation method identifies objects in the image and determines whether they are flooded or submerged based on their temperature and shape; and Machine Learning method uses historical flood data to train a model to automatically detect flooded or submerged areas from thermal infrared imagery.

For the simple threshold method, the histogram shows that the brightness values in the image are relatively evenly distributed. There is a small peak on the left side of the image that could be a flooded or submerged area. Also, all pixels with a brightness value below 100 are considered to be flooded or submerged areas. There are some areas on the left side of the image that could be flooded or submerged areas.

Using Tenbin of generative AI with the prompt of "Extract flooding areas from the simulated thermal infrared image", mission analysis of flooding area detection is conducted.

The simulated thermal image is converted to gray-scale and has a size of 1125 by 2000 pixels. Fig. 5 shows the gray-scale image. Next, we proceed to detect flooded areas. In thermal imagery, flooded areas usually appear cooler (darker in gray-scale) due to lower water temperature compared to the surrounding land. A thresholding technique is applied to highlight these cooler regions. In the thresholded image, the potentially flooded areas are highlighted in black. These regions correspond to the cold areas in the thermal imagery, indicating the accumulation of water due to flooding. Fig. 6 shows the detected flooding areas.

Other flooding area detection method with the following simple prompt "Detect flooded or submerged areas from uploaded thermal infrared images" using Tenbin of generative AI is attempted. Fig. 7 (a) shows the uploaded thermal infrared camera image with the histogram while Fig. 7 (b) shows the histogram equalized image with the histogram. On the other hand, Fig. 7 (c) shows gray-scale image of the uploaded thermal infrared camera image while Fig. 7 (d) shows

⁴ <https://humans-in-space.jaxa.jp/iss/>

⁵ <https://www.nasa.gov/missions/analog-field-testing/why-space-radiation-matters/>

histogram stretched image of the gray-scale image, respectively.

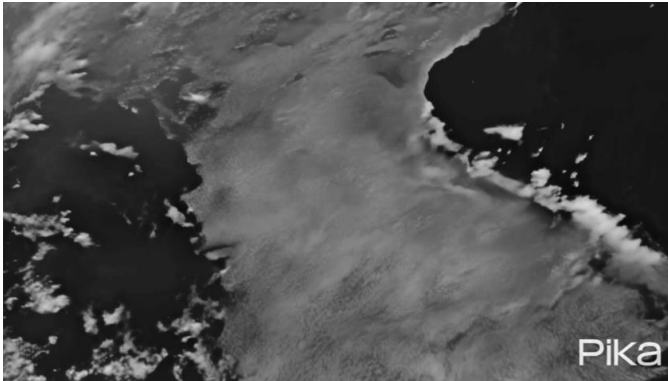


Fig. 5. Gray-scale of the simulated thermal infrared camera image.

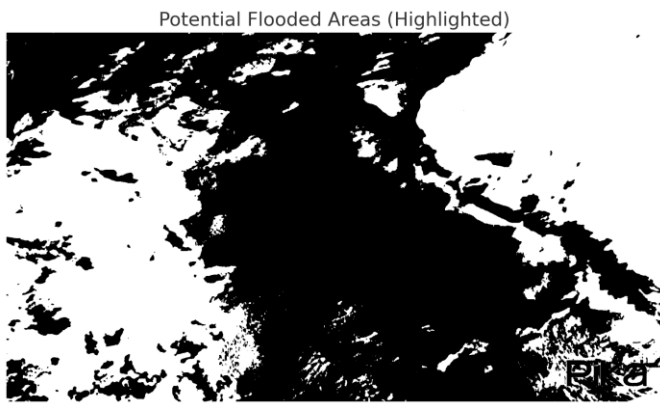
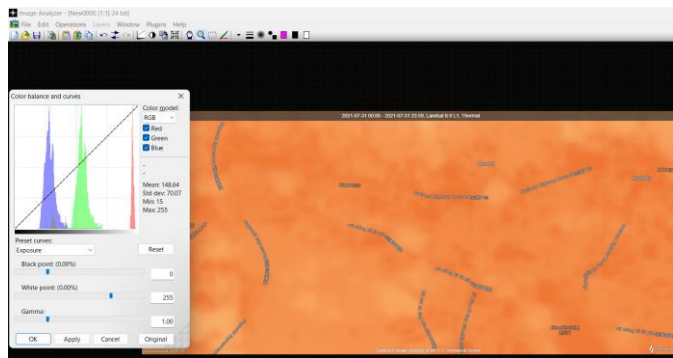
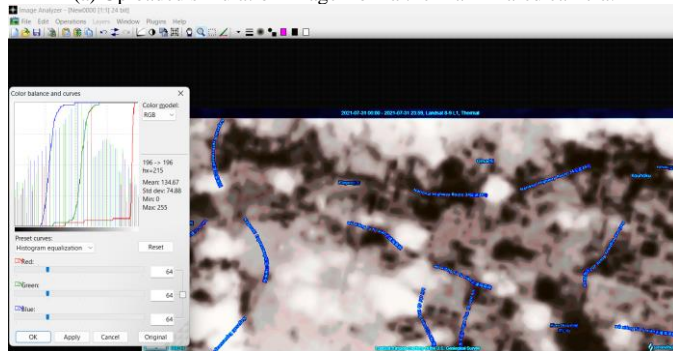


