Enhancing the SmartRoom System with e-Tourism Services

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Abstract—The SmartRoom system is a Smart-M3 based open source service-oriented application for assisting such collaboration activity as conference or meeting in a room equipped with computing and presentational devices and Internet access. In this paper, we consider advanced scenarios for SmartRoom when the latter is enhanced with e-Tourism services. We develop a smart space based architecture for this enhancement. We provide an ontology for representing and sharing the tourism-related information for service construction. Based on the architecture and ontology, several services are designed for the case study. We implement a service for collaborative construction of social program for conference participants. Service integration into the SmartRoom system demonstrates the feasibility of the proposed design.

I. INTRODUCTION

The SmartRoom system provides a set of digital information services for assisting such collaboration activity as conferences or meetings [1], [2]. Personal mobile devices are primary access and control points for users to participate in collaboration activity. The core services aim at support for intensive in-room collaboration using surrounding devices for hosting the system.

The development is based on Smart-M3 platform [3]. It provides means for creating and deploying a smart space in given computing environment. The smart space forms an environment for heterogeneous devices and programmable software agents to share their resources and services. A semantic information broker (SIB) maintains a smart space, representing its informational content in RDF triples, thus applying technologies from the Semantic Web. A smart space application consists of knowledge processors (KPs) that share information and form the smart space, using the known interaction models: blackboard and publish/subscribe.

The SmartRoom system creates a domain-specific knowledge sharing environment. The system consists of software agents (KPs) that construct and deliver services in a shared smart space—SmartRoom space. It makes localization and relation of information in regard to spatial area of the room and to information sources of participants.

In this paper, we propose advanced e-Tourism scenarios for use in SmartRoom collaborative activity. We develop a smart space based architecture for this enhancement. We provide an ontology for representing and sharing the tourism-related information for service construction. Based on the architecture and ontology, several services are designed for the case study. We implement a service for collaborative construction of social program for conference participants. Integration of this service into the SmartRoom system demonstrates the feasibility of the proposed design.

The rest of the paper is organized as follows. Section II introduces possible scenarios for enhancing SmartRoom with e-Tourism services. Section III describes our architecture for integration e-Tourism services into the SmartRoom service pool. Section IV presents our ontology that extends the existing SmartRoom ontology. Section V consists of design solutions for the selected services. Section VI provides implementation details for the social program service. Section VII concludes the paper.

II. E-TOURISM SCENARIOS FOR SMARTROOM

The core SmartRoom services are Presentation-service and Agenda-service: they are responsible for information visualization on Presentation and Agenda screen, respectively. Content-service keeps multimedia content which is used in activity and provides the content to other SmartRoom components on request.

Other local services provide specific pieces of information and assistance for spectators. For instance, Conference-service constructs and dynamically maintains the activity program when the activity is a conference. Similar services are for other activity types (e.g., Social program service), since properties of activity program (list of tours, social program) differ.

Each spectator can become a SmartRoom user via her SmartRoom client, which is a software agent running on her personal mobile device [4], [5]. On behalf of its user the client interacts with services.
SmartRoom has a multimodal interface. Its basic UI elements are public screens and personal mobile devices. Computational part is delegated to local services, which access external services from the Internet if globally available information is required.

Let us consider e-Tourism services and their use for expansion of the SmartRoom service set. The services are summarized in Table I and include Social Program service, Search service and WebPage service. Integration of e-Tourism services enhances the core functionality of the SmartRoom system, introducing a new view what kind of assistance can be implemented for collaboration activity. Let us consider the following scenarios for use of e-Tourism services in SmartRoom.

**Planning social program during the conference:** In this scenario we consider SmartRoom system for collaboration activity as conference. This scenario provides each SmartRoom participant with information about POIs of social program. The organizers can also provide predefined POIs themselves. Each participant can make decisions on her plans related to the social activity of conference: which places are of her interests as well as time of possible visit. The process is iterative: a participant updates her decision depending on observable decisions from others. Participants use their clients to browse Points of Interest (POIs). Based on the collected decisions the organizers finalize the social program construction. The result is (1) which groups to which places have been formed, (2) timetable, and (3) transfer support.

