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Development of a Tourism Information QA Service for the Task-oriented Chatbot Service

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Abstract

The smart tourism chatbot service provide smart tourism services to users easily and conveniently along with the smart tourism app. In this paper, the tourism information QA (Question Answering) service is proposed based on the task-oriented smart tourism chatbot system [13]. The tourism information QA service is an MRC (Machine reading comprehension)-based QA system that finds answers in context and provides them to users. The tourism information QA system consists of NER (Named Entity Recognition), DST (Dialogue State Tracking), Neo4J graph DB, and QA servers. We propose tourism information QA service uses the tourism information NER model and DST model to identify the intent of the user's question and retrieves appropriate context for the answer from the Neo4J tourism knowledgebase. The QA model finds answers from the context and provides them to users through the smart tourism app. We develop the tourism information QA model by transfer learning the bigBird model, which can process the context of 4,096 tokens, using the tourism information QA dataset.

Keywords: *Question Answering, Smart tourism, Trask-oriented chatbot service, Machine Reading Comprehension, Named Entity Recognition, Dialogue State Tracking*

1. INTRODUCTION

Smart tourism services provide tourists with personalized travel planner services and tour guide services based on location information and context awareness [1-5]. Smart tourism services are provided through various service channels such as chatbots, Instagram, and YouTube as well as smart tourism apps. The travel planner service provides users with a personalized travel itinerary of the same quality as package tour products provided by professional travel agencies. The tour guide service provides a high-quality tour guide service that provides a professional guide based on location information according to the travel itinerary created by the travel planner service. Users can use smart tourism services to travel conveniently and safely economically. The smart tourism tour guide service can provide a location-based voice guidance storytelling content service while changing the travel itinerary based on context awareness. After traveling, users can provide their travel itinerary as the recommended travel products to other users. High-quality smart tourism services require tourist information and recommended travel products for travel planner services, and

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location-based storytelling content for tour guide services.

Smart tourism service is provided to users as Android and React smart tourism apps [6] through the smart tourism service platform. The smart tourism app provides recommended travel products, tourist information, and travel planner services. Users can create a personalized travel itinerary using recommended travel products and tourist information from the smart tourism travel planner service [7]. Recommended travel products can be created through big data analysis [8]. Additionally, users can travel conveniently and safely by using the TTS server-based multilingual audio guide service [9]. Smart tourism chatbot service is a tool that can efficiently provide personalized tourism information and travel products to tourists along with smart tourism apps. The task-oriented tourism information chatbot services were developed using the NER (Named entity recognition) and DST (Dialogue State Tracking) models, which were transfer learned from the BERT series of pre-trained language models (PLMs) using the tourism information NER and DST datasets [10-13]. In this paper, we develop the MRC (Machine reading comprehension)-based tourism information QA (Question Answering) service using the BERT series pre-trained language models [14].

2. Related Works

The smart tourism service platform provides smart tourism services to users through smart tourism apps and chatbot services. The tourism information QA service provides detailed tourist information to users using an existing smart tourism service platform. The smart tourism service is developed by adding the tourism information QA model and context to the tourism information NER server, DST server, and Neo4J graph DB of the smart tourism service platform.

2.1 Smart Tourism Service Platform

The smart tourism service platform consists of the smart tourism information system and the smart tourism chatbot system. The smart tourism information system provides smart tourism apps, tourist information, recommended travel products, and travel planner services. The smart tourism chatbot system provides task-oriented tourism chatbot services. Figure 1 shows the functional block diagram of the smart tourism service platform.

