

CulturalHeritageAR: An Ontology-based Outdoor AR Application for Cultural Heritage Sites

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ABSTRACT

In this paper we present a new and interesting application to enhance the experience of visitors to cultural heritage sites. The CulturalHeritageAR is an augmented reality (AR) application that offers contextual information on POIs based on cultural heritage ontology. By selecting themes and relationships, users of the application can browse not only information on the POI, but also information related to the POI including object, event, actor, place, and time.

Author Keywords

Outdoor Augmented reality; cultural heritage site; ontology; mobile application;

ACM Classification Keywords

H.5.1. Information Interfaces and Presentation: Multimedia Information Systems - Artificial, augmented, and virtual realities

INTRODUCTION

We proposed an application developed as an outdoor AR information browser application for offering contextual information related to the cultural heritage sites. Contextual information of a cultural heritage site includes how the site was related to people who lived there, what events took place, and what the artifacts were used for. The application was designed to collect heterogeneous data from different cultural heritage databases and provide contextual information including five themes based on relationships between them by an ontological approach. By facilitating the browsing of information through the Semantic Web (SW) technology, the application can help users to understand and interpret a cultural heritage site in abundant contexts. In addition, augmented reality based visualization and interaction support users in recognizing and interacting with POIs in the site.

SYSTEM DESIGN

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Figure 1 shows the schematic architecture of the overall system. The figure highlights the steps of the process of providing contextual information; this process consists of cultural heritage knowledge creation, semantic querying, real-time data loading, and AR visualization.

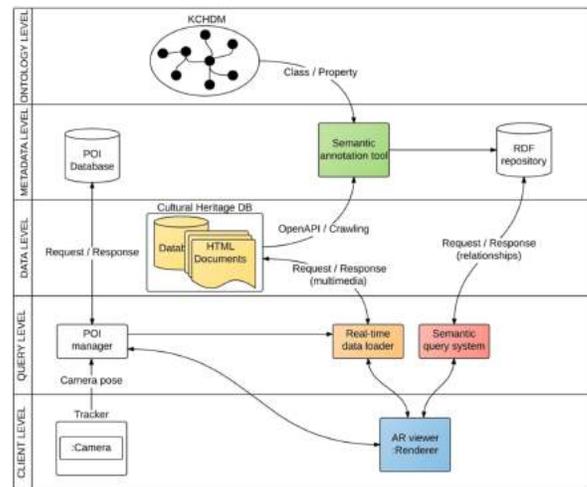


Figure 1. System structure of CulturalHeritageAR

Cultural Heritage Ontology

We proposed the Korea Cultural Heritage Data Model (KCHDM) in the previous work [1] as an ontology for aggregating cultural heritage information from various Korean heritage institutions. KCHDM suggests to use data extracted from a description as instances and properties through an analysis of Korean sentence pattern. KCHDM is composed of five super classes: actor, event, thing, time-span and place along with eighty-four properties that connect classes. We adopted KCHDM to collect and provide contextual information that includes object, event, actor, place and time information related to the cultural heritage sites. Our aim was to allow people to browse the contextual information of a site through relations between cultural heritages items based on the classes and properties of KCHDM.

To collect the content available for use in the application, we found five different web databases delivering everything from simple facts about the artifacts and actors to historic events that took place at heritage sites; The sources consulted were the Cultural Heritage Administration of Korea, the Museum Portal of Korea, the Encyclopedia of Korean Culture, the National Palace Museum of Korea and other sources of Culture

Content. In order to provide various content about the cultural heritage, we decided to use resources from these web databases.

Cultural Heritage Knowledge Base

To improve the semantic data of cultural heritage, more precise and richer metadata is needed. Semantic information for knowledge generation is found mostly in text sources, the descriptive parts of data. The semantic annotation tool facilitates knowledge extraction from the text description. Through syntactic analyses of the text descriptions parsed from cultural heritage databases, the semantic annotation tool recommends instances corresponding to and relationships among the classes and properties of KCHDM. An expert in cultural heritage can formulate ontology semi-automatically by choosing certain pieces of information among recommended instances and relationships. This knowledge is exported in RDF/OWL format and saved in the RDF repository.