In addition to core services of SmartRoom system for this scenario Social Program service, Search service, WebPage service are used. The scenario is used inside SmartRoom. The proposed places and construction result of social program are provided on public screens in the room and on mobile devices at the end of conference. Using their mobile devices participants can also vote for the places of social program during the conference.

**Using e-Tourism services in tourist center:** This scenario provides tourist center officers services to managing tours and to recommend a suitable travel schedule that satisfies participant interests. In this scenario we consider SmartRoom system in tourist center for collaboration activity as tourism. Tourist center officers provide predefined tours for participants. Each tour can contain information about POIs, tourist events, schedule a visit, weather data, transport, accommodation, and other useful information. Most of this information is extracted automated manner from the external web services. Each participant can make decisions on her plans related to the tour: which information satisfies the interests of the participants. Based on the collected participant’s decisions and interests the tourist center officers can to propose recommendations for visit of the tour. The basic result is (1) groups tours, and (2) travel schedule.

For this scenario Social Program service, Search service, WebPage service are used. Presentation service and Agenda service are responsible for tours information visualization on the public screens. The scenario is used inside SmartRoom in tourist center. Participants use e-Tourism services in tourist center via their mobile devices.

These scenarios assume semantic relation of heterogeneous multi-source information. For instance, in addition to photos and description, historical information can be associated with POIs/tours.

Human participants become SmartRoom users. The scenarios for using e-Tourism services can be extended by utilization of runtime information on user presence in the room, including physical and virtual presence. This information is associated with network activity of personal mobile devices. The scenarios are based on the user presence detection in SmartRoom system were presented in [6], [7], [8]. Let us consider these scenarios with use e-Tourism services.

First is user arrival to the room. Before starting the collaboration activity activity, the users arrive and gather in the room (first-time join) and preparing/waiting the forthcoming activity. Detection of user arrivals activates personalized welcome services, e-Tourism services and provides runtime initialization for starting the collaboration activity. For example, everyone can see who is ready to start collaboration activity. In additional, newcomers participants can offer to install the SmartRoom client.

Second is user joins and leaves during the main activity. Real-time status of every user provides important information for the activity agenda. For example, the system moves or cancels a planned presentation if its speaker is absent, or excludes from the group to visit social program or tour.

Third is activity statistics. During the collaboration activity, personalized information about network activity is accumulated. At the end of the collaboration activity a report is generated, which contains the overall network activity, that each user has contributed to the activity. By analysing users network activity at a certain time can be make conclusions about existence of common interests.

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Program</td>
<td>Gives control functions and provides the capability for constructing the social program based on the possible places and tours to visit and the decisions of the participants.</td>
</tr>
<tr>
<td>Search</td>
<td>Finds information about the possible places and tours to visit using external resources, (e.g. photos).</td>
</tr>
<tr>
<td>Web Page</td>
<td>Generates web pages based on templates with use of recent web technology, shares required information in the SmartRoom space.</td>
</tr>
</tbody>
</table>

**TABLE I. **SmartRoom e-Tourism Services
III. SYSTEM ARCHITECTURE

Each e-Tourism service is constructed by one or several KPs. They interact by sharing information in the RDF format and by REST query. The following architecture is proposed for the above e-Tourism scenarios in SmartRoom, see Fig. 1. All services share information in the SmartRoom space.

The Social program service provides each SmartRoom participant with information about possible places of social program. The corresponding KP runs on a dedicated local computer. It runs on organizer’s computer and provides the graphical interface for browsing place information, watching others votes and result social program. This KP interacts with the Search service and Web Page services.

The Search service implements search and extraction of photos and description about POIs. Can also search other tourist information. The corresponding KP runs on a server. POIs is shared in the SmartRoom space by Social program service. This KP extracts the location of the POIs and searches pictures in a certain area around the POI. The search result is shared in the SmartRoom space.