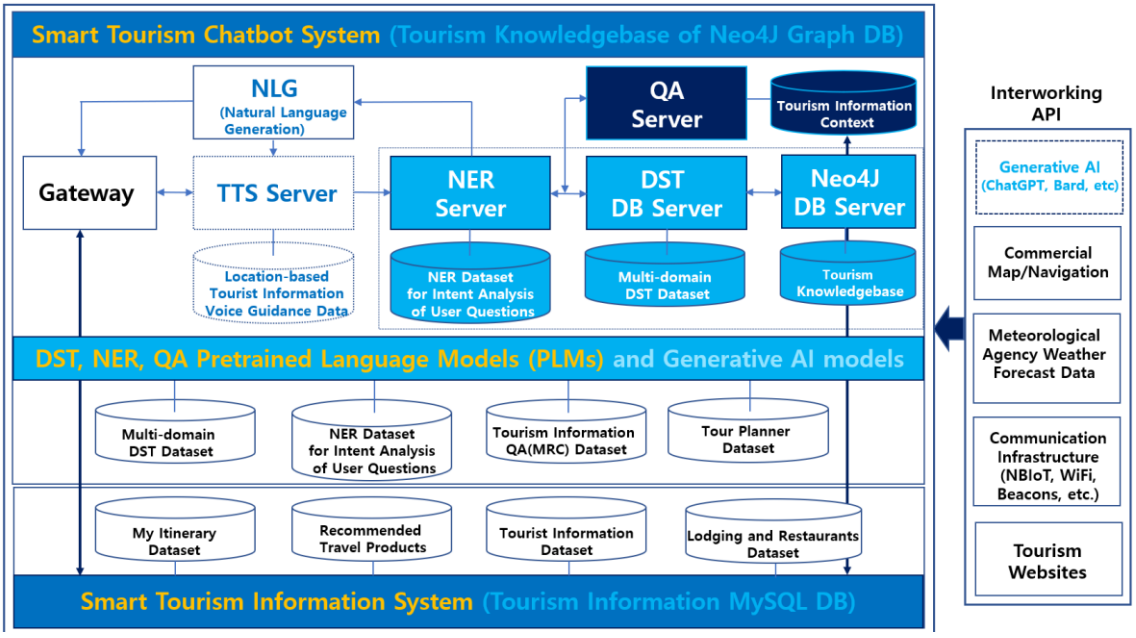
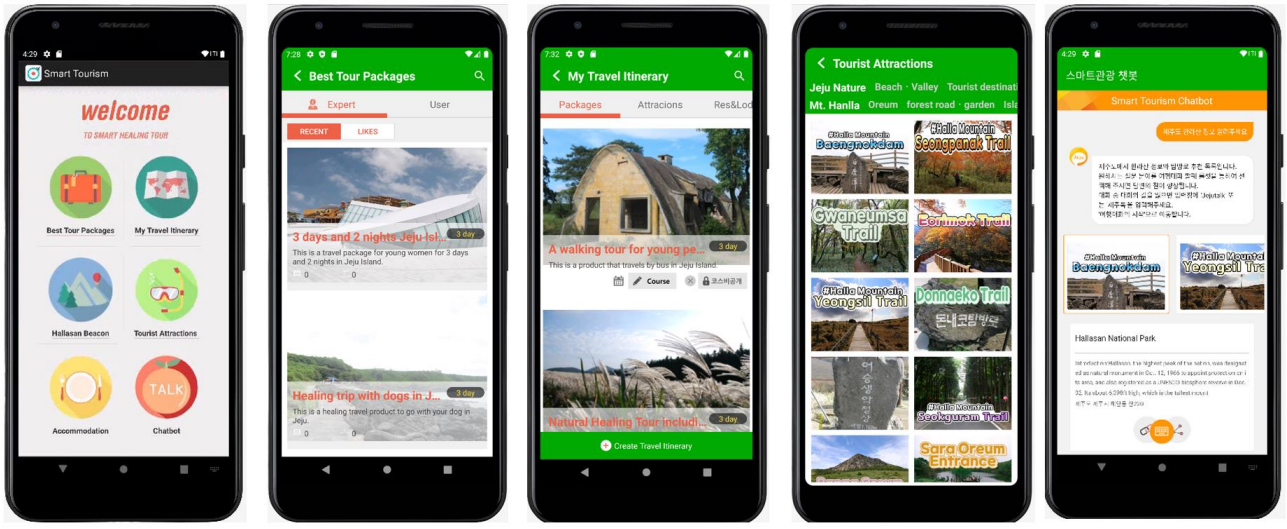


Figure 1. Smart tourism service platform that provides smart tourism apps and chatbot services

The smart tourism chatbot system that provides tourist information chatbot services is composed of the NER server, DST server, and the tourism knowledgebase of Neo4J graph DB. The smart tourism chatbot system also has datasets for transfer learning the BERT-based pre-trained language model and for fine tuning the generative AI model. The smart tourism service platform analyzes the intention of the user's question in the NER server and DST server and searches the tourism information classification code in Neo4J graph DB's tourism knowledgebase to provide answers to the user. The smart tourism information system provides middle-category tourist information of the tourist information classification code to users on the app screen [13]. The tourism information QA service is implemented by adding the QA server and context to the smart tourism chatbot system as shown in Fig. 1. The QA server finds answers in the context searched according to the intent of the question analyzed by the NERT and DST servers.

