Zbornik 19. mednarodne multikonference

INFORMACIJSKA DRUŽBA - IS 2016

Zvezek F

Proceedings of the 19th International Multiconference

INFORMATION SOCIETY - IS 2016

Volume F

Delavnica e-Heritage
Workshop e-Heritage

Uredil / Edited by
Mihai Duguleana

http://is.ijs.si

11.-12. oktober 2016 / 11-12 October 2016
Ljubljana, Slovenia

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PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2016

Multikonferenca Informacijska družba (http://is.ijs.si) je z devetnajsto zaporedno prireditvijo osrednji srednjeevropski dogodek na področju informacijske družbe, računalništva in informatike. Letošnja prireditev je ponovno na več lokacijah, osrednji dogodki pa so na Institutu »Jožef Stefan«.

Informacijska družba, znanje in umetna inteligenca so spet na razpotju tako same zase kot glede vpliva na človeški razvoj. Se bo eksponentna rast elektronike po Moorovem zakonu nadaljevala ali stagnirala? Bo umetna inteligenca nadaljevala svoj neverjetni razvoj in premagovala ljudi na čedalje več področjih in s tem omogočila razcvet civilizacije, ali pa bo eksponentna rast prebivalstva zlasti v Afriki povzročila zadušitev rasti? Čedalje več pokazateljev kaže v oba ekstrema – da prehajamo v naslednje civilizacijsko obdobje, hkrati pa so planetarni konflikti sodobne družbe čedalje težje obvladljivi.

Letos smo v multikonferenco povezali dvanajst odličnih neodvisnih konferenc. Predstavljenih bo okoli 200 predstavitev, povzetkov in referatov v okviru samostojnih konferenc in delavnic. Prireditev bodo spremljale okrogle mize in razprave ter posebni dogodki, kot je svečana podelitev nagrad. Izbrani prispevki bodo izšli tudi v posebni številki revije Informatica, ki se ponaša z 39-letno tradicijo odlične znanstvene revije. Naslednje leto bo torej konferenca praznovala 20 let in revija 40 let, kar je za področje informacijske družbe častitljiv dosežek.

Multikonferenco Informacijska družba 2016 sestavljajo naslednje samostojne konference:

- 25-letnica prve internetne povezave v Sloveniji
- Slovenska konferenca o umetni inteligenci
- Kognitivna znanost
- Izkopavanje znanja in podatkovna skladišča
- Sodelovanje, programska oprema in storitve v informacijski družbi
- Vzgoja in izobraževanje v informacijski družbi
- Delavnica »EM-zdravje«
- Delavnica »E-heritage«
- Tretja študentska računalniška konferenca
- Računalništvo in informatika: včeraj za jutri
- Interakcija človek-računalnik v informacijski družbi
- Uporabno teoretično računalništvo (MATCOS 2016).

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi tudi ACM Slovenija, SLAIS, DKZ in druga slovenska nacionalna akademija, Inženirska akademija Slovenije (IAS). V imenu organizatorjev konference se zahvaljujemo združenjem in inštitucijam, še posebej pa udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

V 2016 bomo četrtič podelili nagrado za življenjske dosežke v čast Donalda Michija in Alana Turinga. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe bo prejel prof. dr. Tomaž Pisanski. Priznanje za dosežek leta bo pripadlo prof. dr. Blažu Zupanu. Že šestič podeljujemo nagradi »informacijska limona« in »informacijska jagoda« za najbolj (ne)uspešne poteze v zvezi z informacijsko družbo. Limono je dobilo ponovno padanje Slovenije na lestvicah informacijske družbe, jagodo pa informacijska podpora Pediatrične klinike. Čestitke nagrajencem!

Bojan Orel, predsednik programskega odbora
Matjaž Gams, predsednik organizacijskega odbora

FOREWORD - INFORMATION SOCIETY 2016

In its 19th year, the Information Society Multiconference (http://is.ijs.si) remains one of the leading conferences in Central Europe devoted to information society, computer science and informatics. In 2016 it is organized at various locations, with the main events at the Jožef Stefan Institute.

The pace of progress of information society, knowledge and artificial intelligence is speeding up, but it seems we are again at a turning point. Will the progress of electronics continue according to the Moore's law or will it start stagnating? Will AI continue to outperform humans at more and more activities and in this way enable the predicted unseen human progress, or will the growth of human population in particular in Africa cause global decline? Both extremes seem more and more likely – fantastic human progress and planetary decline caused by humans destroying our environment and each other.

The Multiconference is running in parallel sessions with 200 presentations of scientific papers at twelve conferences, round tables, workshops and award ceremonies. Selected papers will be published in the Informatica journal, which has 39 years of tradition of excellent research publication. Next year, the conference will celebrate 20 years and the journal 40 years – a remarkable achievement.

The Information Society 2016 Multiconference consists of the following conferences:

- 25th Anniversary of First Internet Connection in Slovenia
- Slovenian Conference on Artificial Intelligence
- Cognitive Science
- Data Mining and Data Warehouses
- Collaboration, Software and Services in Information Society
- Education in Information Society
- Workshop Electronic and Mobile Health
- Workshop »E-heritage«
- 3st Student Computer Science Research Conference
- Computer Science and Informatics: Yesterday for Tomorrow
- Human-Computer Interaction in Information Society
- Middle-European Conference on Applied Theoretical Computer Science (Matcos 2016)

The Multiconference is co-organized and supported by several major research institutions and societies, among them ACM Slovenia, i.e. the Slovenian chapter of the ACM, SLAIS, DKZ and the second national engineering academy, the Slovenian Engineering Academy. In the name of the conference organizers we thank all the societies and institutions, and particularly all the participants for their valuable contribution and their interest in this event, and the reviewers for their thorough reviews.

For the fourth year, the award for life-long outstanding contributions will be delivered in memory of Donald Michie and Alan Turing. The Michie-Turing award will be given to Prof. Tomaž Pisanski for his life-long outstanding contribution to the development and promotion of information society in our country. In addition, an award for current achievements will be given to Prof. Blaž Zupan. The information lemon goes to another fall in the Slovenian international ratings on information society, while the information strawberry is awarded for the information system at the Pediatric Clinic. Congratulations!

Bojan Orel, Programme Committee Chair
Matjaž Gams, Organizing Committee Chair

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FOREWORD

Cultural heritage has always been an effervescent subject among historians, sociologists, naturalists, scientists and researchers alike. The physical and intangible legacy of previous generations is passed via this channel to future members of the society. It is a deliberate act, as conserving the results of past work, culture and even biodiversity is in the very nature of the human beings.

The responsibility of our generation is to follow the most efficient methods for cultural preservation, and to support the activities which lead to the preservation of historic places (buildings, monuments), artefacts (books, paintings, sculptures and other artworks), traditions and folklore, language and landscapes. With the recent advancements in the field of virtual reality, intelligent systems and based on the emergence of the information society, we can now ascend to modern cultural heritage preservation techniques.The eHeritage conference is organized within the Multiconference Information Society. It covers research activities as well as engineering applications in the field of modern cultural heritage preservation methods.

Besides the workshop presentations, the E-heritage project meeting will be organized and live demo presentations of project participants from Romunia, Italy and Slovenia.

Matjaž Gams
Aleš Tavčar

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Reviving the memory of demolished buildings using Augmented Reality

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ABSTRACT

In June 1963 a Reformed church (inaugurated in 1892) from Brașov was demolished following the decision of the communist regime that was in power at that time, in order to build a new wing of the hotel "Aro". Although the Reformed community received a room for carrying out religious services, the church was never reconstructed and eventually forgotten. This paper presents a Mobile Augmented Reality application whose aim is to revive the memory of that church by co-locating the 3D model of it in the actual real environment. In this way, the user has the possibility to discover some issues related to the city's history in an illustrative and attractive way.

Categories and Subject Descriptors

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

General Terms

Design, Experimentation.

Keywords

Augmented Reality, 3D model, mobile, church, tracking.

1. INTRODUCTION

Nowadays, there are many attempts to bring back people's memories related to certain places or buildings that have been fallen into oblivion because these have been affected over time by natural or socio-political factors. Such is the case of a Reformed church from Brașov city, which was demolished by the communist regime.

The Reformed community from Brașov has greatly grown in the XIXth century and so it was necessary to build a church to meet their needs. By the efforts of the parish priest Molnár János, the church project was carried out in the second half of the XIXth century. The church was designed in an eclectic style by architect Ignác Alpár and its construction took 2 years, so on August 24th, 1892 it was inaugurated by Bishop Domokos Szász. It was the only Reformed church in Brașov at that time and one of the most beautiful churches from Brașov (see Figure 1). However, its life was not too long because on June 11th 1963, the local authorities announced their decision to demolish the Reformed Church on the Heroes Boulevard for expanding hotel "Carpați" (former and current Aro). The announcement was made in the meeting of the presbytery in the same day and the community was going to lose both school and rectory next to the church. Despite the leadership Reformed Church and community members' opposition, the party's decision has not changed. All buildings were demolished in the autumn of the same year. The community received instead a gym room, as space for religious services, where the few items saved were moved from the old place of worship: organ, pulpit and banks. On the site of the Reformed complex the new wing of the "Carpați" hotel was built[1]. Today only a commemorative plaque remembers the Reformed Church, a famous building of Brasov in bygone days.

An interesting challenge is to provide residents and tourists historical information in an illustrative and attractive way for reviving the memory of places that no longer exist. Besides the traditional means of restoring the historical value of such places (e. g commemorative plaques, books or illustrations), the recent development of 3D graphic design hardware and software opens up new possibilities for dissemination of lost heritage. With the wide-spread of mobile devices, Augmented Reality (AR) has started to be very attractive for researchers.

In this paper we present a Mobile Augmented Reality (MAR) application for visualizing in the real scene a 3D model of the Reformed church mentioned above, so that the users can get an idea of how it looked before, on the place where it was situated.

2. RELATED WORKS

The Augmented Reality (AR) is a technique used to enhance reality with virtual content: information of different types such as 2D, 3D graphics, audio, video, which is overlapped to the real environment. So, AR supplements reality and it does nor replace it, which can be understood as a mixture between completely synthetic and completely real [10]. In this way, the user can simultaneously perceive in real time both real environment and superimposed virtual elements. These elements can be attached to reality by means of various devices: mobile devices (smartphones, tablets), workstations or smart glasses, including HMDs (head-mounted displays). These devices, equipped with cameras, recognize some markers or certain details from the scene, displaying and integrating the virtual content in video stream

[1] http://erdely.ma/hitvilag.php?id=142488

using the detected targets as landmarks for AR [3]. Markerless AR uses other features of the device (GPS, accelerometer, gyroscope) to recognize the surrounding or to locate AR targets. Usually this is typical for outdoor AR, which is not subject of spatial limitation [7].

Figure 1. The Reformed church before demolition

AR was used in many applications over time, in various areas ranging from education [14] to medicine [16], tourism [6], manufacturing [5], and so on. Several projects related to AR and virtual heritage are discussed in [11], [12]. An application for museum exhibition, which provides a virtual world experience by connecting a beacon installed in real space to an HMD is presented in [2].

Some studies showed that AR can improve the ability to retain information in the process of learning [8]. Also, ease of use and usefulness are investigated [9] and new algorithms for location-based AR are proposed [13]. In [4] *Alma Mater* bronze sculpture of University of Illinois laser scanned and the resulted 3D model was used to temporarily take the place of the missing monument while it was treated for corrosion removing. 3D modelling of real world objects, buildings and scenes is becoming a more common concern nowadays and one reason for this is virtual reconstruction of historical buildings that no longer exist for interactive 3D visualization of them [15]. An easier way is to present only historical photos in AR [1], but the visualization of the historical building in the form of a 3D model is a more attractive experience for the user whereas his/her perspective is not so limited. User can walk on-site around the building under consideration and view it from various positions via the screen of the AR device (smartphone or tablet).

Therefore, using 3D visualizations is an interesting approach for bringing to life demolished historical buildings or other objects, monuments in AR applications because they can be shown in their previous location. In this paper, AR technology is presented using a handheld tablet device as a tool used for increasing interest of residents and tourists for the local history of the city.

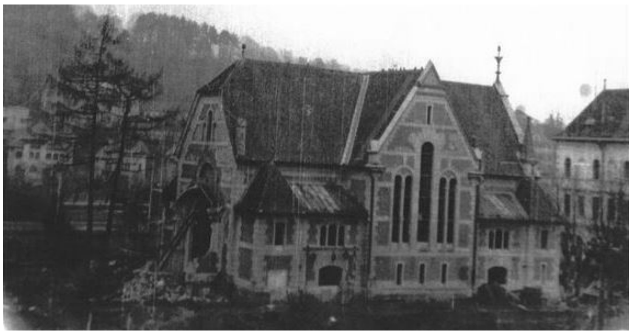

Figure 2. Picture during demolition

3. AR SYSTEM

In this section the architecture of the Mobile AR system will be briefly presented, on two sub-sections: hardware and software parts.

3.1 Hardware equipment

The main component of the system is a mobile handheld device (Samsung Galaxy Tab S2) which runs an Android application (Figure 4). The back camera of the tablet is used to capture the real world scene and the front panel screen is used to display the AR superimposed content over the video stream. The application can be installed on any mobile device that runs an operating system (OS) (Android, iOS or Windows) but, for a good operation, the device should have a CPU with at least 1.9 GHz frequency and a reasonable display resolution.

3.2 Software

For implementing the AR application, the software library Metaio was chosen. Metaio SDK was the most comprehensive solution to create Augmented Reality applications for iPhone, Android, Symbian and WinMobile devices [17]. The application tracks specific markers (reference images) in order to estimate the camera position with respect to these markers and then will register what is being captured by the camera with the 3D model of the building. The virtual content is retrieved from a database and it is displayed so that to be collocated with the real environment. An image database which contains the reference images taken from different positions for the actual building was created. In order to use one or more of these reference images for tracking process, they need to be defined in a configuration file. Also, a camera calibration file is needed for better tracking accuracy. These files are included in the AR application, which will perform the registration process. The virtual content is adjusted in location and scale relative to the camera transformation matrix using the aforementioned library (Figure 5). In this way, the images from camera and the rendered object are merged with spatial correction of position and so the experience of the past by means of modern technologies is provided to user.

Figure 4. The Reformed church's location as it looks today and the way of using the application

4. CONCLUSIONS AND FUTURE WORK

This paper presented the design of a mobile AR application for tourists and other people interested in history, using a demolished Reformed church as an example. A user-centered design methodology was adopted in the development of the application. This paper is intended as a continuation of a previous work [1], by improving the virtual information provided. The mobile application uses overlay augmentation to project 3D-models of a historical building on the current urban context. The purpose of this representation is to rescue this church from complete forgetting (oblivion).

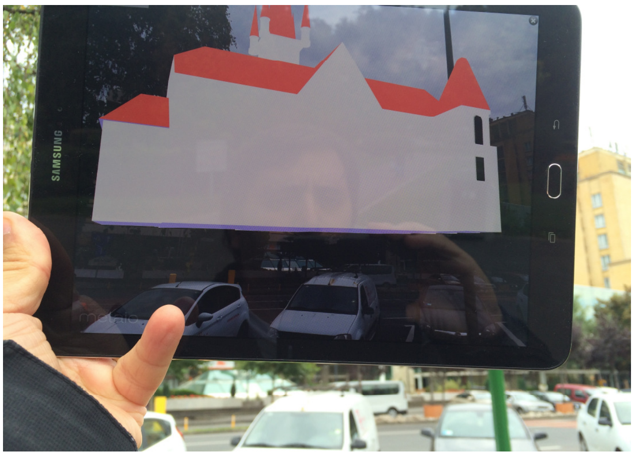

Figure 5. AR view of the church model

As future work, we intend to perform an experiment in order to evaluate the user's feedback related to the application and to improve it following their suggestions too. Some improvements could be: providing more additional information like textual description of the building's history, audio or video content, and also performing similar experiments in other types of sites.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Boboc, R.G., Gîrbacia, F., and Duguleană, M., 2016. A handheld augmented reality to revive demolished Reformed Church from Brașov, in press.

[2] Choi, H.-S. and Kim, S.-H. A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs. *International Journal of Information Management*. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.ijinfomgt.2016.04.017.

[3] Cianciarulo, 2015. From Local Traditions to "Augmented Reality". The MUVIG Museum of Viggiano (Italy). *Procedia - Social and Behavioral Sciences 188*(2015/05/14), 138-143. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.sbspro.2015.03.349.

