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Best Practice on Automatic Toon Image Creation from JSON File of Message Sequence Diagram via Natural Language based Requirement Specifications

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Abstract

In AI image generation tools, most general users must use an effective prompt to craft queries or statements to elicit the desired response (image, result) from the AI model. But we are software engineers who focus on software processes. At the process's early stage, we use informal and formal requirement specifications. At this time, we adapt the natural language approach into requirement engineering and toon engineering. Most Generative AI tools do not produce the same image in the same query. The reason is that the same data asset is not used for the same query. To solve this problem, we intend to use informal requirement engineering and linguistics to create a toon. Therefore, we propose a sequence diagram and image generation mechanism by analyzing and applying key objects and attributes as an informal natural language requirement analysis. Identify morpheme and semantic roles by analyzing natural language through linguistic methods. Based on the analysis results, a sequence diagram and an image are generated through the diagram. We expect consistent image generation using the same image element asset through the proposed mechanism.

Keywords: *Fillmore's Case Grammar, Berkeley Neural Parser, Image Generation, Cartoon*

1. Introduction

With the recent development in AI technology, the field of text-to-image AI has also advanced rapidly. Image generation tools allow you to modify, synthesize, and create images. These tools can generate images with simple text. However, there are cases where the generated image continues to change even if the same prompt is entered. This feature has a problem that the user cannot continue to use the elements of a specific image. There is also an issue where the generated images sometimes do not match the user's detailed description and intent [1]. Due to these issues, users experience the inconvenience of modifying their prompts

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or continually attempting image generation.

To solve this problem, an informal natural language sentence is used to generate an image that fits the user's intention. We propose a UML sequence diagram and image generation mechanism from informal natural language requirements to continue using the same image. Chapter 2 mentions the Berkeley Neural Parser to analyze natural language and redefine the existing Fillmore's case grammar method. Chapter 3 describes the mechanism by analyzing informal natural language to extract sequence diagrams and generate images. Chapter 4 mentions the expected effects and conclusions using the mechanism presented.

2. Related Study

2.1 Berkeley Neural Parser

To analyze informal natural language, it is necessary first to analyze the syntax structure of the sentence to determine the part of speech. Through sentence structure analysis, candidates and messages for objects used in sequence diagrams are determined.

TABLE 1. Part of Speech Tag(POS Tag)

POS	POS Tag	Description
Noun(NN*)	NN	noun, singular or mass
	NNS	noun plural
	NNP	proper noun, singular
	NNPS	proper noun, plural
Pronoun(PRP*)	PRP	personal pronoun
	PRP$	possessive pronoun
Verb(VB*)	VB	verb, base form
	VBD	verb, past tense
	VBG	verb, gerund/present participle
	VBN	verb, past participle
	VBP	verb, non-3d person, singular. present
	VBZ	verb, 3rd person singular. present

Table 1 summarizes the parts of speech to find the diagram elements. In this study, the Berkeley Neural Parser is used to analyze the part of speech of the sentence. The parser decomposes sentences into overlapping sub-phrases to analyze the syntax structure and part of speech [2]. Figure 1 represents the results of analyzing the example sentence using a parser in a tree structure. NN* and PRP* found using the parser are selected as candidates for the object, and VB* is used as the message.

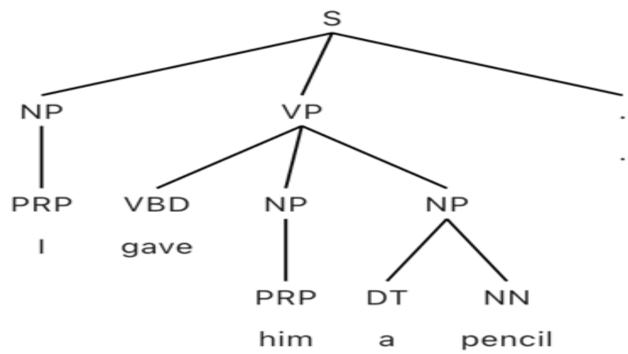

Figure 1. Berkeley Neural Parser Analysis Results

When analyzing the results, 'I' and 'him' in the sentence are pronouns as PRP. 'pencil' is a noun as it is NN. Also, in the analysis result, 'gave' is a verb as it is VBD.