2.2 Smart tourism app that provides tourist information chatbot service

The tourist information chatbot service is provided to users through the chatbot menu of the smart tourism app. Figure 2 shows the main screen of the smart tourism app and the tourist information chatbot menu. The smart tourism app provides not only the chatbot menu, but also Best Tour Packages, My Travel Itinerary, Hallasan Beacon, Tourist Attractions, and Accommodation menus. Users can check, select, and save recommended travel products and tourist information to create their travel itinerary. Additionally, users can easily and conveniently check and select tourist information through the tourist information chatbot service provided in the chatbot menu. The smart tourism app's travel planner menu allows users to create a personalized travel itinerary using recommended travel products and tourist information. The Hallasan Beacon menu in the smart tourism app provides location-based tour guide services to hikers.



(a) Main Menu (b) Best Tour Products (c) My Travel Itinerary (d) Tourist Attractions (e) Chatbot service

Figure 2. Smart tourism app including the chatbot menu

2.3 The task-oriented smart tourism chatbot service

The task-oriented chatbot service can be applied to various task-oriented mobile app services such as creating my travel itinerary and making hotel and restaurant reservations. The task-oriented smart tourism chatbot system [13] uses the NER model to predict the domain, slot, and value of value of the DST model as the performance of the NER model is generally better than that of the DST model. Table 1 shows named entities for the tourism information NER model defined by the 4W1H method. Eight named entity dictionaries are defined based on Table 1 as follows: TOUR (tourist attractions), CAT (category), EXP

(experiential tourism), FLO (flower), HOW, LOC (location), WHEN, WHO. The tourism information NER model is created by transfer learning the KoBERT NER model using the tourism NER dataset created by BIO tagging tourism information and DST source data using named entity dictionaries. Smart tourism chatbot service will be possible by further developing the NER model that adds named entity dictionaries for travel planner service and tour guide service and the tourism knowledgebase of Neo4J graph DB.

Table 1. The tourism information named entity

4W1H	Tourism information named entity
Who	Travel commentator, Alone, Friend, Family, Child, Couple, Colleague, Pet(puppy, cat)
What	Dark tourism, Cultural tourism, Experiential tourism, Marine tourism, Wellness, etc.
When	Season(Spring, Summer, Autumn, Winter), Time(Weekdays, Weekends, Now, Morning, Noon, Evening, Day, Night), Duration(Festival, Flower, Open time), etc.
Where	Tourist attractions, Tourism Information Classification Category(Large, Medium, Small), Photo(Flowers, Sunrise/Sunset), Area(address), etc.
How	Climbing, Walking, Driving, Biking, Personal transportation, etc.

3. MRC-based Tourist information QA service

The MRC-based QA service is suitable as a task-oriented smart tourism chatbot service because it finds accurate answers from the context. In this paper, we propose the MRC-based tourism information QA service that uses the QA server and context to provide users with accurate answers as well as app menus for tourist information. The tourism information QA service is provided by the smart tourism chatbot system consisting of the NER server, DST server, Neo4J graph DB's tourism knowledgebase, and QA server as shown in Fig. 1. The tourism information QA model is developed by transfer learning the bigBird model using the tourism information QA dataset. To provide accurate answers to users' questions, we develop the additional named entity dictionary of the NER model and the context in the tourism knowledgebase. The Neo4J Graph DB's tourism knowledgebase includes context for extracting answers using the QA model. The quality of MRC-based QA service is determined by quality of the context. In this paper, we use not only the tourism information QA dataset but also data from the tourism information MySQL DB table of the smart tourism information system to create a high-quality context.