[4] Dajnowski, A., Ross, T., Craig, A.B., and Dajnowski, B., 2015. New trends in art conservation, the use of lasers to clean as well as generate an augmented reality representation of an iconic public monument in bronze: The Alma Mater. *Studies in Conservation 60*, sup1, 65-72.

[5] Elia, V., Gnoni, M.G., and Lanzilotto, A., 2016. Evaluating the application of augmented reality devices in manufacturing from a process point of view: An AHP based model. *Expert Systems with Applications 63*(11/30/), 187-197. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.eswa.2016.07.006.

[6] Gutierrez, J.M., Molinero, M.A., Soto-Martín, O., and Medina, C.R., 2015. Augmented Reality Technology Spreads Information about Historical Graffiti in Temple of Debod. *Procedia Computer Science 75*(2015/01/01), 390-397. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.procs.2015.12.262.

[7] Han, J.-G., Park, K.-W., Ban, K.-J., and Kim, E.-K., 2013. Cultural Heritage Sites Visualization System based on Outdoor Augmented Reality. *AASRI Procedia 4*(2013/01/01), 64-71. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.aasri.2013.10.011.

[8] Jamali, S.S., Shiratuddin, M.F., Wong, K.W., and Oskam, C.L., 2015. Utilising Mobile-Augmented Reality for Learning Human Anatomy. *Procedia - Social and Behavioral Sciences 197*(2015/07/25), 659-668. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.sbspro.2015.07.054.

[9] Kim, H.-C. and Hyun, M.Y., 2016. Predicting the use of smartphone-based Augmented Reality (AR): Does telepresence really help? *Computers in Human Behavior 59*(6//), 28-38. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.chb.2016.01.001.

[10] Kipper, G., 2013. Chapter 1 - What Is Augmented Reality? In *Augmented Reality* Syngress, Boston, 1-27. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/B978-1-59-749733-6.00001-2.

[11] Noh, Z., Sunar, M.S., and Pan, Z., 2009. A Review on Augmented Reality for Virtual Heritage System. In *Learning by Playing. Game-based Education System Design and Development: 4th International Conference on E-Learning and Games, Edutainment 2009, Banff, Canada, August 9-11, 2009. Proceedings*, M. CHANG, R. KUO, KINSHUK, G.-D. CHEN and M. HIROSE Eds. Springer Berlin Heidelberg, Berlin, Heidelberg, 50-61. DOI= http://dx.doi.org/10.1007/978-3-642-03364-3_7.

[12] Novotny, M., Lacko, J., and SAMUELČÍK, M., 2013. Applications of Multi-touch Augmented Reality System in Education and Presentation of Virtual Heritage. *Procedia Computer Science 25*(2013/01/01), 231-235. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.procs.2013.11.028.

[13] Pryss, R., Geiger, P., Schickler, M., Schobel, J., and Reichert, M., 2016. Advanced Algorithms for Location-Based Smart Mobile Augmented Reality Applications. *Procedia Computer Science 94*(//), 97-104. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.procs.2016.08.017.

[14] Sannikov, S., Zhdanov, F., Chebotarev, P., and Rabinovich, P., 2015. Interactive Educational Content Based on Augmented Reality and 3D Visualization. *Procedia Computer Science 66*(2015/01/01), 720-729. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.procs.2015.11.082.

[15] Styliadis, A.D., 2007. CAAD for Demolished Buildings Modeling with Reverse Engineering Functionality. *RevCAD Journal of Geodesy and Cadastre 07*, 41-74.

[16] Wang, J., Suenaga, H., Liao, H., Hoshi, K., Yang, L., Kobayashi, E., and Sakuma, I., 2015. Real-time computer-generated integral imaging and 3D image calibration for augmented reality surgical navigation. *Computerized Medical Imaging and Graphics 40*(3//), 147-159. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.compmedimag.2014.11.003.

[17] Wang, X., Kim, M.J., Love, P.E.D., and Kang, S.-C., 2013. Augmented Reality in built environment: Classification and implications for future research. *Automation in Construction 32*(7//), 1-13. DOI= http://dx.doi.org/http://dx.doi.org/10.1016/j.autcon.2012.11.021

Books in VR: narrating fables with an Interactive Digital Storytelling approach

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ABSTRACT

This paper presents the design and the architecture of an educational 3D application aimed to the reading of three fables written by Lev Tolstoy. Exploiting Digital Storytelling paradigm, the application is addressed to childhood people, with the aim of narrate some complex phenomena using a simple language.

The paper presents a preliminary usability test in order to evaluate application's performances.

Categories and Subject Descriptors

H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Artificial, augmented, and virtual realities.*

General Terms

Documentation, Design, Experimentation.

Keywords

Digital Storytelling, Virtual Environments, Virtual Reality, Interaction, Education, Learning.

1. INTRODUCTION

Virtual Reality (VR) is a set of technologies enabling to recreate interactive environments wherein users can move or interact, feeling completely immersed in the scene. VR can be used to facilitate and improve learning process [1], relying on the sense of Immersion and Presence in the scene in order to increase engagement of the users [2]. VR is increasingly and commonly used also in museums, in order to engage visitors in new experiences [3].

In such contexts, VR is often used in combination with Digital Storytelling (DS). DS is defined as the practice of combining narrative with digital content, including images, sound, and videos. The outcome is commonly a movie or, in case interaction is enabled, a videogame or a virtual experience [4]. DS contributes to the engagement of the users levering on their emotions, so that they feel encouraged to continue the story in order to solve initial questions.

In order to explore further opportunities offered by the combination of DS and VR, we have designed and implemented a VR application allowing to interactively experience educational fables. The aim of this research is also demonstrate the potential of virtual technologies to engage children in reading enabling a different kind of navigation system for books.

The fables narrated in this application were written by Lev Tolstoy. In his life, Tolstoy wrote many fables with educational purposes in order to spread knowledge among the young population of Russia, poor of education in the XVIII-XIX centuries. *The Russian Readers* book (original title *Russkie knigi diya chteniya*, 1875) is a collection of legends, fables and physical considerations made using a simple language in order to disseminate collective knowledge and educate young people.

The treated arguments and the used language make novellas contained in *The Russian Readers* intrinsically interesting to be developed in a DS application.

We have chosen three different fables; the first one is "How does the wind form", an explanation of the physical phenomena of the wind. The second is "Magnet", a legend regarding the birth of magnets explaining also their physical properties. The last one is "The right judge", a moral value fable in which a judge makes decisions using his wit.

2. THE BOOK APPLICATION

The application has been implemented using the concept of *augmented book* [5], an immersive exploration of a digital copy of a manuscript placed in a three-dimensional context. Such a concept was previously introduced in the framework of MUBIL [6][7], the MUBIL project was an interdisciplinary cooperation project partnered by the Gunnerus Library of Trondheim, the Norwegian University of Science and Technology, and the PERCRO laboratory of Scuola Superiore Sant'Anna, Pisa. The aim of the project was dealing with the creation of a hybrid exhibition space where the content of the historical archives of the Library have been presented to a wider public, with a special attention to youngsters.

Users can browse, see and zoom the book's original pages, but also explore additional resources (such as transcriptions, translations, video, audio, animations, 3D text images and 3D models) in according to an enriched storyboard "augmenting" the book content. Interacting with some hotspots users can select pictures or other relevant content triggering videos or 3D animations (see Figure 1).

Figure 1. The Augmented Tolstoy Book.

The Augmented Book application (AB) has been developed using XVR technology [8]. AB parses and interprets an XML file that allows and disposes the resources on the environment and manages their behavior.

The separation between resources and application allows an easy extension of the book, being the definition of the content independent from the container software application. Beyond being good programming practice, this flexibility has several different advantages: the same application can be used for several different books, or the same book can be "upgraded" enriching objects, improving the content, or appending additional content. In addition, such operations can be "easily" performed also by non-technical people, as they have to modify only an XML file instead of modifying the application (see Figure 2).

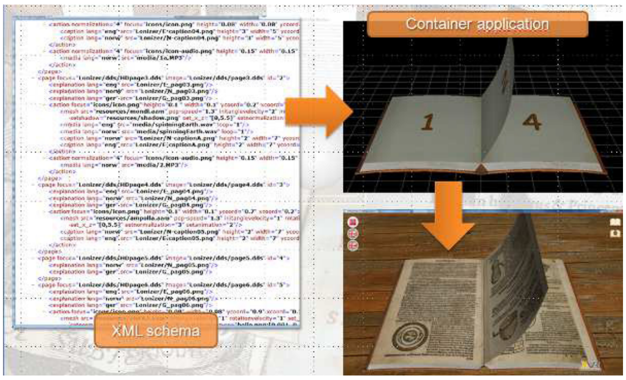

Figure 2. The XML schema of the AB.

The separation of concerns has been applied also to the interaction metaphors allowing to interface users with the touch book (decoupled as much as possible from the devices, such as mouse, joystick, Microsoft Kinect etc.) and to the visualization metaphors (adapting to tablets, desktop PCs, immersive visualization systems).

The Augmented Tolstoy Book (ATB) has been therefore developed as content for the AB container. Readers can browse pages and read them translated either in Italian or in native Russian language depending of their selection on GUI available on top-right of the screen. Italian texts are from the book *"I quattro libri di lettura", Lev Tolstoy (ISBN Editions, 2013)* and the native Russian texts and Cyrillic typefaces are from site www.rvb.ru.

The pictures available in the book pages can be selected. When the user selects a picture, a 3D representation of it moves itself over the book. The 3D reconstruction of the images was created dividing the 2D picture in layers and moving these layers in a different depth, in order to simulate a three-dimensional effect (see Figure 3).

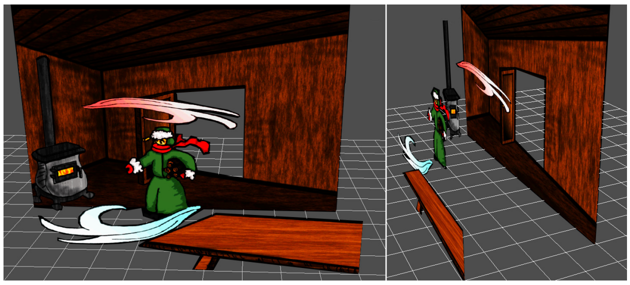

Figure 3. The image divided in depth layers.

3. TEST AND VALIDATION

In order to evaluate the application, a preliminary test was setup involving 20 volunteers working in our laboratory (therefore with a high education level) dealing with a ATB session featuring one of the three fables. We selected "Magnet" because of its immediacy and of its variety, as it contains mixed elements of fable and scientific descriptions.

We have divided the sample of the users in a test group (TG) and in a control group (CG), each of them composed by 10 users. TG has experienced the fable using ATB, while CG has read the same fable on a paper book.

The objective of the test session was to evaluate the pleasantness of the ATB experience, to test if ATB makes explicit all his features and to assess if reading the fable through ATB gives a better comprehension than using a normal book. In order to perform this assessment, TG have answered to a set of subjective Usability Questions (UQ) and Comprehension Questions (CQ), while CG has answered only to CQ.

Analyzing UQ responses, we can see that TG found that ATB provides a higher sense of expressivity (see Figure 4), mainly due to the ATB 3D interactive features.

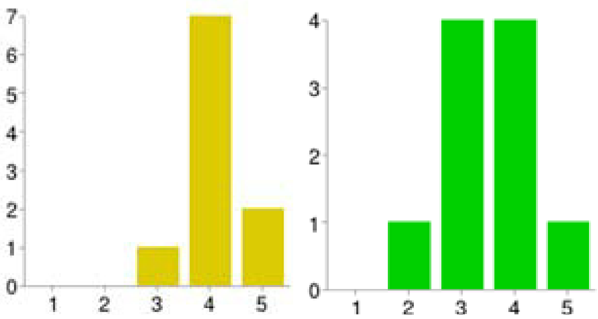

Figure 4. ATB expressivity (left) and ATB expressivity through the contribution of the third dimension

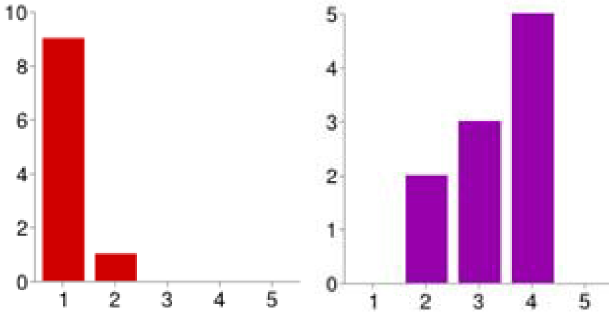

Figure 5. ATB perceived difficulty (left) and ATB involvement of the users (right)

ATB was also considered easy to use, and able to provide a significant sense of involvement (see Figure 5).

In terms of comprehension, the results of TG and CG are comparable, even if CG obtains slightly better results. A possible reason could be that, being the fable fairly short, it may be easier/faster for users to read and learn in a traditional fashion. In particular, some of the questions were aimed at understanding if the impact of the introduction of the augmented content was mainly positive (i.e. help the comprehension by means of additional information) or negative (i.e. acting as element of distraction). The homogeneity observed across the two groups suggests that the impact was mainly at the involvement/amusement level rather than at the understanding one.

4. CONCLUSIONS

The Interactive Digital Storytelling approach pursued within the Augmented Tolstoy Book application suggests that good results can be achieved in terms of comprehension, while at the same time eliciting a better involvement.

The validation test contributes to the implementation of further content exploiting the Augmented Book. In particular, we plan to extend the ATB and to perform additional assessment tests on children, i.e. the public to which the original book was targeted. In this sense, we have already contacted schools interested in participating to the expansion of the book and to insert such technologies in curricular scholastic activities.

5. ACKNOWLEDGMENTS

The study of the related work, the setup of the test methodology and the design of future expansions of the described methodology have been carried out in the context of the EU 2020-TWINN-2015 eHERITAGE project (grant number 692103).

REFERENCES

[1] Riva, Giuseppe. "Virtual reality as communication tool: A sociocognitive analysis." *Presence: Teleoperators and Virtual Environments* 8.4 (1999): 462-468.

[2] Furness, T., William Winn, and Rose Yu. "The impact of three dimensional immersive virtual environments on modern pedagogy: Global change, VR, and learning." *Proceedings of Workshops in Seattle, Washington, and Loughborough, England in May and June*. 1997.

[3] Wojciechowski, Rafal, et al. "Building virtual and augmented reality museum exhibitions." *Proceedings of the ninth international conference on 3D Web technology*. ACM, 2004.

[4] Robin, Bernard R. "Digital storytelling: A powerful technology tool for the 21st century classroom." *Theory into practice* 47.3 (2008): 220-228.

[5] Angeletaki, A., Carrozzino, M., & Giannakos, M. N. (2013, October). Mubil: Creating an Immersive Experience of Old Books to Support Learning in a Museum-Archive Environment. In *International Conference on Entertainment Computing* (pp. 180-184). Springer Berlin Heidelberg.

[6] Carrozzino, M., et al. "Information landscapes for the communication of ancient manuscripts heritage." *Digital Heritage International Congress* (DigitalHeritage), 2013. Vol. 2. IEEE, 2013.

[7] Lorenzini, C., et al. "A Virtual Laboratory An immersive VR experience to spread ancient libraries heritage." *2015 Digital Heritage.* Vol. 2. IEEE, 2015.

[8] Tecchia, Franco et al.. "A Flexible Framework for Wide-Spectrum VR Development." *Presence* 19.4 (2010): 302-312.

Cloud-based development of a natural language conversational virtual agent for cultural heritage applications

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ABSTRACT
Information retrieval instruments have known a consistent development in recent years, powered by the evolution of the Internet and mobile devices. This had a big impact also in the Cultural Heritage field. In particular interactive virtual guides, widely used to provide users with the desired information during visits to heritage sites, have benefited by this technical and technological evolution. This paper describes the implementation of a user-friendly, interactive conversational virtual agent able to communicate via natural language with the user, answer questions and provide information about cultural sites and landmarks. We have designed the agent in a cloud-based environment using IBM Watson Conversation service in order to achieve the desired natural conversation flow between the agent and the users.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual reality.

General Terms
Algorithms, Documentation, Design, Experimentation, Languages

Keywords
Human-computer interface, virtual cultural heritage, chatbot, artificial intelligence

1. INTRODUCTION
The interaction between humans and computers has been reshaped in recent years by the advances in the information technology, internet availability, mobile devices and wireless communication solutions (like Wi-Fi, Bluetooth, ZigBee, and so on). This has considerably improved access to a diversity of information retrieval services; however the way users are allowed to interact with these services, like the specifics of inputting requests and data format, still represents a usability issue to overcome in order to make these instruments really usable in real context scenarios.