2.2 Redefined Fillmore Case Grammar

Sequence is a grammar described by Fillmore that analyzes the semantic relationship of words in sentences centered on verbs [3]. Meaning analysis of the sentence structure analysis results is conducted through the corresponding grammar. A word identified as a candidate for an object is defined as the role of an object to be used in a sequence diagram through semantic analysis.

TABLE 2. Redefined Case Grammar for Use Case Diagram

Case	Definition
Actor	The instigator of the event/action
Counter Actor	The force or resistance against which an action is carried out
Object	The entity which moves or changes or whose existence is in consideration
Theme	The subjective entity of the object
Result	Entity that comes into existence as a result of the action
Source	Origin of object
Instrument	Facility used in carrying out an event
Experiencer	Entity that receives or accepts or experiences or undergoes the effect of an action
Goal	Destination of object

Table 2 summarizes the existing redefined qualification methods [4]. The existing case grammar is redefined to suit the Use Case diagram. Therefore, we redefine the septum method in this study to suit the sequence diagram.

2.3 Study on Code Extraction from Requirements

In previous studies, parsing was performed from informal requirements to extract sequence diagrams and implement source codes [5]. Figure 2 is the overall process of the existing research.

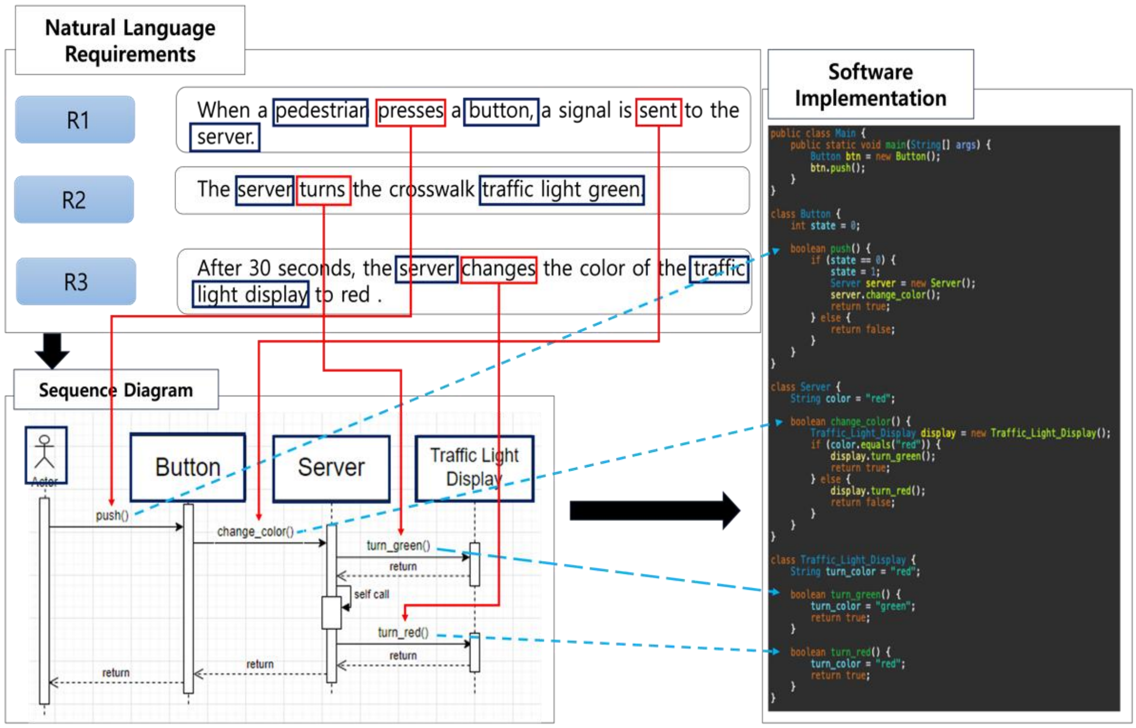

Figure 2. The Entire Process of Previous Research

This study intends to create an image based on informal natural language based on existing research.