3.1 Tourism information QA service using NER, DST, and QA models

The smart tourism chatbot system of the smart tourism service platform consists of the NER server and the DST server. The NER server extracts named entities from user questions entered in the chatbot menu of the smart tourism app to identify the intent of the user's question based on the entity name dictionary defined by the 4W1H method. The DST model matches the named entities analyzed in the NER model with domain, slot, and value values and uses these to manage the dialogue state. For example, the NER server extracts the named entity of “Baeknokdam” defined in the tourist destination named entity dictionary to “Please tell me the height of Baeknokdam in Hallasan Mountain?”. The smart tourism information system provides users with mid-category Hallasan tourism information including “Baeknokdam” through the app menu. The smart tourism chatbot system does not provide users with an accurate answer to the “height of Baekrokdam,” so users must search and check it through the app screen. The tourist information QA service provides users with an accurate answer to the above question: “The height of Baekrokdam on Hallasan Mountain is 1,950m”.

In tourism information QA services, accurate answers to user questions can be provided in two ways. The first method is to add attribute data from the tourist destination MySQL DB table of the smart tourism information system to the named entity dictionary of the NER model. In this paper, we define the named

entity dictionary containing tourist attraction attribute data and service menus and perform transfer learning for the NER model with the additionally developed dataset. Table 2 shows the attribute data and service menu of the tourist destination MySQL DB table. For example, the NER server extracts the named entities of “address” and “weather” in addition to “Seongsan Ilchulbong” for “Please tell me the address and weather of Seongsan Ilchulbong”. For the named entity of "weather", weather information from the Korea Meteorological Administration is provided. As an example of a service provided by a smart tourism app, Naver Map's Navi service is provided to the question “Please tell me the navi route to Seongsan Ilchulbong.” The second method is the tourist information QA service, which finds the correct answer in the context and provides it to the user. For example, as in the example described above, the named entity of “Baeknokdam” is extracted from the NER server for “Please tell me the height of Baekrokdam in Hallasan?”. The QA server finds the correct answer of "1950m" in the Baekrokdam context searched from the tourism knowledgebase of Neo4J graph DB and provides it to the user.

Table 2. Attribute data of MySQL DB tourist information table

key value	attribute data
tourist destination code	Address, phone number, operating hours, entrance fee, travel time, travel distance, homepage, photos, introduction, storytelling content, classification code, GPS coordinates, phase relationship data, KML data, VR, YouTube, #tag information

3.2 Tourist information QA service procedure

The MRC-based tourism information QA service finds answers from the context and provides them to users. To provide high-quality tourism information QA services, context containing answers to user questions must be found in the tourism knowledgebase of Neo4J graph DB. Figure 3 shows the operation process of the proposed tourism information QA system.