A possible solution to handle a Human-Computer interaction is to use conversational agents, in other words by implementing a dialogue system capable of processing and understanding user queries and providing appropriate answers from their knowledge base. The simplest implementation of such a system is a chat-bot software agent (a computer program conducting a conversation with user(s) via auditory/textual methods – thus simulating a human conversational partner) that enable a natural language communication. There are several chat-bots implemented in various domains, like e-commerce, gaming, entertainment and cultural apps, research/education, medical and many others [1].

In this paper we describe our implementation of a natural language conversational virtual agent, capable of offering information and answering questions related to the cultural heritage field.

The agent has been developed using IBM Watson Conversation service, a specialized service for the creation of virtual agents and bots that combine machine learning, natural language understanding and integrated dialog tools to provide automated customer engagements [6].

The entire development process has been realized on the Bluemix cloud platform, resulting in an online application – available on a web page, accessible from both desktop and mobile devices.

The conversational agent has been configured to be able to provide information about the main cultural and historical sites from the city of Brasov, Romania.

2. BACKGROUND
The presentation of cultural heritage sites and artefacts is being enhanced today by the means of technology, especially multimedia and computer graphics. Consequently, in recent years an increasing number of virtual heritage applications have been developed with the intent of better highlighting physical exhibits by providing virtual presentations and digital content.

These applications may simply render digital content, making the user a passive viewer, or may involve the user in an interactive experience. Research has shown that the latter type of applications are being preferred by the users, and also are being credited to have a better impact on the learning outcome [5].

Virtual guides/tours represent a particular type of virtual cultural heritage applications aimed at increasing the visitor's engagement and immersion in the Virtual Environment and encouraging him/her to explore more objects [8]. It is well known that having a human guide when visiting a cultural site helps the user to have a better understanding. Unfortunately a human guide is not always available when experiencing a virtual tour of a heritage site. Consequently, the possibility for each visitor to have his own, personal virtual assistant, offering information and answering questions, represents an important aspect when designing a virtual guide application. Furthermore, enabling the virtual agents to communicate using natural language eases the way users interact with the system, hence making it more attractive.

Such virtual guides have already been implemented in contemporary museums [3], with the potential not only to entertain and engage visitors but also to enhance the learning process, provide customized feedback, answer the visitor's questions, and so on.

There are several implementations of virtual agents with a human form (virtual humans) acting as museum guides [7][9]. This approach however is constrained by the fact that usually avatars acting as museum guides are static entities which cannot "accompany" visitors and can interact only with the users situated in their vicinity [7].

Another type of virtual agents are conversational systems (or chatbots), capable of natural language interaction and of engaging into a realistic dialogue with the user (answering questions, providing information, and so on). Such systems have been considered from the beginning ideal candidates to be deployed on mobile devices (from the old-fashioned PDA's to today's smartphones and tablets). Such examples include Maga [2], a mobile archeological guide assisting visitors at the archeological museum in Agrigento, Italy, or the work described in [4], where the authors have added to the chatbot a visual interface ("a talking head").

However, all these solutions required a tremendous effort in terms of design and development of algorithms, AI features, interfaces, software modules, leading to a complex and expensive process, which made such solutions difficult to implement and somewhat hard to be replicated in other contexts.

Our approach, based on cloud computing infrastructure and the latest online available APIs in the field of cognitive technologies and artificial intelligence, aims at providing a new direction in the development of online, cognitive, natural language conversational virtual agents with a higher degree of availability for cultural heritage applications.

3. SYSTEM IMPLEMENTATION

3.1 Conversation service

IBM Watson Conversation service integrates a number of cognitive technologies that allow building and training a bot. There are three basic pillars used to describe a bot and its functionality: defining intents and entities and crafting dialog to simulate conversation [6].

During the development of such a system, the first step the agent have to overcome consists of analyzing and understanding the user queries in order to identify the purpose of a particular input. To achieve this result, in the Conversation service relevant intents (keywords preceded by #) and examples have been defined.

In our setup, we have created in the Conversation service workspace a number of four initial intents:

- #date
- #recommendation
- #definition
- #location

For each of them, several (from 5 to 11) user examples have been defined in order for the bot to accurately identify the correct purpose of each user input. Using these intents we aim at being able to provide information about specific cultural sites: what each particular site represents (#definition), when it was built (#date), what is its location (#location) and what is worth visiting there (#recommendation).

Once the purpose or intent of the user's input has been established by the bot, the Conversation service needs to extract relevant information from the same input. For this purpose, several entities (keywords preceded by @) pertinent to the cultural heritage content we are targeting have been declared in the service. Each entity have been created together with a set of values used to trigger in the bot different responses.

There are three entities that we have defined in our implementation:

- @Buildings (historical landmarks of the city of Brasov: the Black Church, Council House and Saint Nicholas church)
- @Cities (Brasov)
- @Populations (the historical populations that have inhabited Brasov throughout the ages: Romanians, Hungarians, Germans and Teutons).

Hence, each user query is being parsed and both intents and entities are being extracted. They are used further on in the dialog flow for the agent to provide the best answer back to the user. This is accomplished by the dialog component of the Conversation service.

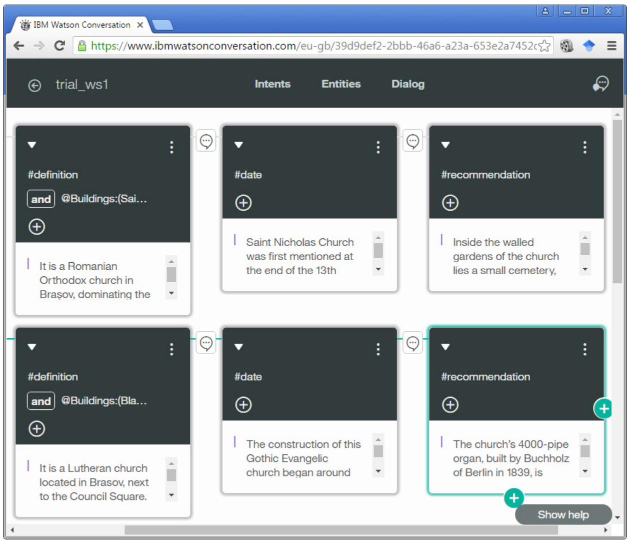

Figure 1. Conversation service Dialog nodes network

The dialog component uses the previously identified intent and entity, together with the application context to provide the answer. The structure of a defined dialog is basically a network of nodes, each level defining a step in the conversation. The dialog nodes are chained together in a tree-like structure representing the foundation of the interactive conversation with the user.

A view from the dialog component in our application is depicted in Figure 1. It can be noticed that each node has been defined by the conditions that make it active and the output object defining the response to be provided back to the user. Also in this example we have defined for each node an additional dialog branch corresponding to specific intents that allow for the conversation to be continued in several directions.

3.2 Interface

We have designed the interface of our conversational virtual agent as a web application available online. Using a simple, easy-to-use webpage it enables an interactive dialog between the user and the chatbot.

The Web application has been created using the IBM Bluemix hybrid cloud development platform which allows a seamless integration of an IBM Watson Conversation service instance in our app. Moreover, this cloud-based development environment enables the use of the latest Web technologies, in our case allowing for a quick and flexible development of a server-side JavaScript app using IBM SDK for Node.js.

The Node.js app provides a simple chat interface where the user can ask questions and the agent provides the appropriate answers. Since this is currently a work in progress, together with the chat interface on the webpage, the JSON responses at each turn of the conversation are displayed. These are of particular importance because they reveal how each question is being interpreted by the Conversation service, what intents and entities are being extracted and how the response is being selected from the dialog tree.

A sample screenshot of the app's interface on a desktop browser is displayed in Figure 2.

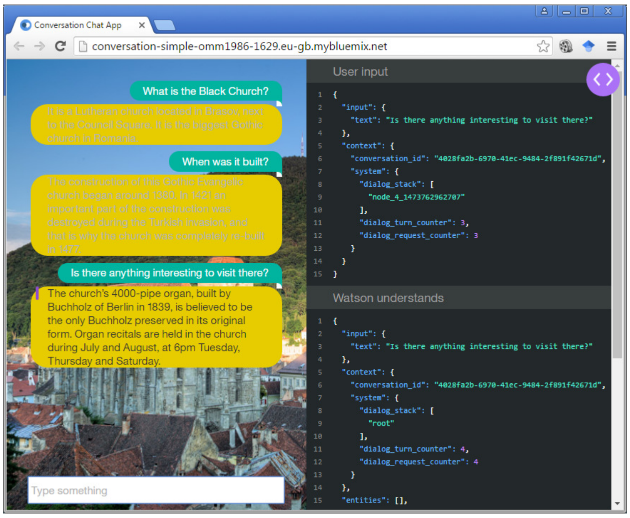

Figure 2. Conversational agent – online desktop interface

3.3 Usage and applications

As previously stated, the conversational agent is accessible through a web page, on both a desktop computer and any Internet-connected mobile device. The user text-inputs is enquiry using natural language (currently only English language is supported) and the query is then processed on the server by the Conversation service. After extracting intents and entities and looking for matches in the dialog tree nodes, the bot replies with the appropriate answer (if any is found) or a message stating that it cannot answer that particular question.

We have configured the Conversation service so that the bot is designed to answer questions pertinent to several medieval cultural and historical buildings from the city of Brasov, Romania, and also questions regarding other aspects of the city history.

Table 1. Conversation sample

User's Query	Agent's response
What is the Black Church?	
	It is a Lutheran church located in Brasov, next to the Council Square. It is the biggest Gothic church in Romania.
When was it built?	
	The construction of this Gothic Evangelic church began around 1380. In 1421 an important part of the construction was destroyed during the Turkish invasion, and that is why the church was completely re-built in 1477.
Is there anything interesting to visit there?	
	The church's 4000-pipe organ, built by Buchholz of Berlin in 1839, is believed to be the only Buchholz preserved in its original form. Organ recitals are held in the church during July and August, at 6pm Tuesday, Thursday and Saturday.

The visitor can ask questions in order to find out general information about the main attractions (the Black Church, Council House and Saint Nicholas church), their establishment date, location within Brasov and also main sights and important artefacts that can be seen for each of them.

A sample user-virtual agent dialog is shown in Table 1.

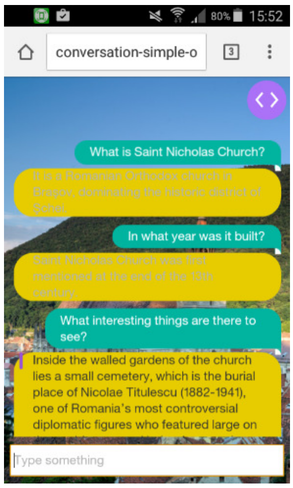

Figure 3. Mobile interface

Our goal is to make this application a virtual guide assisting tourists in visiting the historical medieval district of Brasov, with its main sights and attractions. Obviously such a guide needs to be accessed on the visitor's mobile device, which is why the interface of our app has been optimized for mobile rendering (as shown in Figure 3).

Given this, as a future development we are looking into adding full vocal support to the conversational agent by implementing speech synthesis from the bot's text response by using the Android/iOS Text to Speech APIs.

4. CONCLUSIONS AND FUTURE WORK

The conversational agent described in this paper has the potential of assisting the visitors of cultural heritage sites by providing a very user-friendly interface – communicating in a natural language – thus overcoming interaction constraints encountered in traditional pre-recorded guides (either audio or video).

Being available online, the conversational agent can be easily accessed via any mobile device (smartphone, tablet) and from any location, a huge gain in mobility and accessibility.

Besides the improved and easy access to the virtual online resources, our proposed approach makes implementing such cultural heritage interactive guides available for a broader range of heritage centers (due to the easy to use, cloud-based development). The developed system can be easily replicated by specialized software engineers but also by archeologists, historians and any other researchers without specialized IT knowledge. This is a very important feature, especially in the cultural heritage field, which usually implies interdisciplinary work and a synergy between various branches of science.

We are currently focusing on improving the knowledge base and internal structure (intents, entities and dialog tree) in order to achieve more realistic and human-like conversations and also to improve answers given to user queries. Also, we are considering adding features like location awareness (based on the GPS position of the mobile device used to access the agent) in order to make the agent more interactive and able to actively suggest personalized information related to the sites surrounding the visitor's location at a given time.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] AbuShawar, B., Atwell, E., 2015. A chatbot as a Question Answering Tool. In *Proceedings of the 2015 International Conference on Advances in Software, Control and Mechanical Engineering* (Antalya, Turkey, September 7-8, 2015). ICSCME'2015. DOI= http://dx.doi.org/10.17758/UR.U0915120

[2] Augello, A., Santangelo, A., Sorce, S., Pilato, G., Gentile, A., Genco, A., Gaglio, S. (2006). MAGA: A mobile archaeological guide at Agrigento. In *Proceedings of the Workshop Giornata nazionale su Guide Mobili Virtuali* 2006, ACM-SIGCHI.

[3] Bickmore, T., Pfeifer, L., Schulman, D. (2011). Relational Agents Improve Engagement and Learning in Science Museum Visitors. In *Intelligent Virtual Agents: 10th International Conference* (Reykjavik, Iceland, September 15-17, 2011). IVA 2011, Springer Berlin Heidelberg, Berlin, 55-67. DOI=http://dx.doi.org/10.1007/978-3-642-23974-8_7

[4] Gaglio, S., Pilato, G., Pirrone, R., Gambino, O., Augello, A., Caronia, A. (2008). A Java3D Talking Head for a Chatbot. In *International Conference on Complex, Intelligent and Software Intensive Systems* (Barcelona, Spain, 2008). CISIS 2008, pp. 709-714. DOI=http://doi.acm.org/10.1109/CISIS.2008.57

[5] Garau, M., Slater, M., Pertaub, D. P., & Razzaque, S. (2005). The responses of people to virtual humans in an immersive virtual environment. *Presence: Teleoperators and Virtual Environments*, 14(1), 104-116. DOI= http://dx.doi.org/10.1162/1054746053890242

[6] IBM Watson Developer Cloud: Conversation service overview. Retrieved September 13, 2016 from IBM: https://www.ibm.com/watson/developercloud/doc/conversation/

[7] Kopp, S., Gesellensetter, L., Krämer, N. C., Wachsmuth, I. (2005). A conversational agent as museum guide–design and evaluation of a real-world application. In *5th International Working Conference on Intelligent Virtual Agents* (Kos, Greece, September 12-14, 2005). IVA 2005, Springer Berlin Heidelberg, Berlin, 329-343. DOI=http://dx.doi.org/10.1007/11550617_28

[8] Rizvic, S., 2014. Story Guided Virtual Cultural Heritage Applications. *Journal of Interactive Humanities*, 2, 1 (2014). DOI=http://dx.doi.org/10.14448/jih.02.0002

[9] Swartout, W., Traum, D., Artstein, R., Noren, D., Debevec, P., Bronnenkant, K Williams, J., Leuski, A., Narayanan, S., Piepol, D., Lane, C. (2010). Ada and Grace: Toward realistic and engaging virtual museum guides. In 10th *International Conference on Intelligent Virtual Agents* (Philadelphia, PA, USA, September 20-22, 2010). IVA 2010, Springer Berlin Heidelberg, Berlin, 286-300. DOI=http://dx.doi.org/10.1007/978-3-642-15892-6_30

Haptic Interface Design for Experiencing Ancient Works

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ABSTRACT
In this paper a haptic device is proposed and investigating for experiencing ancient work of woodcutting with a hand saw. Cutting trunk of the trees with a handsaw was one of the most important jobs for people living in mountains. The hand saw, long about 1.5-2m, was handled by two people. The proposed structure for the haptic device has the main feature of decupling the two type of force present in the sawing procedure: the pulling of the saw and the pushing downwards force. The latter force is influencing the cutting depth of the teeth, so also the strength of the stroke. The proposed haptic device is also permitting displacement in two directions: forward-backward for cutting and downward for showing the progress of the sawing.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities, H.5.2 [**User Interfaces**]: Haptic I/O

General Terms
Design, Experimentation, Human Factors.

Keywords
Haptic, Cultural Heritage, Design, Simulation.

1. INTRODUCTION
Several ancient works required at least two persons to perform them. For example slicing and cutting trunk of the trees, which was one of the most important jobs for people living in mountains. The tool used for such an activity was the hand saw, long about 1.5-2m (Figure 1), with two handles and sharp cutting blade. The posture for handling it was in standing position, it was important not to force the saw through the wood, but let the teeth do the work. Once the groove was started, the power from the stroke should have come from the body stance.

