Dialogue Platform for Interactive Personal Assistant Software

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Abstract. An interactive personal assistant software system can perform services desired by users through a natural language interface. In this paper, we propose an effective knowledge platform structure that considers expanded structural application domains of language understanding and dialogue management modules. These modules form the core technology of the interactive personal assistant software. For the proposed platform, analysis factors of user intention are systematically defined to understand language, effective dialogue management methods are included to compensate for analytic errors, and the structure of ontology knowledge is described to expand domain knowledge.

Keywords: dialogue engine, natural language processing, dialogue platform, dialogue manager

1. Introduction

Widespread use of smart mobile devices has led to an increase in the demand of a dialogue interface that comprehends user queries through natural language and provides corresponding services without requiring complicated usage procedures. However, the existing dialogue systems are used sparingly because they usually provide only low-level interaction through simple questions and answers or have a restricted structure that prevents the expansion of application domains[1][2].

In this paper, a dialogue platform that effectively manages dialogue and effortlessly maintains knowledge in various application domains is proposed. In Section 2, the overall structure of the dialogue platform and factors that form the platform (i.e., a language understanding model, a factor analysis model, domain knowledge, and a

dialogue transition model) are explained. Finally, in Section 7, conclusions and further research plans are presented.

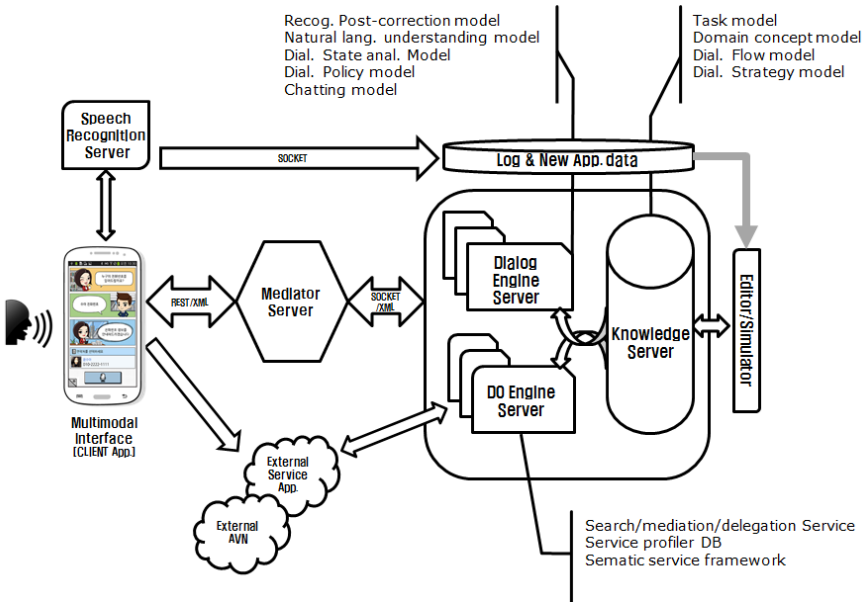

Fig. 1. Architecture of the platform for the personal assistant software

2. Dialogue platform for interactive personal assistant software

Fig. 1 illustrates the platform proposed in this paper. This platform mainly consists of a dialogue engine, do engine, and knowledge manager. The dialogue engine comprises a language understanding and dialogue management model. The language understanding model analyzes user intention from their speech. The do engine manages intelligent connection services, and the knowledge manager manages knowledge of a dialogue domain. This paper mainly examines the dialogue engine and knowledge manager and excludes the do engine.

2.1 User intention analysis factors and language understanding

To accurately analyze user intention through their respective speech in various application domains, the interactive personal assistant defines five analysis factors: domain, speech act, predicator, named entity, and argument.

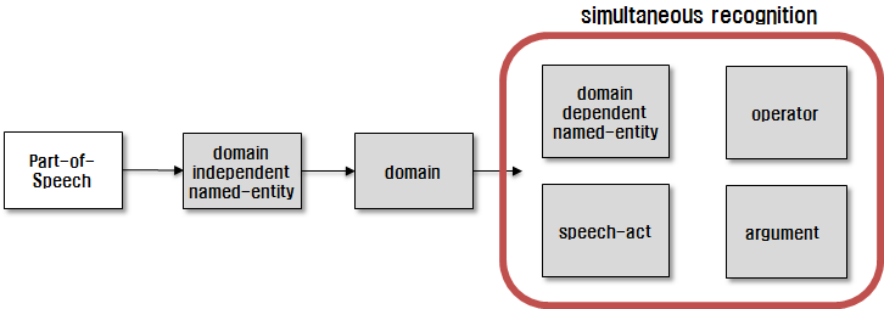

Fig. 2. Recognition process of language understanding

For language understanding, interrelated analysis factors were simultaneously analyzed to remove ambiguity. Moreover, conditional random fields, which are a part of the statistical machine learning method, were applied in the analysis model (Fig. 2).