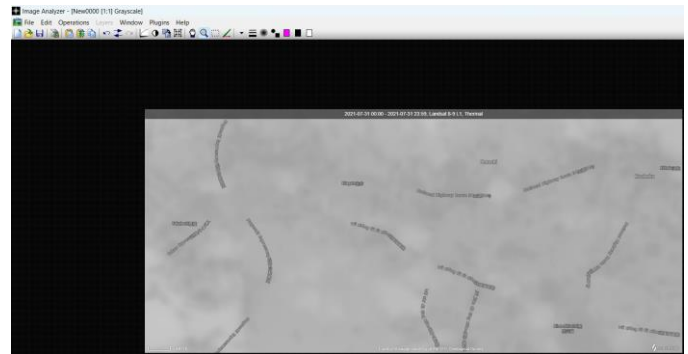
Fig. 6. Detected flooding areas from the gray-scale image.



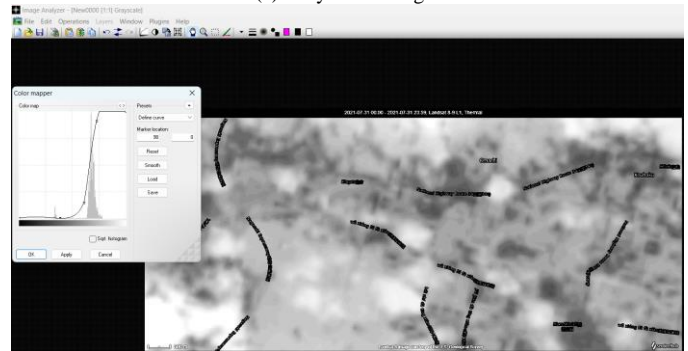
(a) Uploaded simulation image from a thermal infrared camera.



(b) Histogram equalized image.



(c) Gray-scale image.



(d) Histogram stretched image.

Fig. 7. Flooding area detection with the simulated thermal infrared camera image.

C. New Insights Gained by Combining 360-degree Camera Images and Thermal Infrared Camera Images

Using the Tenbin AI with the simple prompt "Combining visible light images from a 360° camera taken at ISS altitude with thermal infrared images at 200 m resolution allows for many interesting applications" the following responses are obtained,

1) *Analyzing the urban heat island effect:* By identifying urban structures with visible light images and observing their heat distribution with thermal infrared images, you can investigate temperature rises in urban areas in detail.

2) *Early detection and monitoring of forest fires:* By identifying smoke and flames with visible light images and identifying high-temperature areas with thermal infrared images, forest fires can be detected earlier and more accurately.

3) *Observing ocean surface temperature distribution:* By visually identifying ocean currents and eddies with visible light images and observing the distribution of sea surface temperatures with thermal infrared images, studying climate change and its impact on marine ecosystems can be done.

4) *Assessing agricultural productivity:* Identifying crop types and distribution with visible light images and evaluating crop stress and irrigation efficiency with thermal infrared images can be performed.