3. Image Generation Mechanism

This study proceeds according to the image generation process, as shown in Figure 3.

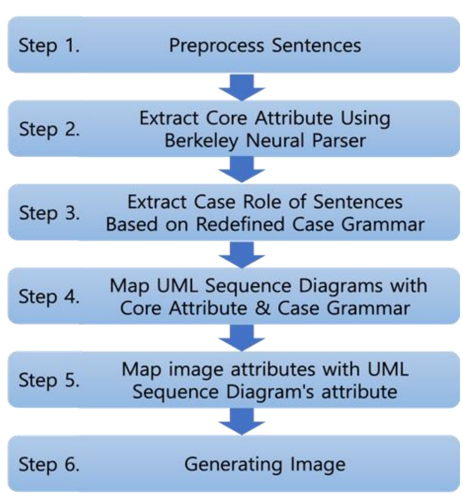

Figure 3. Mechanism Process

3.1 Sentences Preprocessing

If natural language sentences are composed of a complex structure, there is a problem that it is difficult to proceed with syntax analysis. To solve these problems, we first identify the main clause in the sentence. Second, it identifies dependent clauses and phrases. Third, separate clauses and phrases to analyze whether they have an independent meaning. Finally, after separating only meaningful sentences from sentences, necessary words are added, or unnecessary words are deleted.

TABLE 3. Informal Requirement Preprocessing Results

	Before Preprocessing	After Preprocessing
1	Sam walks to the flower shop.	Sam walks to the flower shop.
2	Sam buys a flower from Jessica, a female employee.	Sam buys a flower from Jessica.
3	Sam gives Emma a flower	Sam gives Emma a flower
4	Emma gives Sam a letter	Emma gives Sam a letter

Table 3 shows the sentences before preprocessing and the sentences after preprocessing. Extracting core attributes is carried out using the sentence after preprocessing.

3.2 Key Attributes Extraction Using the Berkely Neural Parser

In Table 3, the core attributes of the preprocessed sentences are extracted. Syntax analysis and part of speech are identified by extracting core attributes. Figure 4 shows the results of analyzing the sentences using the parser after preprocessing in Table 3 as a tree.

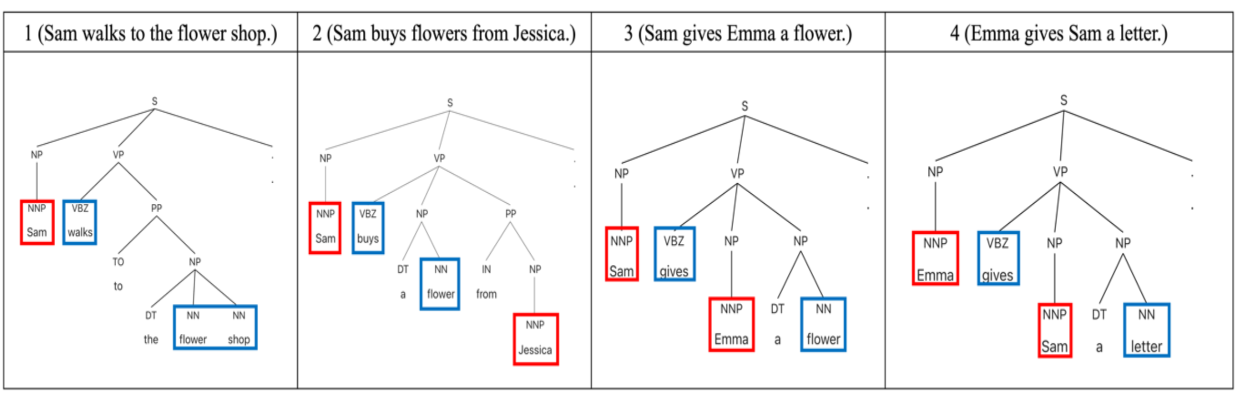

Figure 4. Informal Natural Language Requirements Syntax Results

Based on the results shown in Figure 4, the nouns of the sentences are 'Sam,' 'flower shop,' 'flower,' 'Jessica,' 'Emma,' and 'letter.' The verbs of the sentences are 'walks,' 'buys,' and 'gives.' A diagram is generated based on the result of this analysis and the role of the sentence extracted using case grammar.