Augmented Reality Module

To make each set of local reference coordinates, we registered the images of the POIs as a marker in advance. Uniform Resource Identifiers (URI) of the POIs were registered at each virtual finger icon that represents a POI; these URIs function as a trigger for data loading. Although computer vision technology is not discussed in this paper, we plan to integrate a developed novel module to the next prototype for tracking heritage buildings and artifacts.

Semantic Query Module

In order to retrieve contextualized information from the Korean cultural heritage knowledge base, semantic data processing was required. An arbitrary POI can be queried against any knowledge base that satisfies the requirements of the KCHDM ontology. During the concrete running of a use case, the given real-world POI can be assigned to a resource included in our knowledge base which is stored in N3 format. In the data acquisition phase, predefined attributes (for instance, descriptions, and URLs of audio and image files) were collected and displayed in the GUI. In addition, when the user wants to obtain further information, the corresponding POIs can be queried by running predefined parameterized SPARQL queries.

User Interface

Using the application, users go through five phases; (1) AR view, (2) Detailed content view of the POI, (3) List view, (4) Preview, and (5) Detailed content view of the related cultural heritage item. In the fifth phase, the user can repeat the process from phase 3 if there are other cultural heritage items related to the item described in the fifth phase.

1) AR view: The application starts in the AR view. When user reaches a POI, it will be shown as a finger icon floating in the real world (Figure 2a).

2) Detailed content view of the POI: When the user chooses a POI using AR view, the detailed content view appears on the screen with a semi-transparent background overlaid on a live video camera view. There are four types of content shown in

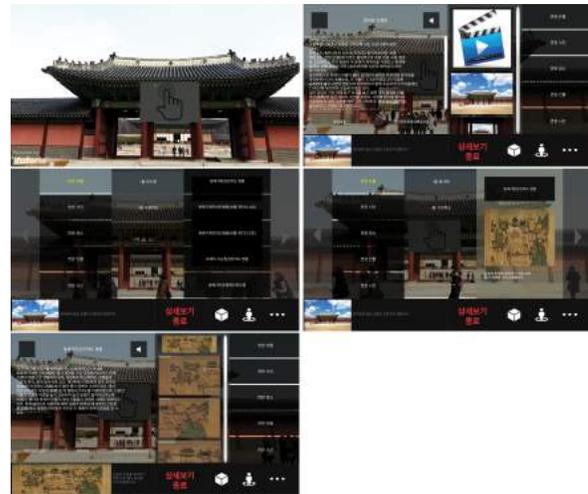


Figure 2. Views for different phases: (a) AR view, (b) Detailed content view of the POI, (c) List view, (d) Preview, and (e) Detailed content view of related items of cultural heritage (from left to right)

the application: text description, audios, images, and videos. The detail content view describes the POI with a few pages of text and thumbnail images (Figure 2b). The user can tab on the reference website names to see other text pages. Tapping on an icon and a thumbnail image allows the user to hear and see the linked audio, pictures, and videos.

3) List view: The list view shows the items of cultural heritages related to the POI as a list filtered by theme (class) and relationship (property) selections (Figure 2c). There are five themes that the user can choose: related object, related event, related actor, related place, and related time. When the user chooses a theme and a relationship, the list of related items of cultural heritages appears on the screen. For instance, tapping on the related object theme causes the list of relationships between the POI and other instances of the object class to appear. When the user chooses the relationship depicted by, the names of objects that depicts the POI appears on the lists.

4) Preview: When the user chooses a related item of cultural heritage, the preview appears on the screen, describing the item of cultural heritage with several short sentences of text and a representative thumbnail image (Figure 2d).

5) Detailed content view of related items of cultural heritage: When the user taps on an arrow icon beside the preview box, the detailed content view appears, describing the items of cultural heritage related to the POI (Figure 2e).

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