The Web Page service provides access to web content of other SmartRoom services. The corresponding KP runs on a server. This KP provides web pages for Presentation service, Agenda service and SmartRoom client through REST query with parameters and sharing them URL in the SmartRoom space.

Initially, Presentation service and Agenda services were intended for collaboration activity as conferences. In the mode for e-Tourism scenarios these services can visualize the desired tourist information by displaying the desired web pages. Presentation service displays the information of POIs and voting process. Agenda service displays the result of social program.

IV. ONTOLOGICAL REPRESENTATION OF TOURISM-RELATED INFORMATION

Basis on the proposed scenarios and architecture found it necessary to develop an ontology used for e-Tourism scenarios in SmartRoom. In the SmartRoom system the ontology defines how the data related to different services and users is represented. The SmartRoom ontology consists of two parts: service ontology and user profile ontology. Described ontology use combination of service and profile ontologies.

In Fig. 2 you can see part of ontology for Social Program service. This entity comes as part of SmartRoom services pool and have ontology representation. Main unique property for Social Program service are hasClientIdUrl, hasAgendaServiceUrl, hasPresentationServiceUrl. This properties used for accessing user interface which presented as web application. Values of properties posted by Web Page service.

When organizers add new program in SmartRoom Space published new individual of SocialProgram class and setted connection with service individual. In this case also set the following properties: socialProgramTitle, socialProgramLatitudeCoordinate, socialProgramLongitudeCoordinate. Two last properties used for automated search of POIs. Current program, that used for conference mode, matched SocialProgram individual use ideas of Section individual from another works [1], [9] about SmartRoom services in conference mode.

SocialProgram individual not use direct relation with Place individual and there is intermediate individual Placeslot. This is done to add the necessary properties that do not
Fig. 3. Ontology of service’s individuals

Involvement of disagreement with representation entity of \textit{Place}. \textit{SocialProgramPresentPlaceSlot} is connecting property between \textit{SocialProgram} and \textit{PlaceSlot} individuals.

In Fig. 3 presented another part of ontology with \textit{PlaceSlot}, \textit{Place}, \textit{Photo} individuals. \textit{PlaceSlot} individual have object property \textit{placeslotPresentPlace} with \textit{Place} individual. Also this individual have object properties \textit{placeslotPlusRate}, \textit{placeslotMinusRate} with Person individual, that produced during the vote. When new vote starts this properties cleaned.

\textit{Place} and \textit{Photo} individuals are from common area with other system. In our scenarios POIs can be searched automatically, and in this case \textit{Place} and \textit{Photo} individuals can be chosen from presented in SmartRoom Space. Existing individuals can also be supplemented with new information, including additional media information.

V. SERVICE DESIGN

A. Social Program service

Social Program service is agent that gives control for organizers and provide program constructing logic.

As the control functions can be considered ability to create a cultural program, adding new POIs, specifying the basic information, perform a search of media content. In the future there will be ability to search POIs and all their information. Organizers can see all information about current user decisions. They also can observe all media content that presented to participants.

For more usability organizers can save prepared program in file and when it necessary load program. In that case all added POIs also will be restored.

Constructing logic consist from getting notifications from other services, it can be notifications from Search services or from Web Page services and handle related actions.

Voting mechanism brings actual information to organizers based on actual content of SmartRoom Space. When some participants make decision about POIs, Web Page service send responsible notification to Social Program service, which in turn, processing this notification and provide new information in interface.

After notification processing, Social Program service forming new JSON object and send it to Web Page service. This object used as content for building participants web interface.

Ontology provides semantic relations between the participants and POIs. For instance, historical information can be associated with POI. Relation of a given POI and participant’s region can be identified, e.g., the architect of the building was from certain country. This type of relations is realized in a localized manner, in the SmartRoom space.

For now this relations presented in link between POI and Person individual. In future improvement, this relations will present for what principle POIs and Person connecting.

When service used in tourist centre, there is many programs with different POIs. Service provide JSON object with all programs and processing decisions of clients.