5) *Volcanic activity monitoring:* By observing the shape and plumes of volcanoes with visible light imagery and detecting thermal anomalies with thermal infrared imagery, you can monitor changes in volcanic activity.

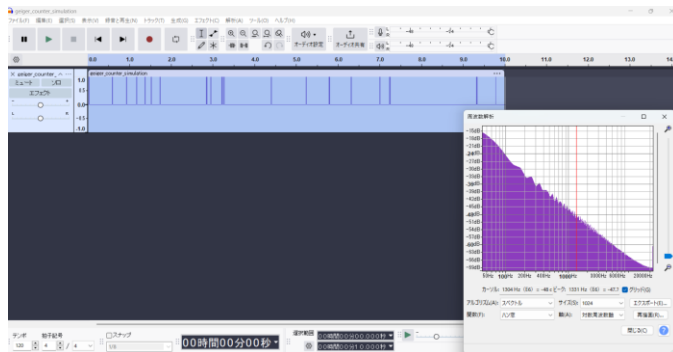
6) *Urban planning and sustainability research:* By examining urban structures and green spaces with visible light imagery and identifying energy-efficient buildings and areas with thermal infrared imagery, you can use this data for urban planning.

7) *Observing changes in glaciers and polar regions:* By examining the shape and extent of glaciers with visible light imagery and observing temperature changes with thermal infrared imagery, you can study the effects of climate change.

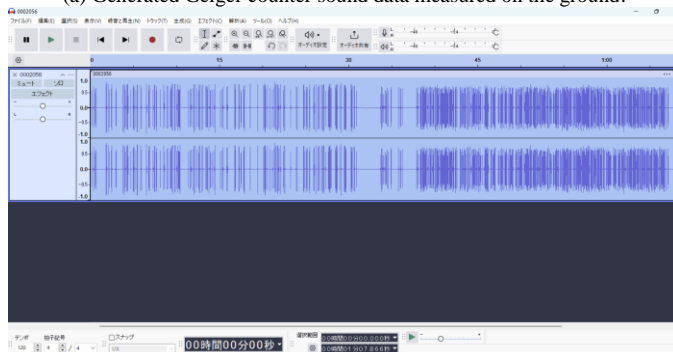
8) *Air pollution research:* By observing smog and atmospheric conditions with visible light imagery and observing temperature gradients in the atmosphere with thermal infrared imagery, you can study the distribution and dynamics of air pollution.

D. Insights from the Simulated Geiger Counter Sound Data

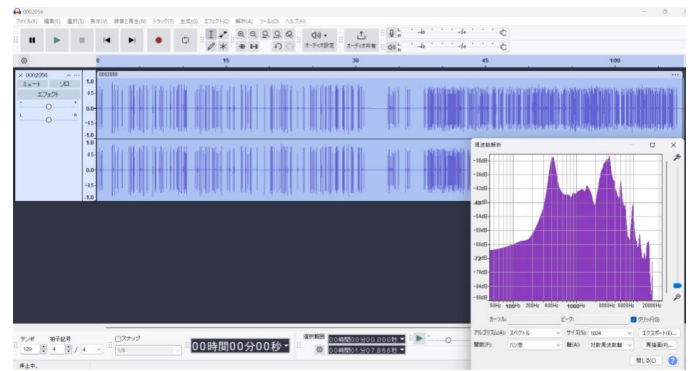
Geiger counter sound data on the Earth's surface is simulated by using the Tenbin AI with the simple prompt "Generate Geiger counter sound data which is measured on the ground and the 400 km altitude". Then the frequency components of the Geiger counter sound data are investigated with Audacity of sound data analysis software tool⁶. Fig. 8 (a) shows the generated Geiger counter sound data measured on the ground and its frequency components while Fig. 8 (b) shows the generated Geiger counter sound data at the 400 km altitude. Meanwhile, Fig. 8 (c) shows its frequency components.



(a) Generated Geiger counter sound data measured on the ground.



(b) Generated Geiger counter sound data measured at the 400 km altitude.



(c) Frequency components of the generated Geiger counter sound data measured at the 400 km altitude.