3.3 Role Extracting on the Sentence Structure

Previously redefined case grammar is not suitable for generating sequence diagrams. Case grammar redefined to match the cartoon's elements is also unsuitable for sequence diagrams [6]. Therefore, the case grammar is redefined, as shown in Figure 5.

Case	Definition
Actor	Person or thing that triggers an event or action
Object	The entity which moves or changes or whose existence is in consideration
Theme	The subjective entity of Object
Source	The object that sent the message

✚

Target	Object that received the message

Figure 5. Redefined Case Grammar for Sequence Diagram

In a redefined case, grammar, Theme, Source, and Target are types of objects. A source is an object that sends a message. A target is an object that receives a message. A theme is an object that includes both source and target properties.

TABLE 4. Semantic Analysis Results of Informal Natural Language Requirements

	Applying Case Grammar
1	Sam[Theme] walks[Verb] to the flower shop.
2	Sam[Source] buys[Verb] flowers from Jessica[Target].
3	Sam[Source] gives[Verb] Emma[Target] a flower.
4	Emma[Source] gives[Verb] Sam[Target] a letter.

Table 4 shows the results of the semantic analysis of informal requirements. In other words, it is the result of applying the role of case grammar to the sentences preprocessed in Table 3.

3.4 Mapping Sequence Diagram Key Attributes with Case Grammar

Among VB*, PRP*, and NN* analyzed using the parser, only nouns representing people among PRP* and NN* elements are used as objects in the diagram. VB* is used as a message.

TABLE 5. Mapping Case Grammar and Sequence Diagram Elements

Case Grammar	Diagram Component
Actor	Actor
Theme Source Target	Object
VB*	Message

Table 5 is the result of mapping the elements of Fillmore's case grammar method and the diagram elements. Figure 6 is a diagram generated by the sentence 'Emma gives Sam a letter.'.

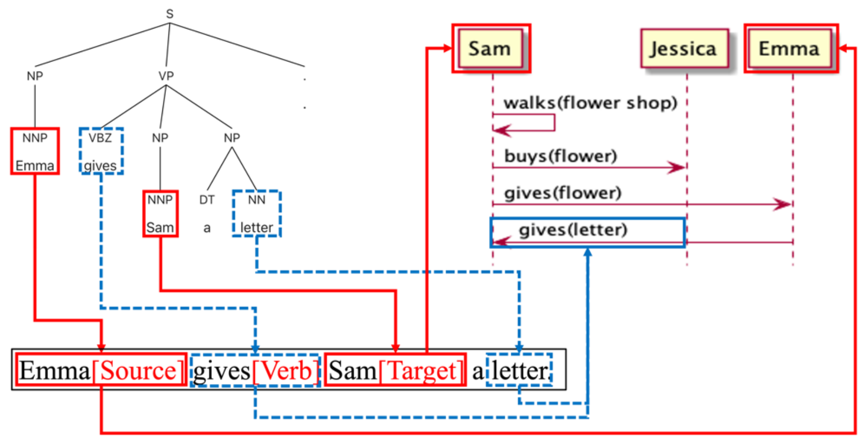

Figure 6. Mapping Sentence Analysis Results and Diagram Elements

In the sentence 'Emma gives Sam a letter.', "Emma ' is the source, 'Sam' is the Target, and 'gives' is the message. Therefore, a diagram is generated to send the message 'gives' from the source 'Emma' to the target 'Sam'.

3.5 Mapping Sequence Diagrams with Image Properties

The elements of the JSON file are constructed based on the diagram generated by analyzing the sentence. For each object in the diagram, the properties of the object are defined in the objects in the JSON file.