The haptic simulator and interface for experiencing the woodworking process with a hand saw needs a virtual environment, a haptic device, visual and acoustic feedback and a control laws for the feedback generation. This interface can be used by one or two persons. If only one person is handling the device, then an avatar is replacing the partner. In case two persons are using the proposed interface, they have to share among them information regarding the position of the blade.

2. HAPTIC INTERFACES AND COLLABORATON
The haptic interface is a force-reflecting device which allows users to touch, feel and manipulate simulated three-dimensional objects in a virtual computer-generated environment.

A skill demonstrator usually requires investments in setup for physically reconstructing the scenario and long duration of testing and validating, while hands-on training is becoming less and less possible. An ancient work simulator with proper visual, haptic and acoustic feedback (similar to the real world) would help amateurs by providing an intuitive way to feel the tool and interact with the virtual 3D objects, without a real physical contact.

Haptic fidelity is still an issue in the design of haptic devices, because in a typical implementation the control loop of the haptic device must be updated at a very high rate (approximately 1000 Hz) to ensure stability and a responsive interface [1]. Also the mathematical model for the haptic force computation needs to be made as effective as possible. The requirement in the design of a haptic devices are [2]: the natural dynamics should not distract the user from the environment being simulated, mass and friction should be as low as possible and must be capable of producing enough force so that virtual objects feel solid.

Haptic collaboration is the subject of many researches [3]. In [4] is proposed the haptic collaboration in a maze game, where each player controls separate degree of freedom control (DOF) of an object independently in collaborative virtual environment. In [5] the users are standing in front of a screen and they operate each a string based robot. 3D distributed collaborative environment with haptic feedback is present in the fields of education, medical rehabilitation, collaborative training etc. [6]. Cooperative manipulation refers to the simultaneous manipulation of a virtual object by two or more users, located at separated places and operating their own haptic devices. The collaboration mode means that each user controls separate DOF of the object.

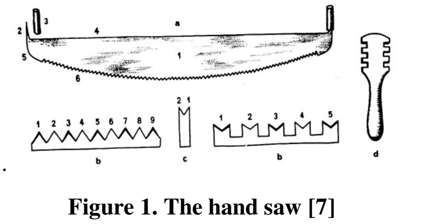


Figure 1. The hand saw [7]

3. THE WORK OF WOOD CUTTING

Wood cutting and slicing with a saw (Figure 2) by two persons is usually performed in standing position with slight front inclination of the upper body. The saw is usually in the right hand, with the left leg in front of the body and the knees are bent. The left hand can be on the wood for holding it still or resting on the left knee and the left side is leaned into the direction of cut.

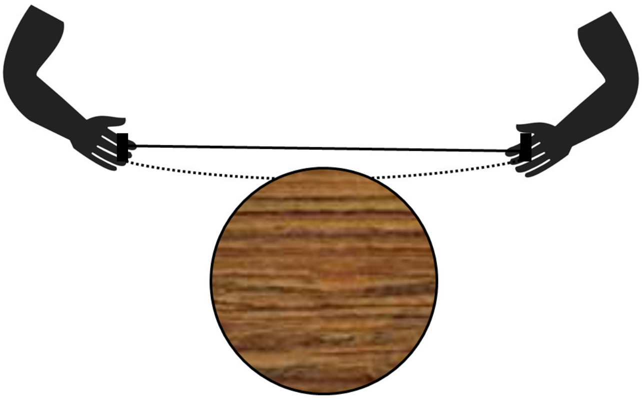


Figure 2. Wood cutting with a saw

From the two persons involved in the wood slicing, the one which is pulling the saw is the active one, the other is just pushing back the saw with minimal effort. So the entire procedure, from one person's point of view, can be decomposed in two separate phases: the active phase – when the person is pulling the saw, and the passive phase – when the person is pushing the saw considered to be a guided movement only, without actually pushing it.

In the active phase two separate movement are involved: (I) in the horizontal plane the pushing-pulling movement of the saw, (II) in the vertical plane the movement of the saw blade is marking the progress of the cutting procedure.

The ideal path of the saw is linear, but usually cannot be achieved. Almost all the time, due to the geometric parameters and physiology of the hand, the path is curved at the end of the active phase (Figure 3).

The force of the user in the active phase can be decomposed in two components: the one which is the pulling force and which will move the saw and one which is pushing downwards the saw. These two components are not independent: the bigger the downward force will imply bigger force for pulling, because the teeth of the saw are cutting deeper into the wood.

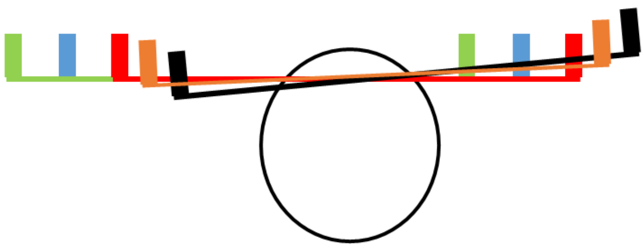


Figure 3. Path of the saw

4. FUNCTIONAL REQUIREMENT AND DESIGN OF THE HAPTIC INTERFACE

The haptic interface for simulating the sawing procedure needs the following components from one person's point of view: a haptic device, visual feedback (2D screen, immersive or stereoscopic) and acoustic feedback. For remote collaboration, two haptic interfaces have to be connected to exchange information regarding the position of the saw: the one in the active phase is sending position information for guiding the other one in the passive phase. This passive phase of the simulation can be achieved with a virtual fixture (known in the literature also as active constraint or motion constraint) [8].

4.1 Requirement from functional perspective

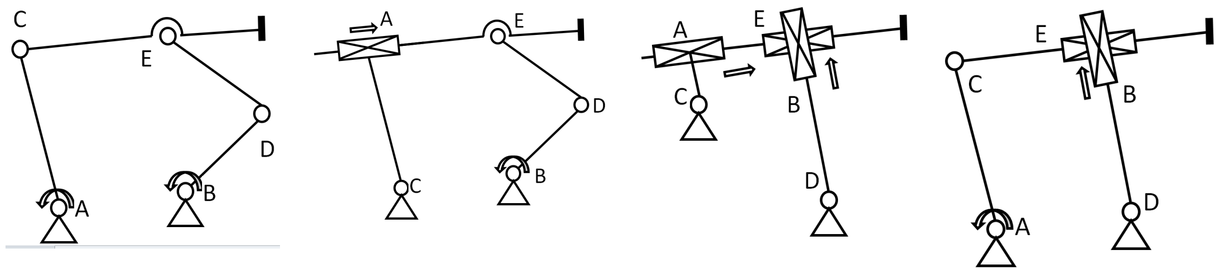
The haptic devices components are: a handle, a mechanical system and electric motors with controllers. The haptic device for simulating the sawing procedure has to allow two type of motion: (I) pushing/pulling forward and backward, and (II) pushing downwards the handle in order to increase the cutting depth. This haptic device has to provide force feedback to reproduce the two components of the haptic feedback.

Design requirement for the haptic device are the following:

- Two degrees of freedom (DOF) for the mechanical system controlled with separate electric motors to decuple the force feedback in two directions.
- The trajectory of the handle has to be non-linear: mainly linear trajectory for the saw's blade, but also rotation for the handle in the vertical plane (less then 10deg.)
- The dimension of the device should be as small as possible to decrease the inertia of the elements.
- Friction in joint should be minimized, by introducing only limited number of mechanical joints and mainly rotation joints.
- The force feedback should be reflecting and reacting to the force input in two directions: the pushing/pulling forward and backward, and downwards pushing. These two forces are not independent – the bigger the downward force, the pulling will be harder to achieve because of the cutting depth.
- The handles position in time need to change showing the progress of the sawing procedure. This means a translation movement in downwards direction of the handle, without affecting the path of the saw.

4.2 Design solutions

The haptic device can be designed using strings or a linkage. The string based devices has some advantages [9]: workspaces is larger, inertias are low, speed is high, but are not suitable for big force input. As a linkage, the haptic device can be design as a serial robot arm with 2 or more DOF, but this has the disadvantage of not being decupled in the mentioned two directions. For the haptic feedback in two directions, a mechanism with closed kinematic chain is required. A mechanism with 2 DOF will need five mechanical joint with one degree of freedom (revolute joints or translation joints). The possible solutions are presented in Figure 4 (also is possible to interchange the position of the revolute and translational joint on the same link). From



a **b** **c** **d**

Figure 4. Mechanisms with 2 DOF and five joints.

these solution, according to the requirements and for quick response, the best design is the one with just revolute joints (Figure 4, a).

The control of the torques of the haptic device can be achieved with the hybrid dynamic model [10] (measuring the force in one DOF and the displacement in the other) or with classic control theory.

5. HAPTIC INTERFACE SIMULATION AND EVALUATION

The simulation of the chosen design (Figure 5) was performed using the multibody dynamics simulation tool MSC ADAMS® software (www.adams.com). The considered lengths of the links were: l_1=680mm, l_2=505mm, l_3=353mmm, l_4=434mm.

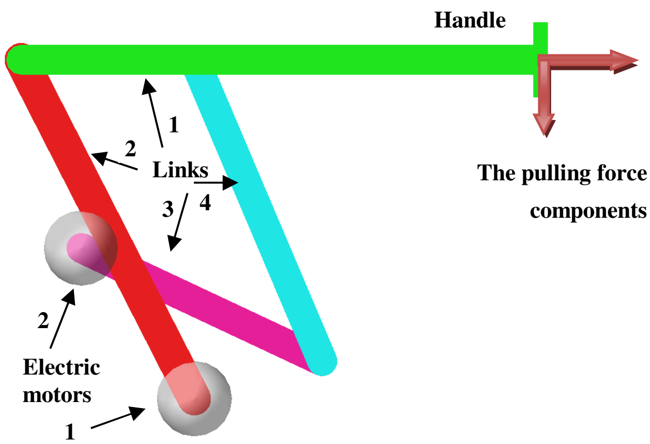


Figure 5. The haptic device model.

The first simulation was a kinematic one, imposing the displacement of the handle in two directions (Figure 6). This simulation will check the fulfillment of the correct position of the handle. The variation of the angle of the handle (in the vertical plane) is presented in Figure 7. It can be seen that variation is low (less than 5 deg. during the linear movement and more than 5 deg. at the end of the path – as it is required) and it is mostly depending on the length of link 2.

The second simulation was an inverse dynamic one. The movement of the device was imposed as in the previous case, but this time a force was added on the handle. The imposed force profiles in the two directions (the pulling and the pushing downwards components) are presented in Figure 8.

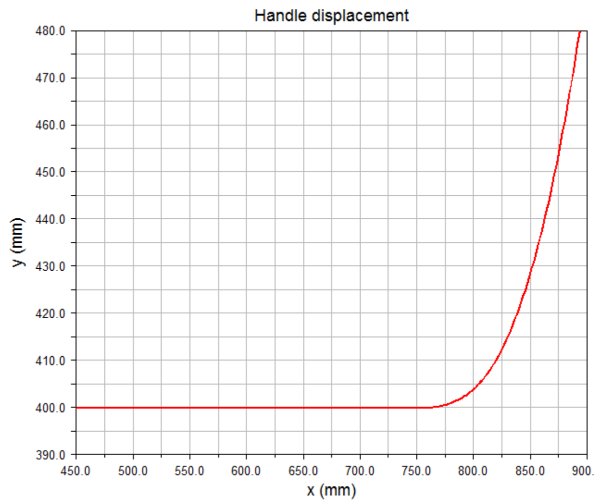


Figure 6. The handle's displacement.

The rotion angles of the two electric motors were measured from the kinematic simulation, and these values were imposed in the inverse dynamic simulation. This means that the torques required for generating the imposed motion could be computed.

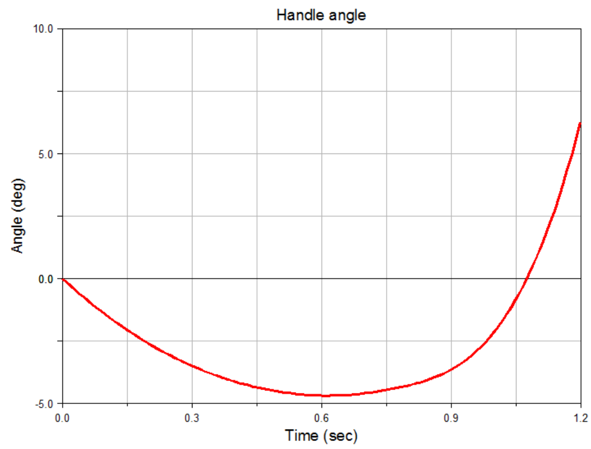


Figure 7. The handle's angle.

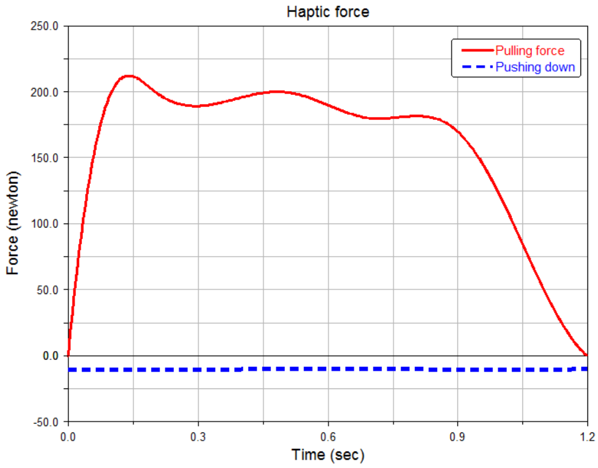


Figure 8. The imposed haptic force.

Figure 9 is presenting the torques of the two electric motors (1 and 2 form Figure 5) in three scenarios. The path of the handle was the same, but the haptic force was modified. The three cases presented are: the original force (with the magnitude presented in Figure 8), 10% and 20% reduction of the original force. It can be seen that proportional with the reduction of the haptic force, the torques of the motors are reduced too.

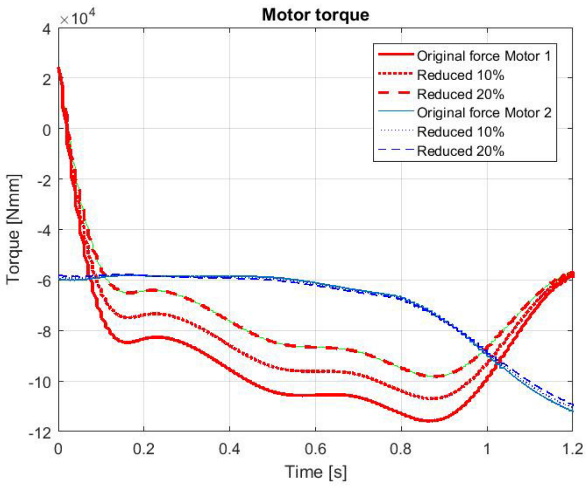


Figure 9. The torques of the electric motors.

6. CONCLISUONS

Remote collaboration for experiencing ancient works requires a virtual environment, a haptic device, visual and acoustic feedback and a control laws for the feedback generation. The proposed structure of the haptic device is a mechanism with 2 degrees of freedom, where the user is manipulating a handle in two directions in the vertical plane: pushing-pulling for cutting the timber and downwards for illustrating the progress in the process of sawing. This mechanism is permitting a straight path of the handle with just small variation of the handle's angle and the force feedback is decoupled in two directions. The force feedback is generated with two electric motors, where the torques are proportional with the user's force.

7. ACKNOWLEDGMENTS

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8. REFERENCES

[1] Carignan, C. R., & Cleary, K. R. 2000. Closed-loop force control for haptic simulation of virtual environments. Haptics-e 2000; 1(2):1-14.

[2] Massie, T. H. and Salisbury, J. K. 1994. The phantom haptic interface: A device for probing virtual objects. In *Proceedings of the ASME winter annual meeting, symposium on haptic interfaces for virtual environment and teleoperator systems*. Annual Meeting, Dynamic Systems and Control Division 1994; 55(1): 295-301.

[3] Sallnäs, E. L., Rassmus-Gröhn, K., & Sjöström, C. 2000. Supporting presence in collaborative environments by haptic force feedback. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *7*(4), 461-476.

[4] Liu, L., Liu, G., Zhang, Y., Guo, W., Lu, K., and Zhou, M. 2011. Separate DOF control and mutual guidance in networked haptic collaboration maze game: Design and evaluation. In *Robotics and Automation (ICRA), 2011 IEEE International Conference on,* 913-918.

