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A Smart Space-Based Design of Semantic Layer for Advancing Museum Information Services

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The History Museum of PetrSU

- It has the museum information system (MIS).
- Exhibits are presented as photographs and various textual documents, newspapers, academic journals, etc.
- It is oriented to everyday life history.
- Virtual exposition is presented on eight touch-screens.
The layer aims at solving the following application problems:

1. adding text and voice semantic annotation about the exhibits by the visitors and museums personnel collectively;
2. semantic information linking of annotations about the exhibits in the museum collection;
3. personalized search for information about the exhibits based on user requests taking into account the context;
4. automatic generation of a virtual exposition based personalized context information.
Smart Museum Environment

- The layer becomes responsible for construction and delivery of semantic services:
  - visit service;
  - exhibition service;
  - semantic enrichment service.

- Smart museum space follows an ontology and is represented using RDF.

- The semantic network is a directed graph consisting of nodes, which represent exhibits, events, persons, etc.
Software Infrastructure

- Software infrastructure implements the semantic layer as the multi-agent service-oriented information system.
- Software infrastructure is based on Smart-M3 platform.
- It consists of the semantic information broker (SIB) and knowledge processors (KP).
## Classes of IoT-enabled devices

<table>
<thead>
<tr>
<th>Class of devices</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public multimedia devices</td>
<td>They include interactive screens, media projectors, and microphones. The devices are primarily for service consumption by visualization.</td>
</tr>
<tr>
<td>Personal mobile devices</td>
<td>They include smartphones, tablets, and laptops. The devices can be used for personalized service delivery and participation in the activity.</td>
</tr>
<tr>
<td>Server machines</td>
<td>They are responsible for data storage and processing functions. Typically the devices are non-local, e.g., a server is in the corporate network or in the Internet.</td>
</tr>
<tr>
<td>Local computers</td>
<td>They are responsible for service construction based on search and analysis of shared content in the semantic network. Typically, they are physically present in the room.</td>
</tr>
<tr>
<td>Smart IoT devices</td>
<td>They represent physical things augmenting them with processing and communication capabilities, e.g., a exhibit is equipped with RFID to provide description for close devices.</td>
</tr>
<tr>
<td>Network communication devices</td>
<td>They create local area networks such that all other participating devices can communicate locally as well as have access to external resources.</td>
</tr>
</tbody>
</table>
Visit service

The service is responsible for construction of a visit program and for visualization of this program on the main screen.

Visit maintenance KP

Semantic Information Broker (SIB)

RDF triplestore (semantic network)

Visit program KP

Main screen

$\nu$

program delivery $\tau$

control actions $\pi$

visit program and recommendations $\mathcal{S}$

recommendations $\mathcal{S}$

information about visitors and exhibits $\{x_{per}, x_{exh}\}$

$\mathcal{S}$ activation $\mathcal{S}$

Andrey Vdovenko
Exhibition service

The service performs selection of exhibits from the created visit program for formation of virtual exhibitions on a series of screens.
Semantic Enrichment Service

The result of the service is enrichment of museum information model.
Ontology for Visit Program

- **Class Visit Program** stores a title, description, time stamp, and exposition structure.

- Property *firstExhibitSlot* is used to arrange the exposition structure.

- **Class Relation** provides linking capabilities of exhibits.

- Data property *RelationType* expresses relation between other exhibits and persons.
Ontology for Visitor Profile

- Class *Person* represents a visitor following the FOAF specification.
- Linking a person to profile provides search function for making recommendations.
- User context is the important point for semantic search.
- The user has preferences in the terms of interesting exhibits for her/him.
Notification Model

- Based on publish/subscribe model.
- Simplifying interaction between agents.
- Activity individual variant solves the task for notification of a concrete user about updates in her/his exhibits.

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<th>Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>KP Semantic Analysis</td>
<td>Carrying out additional analysis to discover new relations with appearance of new Exhibit.</td>
</tr>
<tr>
<td>newExhibit</td>
<td>Carrying out additional analysis to discover new relations with appearance of new ExhibitReview.</td>
</tr>
<tr>
<td>Exhibit</td>
<td>Screen content changing accordingly with parameter screenMode.</td>
</tr>
<tr>
<td>changeScreenMode</td>
<td>Changing current slide on screen.</td>
</tr>
<tr>
<td>slideUrl</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

- Studied the semantic layer represents the opportunities for constructing services that enhance the existing MIS.
- Developed design of the semantic layer implements the latter as a Smart-M3-based software infrastructure.
- The proposed solutions were analyzed in respect to the case study of the History Museum of PetrSU.
- The proposed solutions can serve as reference ones for development of other museums and cultural heritage areas.

Thank you for attention

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