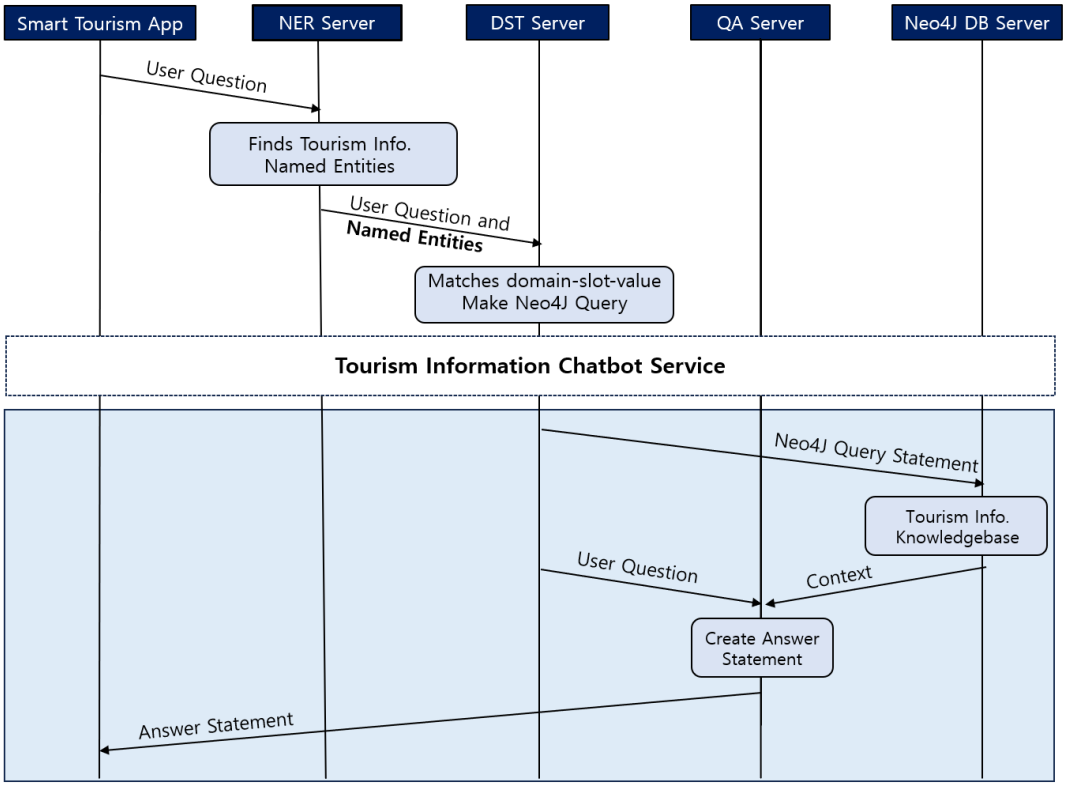


Figure 3. The procedure for providing the tourism information chatbot and QA service.

Users enter questions into the chatbot menu of the smart tourism app. The NER server of the smart tourism chatbot system extracts related named entities from the user's question to understand the intent of the user's question. The DST server matches the entity name analyzed by the NER server to predefined domains, slots, and values and manages the dialogue state. For example, if the user asks “Please tell me the height” after entering “Please tell me the information about Baekrokdam of Hallasan,” the DST server analyzes it as “the height Baekrokdam of Hallasan”. The Neo4J DB server searches the classification code and context from the tourism knowledgebase of the Neo4J graph DB using the DB query statement created in the DST server. Users can receive accurate answers found in the context as the tourism QA model from the smart tourism chatbot system. The smart tourism information system also provides the app menu of mid-category tourist information. The smart tourism service platform provides users with accurate answers and services as well as mid-category tourism information.

3.3 Tourism information QA model and context dataset

The length of the input sentence in the Transformer model is limited to 512 tokens because the time and space complexity of full attention used in the Transformer model is proportional to the square of the input sentence length. The BERT model, based on the Transformer model, processes long sentences by breaking them into 512 token units. The bigBird model used in the tourism information QA server can process long input sentences of 4,096 tokens by optimizing the computational problem to O(n) using block sparse attention. The tourism information QA dataset [14] for transfer learning the bigBird model is created in the JSON format of the KLUE MRC dataset. The tourism information QA dataset excluded tourism information added to the named entity dictionary of the NER model from the existing dataset. The tourism information QA dataset consists of more than 1,000 contexts and 10,000 questions. The performance of the KoBigBird model using the tourism information QA dataset, the EM and F1 scores were 96.85 and 98.84, respectively [14].

4. Conclusions and Further Study

Smart tourism services are being developed based on generative AI models such as ChatGPT, Bard (Gemini), and Llama. However, the task-oriented chatbot service is suitable for a smart tourism service that provides a travel planner service and tour guide service implemented as an expert system. In this paper, the tourism information QA service is proposed based on the smart tourism service platform for task-oriented chatbot service. The existing smart tourism service platform provides mid-category tourism information found in the smart tourism information system on the app menu screen according to the intention of the user's question analyzed by the NER and DST servers. Tourist information QA service is provided in two ways according to the results of analysis of the intent of user questions on the NER and DST servers as follows: (1) providing tourism information attribute data and services from the smart tourism information system, (2) providing answers found by QA model in the context searched from Neo4J DB's tourism knowledgebase. Users can check tourist information provided by the smart tourism service platform and save it as a place of interest to create their own travel itinerary. In the future, we plan to further develop the task-oriented chatbot system to provide smart tourism travel planner services and tour guide services as chatbot services.

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