[5] Ullah, S., Richard, P., Otmane, S., Naud, M., and Mallem, M. 2010. Haptic guides in cooperative virtual environments: Design and human performance evaluation. In *2010 IEEE Haptics Symposium* (pp. 457-462). IEEE.

[6] Wang, J., Chellali, A., and Cao, C. G. 2016. Haptic Communication in Collaborative Virtual Environments. In *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 2016, 58 (3):496-508.

[7] Kovács, F. 1934. Woodworking tools of Transylvania (In Hungarian: Erdei famegmunkáló eszközök Gyergyócsomafalván) , Erdélyi Múzeum, 138-142, 1934.

[8] Bowyer, S. A., Davies, B. L., & y Baena, F. R. 2014. Active constraints/virtual fixtures: A survey. *IEEE Transactions on Robotics*, *30*(1), 138-157.

[9] Antonya, Cs. 2013. Force Feedback in String based Haptic Systems. In: *Procedia Computer Science*, *25*, 90-97.

[10] Antonya, Cs. 2013. Hybrid dynamic model for haptic systems with planar mechanisms. In: *2013 6th IEEE Conference on Robotics, Automation and Mechatronics (RAM)*, 174-178.

Interactive VR for the dissemination of local heritage in schools

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ABSTRACT

This paper presents MuraVagando, an educational 3D application based on VR technologies designed and realized with and for secondary school students in order to raise their awareness about their local heritage, in particular the medieval walls of Grosseto, Tuscany, one of the rare examples in Italy of defensive walls remained nearly intact to this date.

Categories and Subject Descriptors

H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Artificial, augmented, and virtual realities.*

General Terms

Documentation, Design, Experimentation.

Keywords

Digital Storytelling, Virtual Environments, Virtual Reality, Interaction, Education, Learning.

1. INTRODUCTION

Several recent educational approaches are successfully exploiting technologies (such as tablets, smart phones, videogames, etc.) which kids use routinely. In this respect, Interactive Digital Storytelling [1] represents an interesting opportunity taking advantage of multimedia technologies to develop learning mechanisms [2], with the added values of providing a tool able to convey even complex concepts in an intuitive and playful way, and easily customized to meet different needs, personalities, capabilities [3].

Following these principles, we have in the past [4][5] setup a learning methodology and experimented a number of educational programs focused on the following objectives: conveying a content, identified together with teachers, by telling a story; providing knowledge about technology, by means of a learning-by-doing approach enabling kids to create a multimedia product suitable to tell the chosen story; enhancing team skills in kids.

We have applied such a methodology to the case of the Grosseto, a town in Tuscany whose city walls have remained almost completely intact since their foundations in the XVI century, following a development approach already experimented with success in previous occasions related to the towns of Pisa [6] and Lucca [7].

2. THE MURAVAGANDO PROJECT

The project has been organized by Scuola Superiore Sant'Anna of Pisa and the History Institute of the Contemporary Age (ISGREC) of Grosseto, and developed together with the V class of the Polo Bianciardi Arts High School of Grosseto. The students have been protagonist of an innovative educational path aimed at acquiring scientific and technological competencies applied to the communication of cultural heritage. This experimentation dealing with the Town Walls of Grosseto has built on a knowledge base previously formed in past educational projects and integrated with a VR-based technological approach. A series of meetings in the classroom has leaded to get the students familiar with the concepts of storyboard making, 3D modelling, video shooting/editing and 3D programming. The result is an interactive application that will be disseminated on the web, exploiting HTML5 3D features, and as a kiosk in local museums using touch interaction.

3. THE APPLICATION

The MuraVagando project was developed in order to introduce high school students to their own cultural heritage in a way that differed from the usual in-class activity. To enrich their daily learning experience, students were made part of the creation pipeline of a Virtual Application, also named MuraVagando, from which users would be able to visit a three-dimensional reconstruction of their home town, Grosseto. Being "Arts and Drawings" their area of expertise, students were asked to use their artistic skills in order to design a nice-looking interface as well as producing several assets to be used in the final application.

After visiting the most relevant historical sites of the city to familiarize with the local artistic style, students were guided to design every element of the final application and its features under our technical supervision. They were first asked to draft a wireframe of the main User Interface together, comprehensive of buttons, background images, menus and icons. After that, every student was asked to select a unique spot of the city, draw it on paper, write a description to be used as label, draw a monochromatic icon, and draw a cardboard cut-out of what a local citizen would have looked like when that opera was created. Once all the assets were completed and digitalized, our task was to find the best fit for all those elements, creating a digital scene that users could explore and share.

The final product is a large three-dimensional interactive reconstruction of Grosseto's Old Town and of its walls that can be accessed both as a web-page and as a stand-alone applications running on touch-screens, also providing portability to immersive setups such as Oculus Rift. Particular focus was put on reconstructing all those elements that students have focused on throughout the entire project, such as churches, statues, protective walls and ramparts, as well as other elements they have chosen for their drawings. The application consists of a single centred canvas that renders the only camera in the scene; a contextual menu is positioned to the left side of the canvas and it contains three main categories named "Ramparts", "Churches" and "Monuments" (Fig. 1). While pressing on any of these buttons, a second menu appears to the right side of the canvas, showing a list of specific elements belonging to the selected category. A single button representing the city map is positioned right below the canvas, and it is used to access the corresponding view mode.

Figure 1. The main page of the Web application

3.1 The Scene

The main focus of the scene is always on the external walls, cardinal element of the entire project and main architectural element of the town. The walls have been reconstructed in 3D in accordance with the students' drawings. Transparency was applied on the floor edges to create a turntable effects: the walls and the city is standing on a drawing that fades out to merge with the surrounding environment.

Figure 2. Descriptive panels

It is important to notice that the final model is not a precise scale reconstruction of the actual town: each point of interest chosen by the students was highlighted by scaling up the corresponding mesh to make it stand out from the context, and brighter materials were applied for the same purpose. Each of these spots comes with a descriptive panel written by the same student, presented in the model as a big wooden board (Fig. 2). Panels locations are also used as landing point for state transitions activated by the already described menus.

3.2 Navigation

Users can navigate the scene in three different ways:

- Free Mode: On Free Mode, the users can freely move the camera around the scene, with no limitations.

- City Tour: On City Tour mode, the camera follows a predefined path that starts from just outside the city walls, and moves around the entire scene, just like a modern drone. The camera visits all the interesting spots in the scene in a continuous seamless loop, while users can only rotate the view on local Y and Z axis. This mode is used as default when the application does not receive any input for more than 30 seconds in Free Mode.

- Map Mode: on Map Mode, the camera floats above the scene, continuously rotating on the vertical axis. (Fig. 3)

Figure 3. The map mode

Each navigation mode can be activated in any moment by using the application GUI. Smooth linear transitions were implemented during the location changes to avoid spatial disorientation.

4. TECHNICAL IMPLEMENTATION

In the preliminary design phase, no specific target platform to build for was identified, as the school could not provide a list of possible devices they were willing to use to share the project. Due to this lack of information, a web based application was planned, with possibilities to extend it on additional platforms. After comparing several libraries and frameworks, the most reasonable choice was to use Unity Engine to manage the project, as it allows users to export scenes on several different platforms, including those we might be interested in. Being our project free from revenues, we were able to use it with no additional costs.

4.1 3D Models

The main challenge of modelling a web-based scene with dozens of different monuments and buildings is to keep the number of vertices low. While buildings such as churches or palaces could be approximated to parallelepipeds, statues, fountains and walls required a more complex geometry to be described without too much data loss. Different modelling pipelines had therefore to be used in order to create the meshes:

1) the old Medieval walls have been reconstructed by repeating a mesh sample on a NURBS path, creating a first high-poly version. Then, a re-topologized low-poly version was modelled following the high-poly version topology, transferring the UV coordinates from one model to the other;

2) the most important buildings such as churches and wells have been modelled by hand, following the proportions given by the students' drawings. Such models were also scaled up to stand out from the overall view. Minor structures such as modern houses were also recreated, based on their real position;

3) statues have been modelled loosely according to their shape. However, students only provided one perspective drawing for each statue in the project, it was therefore decided to use a billboard mesh resembling the statues front shape, apply the drawing as texture, and move forward and backward some vertices in order to create a three-dimensional effect. (Fig. 4);

Figure 4. A sculpture billboard

4) some minor elements have been procedurally generated by using Unity features: trees were added to the scene by using Unity Tree Editor plug-in, and the sky was created by using Unity standard skybox material. (Fig. 5)

All the models have been built by using the free modelling tool Blender.

Figure 5. The 3D model of Grosseto

4.2 Textures and Materials

The biggest challenge of the project was to achieve a homogeneous look. The students were encouraged to use their own style to realize the drawings, and this brought inconsistency among the produced material. The papers we received came in different colours and styles, some of them had a white background while some others had a yellow one, some students drew different parts of the same object while some others drew just the main view, and most importantly for a 3D model, most of them drew in perspective mode, rather than using an orthogonal view.

The only shared feature we could identify amongst the drawings was a certain similarity with cartoons. Besides that, all the drawings differed from each other in terms of style, proportion, colours and techniques used. Being purpose of the project to preserve students artworks, the chosen approach was to create a game-alike "cartoony" environment, applying the drawings as textures on the meshes, reducing the reflectivity and increasing saturation (Fig.6). Minor buildings were rendered using CEL shading materials for the same purpose.

To avoid inconsistency in the scene, we pre-processed each single drawing we received with a graphic tool, increasing the yellow balance where needed, and adjusting proportions. Once the images had a homogeneous appearance, they were imported into Blender and applied as textures to the UV unwrapped models we previously created. No Normal mapping was done, to keep the scene as "cartoony" as possible.

Figure 6. Modeling town elements

A special case is represented by videos. During the first meetings with the students, it was agreed all together that the application should speak the language of young people, avoiding as much as possible a formal approach. Therefore, the entire experience was conceived as a gathering where some of the students of the school invite people of the same age to wander around the ancient walls (MuraVagando recalls the Italian term for "wandering") and discover a place in their town rich of stories and cultural elements, yet often disregarded by young. Therefore in the beginning, and occasionally in specific points of the town, cut-scene videos appear that have been shot by students playing as actors.

4.3 User Interface

As mentioned above, the project comes in two different versions: a web-based HTML page and a standard Unity executable file to be used on touch-screens. Although the versions share a similar design, due to the different devices on which they are hosted some elements of the User Interface had to be positioned differently.

In both the web and the touch-screen version, a contextual menu called "Categories" is positioned on the left side of the main canvas, but while the web version did have enough space not to overlap with the rendered scene, the touch-screen application came with different proportions and the buttons had to be positioned on top of the rendering canvas. Once any of these category button is pressed, a second menu called "Places" appears on the right side with the same parameters described for the category menu. Clicking on any of these places button applies a parabolic roto-translation transformation of the camera from its current position to the location of the specified element in the scene.

A third menu named "Navigation" is used to activate the navigation modes described in section 3.2, but while in the web version the menu is composed of three different icons positioned below the canvas, on touch-screen two arrows had to be added to move the camera forward and backward while in Free Mode, so that no complex gestures had to be used to move the camera around the scene.
A different UI is presented while in Map Mode: once the camera reaches its top position above the model, users can no longer access the contextual menus and they cannot freely move around the scene; they can only select from some hotspots placed on the scene.

4.4 Code Structure

Being the Unity Engine mainly used in game development, the design process has benefited from structuring the entire project as a videogame. However, this choice also presented its downsides, as Unity puts special restrictions on how elements interact with each other in the scene. Specifically, reserved folder names had to be considered to load assets at runtime, and GameObject – Component relationship had to be taken into account while designing the scripts and their behaviour.
The entire scene is controlled by a singleton "Scene Handler" component attached to an empty Game object. Main tasks of this script are:

- controlling the application status. In addition to the status described in section 3.3, the application also features a specific status in which users watch a video, and while the camera is animating from two different positions. Transitions between those status were handled by the component to ensure that only one status could be active at the same time;

- animating the camera: Once a transition is activated, a parabolic trajectory is computed based on the current camera position and rotation, the final position and rotation, the desired parable height and the animation duration both in terms of time and frames;

- communication with the external functions (Web only). While the touchscreen version is completely handled by Unity, the web page is mostly independent and Unity only take care of rendering inside the specified <canvas> element. However, external JavaScript functions can be called to interact with the component and modify the application behaviour;

5. CONCLUSIONS

The project ended in June and so far was only publicly presented once at a conference. The application is going to be published on the web in October and agreements are being taken with local cultural institutions to place two interactive kiosks running the application. In this phase we plan to run a user study in order to gather information about the efficacy of the application as a dissemination tool and to identify guidelines for future developments.

6. ACKNOWLEDGMENTS

We would like to thank Elena Vellati and Luciana Rocchi of ISGREC (Istituto Storico Grossetano della Resistenza e dell'Età Contemporanea) for creating the opportunity for this project to happen. We would also like to thank students and teachers of Polo Bianciardi, Grosseto, in particular Marcella Parisi, Marta Rabagli and Biagio Cuomo, for the guidance and coordination of the students' work and for their contribution to the final application.

REFERENCES

[1] Lambert, J. (2006). 2nd edit. Digital Storytelling: capturing lives, creating community, Berkeley

[2] Xu, Y., Park, H., & Baek, Y. (2011). A New Approach Toward Digital Storytelling: An Activity Focused on Writing Self-efficacy in a Virtual Learning Environment. Educational Technology & Society, 14(4), 181-191.

[3] Sadik, A. (2008). Digital storytelling: A meaningful technology-integrated approach for engaged student learning. Educational technology research and development, 56(4), 487-506.

[4] Baroni, A., Evangelista, C., Carrozzino, M., & Bergamasco, M. (2005, June). Building 3D interactive environments for the children's narrative: a didactic project. In Proceedings of the 2005 ACM SIGCHI International Conference on Advances in computer entertainment technology (pp. 350-353). ACM.

[5] Carrozzino, M., Evangelista, C., Neri, V., & Bergamasco, M. (2012). Interactive Digital Storytelling for Children's Education. Educational Stages and Interactive Learning: From Kindergarten to Workplace Training, IGI Global, 231-252.

[6] Carrozzino, M., Brogi, A., Tecchia, F., & Bergamasco, M. (2005, June). The 3D interactive visit to Piazza dei Miracoli, Italy. In Proceedings of the 2005 ACM SIGCHI International Conference on Advances in computer entertainment technology (pp. 192-195). ACM.

[7] Camin, L., Carrozzino, M., Leonardi, R., & Negri, A. (2010). Nuove tecnologie per la conoscenza e la comunicazione di Lucca romana. Archeologia e calcolatori, (21), 49-73.

PROVIDING RECOMMEDATIONS FOR VIRTUAL MUSEUM TOURS USING INTELLIGENT ASSISTANTS

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ABSTRACT
Personalization technology and services have been widely adopted in many domains, especially on various web platforms. This kind of technology is also finding its way to cultural heritage applications since it can broaden the interest in visiting cultural sights. Recommendation systems suggest to users some specific domains that they might be interested in but were unfamiliar with due to their lesser popularity. In this paper we propose a web service for virtual museum tours that is based on intelligent virtual assistants who learn user preferences and provide recommendations about museum exhibitions.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]: Language processing, virtual assistants, artificial intelligence.

General Terms
Algorithms, Performance, Design, Experimentation, Languages

Keywords
Virtual assistants, language processing, cultural heritage, recommender systems, artificial intelligence,

1. INTRODUCTION
Most of the museums offer to its visitors a wide selection of artwork, sculptures, vases, ancient objects, and other exhibits. This might be overwhelming for the visitors and most of the seen exhibits might not be of interest to them. This might cause them to lose interest in the exhibition and miss artwork or other objects that are more linked to their personal preferences. Since more and more content is available in digital form and available on the internet, users would benefit from services and applications that provide virtual tours and suggest specific exhibits that users might like more.

In this paper we propose an online web service that offers virtual tours in museums that are covered with the Google Arts & Culture project (Google Street View). The application provides a natural language interface using a virtual assistant (VA), where users can input questions or requests and the VA takes care of identifying the correct answer and displays the corresponding feed from Google Street View. Moreover, a recommender system is integrated in the web service that provides suggestions regarding exhibits targeted for a specific user. We will present a proof-of-concept realization of the system and define the experimental setup.

2. RELATED WORK
In the literature, several research papers were published on recommendation systems for museum visits. Pechenizkiy and Calders in [1] presented a simple user-focused framework for personalizing museum tours. They focused on efficient learning since the system should be able to quickly provide relevant suggestions only after a small set of user preferences.