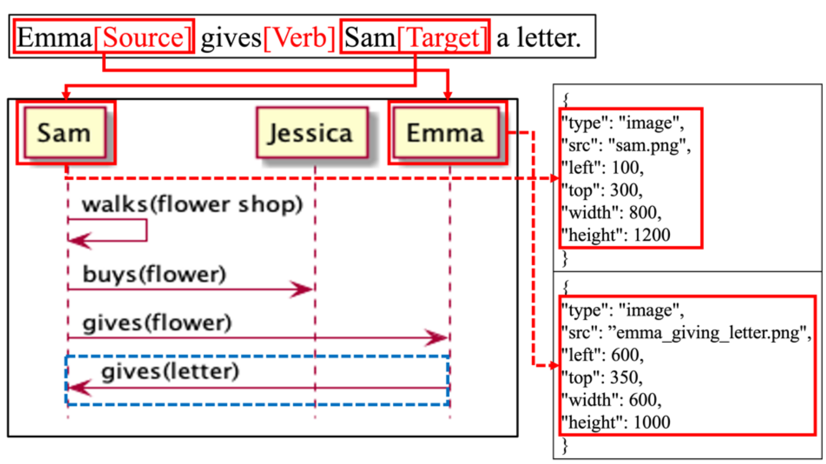

Figure 7. Mapping Sequence Diagram Elements to a JSON File

Figure 7 is a part of the JSON file that defines the object properties of the sentence 'Emma giveaways Sam letter.' The JSON files defined through diagrams are used to create images. When defining the properties of an object in a JSON file, the diagram maps it to an object and a pair of messages.

3.6 Image Generation

The JSON file defining the object's properties is analyzed using FabricJS [7]. Using FabricJS, the properties of objects defined in the JSON file are shown in canvas. In the image created in canvas using FabricJS, the image is placed according to the flow of the diagram.

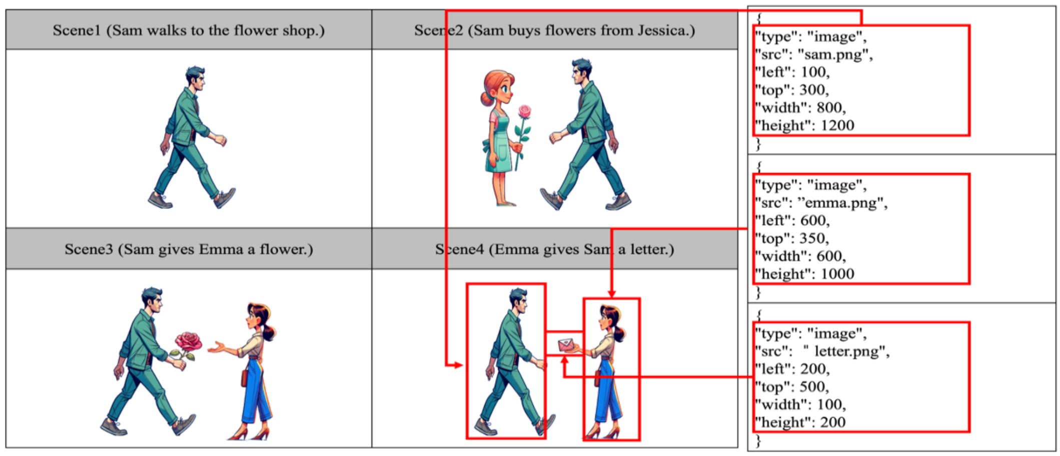

Figure 8. Image Results Generated based on JSON Files

When an image is generated using sentences 1-4 in Table 3, it is generated as shown in Figure 8. As for the image, the position and size of the asset are determined based on the properties of the object defined inside the JSON file.

4. Conclusion

Using the proposed image generation mechanism, atypical natural language requirements can be analyzed using a parser and redefined Fillmore's quarantine. In addition, diagrams can be generated using the analyzed natural language requirements. Generating a diagram by analyzing the current informal natural language requirements can save time and money for software design. It can also be verified and improved in quality by comparing existing design and natural language requirements with sequence diagrams generated by analyzing them.

Additionally, if you use an image created using a diagram, you can generate an image that fits the user's requirements. Therefore, it is expected that users will be able to save money by reducing the time they spend drawing. In addition, users can continuously use the image element asset they want to create a consistent image to compensate for the shortcomings of existing image-generating AI.

In the future, when conducting natural language analysis, we plan to analyze the dependence of words in the sentence and conduct a more accurate requirement analysis. We will also map elements other than elements of the primary sequence diagram with elements of the code to create an image more tailored to the user's requirements.

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