2.2 Interaction model using state transition operations

The proposed platform defines actions to be performed by the system in response to user speech as state transition operations using finite-state automata-based dialogue model and determines the next operation by applying a statistical model (Table 1).

Table 1. State transition operations

State transition operation	Description
new_task	Beginning of a new task, creation of a state
state_changing	Factor input, adjustment of a state form
task_switching	Task switch
task_cancel	Discontinuance of dialogue, termination of a state

task_ complete	Completion of a state form
state_unknown	Failure of analysis
Exception	Exception

To estimate the state transition operations not affected by voice recognition errors, these operations are performed on each result of N-best voice recognition. Subsequently, a state transition operation (O) that statistically has the highest probability is selected. At this time, information such as results of the language understanding model (I), results of morpheme analysis (M), and dialogue status (S), is used to measure the probability, as shown in Equation (1).

$$O' = \underset{O}{\operatorname{argmax}}\, P(O, I, M, S) \qquad (1)$$

2.3 Representation of domain knowledge using ontology

A knowledge representation method based on ontology is typically used to model a lexical relation within a specific domain. It is also used to represent knowledge inside any system in a single structure [3].

In this study, ontology is used to represent domain knowledge that consists of domain actions and factor information required to perform each domain action. The proposed method adds a pertinent concept when a new domain or domain action is added and establishes its relation with the existing concept, thus facilitating effective domain expansion.

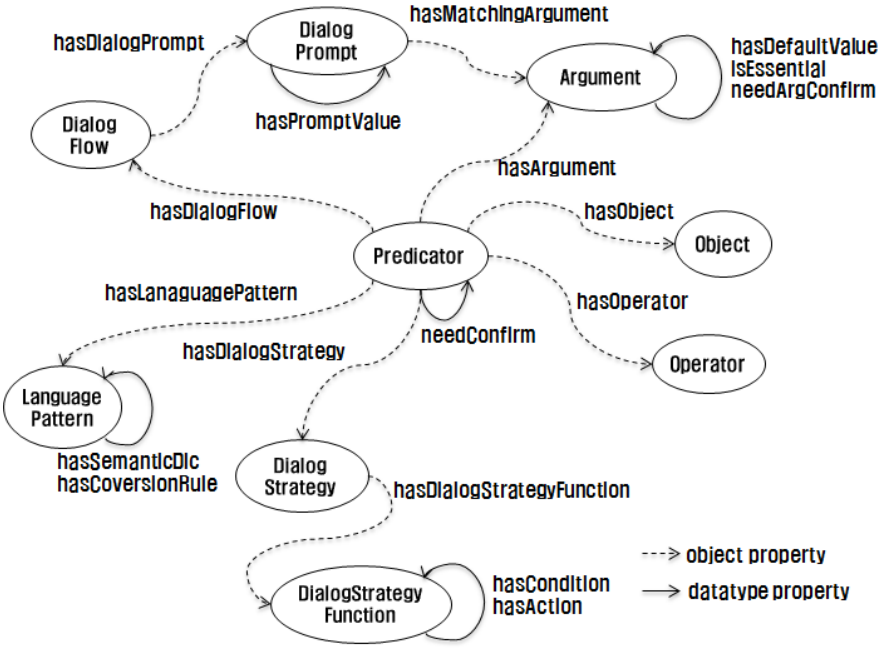

Fig. 3. Example of an ontology schema for domain knowledge

Fig. 3 shows an example representing domain knowledge using ontology. The properties *has_argument* and *has_predicator* are inversely related to each other. The domain knowledge was modeled using OWL, a W3C standard.

3. Conclusion

In this paper, a dialogue platform for interactive personal assistant software was proposed. The proposed model can effectively expand domain knowledge using ontology and process dialogues without being strongly affected by voice recognition errors.

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