Mathias et al. [2] proposed a new method for personalized museum tour recommendations. Their research tackles the problem of optimizing museum visits according to visitor's preferences and artwork importance. Through questionnaires they showed that the system clearly improves the satisfaction of visitors who follow the proposed tour.

Huang et al. [3] proposed a method for personalized guide recommendation system for museum visitors. The developed system used association rule mining to discover recommendations from both collective and individual visiting behavior. Using this system the visitors avoid the exposure to excessive exhibit information. Using questionnaires they showed that visitors had a positive attitude towards the provided suggestions.

Keller and Viennet [4] have evaluated several recommendation methods to suggest relevant content to museum visitors. Their dataset was collected through a mobile interface that displayed audiovisual content to museum visitors. They were able to bookmark (like) certain content which was later regarded as positive data for the learner. Their system is similar to ours in the way they collected and regarded the data since they do not use five star ratings.

Although research has already been performed in this area, our approach is different than the one presented in most other papers in the way it interacts with the user and presents the content.

3. VIRTUAL MUSEUM GUIDE
This section covers the basic concepts of the developed virtual assistant that can model the preferences of the users and can

provided targeted recommendations regarding exhibitions in a virtual museum.

3.1 Virtual assistant

The core of the whole system is a web based virtual assistant that can, to a certain degree, understand the questions inputted by the users. The VA is instantiated from an existing web framework that allows the creation of basic virtual assistants. It provides functionalities for a full customization of the UI and the creation of the VA knowledge base. Its content is created from part of the exhibits of the British Museum (http://www.britishmuseum.org/). In addition, the background page that is linked to each knowledge base entry is a Google Street View representation of the location where the exhibit is located. Figure 1 shows the initial page that is displayed when the VA is instantiated to the content of the British Museum.

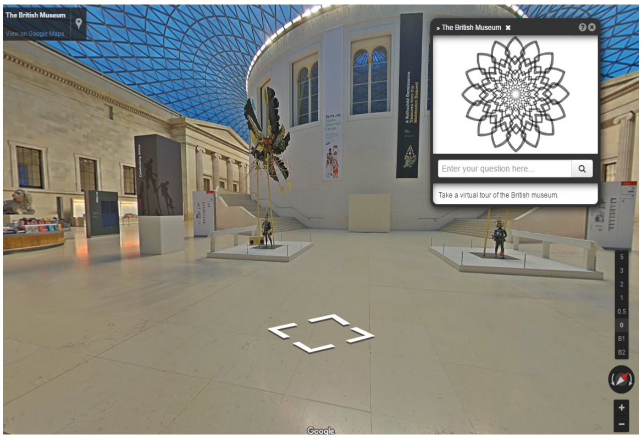

Figure 1. The initial view of the British Museum application.

The knowledge base entries can related to a specific room in the museum, a similar group of objects, or to an important exhibit. The VA displays a description of the object, while the page in the background shows a Google Street View of the searched object. The user can freely move around and observe the object from different point of views (see Figure 2).

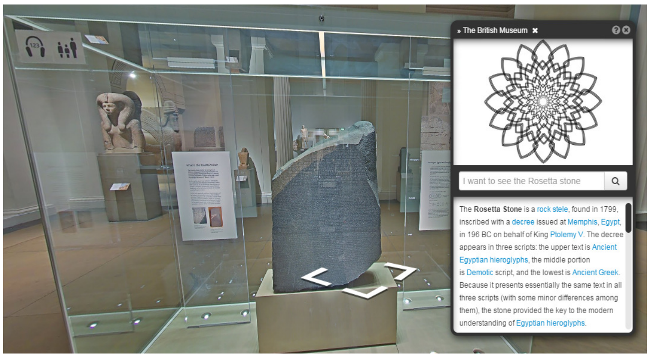

Figure 2. Inquiry regarding a specific object.

As already mentioned, the VA analyses the question posed by the user, it then searches in its knowledge base and displays the answer. If the query is regarding a specific exhibit then the answer is a description of the object that can contain links where additional information can be found. Figure 3 displays a close-up of the VA and the answer when the user searched for information regarding the Rosetta Stone.

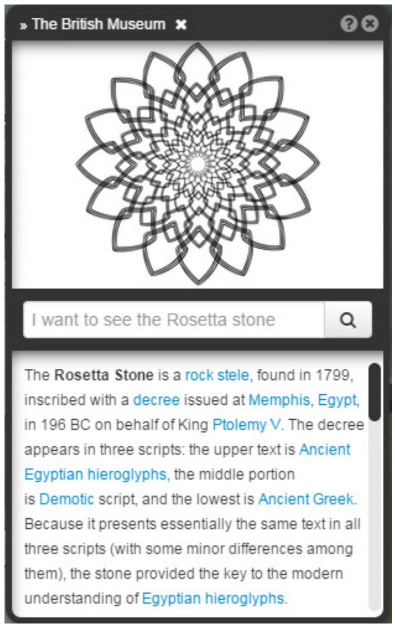

Figure 3. A predefined answer regarding the Rosetta stone.

Every query of the user is stored in the admin web portal. The records regarding specific exhibits are marked and are later used by the recommender system to build a model of user preferences. We regard such entries as likes produced by the user.

3.2 Recommender system

The virtual assistant by itself is a useful interaction tool and can deliver to the user a lot of information regarding museum exhibitions. However, such a simple system is not very different from an online search even though it can provide better targeted information faster. Therefore we designed a recommendation system linked to the virtual assistant.

Due to the specificity of the problem (no implicit rating from users) we had to design a recommendation system that learns user preferences based on implicit data (queries, time spent on each answer, motion, etc.) and item features. We decided to implement a content-based filtering algorithm. To generate a recommendation, the recommender does not use data from other users but the similarity between items in the dataset. These similarities can be computed by using one of the numerous similarity measures to predict ratings for user-item pairs not present in the dataset.

Figure 4 shows a schematic representation of the basic recommendation mechanism. Each item is labeled with a vector of features that describes the exhibit. To the top vase in the figure might correspond the vector V1 = {vase, china, ancient, big, colored}. The vector of the second vase might be V2 = {vase, greek, ancient, big, colored} and the vector of the third vase V3 = {vase, general, ancient, big, colored}. Since User 1 searched for the first two vases, his preference model might state that he likes big, colored and ancient vases. Based on the similarities of the user preference vector and V3, the third vase is recommended to the user. A similar mechanism is adopted for User 2.

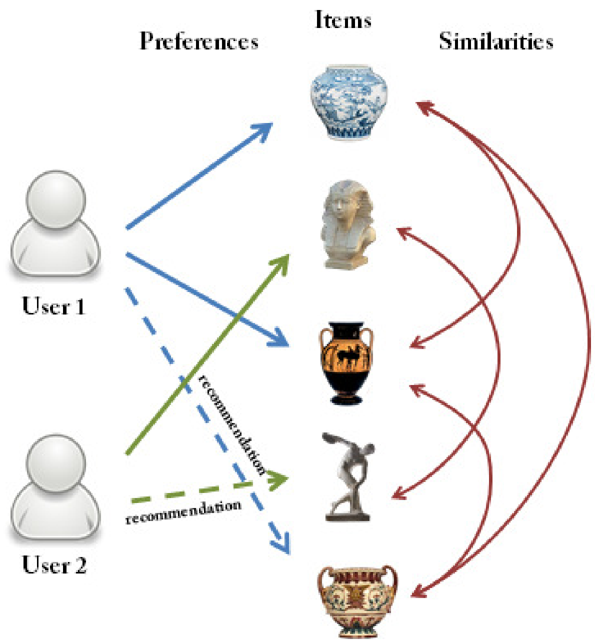

Figure 4. A simplified recommendation mechanism.

4. EXPERIMENTAL SETUP

In order to verify the quality of recommendations and the accuracy of the system, we designed an experiment involving several users. Since the experiment is still ongoing, only the setup is presented. Users were invited to use the virtual assistant and ask various questions. All the queries regarding exhibits will be collected and stored as the dataset. Next, the 10-fold cross validation mechanism will be used to create the learning and testing set and verify how the model performs. The learning set is used to create the vector of user preferences. The test set is then used for recommendations. Each item is classified using the model of user preferences. If the model would recommend the item from the test set, then the recommender has correctly classified the item.

To fully evaluate the model, the receiver operating characteristic (ROC) curve will be created. It is a graphical plot that illustrates the performance of a binary classifier as its discrimination threshold is varied. An example of the ROC curve is presented in Figure 5. The curve is created by plotting the true positive rate (recall) against the false positive rate (fall-out) at various threshold settings. The closest is the curve to the top left corner, the better the model performs (perfect classification). A point on a diagonal line results from a completely random guess. Based on the performance of the recommender model on the test set, the ROC curve will be created. This measure will tell us how well the model performs and will enable direct comparison between different recommendation methods.

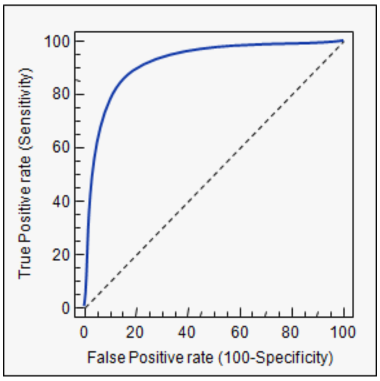

Figure 5. ROC curve as a measure of the recommender accuracy.

5. CONCLUSION

In this paper we presented a web-based application for virtual tours in museums and other buildings or objects related to cultural heritage. The core of the application is a virtual assistant that facilitates the communication with the user in natural language. The knowledge base of the assistant contains the information regarding exhibits, groups of objects and exhibition rooms taken from the British Museum. In addition, each answer is linked to a specific location from the Google Street view service so the user can experience a virtual tour of the museum. Moreover, the virtual assistant uses a recommendation engine that suggests specific exhibits based on the preference model of the user. Our intention is to evaluate the performance of the recommendation system and the overall user experience when using the application.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Pechenizkiy, M. and Calders, T. 2007. A Framework for Guiding the Museum Tours Personalization. Proceedings UM 2007 International Workshop on Personalization Enhanced Access to Cultural Heritage (CHIP).

[2] Mathias, M., Moussa, A., Zhou, F., Torres-Moreno, et al. 2014. Optimisation using Natural Language Processing: Personalized Tour Recommendation for Museums. Proceedings of the 2014 Federated Conference on Computer Science and Information Systems. pp. 439-446

[3] Huang, M. Y., Liu, C. H., Lee, C. Y. and Huang, Y. M. 2011. Designing a Personalized Guide Recommendation System to Mitigate Information Overload in Museum Learning. Educational Technology & Society 15 (4). Pp 150-166.

[4] Keller, I. and Viennet, E. 2015. Recommender Systems for Museums: Evaluation on a Real Dataset. IMMM 2015 : The Fifth International Conference on Advances in Information Mining and Management.

Using a Natural User Interface to Enhance the Ability to Interact with Reconstructed Virtual Heritage Environments

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ABSTRACT
Virtual Reality (VR) techniques are used to create computer-simulated environments which enable new forms of cultural entertainment. A critical problem is how to design the 3D Virtual Environments (VE) and what methods should be used for interaction, in order to offer an entertaining experience in a ubiquitous approach. The paper focuses on the added value of gaming methods for 3D reconstruction and interaction with 3D representations of cultural heritage assets using a NUI designed for games. The impact of the game mechanics and interaction was investigated by developing a VE of a medieval burg (Brasov, Transylvania). The VE development involves high quality 3D reconstruction of the burg, creating a collection of gestures to interact with the VE, and their implementation and testing within the VE. The paper also includes a qualitative and quantitative evaluation of the implemented system, as tested by subjects who carried out a navigation session of the VE.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities, H.5.2 [**User Interfaces**]: Input devices and strategies

General Terms
Design, Experimentation, Human Factors.

Keywords
3D reconstruction; virtual heritage; games engine; interaction; navigation; Kinect.

1. INTRODUCTION
Technological breakthroughs in real-time computer graphics, virtual and augmented reality enabled creating 3D virtual environments (VE) that allow users to explore cultural heritage. Virtual Heritage (VH) supports the reconstruction, preservation, transfer and display of cultural heritage information using virtual reality. Virtual Reality (VR) refers to a system of concepts, methods and techniques used to develop simulated environments by means of modern computer systems (computers and specialized equipment). 3D historic site reconstruction is one of the most VR - supported cultural dissemination form.

A critical problem is how to design the VH environments in order to offer an entertaining experience in a ubiquitous and personalized manner. Most literature has argued that interactive engagement in a computer-based environment is best demonstrated by games [1]. Game mechanics and interfaces represent an exceptional opportunity providing innovative approaches to interact with 3D representations of cultural heritage assets.

In this paper we examine the potential of using computer game engines and user interface techniques, to intuitively create and explore a VE. This article attempts to find answers to the following questions:

1. What is the added value of the game mechanics for the development of VH environments?

2. What is the value and utility of this approach in cultural heritage interactive exploration, using a Natural User Interface (NUI) device?

3. Are NUI technologies useful for the navigation in a 3D VH environment?

The impact of the game mechanics and NUI interaction techniques were investigated by implementing a virtual environment of the medieval burg of Brasov.

2. VIRTUAL HERITAGE SYSTEM
Virtual Heritage (VH) is a system built to create visual representations of cultural heritage facets like historic sites, towns, monuments or artifacts. This concept can become a platform for understanding and learning certain events and historical elements by researchers and visitors. The use of VR technology in architectural heritage facilitates access to cultural heritage sites by mitigating the preservation and dissemination difficulties. To create a VH system, one must address two basic issues: virtual environment reconstruction and interaction. The implementation of these two concepts, which is more than a mere reproduction of an archaeological site, represents a simulation process where objects, behaviors, ecosystems are combined [2][3][4]. The goal is to analyze the cultural artifacts, to preserve and share a record of their geometry and appearance, then to acquire detailed shape information [3][5][6][7].

2.1 Virtual Environment reconstruction
The procedure of building virtual environments starts with a virtual construction of an archaeological site. Firstly, the ancient potential landscape (geomorphology, water system, potential soil use, vegetation) will be rebuilt and secondly, the anthropic layer of the landscape (sites, monuments, road system, settlements). In addition, the people / environment and people / people relationships are to be defined. However, one issue is raised regarding 3D reconstruction: how can we build a realistic virtual

archaeological model based on fragmentary data, in order to obtain the highest reliability and accuracy? Finally, the 3D reconstruction is an interpretation based on the complex analysis of various types of sources, where the “vision” concept has a basic role [3][8]. A 3D reconstruction of a totally or partially destroyed building requires a 3D CAD model that observes the historical construction details. The concept of "cultural heritage" involves several actions (acquiring, processing, presenting and recording data) in order to determine the position, shape, structure, size and other characteristics of a monument or historical site in 3D space at a given time [9].

2.2 Interaction

The interaction between elements of the virtual environment is an important challenge, compared to the implementation of static elements. While reconstructions used in research do not require special functionalities for navigation, in case of games, the use of real time fast running applications is required. In accordance with the increasing presence of VR based software in computer applications, there has been a growing need for more realistic virtual worlds with ever increasing complexity (the size of the scenes, the complexity of details) compelling developers to invent ever more complex solutions to address the challenges created by such requirements [10].

Using 3D game engines to create immersive environments was a technique rarely used despite the commercial success and the high level of photorealism achieved by current software / hardware technology (called Serious Games–SG) [11].

2.3 Game engines for virtual reconstruction of medieval cities

The use of game methods to develop virtual heritage applications is known, and a number of projects have used this approach to reconstruct medieval cities (Google Art Project, Google Earth, Real and Virtual, Panoramic Earth, Paris Medieval, Battle Castle Dover, Medieval City of Bologna, City Engine, Castel Almodovar, Nürnberg 3D, London Project and video games like Second Life, Assassins’s Creed series, Mount and Blade, Chivalry: Medieval Warfare, War of the Roses, Total War series). For some projects (especially from universities) we have little information, because they have never been released to the wider public. The surveyed projects used several game engines for visualization and virtual reconstruction of medieval cities. It was also revealed that none of the projects surveyed (online virtual tours, videos, university projects and games developed in the last 10 years) used NUI. However the compatibility of the surveyed projects with NUI sensors has not been formally tested and evaluated. In the case of new games and computer graphics engine sites, although it is speculated that the tests have started, they have never been made public.