Fig. 8. Generated Geiger counter sound data measured on the ground and at 400 km altitude (SaganSat-0 altitude) and their frequency components.

V. CONCLUSION

Method for mission analysis using ToT: Tree of Thought-based prompt technology utilized generative analysis AI is proposed. Mission analysis needs methods for simulation of the supposed images which will be acquired with the imaging mission instruments, and the other mission instruments.

In order to create simulation images, ToT-based prompt technology utilized generative AI. An application of the proposed method is shown for a mission analysis for SaganSat-0 of remote sensing satellite which will carry three mission instruments, a 720-degree camera, a thermal infrared camera and a Geiger counter. The simulated images and the Geiger counter sounds created by the proposed method are shown here together with analyzed results. In summary, it is found that ToT-based prompt technology is superior to the other CoT and plain generative AIs.

VI. FUTURE RESEARCH WORKS

SaganSat-0 of remote sensing satellite was launched with launching vehicle Falcon-9 on 5 August 2024 and will be put into orbit at 400 km altitude just same as ISS orbit after being released from the ISS in the near future. Then, three mission instrument data will be acquired after all. Therefore, mission analysis will be made after the actual three mission instrument data are obtained. ToT-based prompt technology will be evaluated by using the actual three mission instrument data through a comparison. Then improvements will take place for ToT prompt technology.

ACKNOWLEDGMENT

The author would like to thank Prof. Dr. Hiroshi Okumura for his valuable discussions for this research works. Also, the author would like to thank Sho Kobayashi and M. Tanaka of Saga Prefectural Space Science Museum Yumeginga for their providing data and information.

REFERENCES

- [1] Jason Wei, Xuezhi Wang, and Dale Schuurmans, Chain of Thought Prompting: A Simple yet Effective Method for Improving Reasoning in Language Models, Proceedings of the 2022 Conference of the North American Chapter of the Association for Computational Linguistics (NAACL 2022), 2022.

6 https://forest.watch.impress.co.jp/library/software/audacity/download_10718.html