B. Search service

Many people share the media content related to their tourist trips and the places they visited. Also, local residents share content with information POI and tourist information: description POIs and tourist events, schedule a visit, weather data and transport, accommodation and other useful information. Search service finds this information using external web services.

For e-Tourism scenarios Search service implements search and extraction of photos and description about POIs. Descriptive information is extracted from different Internet sources taking into account location. There are huge collections of photos and other pictures collected at image hosting web services such as Flickr and Panoramio. Many people share the media content related to their tourist trips and the places they visited.

C. Web Page service

Web Page service follows ideas that was presented in our previous work dedicated to service’s delivery [10]. This service provide access to web content of other SmartRoom services. Every service’s page presented as template, which
construction are dynamical and depends from information that passed to this.

Every services which can be accessed through Web Page service have templates for its presentation. Basically, template use HTML and JavaScript. In advance, template can use CSS styles for more attractive view.

Main idea in that there are global JSON objects, which presents information of service. This objects used for constructing graphical user interface through JavaScript and as parameters in transition to next page.

In our previous work we developed active control of notification losses [11].

In Fig. 4 presented notification individual of dynamic services for clients. This notification provide ability to calculate count of losses for each client. Count of notification controlled and stored by Web Page service for each service that presented by it.

D. Interaction between agents

Notification model: The notification model introduced in [12]. KP subscribes on its own notification type (a special set of RDF triples kept in the smart space). Our notification model is presented in Table II.

Activity individual: An example of an activity individual for the interaction between Social program service and Search service represented in Fig. 5. The interaction is performed in the following steps.

1) Search service subscribes on SearchActivity class.
2) Social program service publishes the SearchActivity individual in SmartRoom space.
3) Social program service subscribes on this individual stopSearch property.
4) Search service gets SearchActivity individual by subscription and extracts search type and parameters.
5) Search service performs a search and publish result in the SmartRoom space.
6) Search service sets search status in stopSearch property.
7) Social program service gets search status from stopSearch property value and removes the SearchActivity individual from SmartRoom space.

REST query: For interaction with Web Page service we use idea that this service have minimum information about stored services. In this case subscription mechanism is not suitable, because service must have additional knowledge about individuals. Web Page service acts as a mediator between SmartSpaces and web application on client side. On this basis we supposed interaction through REST query with parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent</td>
<td>Web Page</td>
</tr>
<tr>
<td>Notification</td>
<td>startUpdateServicePage</td>
</tr>
<tr>
<td>Parameter</td>
<td>Service</td>
</tr>
<tr>
<td>Agent</td>
<td>Social Program</td>
</tr>
<tr>
<td>Notification</td>
<td>voteUpdate</td>
</tr>
<tr>
<td>Parameter</td>
<td>Place</td>
</tr>
<tr>
<td>Agent</td>
<td>Client</td>
</tr>
<tr>
<td>Notification</td>
<td>updateServiceInformation</td>
</tr>
<tr>
<td>Parameter</td>
<td>DSNotificationParameter</td>
</tr>
</tbody>
</table>

Fig. 5. Search Activity individual
For example, when participant vote, web application sends POST request on special URL, responded for special actions, with parameters Placeslot UUID, Person UUID and vote value.

Another example is how Social Program service interacts with Web Page service. On Social Program service side organized subscription on VoteUpdate notification. When notification received by Social Program service, starts process of forming new JSON object, see Listing 1. This object follow structure of ontology with Social Program as root element. Every property of individuals are represented in this object.

After the formation of the object, it should be sent to the Web Page service by unique url as POST request. Web Page service receives this request and replaces current instance with new JSON object. New instance used for background updates with by AJAX calls and for building page in template engine of Web Page service.

Use of this kind of interaction gives good ability for building new services on basis of Web Page service. With modification Web Page service can store new services in dynamic way.

