Semantic Web Technologies for improving remote visits of museums, using a mobile robot

Michel Buffa, Catherine Faron Zucker, Thierry Bergeron, Hatim Aouzal

Semantic Web Technologies for improving remote visits of museums, using a mobile robot

Michel Buffa, Catherine Faron Zucker, Thierry Bergeron, and Hatim Aouzal

Université Côte d'Azur, CNRS, INRIA, I3S, France

Abstract. The Azkar research project focuses on the remote control of a mobile robot using the emerging Web technologies WebRTC for real time communication. One of the use cases addressed is a remote visit of the French Museum of the Great War in Meaux. For this purpose, we designed an ontology for describing the main scenes in the museum, the objects that compose them, the different trails the robot can follow in a given time period, for a targeted audience, the way points, observation points. This RDF dataset is exploited to assist the human guide in designing a trail, and possibly adapting it during the visit. In this paper we present the Azkar Museum Ontology, the RDF dataset describing some emblematic scenes of the museum, and an experiment that took place in June 2016 with a robot controlled by an operator located 800 kms from the museum. We propose to demonstrate this work during the conference by organizing a remote visit from the conference demo location.

1 Introduction

In this paper we present a work started in 2015 in the context of the Azkar project[1], funded by the French Public Investment Bank, that focuses on the remote control of a mobile robot using the emerging Web technologies WebRTC for real time communication. One of the use cases addressed in this project is the tele-robotic exploration of museums for primary and secondary schools and we report on our work enabling a remote visit of the French Museum of the Great War[2].

The research question we address is "How can we assist a teacher planning a guided tour of a museum for her class and how can we assist her during the visit itself?" Our contribution lies in the joint use of (1) a mobile robot equipped with cameras and sensors, (2) the emergent W3C standard WebRTC for real time communication, and (3) an RDF dataset and the Linked Data to represent museum data and related resources.

In the experiment conducted with the Museum of the Great War in 2016, a human remotely controls the mobile robot in the museum, and plays the role of guide for children in school, using high-level tools to help him in this task, for designing the visit, for selecting locations and orientations of the robot in

[1] http://azkar.fr

[2] http://www.museedelagrandeguerre.eu/en

Fig. 1. The Kompaï remotely controlled mobile robot in front of two emblematic scenes of the Museum of the Great War in Meaux, France: soldiers in uniform and a French trench.

front of some scenes, for proposing linked multimedia resources, etc. These tools rely on the exploitation of semantic descriptions of the scenes, of the objects in the scenes, of possible locations/orientations for observing a scene, and more generally, of topology constraints (distances, time to go from one location to another, on board camera field of view, etc.). We designed the Azkar Museum Ontology (AMO) and created an RDF dataset. During the planning of the visit, this dataset is queried in combination with the Web of Data to retrieve relevant multimedia resources to propose to the visitors, and during the visit, requests are triggered in certain situations (geo-localization, time elapsed) in order to take or suggest decisions (display this video, go to the next location).

This paper is organized as follows. Section 2 summarizes related works. Section 3 presents the AMO ontology and the dataset we constructed for the Museum of the Great War. Section 4 concludes.

2 Related works

The number of robots that have been deployed in museums and exhibitions has grown steadily (see [1] for a survey), most of them acting as simple mobile video conference systems, such as [3]. However, in this field, research works involving mobile robots usually do not rely on semantic descriptions of the scenes, and focus more on low level constraints such as sensors, latency or security (see for example [6] or [3]).

Regarding the use of knowledge models, several works have been conducted aiming the development of support systems to museum visits and access to cul-

[3] http://www.nma.gov.au/engage-learn/robot-tours

tural heritage, most of them involving mobile devices (phones, tablets) adaptable to the user's profile and sensitive to its context, to improve the user experience and help build his visit of the museum based on his preferences and constraints. Several kinds of recommendation systems are used, e.g. content based in the CHIP project [7], collaborative filtering in [2] and [4].

The Azkar project is at the intersection of both worlds: it uses a mobile robot and an RDF dataset for describing some high level visitor profiles (primary schools and high schools) as well as the historical content of the museum scenes the robot is going to explore. The above cited papers, as well as the Hippie project (1999) [5] have been a good inspiration for the remote control framework we developed (which is out of the scope of this paper) and for the high level design of the AMO vocabulary, starting bottom up from a large database that describes all data in the museum, with many details and object that are not noticeable during a visit, and arriving to an abstract description of museum scenes.