- [2] Yixin Nie, Pengcheng Yin, and Graham Neubig, "Improving Chain of Thought Prompting with Recursive Decomposition", 2022. <https://arxiv.org/abs/2209.07141>, Accessed on 15 August 2024.
- [3] Yufei Wang, et al., "Chain of Thought Prompting for Solving Math Word Problems" 2022. <https://arxiv.org/abs/2209.13341>, Accessed on 15 August 2024.
- [4] Yixin Nie, et al., "Chain of Thought Prompting for Multimodal Reasoning", 2022. <https://arxiv.org/abs/2210.02419>, Accessed on 15 August 2024.
- [5] Xuezhi Wang, et al., "Chain of Thought Prompting for Commonsense Reasoning", 2022. <https://arxiv.org/abs/2210.03541>, Accessed on 15 August 2024.
- [6] Yixin Nie, et al., "Analyzing the Effectiveness of Chain of Thought Prompting", 2022. <https://arxiv.org/abs/2210.05191>, Accessed on 15 August 2024.
- [7] Pengcheng Yin, et al., "Evaluating the Reasoning Ability of Language Models with Chain of Thought Prompting", 2022. <https://arxiv.org/abs/2210.06241>, Accessed on 15 August 2024.
- [8] Yufei Wang, et al., "Chain of Thought Prompting for Dialogue Systems", 2022. <https://arxiv.org/abs/2210.08191>, Accessed on 15 August 2024.
- [9] Xuezhi Wang, et al., "Chain of Thought Prompting for Explainable AI", 2022. <https://arxiv.org/abs/2210.09241>, Accessed on 15 August 2024.
- [10] Yixin Nie, et al., "Chain of Thought Prompting for Multitask Learning", 2022. <https://arxiv.org/abs/2210.10341>, Accessed on 15 August 2024.
- [11] Jason Wei Xuezhi Wang Dale Schuurmans Maarten Bosma, Brian Ichter Fei Xia Ed H. Chi Quoc V. Le Denny Zhou, "Google Research", Brain Team {jasonwei,dennyzhou}@google.com, "Chain-of-Thought Prompting Elicits Reasoning in Large Language Models", 2023, <https://arxiv.org/html/2201.11903>, Accessed on 15 August 2024.
- [12] Shunyu Yao, Dian Yu, Jeffrey Zhao, Izhak Shafran, Thomas L. Griffiths, Yuan Cao, Karthik Narasimhan, "Tree of Thoughts: Deliberate Problem Solving with Large Language Models, Computer Science > Computation and Language", [Submitted on 17 May 2023 (v1), last revised 3 Dec 2023 (this version, v2)], <https://arxiv.org/abs/2305.10601>, Accessed on 15 August 2024.
- [13] Pengcheng Yin, et al., "Think-Then-Act: Bridging the Gap between Reasoning and Acting in Language Models", 2022. <https://arxiv.org/abs/2209.07131>, Accessed on 15 August 2024.
- [14] Yixin Nie, et al., "Improving Think-Then-Act Prompting with Recursive Reasoning", 2022. <https://arxiv.org/abs/2210.02411>, Accessed on 15 August 2024.
- [15] Yufei Wang, et al., "Think-Then-Act Prompting for Solving Math Word Problems", 2022. <https://arxiv.org/abs/2210.13331>, Accessed on 15 August 2024.
- [16] Yixin Nie, et al., "Think-Then-Act Prompting for Multimodal Reasoning", 2022. <https://arxiv.org/abs/2210.04411>, Accessed on 15 August 2024.
- [17] Xuezhi Wang, et al., "Think-Then-Act Prompting for Commonsense Reasoning", 2022. <https://arxiv.org/abs/2210.05511>, Accessed on 15 August 2024.
- [18] Yixin Nie, et al., "Analyzing the Effectiveness of Think-Then-Act Prompting", 2022. <https://arxiv.org/abs/2210.06111>, Accessed on 15 August 2024.
- [19] Pengcheng Yin, et al., "Evaluating the Reasoning Ability of Language Models with Think-Then-Act Prompting", 2022. <https://arxiv.org/abs/2210.07211>, Accessed on 15 August 2024.
- [20] Yufei Wang, et al., "Think-Then-Act Prompting for Dialogue Systems", 2022. <https://arxiv.org/abs/2210.09111>, Accessed on 15 August 2024.
- [21] Xuezhi Wang, et al., "Think-Then-Act Prompting for Explainable AI", 2022. <https://arxiv.org/abs/2210.10211>, Accessed on 15 August 2024.
- [22] Yixin Nie, et al., "Think-Then-Act Prompting for Multitask Learning", 2022. <https://arxiv.org/abs/2210.11311>, Accessed on 15 August 2024.

AUTHOR'S PROFILE

Kohei Arai, He received BS, MS and PhD degrees in 1972, 1974 and 1982, respectively. He was with The Institute for Industrial Science and Technology of the University of Tokyo from April 1974 to December 1978 also was with National Space Development Agency of Japan (Current JAXA) from January, 1979 to March, 1990. During from 1985 to 1987, he was with Canada Centre for Remote Sensing as a Post Doctoral Fellow of National Science and Engineering Research Council of Canada. He moved to Saga University as a Professor in Department of Information Science on April 1990. He was a councilor for the Aeronautics and Space related to the Technology Committee of the Ministry of Science and Technology during from 1998 to 2000. He was a councilor of Saga University for 2002 and 2003. He also was an executive councilor for the Remote Sensing Society of Japan for 2003 to 2005. He is a Science Council of Japan Special Member since 2012. He is an Adjunct Professor of Brawijaya University, Kurume Institute of Technology and Nishi-Kyushu University. He also was Vice Chairman of the Science Commission "A" of ICSU/COSPAR for 2008-2016 then he is now award committee member of ICSU/COSPAR. He wrote 87 books and published 710 journal papers as well as 650 conference papers. He received 66 of awards including ICSU/COSPAR Vikram Sarabhai Medal in 2016, and Science award of Ministry of Education of Japan in 2015. He is now Editor-in-Chief of IJACSA and IJISA. <http://teagis.ip.is.saga-u.ac.jp/index.html>