Listing 1. Example of JSON object of Social Program service
```json
{"SocialProgram": {
    "Uuid": ...,
    "Title": "Test Program for Petrozavodsk",
    "Latitude": "61.784",
    "Longitude": "34.349",
    "Placeslots": [
        {
            "UUID": ...,
            "MinusRating": [{"Person": {...},...}],
            "PlusRating": [{"Person": {...},...}],
            "Place": {
                "Uuid": ...,
                "Description": "test",
                "Latitude": "61.756",
                "Longitude": "34.437",
                "Photos": [
                    {
                        "Uuid": ...,
                        "Description": "test",
                        "Latitude": "61.763",
                        "Longitude": "34.419",
                        "Title": ...,
                        "Url": ...,
                        "UrlMedium": ...,
                        "UrlThumb": ...
                    }
                ]
            }
        },
        ...
    ]
}}
```

VI. CASE STUDY IMPLEMENTATION: SOCIAL PROGRAM FOR CONFERENCE

Social Program service is written with use of C# language and .Net Framework. For graphical user interface used Windows Presentation Foundation (WPF). For interaction with Smart Spaces is used SmartSlog SDK.
Structure of agent is quite simple. There is KP (Knowledge Processor) module, which response for work with SmartRoom Space.

Every individual of ontology represented in appropriate class with same properties, which is called model in C#. This model used in building graphical user interface and for constructing JSON object for Web Page service. Another module is class that join in itself model and different KP functions. This module used in code behind for graphical user interface for processing different functionality. Graphical user interface divided in standalone controls, it is helpful for next re-usage.

In Fig. 6 presented Social Program service interface for clients. First three show detail page of POI, there are control for slide show of photos, showing notification on event of voting and collapsible list view with main data like description and how&who voted. On last screenshot introduced full list of all POIs and total rating for each of them.

In Fig. 7 shows examples of screens for agenda and presentation services.

The Search service is written in .NET Framework using Visual C#. For conversion web services responses in the data structure of Search service the serialization mechanism is used.

Search service uses the architecture of WorldAroundMe search logic [13]. This architecture consist from Core and Drivers and provides the extensibility in adding new web services and functionality. The Core redirects search requests from e-Tourism services to appropriate drivers. They forward request to associated services and receive result of search, e.g., links to images.

For Planning social program during the conference scenario Search service finds photos and description for the POIs based on their location. Location of POIs is shared in the SmartRoom space. Social program service and Search service interact using a subscription through SearchActivity individual, which contains the search parameters (e.g., location of POI, type of search, and other). Search service extracts the search parameters and depending on the type of search uses appropriate driver to access the web services (e.g., for type of search photo it is Flickr and Panoramio). Search service share the result of search in the he SmartRoom space; this result becomes available to other services.

Service is written on Python language. CherryPy\(^2\) used as web engine and Mako\(^3\) as template engine. Structure of service splitted on three main parts. One of them, request dispatcher is implemented with CherryPy. This dispatcher redirects to appropriate module and invoke actions based on requested URL. Another one, KP module is written with use of Python KPI. KP provide SmartSpace interaction for web users. And the last, templates is written with use of HTML, JavaScript and CSS. Additionally, were used jQuery\(^4\) and jQuery Mobile\(^5\) to simplify the development process. This templates present to user information and give ability to perform actions.

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\(^2\)www.cherrypy.org - CherryPy official site
\(^3\)www.makotemplates.org - Mako official site
\(^4\)http://jquery.com/ - jQuery official site
\(^5\)http://jquerymobile.com/ - jQuery Mobile official site
When Web Page service detects services, that presented in its memory, starts process, that maintains this service’s pages and publish its url for accessing by other agents. For updating global objects used periodic AJAX calls to service on particular url, which used for this kind of interaction.

VII. Conclusion

This paper continued our study on methods for creating collaborative work environments. Our approach employs the SmartRoom system to implement within this base system various services from different domains. We showed that such an application domain as tourism can be used for enhancing the SmartRoom service pool. The implemented service for social program, constructed collaboratively by conference participant, demonstrates the feasibility of our generic approach.

REFERENCES