3 The AMO Vocabulary and the RDF Dataset describing the Museum of the Great War

The AMO vocabulary is available online[4]; it comprises 9 main classes and 26 properties. Its main classes represent museum objects, scenes, points of interest, maps, trails, and primary target audience (primary or high school). Its main properties enable to relate objects, points of interest and external medias (that may differ depending on the target audience) to scenes, scenes to trails, trails to maps and to describe these instances.

Based on AMO, we created an RDF dataset from the Flora relational database[5] used by many French museums, that contains detailed descriptions of every single object in the museum catalog. The Azkar RDF dataset comprises today 421 instances and 2401 triples describing two scenes (a set of fully equipped French and German soldiers, called "Marne 14", and two trenches).

Currently, we implemented 32 SPARQL requests, the core ones perform tasks such as "giving this x and y position of the robot and a radius, give me the description of the current scene as well as related multimedia resources", or "please send the accurate description of all the soldiers in the Marne 14 scene with details and hires pictures (urls) about their equipment. In our experimentation, we remotely controlled the robot from our offices, 800 kilometers away from the museum. The commands, sensor data, audio and video streams are exchanged using WebRTC, through a p2p connection with the robot. When the robot is near a given scene, different observation points appear on the map, as well as linked resources (multimedia descriptions of the scene: local resources as well as resources from external data sources such as DBpedia.fr), as shown in Figure 2. SPARQL queries are triggered depending on the location of the robot, time, the current observed scene, pilot's interactions and the way the tour has been designed.

[4] http://mainline.i3s.unice.fr/azkar/ontology
[5] http://www.everteam.com/fr/cp-certification-flora-musee/

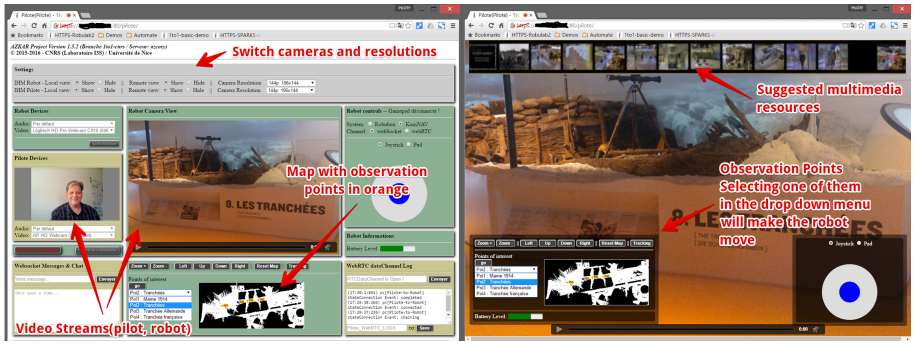

Fig. 2. Pilot GUI. We can see the observation points associated with the trench scene, in orange, on top of the map. The second switchable view presents the suggested multimedia resources. Clicking on one of them will send the url of the resource to the client for a local rendering (video, image, html).

4 Proposed demonstration

The demo will be as follow: from the demos session location, attendees will control in real time a robot located in France (either in the Museum or in a fake museum area in our lab, time zones may not be compatible). The remote pilot will see real-time audio video streams and how semantic descriptions of the scenes and related multimedia resources augment the experience.

References

1. K.O. Arras, W. Burgard, and al. Robots in exhibitions. In *Proceedings of IROS 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems, EPFL Lausanne, Switzerland*, 2002.
2. I. Benouaret. Un système de recommandation sensible au contexte pour la visite de musée. In *CORIA*, 2015.
3. W. Burgard, A.B. Cremers, D. Fox, D. Hähnel, G. Lakemeyer, D. Schulz, W. Steiner, and S. Thrun. Experiences with an interactive museum tour-guide robot. *Artificial intelligence*, 114(1), 1999.
4. P.Y. Gicquel and D. Lenne. Proximités sémantiques et contextuelles pour l'apprentissage informel: Application à la visite de musée. In *EIAH&IA 2013*, 2013.
5. R Oppermann and M Specht. A context-sensitive nomadic information system as an exhibition guide. handheld & ubiq. In *Computing 2nd Int. Symp*, 2000.
6. C.H. Park, E.S. Ryu, and A.M. Howard. Telerobotic haptic exploration in art galleries and museums for individuals with visual impairments. *IEEE transactions on Haptics*, 8(3), 2015.
7. Y. Wang, N. Stash, L. Aroyo, L. Hollink, and G. Schreiber. Using semantic relations for content-based recommender systems in cultural heritage. In *Int. Conf. on Ontology Patterns*, volume 516 of *CEUR*, 2009.