3. TEST CASE: THE MEDIEVAL BURG OF BRASOV VIRTUAL HERITAGE ENVIRONMENT

The virtual environment development of the medieval Brasov burg, based on game mechanics consisted of the following steps (Figure 1): high quality 3D reconstruction of the medieval burg of Brasov, creating a collection of gestures to interact with the virtual environment, implementing and testing gestures in the virtual environment, verifying and testing on human subjects, studying results and drawing conclusions.

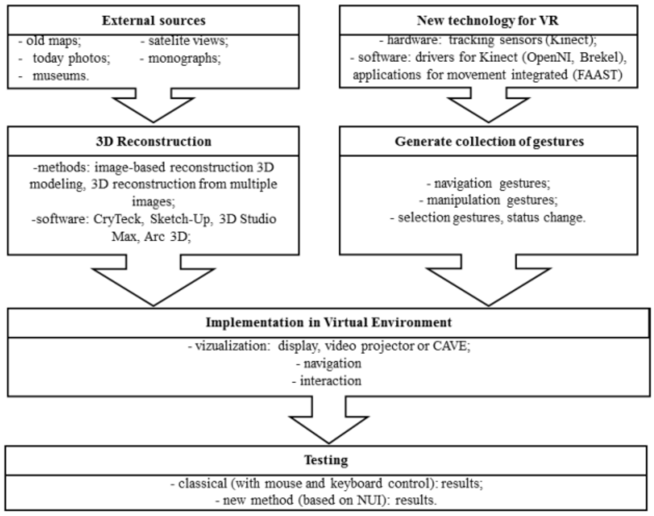

Figure 1. The algorithm of the test case

The graphics engine used in the virtual reconstruction of the medieval burg is CryEngine 3.4.5, (http://www.crytek.com/cryengine) also called Sandbox Editor. The main reasons behind this choice are: realistic graphics, freedom of control, movement and interaction.

3.1 3D reconstruction of the burg of Brasov

In order to achieve the 3D reconstructed model of the medieval burg of Brasov (Ger.: Kronstadt - in the Middle Ages), several sources of information were used: old maps (Figure 2,a) [12], satellite photos - Google Earth (http://www.google.com/earth/) (Fig. 2,b), photos of present vestiges (Figure 2,c), and other historical sources, such as information from The Carpenter Tower Museum, The National Museum and The First Romanian School of Brasov, The Virtual Museum inside The Drapers’ Bastion, documents from The National Heritage Centre, information from The City Hall Museum, monographs [13][14]. The southern defense wall of the burg which also includes some major towers like The Drapers' Bastion and The Carpenters’ Tower has been recently rebuilt in detail (orange in Figure 2,b).

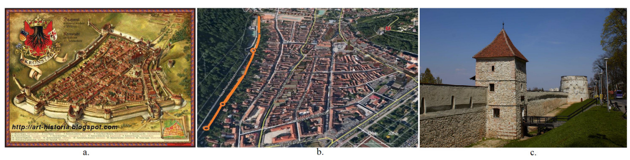

Figure 2. (a) Brasov map, 17th century [12], (b) satellite view (Google earth), (c) photos taken from the ground (by C. Postelnicu), on the T. Bradiceanu St., showing the Drapers' Bastion and The Carpenters’ Tower.

We used different 3D reconstruction methods: image-based reconstruction, 3D modeling, 3D reconstruction from multiple images (especially for details) and multiplication. The implementation of reconstructed 3D environment into the virtual environment and interaction tasks, have been achieved using CryEngine software in collaboration with other software applications listed below. Firstly we focused on rebuilding the southern part of the burg, near Mount Tampa. Later we added the specific elements for the interior of the Carpenters Tower, using other application software: Google Sketch-up (http://www.sketchup.com/), 3D StudioMax2011 (http://www.autodesk.com/products) and ARC 3D for details (http://www.arc3d.be/). The original purpose of the project was to reconstruct the burg only partially. Later, the project grew significantly, elements such as walls, streets and buildings appearing throughout the stage (Figure 3).

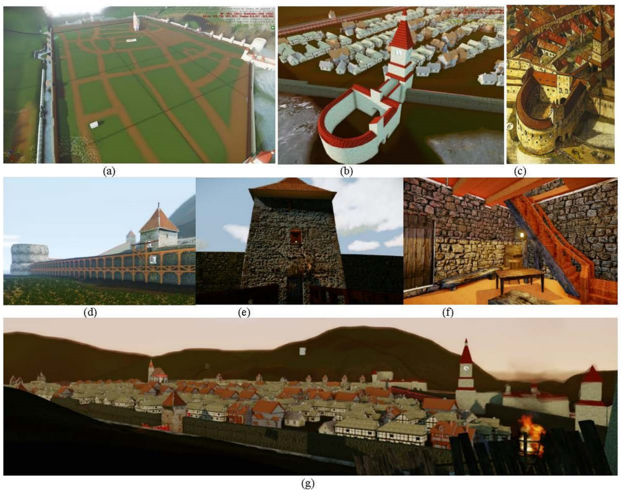

Figure 2. The 3D virtual reconstruction of ancient buildings. (a) the reconstructed old saxon town streets; (b) the Main Gateway; (c) the same gateway, detail from ancient map [25]; (d) the southern defense wall with the Carpenters' Tower, interior (e) and exterior (f), photos taken with Cryengine 3.4.5; (g) the medieval burg of Brasov, XVII century

The major monuments (towers, gates, The Black Church, etc.) were reproduced and located according to plans and historical documents. In the beginning, our intention was to create a virtual panorama using photos and textures acquired on site. Later, due to high consumption of resources (processing and graphics), we chose to use a random reconstruction of buildings between the virtual walls of the virtual burg of Brasov, by multiplying models for atmosphere, most of which are similar also in reality.

3.2 Interaction techniques description

In order to navigate in the virtual environment using just a Kinect sensor, we propose a simple and intuitive model, based on the main types of movements and choices in a virtual environment: change of perspective and/or plan of interaction with the environment, activation of certain objects and commands - such as grabbing and/or throwing objects in the scene, their manipulation in a virtual environment, pushing or pulling certain objects in the scene. We developed a series of gestures based on skeleton joints tracking, which were mapped to the interaction commands with the virtual environment: moving forward, backing, swimming, bending left and right, grabbing, jumping, and squatting. The following graphic (Figure 3) illustrates an example of gesture sensing in the real environment, interpretation in FAAST application and the result in virtual environment.

4. EXPERIMENTAL DATA

The aim of the evaluation study presented in this section is to assess the way a game interface can be used for virtual heritage applications. In the conducted experiment we compared the proposed natural interaction game interface with a traditional WIMP interface. For our test case, we decided to use the old burg of Brasov virtual heritage environment previously presented.

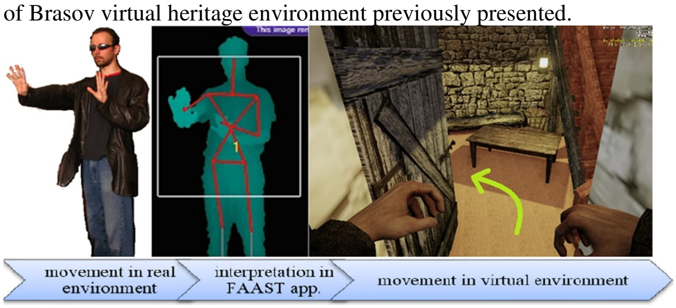

Figure 3. The act of opening a virtual door and its effect in the virtual environment

We carried out a usability test on a number of 24 subjects aged 19 to 57 (mean= 29,80). Each subject filled in a questionnaire providing information about age and sex, previous experience in playing games and using VR technologies, experience with virtual environments and computer skills. A few of the subjects, usually PhD students, had previous experience in using natural user interfaces. However, all the users were proficient in at least one game (as virtual environment) and had good computer skills. The users had 20 minutes, prior to the experiment, to practice the natural game interface functions of navigation and interaction with the virtual environment. Half of the users first used the traditional desktop WIMP interface, then, after a 20 minute break, they were asked to conduct the same task using the game interface. The other half interacted with the virtual environment using the game interface in first instance, and then the desktop system. Each time value was recorded for the assessment of the results. The application ran on a Windows 7 PC with Intel Xeon 3,6 GHz Processor and 16 GB RAM with a NVIDIA Quadro 6000 GPU.

The task completion time was measured for each participant. Figure 4 displays the average time needed by the subjects to complete the assigned tasks using both user interfaces. Concerning the performance evaluation, it is to be observed that natural game interface does not considerably improve the navigation in the virtual environment, compared to conventional WIMP interface.

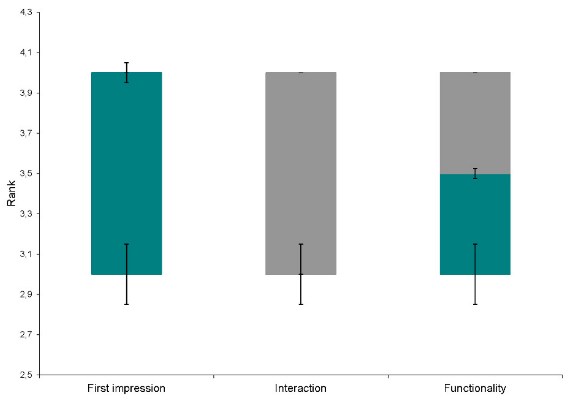

Figure 4. Comparative tests

At the end of the experiment the participants were asked to rate the game interfaces on a 5-point Likert scale: Strongly agree (5), Agree (4), Neutral (3), Disagree (2) or Strongly disagree (1) (Figure 5). The post experiment questionnaire was meant to evaluate ease of use, satisfaction level, and intuitiveness of the game-like interface.

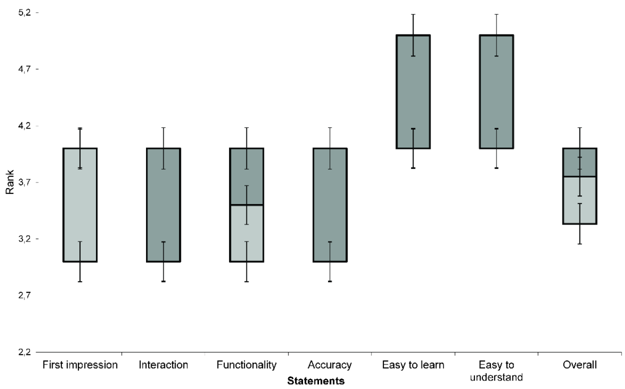

Figure 5. Results of the subjective questionnaire

In comparison with the traditional WIMP interface, the subjects expressed great interest in using game technologies for virtual heritage. The stated reasons relate to the more intuitive virtual environment and the simplification of the series of windows and menus needed for various operations. The users appreciated the gestures interaction functionalities which offered the opportunity of a natural communication of commands. The subjects considered the game interface commands easy to learn and understand, thanks to the natural and intuitive communication paradigm.

5. CONCLUSIONS

This paper discusses the development of a VH application based on NUI game methods. The test case developed for this purpose was the 3D complex reconstruction of the medieval burg of Brasov, Transylvania, using an available game engine. The advantage of using game technology for development of cultural heritage virtual environment resides in the possibility to achieve better quality, faster development, complexity and fidelity by using high quality real-time graphics, powerful AI to handle character behavior, advanced algorithms for character movement system. We also proposed and developed a simple and intuitive interface for virtual environment exploration, based on the main types of movement gestures. The navigation includes forward/backward movement, left/right turn and jump/squat. In the interactive 3D reconstructed medieval burg of Brasov, the user can choose which buildings and rooms to visit, interact with characters and manipulate virtual objects, experience near-photorealism in indoor and wide-open outdoor environments and extraordinary real-time special effects (like swimming).

6. ACKNOWLEDGMENTS

This paper is supported by European Union's Horizon 2020 research and innovation programme under grant agreement No 692103, project eHERITAGE (Expanding the Research and Innovation Capacity in Cultural Heritage Virtual Reality Applications). 3D reconstruction and user interface activities were developed in the master thesis "Gesture navigation and interaction in virtual reconstructed medieval burgs" held at the Transilvania University of Brasov by Alexandru Constantin Georgescu, 2013.

7. REFERENCES

[1] Champion E. Otherness of Place: Game-based Interaction and Learning in Virtual Heritage Projects. International Journal of Heritage Studies, 2008, 14, 210 – 228.

[2] Noh Z.; Shahrizal Sunar M.; Pan Z. A Review on Augmented Reality for Virtual Heritage System, Learning by Playing. Game-based Education System Design and Development, Lecture Notes in Computer Science, 2009, 5670, 50-61

[3] Pescarin S. Ancient Landscape Reconstruction, in 1st Digital Cultural Heritage Workshop, 2012, The Cyprus Institute, Nicosia, Cyprus.

[4] Rua H.; Alvito P. Living the Past: 3D Models, Virtual Reality and Game Engines as Tools for Supporting Archaeology and the Reconstruction of Cultural Heritage – the Case-Study of the Roman Villa of Casal De Freiria, Journal of Archaeological Science, 2011, 38, 3296-3308.

[5] Beraldin J.-A.; Picard M.; El-Hakim S.; Godin G., Borgeat L., et al. Virtual Reconstruction of Heritage Sites: Opportunities and Challenges Created by 3d Technologies, in The Intl. Workshop on Recording, Modeling and Visualization of Cultural Heritage, 2005, Ascona, CH.

[6] Mansor I.; Puteri S.J.; Maisarah A.; Nurul S.A.L.; NorZalifa Z.A. Virtual Reality in Heritage Studies and Historical Reconstruction through Animation – a Case Study of a 16th Century University Complex in the Ottoman World, in 7th International Conference on Construction Applications of Virtual Reality, 2007, Penn State University, USA.

[7] Popovici D.M.; Querrec R.; Bogdan C.M.; Popovici N. A Behavioral Perspective of Virtual Heritage Reconstruction, Int. J. of Computers, Comm. & Control, 2010, V, 8.

[8] de Heras Ciechomski P.; Ulicny B.; Cetre R.; Thalmann D. A Case Study of a Virtual Audience in a Reconstruction of an Ancient Roman Odeon in Aphrodisias, in VAST-04 The 5th International Symposium on Virtual Reality, Archaeology and Cultural Heritage, 2004.

[9] Yilmaz, H. M.; Yakar, M.; Yildiz, F. Documentation of historical caravansaries by digital close range photogrammetry. Aut in Construction, 2008, 17(4), 489-498.

[10] Tyberghein J.; Sunshine E.; Richter F.; Gist M.; van Brussel C. Developing Video Games and Virtual Environments with the Crystal Space Engine, (www.crystalspace3d.org), 2010.

[11] Carrozzino M.; Evangelista C.; Brondi R.; Lorenzini C.; Bergamasco M. Social Networks and Web-Based Serious Games as Novel Educational Tools. Procedia Computer Science, 2012, 15, 303-306.

[12] Brasov map from http://art-historia.blogspot.ro/2009 /04/afisele-art-historia.html (accesed on 24 October 2013).

[13] Oltean V.; Radu M.; Marin E.; Nussbächer G. Brașov – monografie comercială, Brasov, ISBN: 973-0-03514-8, Brasov, 2004, 40-52.

[14] Oltean V. Configurația Istorică și Bisericească a Brașovului, (Sec. XIII – XX), Ed. Andreiana, ISBN 978-606-8106-19-9, Sibiu, 2010, 14-88

COMPUTER-GENERATED KNOWLEDGE BASE FOR VIRTUAL ASSISTANTS

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ABSTRACT

Manual creation of knowledge bases for virtual assistants is a time-consuming and demanding task. This is a major drawback of such systems that limits the effective transfer of virtual assistant into everyday use. We propose a procedure that would automate the construction of the knowledge base and thus increase the use of virtual assistants.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Language processing, virtual assistants, artificial intelligence.

General Terms

Algorithms, Performance, Design, Experimentation, Languages

Keywords

Virtual assistants, language processing, cultural heritage, artificial intelligence

1. INTRODUCTION

Virtual assistants have become in recent years a useful tool that helps users find information faster and in a more accurate manner. Companies like Google, Microsoft or Apple provide general assistants that help users find restaurants or shops close to their location, manage their phone or provide computer-aided support for software packages.

The general versions of the virtual assistants usually do not perform well enough on specific domains, where the required answers deal with information that is harder to find. The web-based framework "Asistent" [1] deals with this problem, since it supports the instantiation of virtual assistants for question answering regarding specific topics. The core of the whole system is a web based virtual assistant that can, to a certain degree, understand the questions inputted by the users. These assistants are installed in several Slovenian municipalities and it helps users of the municipality web page to find information on this page faster.

A drawback of the framework is the need to create the knowledge base of the assistants manually from various sources. Currently, the basic functionality of the Asistant is to answer 500 predefined questions regarding the municipality, its organizational structure, forms, acts, and touristic and cultural related topics. These answers were created manually, thus adapting the assistant to a different municipality takes a lot of time and resources.

This paper presents a computer-based approach for the automatic creation of the assistant's knowledge base from the learning set composed of the 500 predefined questions. The approach is based on machine learning methods to identify web pages where the required information is found and how to extract the knowledge into answers.

2. VIRTUAL ASSISTANT FOR MUNICIPALITIES

Virtual assistants for municipalities were created during the "Asistent" project. It understands questions in natural language and can provide answers regarding Slovenian municipalities. The virtual assistants are installed on the web pages of municipalities and are used by users to facilitate the search of information located on the web pages of municipalities. Figure 1 shows an example of use of the virtual assistant for one municipality.

Figure 1. A virtual assistant for a Slovenian municipality.

During the project, a set of 500 questions were identified as common for all municipalities and manually created answers were used to populate the knowledge base of the three initial municipalities.

The virtual assistant analyses the question posed by the user, it then searches in its knowledge base and displays the answer. If the query is linked to a specific content on the web page, the answer provides an abstract of the information needed and redirects the background page of the browser to the location where additional information can be found.

A drawback of this system is the need for manual definition of the knowledge base entries, which turned out to be too time demanding. This is one of the reasons why the virtual assistants were not adopted in larger numbers by the municipalities.

3. CREATION OF THE KNOWLEDGE BASE

The aim of this work is to design a method that can automatically create the knowledge base of the virtual assistant based on the initial set of 500 pre-prepared questions.

3.1 Learning

The learning system works in two steps. First, it tries to find relevant web pages that contain the needed information. This is achieved by: (i) parsing the web pages of the municipalities and using machine learning methods to classify the correct page, or (ii) parse the results of queries from search engines. The second step is to extract the key information from the identified web pages and use it to construct computer-generated answers.

The construction of classification models follows the standard machine learning methodology. A simplified scheme of the general learning system is presented in Figure 2. Labeled data is collected from the manually constructed assistant's knowledge bases, which resulted in 1589 learning instances. The system uses Multi-label learning to create a classification model that can classify instances into multiple classes. This is an important aspect, since answers to more than one question can be found on the same page.

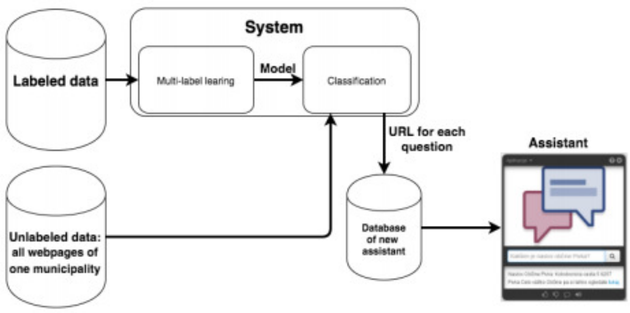

Figure 2. The general scheme of the learning system for the automatic knowledge base construction.

After the classification and the pages that contain the needed information are identified, an efficient extraction mechanism is required. The entire content of the web page cannot be used as the response of the virtual assistant, since only limited space is available in the GUI. The additional information (the web page) is displayed in the background (in the browser). The answers that require such processing are from cultural and natural heritage, description of the municipality, news, facts, etc.

The extraction algorithm is based on keywords and regular expressions that are defined beforehand for a specific question. The keywords are transformed into regular expressions, that are later used to match the content. First, the algorithm parses the structure of the page and recursively searches for newline breaks and adds the whole content to its parent node. This helps to delimit the content and sections of the page. Next, the algorithm traverses the entire tree structure that was just created and applies the regular expressions to all text nodes. Then it counts the number of expressions that were triggered and selects as the short answer the text node with the highest matching number.

3.2 Evalutaion

The evaluation was performed for both tasks described in the previous section. We used a variation of the leave-one-out method: leave-one-municipality-out. During each run, data from one municipality was used for the test set and all other for the training set. Each time a manual evaluation was performed for all municipalities.

In the first task, the system suggested one web page that should contain the answer to the question. These pages were reviewed and labeled as: highly relevant, relevant or irrelevant. More than 50% of the answers were at least relevant to the question and 37.5% labeled as highly relevant.

A similar approach was used for the second task. One municipality was used as the gold standard and the learning set, since it has the most comprehensive set of answers. The quality of the generated answers was verified manually on the other 16 municipalities. The answer was deemed as relevant if it contained the required information in a user friendly format. 82% of the generated answers were labeled as relevant, which is an adequate enough result to facilitate the work of municipalities during the adaptation of the system.

4. CONCLUSION

We presented an approach for the automated construction of the knowledge base for virtual assistants that can provide answers to questions regarding the municipalities and their related activities. The approach uses the manually created 500 questions for the learning set and is based on machine learning techniques to adapt the questions to other municipalities. We showed that the approach generates a reasonable amount of relevant answers that can be used to populate the initial knowledge base. The classification accuracies achieved for both tasks are high enough to create an informative initial version of the knowledge base that can be improved further.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Projekt asistent - virtualni asistent za občine in društva. http://www.projekt-asistent.si/ . (Visited on 29/9/2016)

Using Mixed Reality and Natural interaction in Cultural Heritage Applications

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ABSTRACT

In this paper, we present a general architecture for Mixed Reality systems with the aim of providing users with immersive experiences. The proposed solution has been developed in order to provide a useful instrument to develop Cultural Heritage applications, especially when dealing with the communication / dissemination of intangible knowledge such as manual activities.

The proposed architecture exploits Natural User Interfaces solutions in order to provide high sense of presence and immersion.

The paper presents also two case studies, where two different applications aimed at teaching and disseminating crafts knowledge, in particular printmaking and weaving, have been developed on top of the presented architecture.

Categories and Subject Descriptors

H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Artificial, augmented, and virtual realities.*

General Terms

Documentation, Design, Experimentation, Standardization.

Keywords

Natural Interaction, Mixed Reality, Virtual Reality, Cultural Heritage, Museum Application.

1. INTRODUCTION

Virtual Reality (VR) applications create interactive environments in which the observer feels totally immersed: users can move or interact in a completely synthetic world [1]. Differently, in Augmented Reality (AR) applications the digital content is integrated into the real environment [2]. VR and AR technologies are becoming extremely popular and are used nowadays to implement many kind of applications in several different fields: military, medicine, education, visualization, entertainment, etc… . These two technologies represent two different expressions of a common family of technology and application falling under the definition of Mixed Reality (MR). Milgram and Kishino [3] theorized the concept of "virtuality continuum" in order to create a classification able to describe this concept. They placed on one extreme of the continuum the real world and on the other side a completely virtual world. The space of virtuality continuum lying between the two extremes, all the technologies and applications, represents different flavors of Mixed Reality (MR), including AR (real environments augmented with virtual contents) and Augmented Virtuality (virtual environments augmented with real contents).

VR and MR applications in the context of Cultural Heritage (CH) are nowadays gaining an increasing consent, for a variety of purposes including digital conservation (reconstructing artwork damaged or destroyed) [4][5], for validation of scientific hypotheses in archeological reconstructions [6] and for education [7]. At the same time the recent spreading of depth sensors together with sensorised controllers is nowadays shaping the way we interact with the Virtual Environments (VE). Natural User Interfaces[1] (NUIs) are becoming more and more popular, and new richer interaction metaphors can be designed in order to improve the engagement and sense of presence of the users providing a completely new experience [8]. NUIs enabling visitors to be physically and emotionally involved during a virtual experience are becoming popular also in the Cultural Heritage context [9].

In this paper we present a general architecture for Mixed Reality systems that can be used to provide an immersive experience to Cultural Heritage visitors. The proposed solution can be used both for dissemination purposes, as it enhances the engagement of the user, and for training/teaching activities. In particular such systems results extremely effective when trying to transmit intangible knowledge, as like as craftsmanship, since it allows the visitors to physically emulate the proposed actions. Moreover the system can be used both with static prerecorded material and with real-time capture of the real context.

2. STATE OF THE ART

As above mentioned, differently from VR, MR mixes "synthetic" and "real" information making them coexisting in the same environment. Most of the applications developed in the context of CH are based on Augmented Reality [10][11]. The main reason is because commonly these applications keep the cultural asset in the foreground, enriching its images with digital content. When

[1] Natural User Interface is a term used to identify human-computer interactions based on typical inter-human communication. These interfaces allow computers to understand the innate human means of interaction (e.g. voice and gestures) and not induce humans to train to the language of computers (e.g., keyboard and mouse).

dealing with intangible assets, such as performing arts, manual activities, lost civilizations habits, there is not a real concrete object to augment. This kind of evanescent knowledge requires a deeper usage of virtual components [12] because the real part is not physically present or is not always available.

All MR solutions usually needs to merge 3D (live or recorded) information coming from the real environment with a 3D synthetic environment as smoothly as possible. By using immersive displays like HMDs, the user experience can be further enhanced. Tecchia et al. in their work [13] proposed a HMD visualization system including the real time stream of 3D images of user's hands recorded with a depth-camera. The system makes use of two colored markers placed on top of the user hands to enable a basic interaction with the VE. The depth sensor put on top of the HMD was in charge of recording the peri-personal space and in particular the user hands. The acquired stream was used to recreate a representation of the user inside the VE. Moreover, using the combination of RGB and depth information coming from the camera, the system recognizes the fingers movements in the environment allowing the user interaction with the environment (e.g. virtual object pinching).

The metaphors of interaction enabled inside MR applications, from completely Virtual to Augmented ones, represent another extremely important design aspect. Specific solutions impact differently on the sense of Presence, Immersion and Engagement of the user. In the context of CH applications, improving these factors can enhance the impact of a dissemination application. It becomes even more important when the aim of the application is learning or training. Safeguarding and passing over skills and intangible cultural heritage features is the subject of several experiments, as well as large research projects [14][15]. Carrozzino et al. [9] argued that Immersive VEs combined with natural interaction would provide a powerful solution to develop a system to transfer practical skills.

In the last years several researchers and technological industry leaders have focused on the development of different solutions enabling a smooth and simple natural interaction of the user inside the VE. Most of the efforts so far are focusing on hand tracking solutions [16][17][18]. The Leap Motion Controller represents one of the latest technological products created to enable user natural interaction inside the VE based on hand tracking/gestures. It is gaining a lot of popularity due to the ease of use and tracking performance achieved with the latest updates. This device can be easily integrated in any VR/MR application in order to allow users to see and interact with the VE with their own hands. Coupling the Leap Motion controller with an HMD (e.g. the Oculus Rift or HTC Vive) provides developers with an extremely powerful and relatively cheap VR/MR solution that can be used in many Cultural Heritage contexts to provide extremely engaging experiences to the users.

3. THE ARCHITECTURE

The proposed system has been designed and realized on top of the XVR technology [19]. This allows a good flexibility in terms of support of hardware devices and ease of developing dedicated software add-ons able to expand the capabilities of the framework.

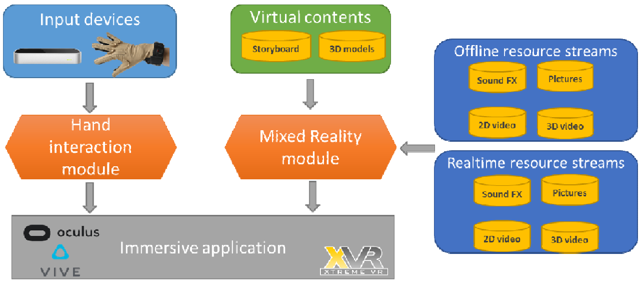

Figure 2. The architecture of the proposed solution.

As shown in Figure 2, the system is composed by a Mixed Reality module which is in charge of merging the real content coming from various streams (audio, images or video either 2D or 3D) with the virtual contents. The resources coming from the real world can be either pre-recorded or real-time captures of the world. The system takes care of handling the different streams, registering them inside the VE and rendering them to the user.

The virtual content consists of 3D models and Virtual Storyboards (VS). The system interprets the VS, a sequence of instructions defining the application storyboard, in real time. The VS, defined in text files in order to be easily authored by any text tool, provides the possibility of defining custom key-points that can alter the flow of the application. The VS allows also to specify how the real world resources and other elements (e.g. camera animations, interactive elements, movements and dialogues) are displayed in the VE and how the user can interact with them.

We are currently working on two different versions of the systems, using either the Oculus Rift HMD or a projection-based system (such as the X-CAVE facility at PERCRO laboratory) for visualization. In the first case the user interaction is achieved by using a Leap Motion camera mounted on the HMD front and in charge of retrieving motion data required to animate an avatar of the user’s hands and to interact with the virtual environment.

All the resources and the relationship between the resources, the action of the users, the timing and the environment are defined in a configuration file in order to be able to replicate the same functionalities in different contexts, loading custom resources and developing different game dynamics.

3.1 Interaction in the VE

The developed architecture contains a hand interaction module dedicated to the management of user interaction with the VE. The module is in charge of tracking the user hands and detecting gestures. Using the tracking information, a virtual representation of the user hands is provided in the VE. Moreover the detected gestures are used in order to enable actions to undertake in the Virtual Environment. Currently pointing, tapping and pinching gestures have been implemented in the system. These actions can be used to develop the user interaction with the environment (e.g. selection/pressing of GUI elements like a button, object selection and or transformation). The module offers an abstraction to the above infrastructure allowing the use of different input systems. The architecture have been tested with the Leap Motion Controller and with the CyberGlove II. Other hand tracking systems will be included in the future.

3.2 Case studies

Using our architecture, two different case study applications have been developed, for two different kinds of intangible Cultural Heritage dealing with craft.

The subject of the first application has been the work of printmakers. The VE replicates a structured print house featuring different locations where artisans can show their job, retracing all the steps involved in the process of making a stamp.

An approach similar to "I'm in VR" has been used to stream pre-recorded depth-movies inside the 3D VE [15], in order to reproduce real artisan movements. Depth movies allow to observe human motion with a high level of detail. More complex systems using graphics animations would require the use of very expensive motion tracking systems that can also hinder the artisan work (see Figure 3, right).

Artisans are visualized as pre-recorded depth-movies tessellated in real-time, rendered as polygonal meshes and merged inside the VE. Users can also explore the environment using natural movements or teleporting themselves in different places; they can also interact with the environment by selecting 3D objects and GUI buttons using the provided NUI.

A virtual character, a pedagogical agent, guides the user through the environment in order to explain the actions of the artisans and to provide information about their work (see Figure 3, left).

Figure 3. The pedagogical agent inside the VE (left) and the artisan pre-recorded depth-movies (right)

Figure 4. Watching own hands and the artisan's hands at the same time

Visitors, beyond observing the artisans from a classic "third person view" (see Figure 3 left), can observe the manual activities from a "first person point of view" (see Figure 4) as they were seeing his/her own hands. Furthermore, when in first person view, users can try to emulate the movements of the artisan as they see both their own hands, captured by the hand tracking device, and the artisan's ones.

The second application developed with the proposed architecture is related to the work of weavers. Weaving is a repetitive manual job, made on a loom. The developed application recreates an artisan workshop where different weavers are working. Users can freely explore the space around the artisan and, like the previously described application, see their own hands and overlap them to the "ghost" hands of the artisan in order to learn how to perform some of the actions needed during the work of weavers. The artisans' hands can be visualized both as pre-recorded depth-movies and as computer graphics animated "avatars". The 3D avatar animations have been recorded using the Cyber Globe II. Using the data gloves to capture the artisans' hands movements has been possible in this case because weavers commonly wear gloves in their work and therefore this did not hinder the artisan's activities. This allowed also to compare depth videos against avatar animations (see Figure 5) in terms of information delivery and perceived quality.

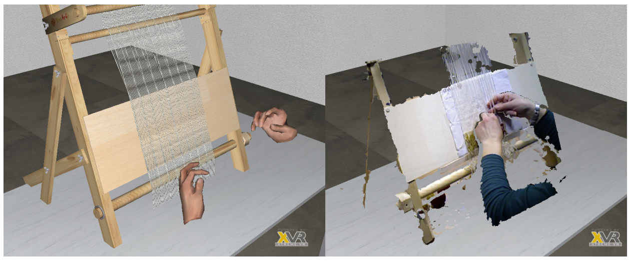

Figure 5. Motion tracking recorder by Cyber Gloves vs Kinect depth-stream recording reproductions.

4. ACKNOWLEDGMENTS

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The study of the related work, the setup of the test methodology and the design of future expansions of the described methodology have been carried out in the context of the EU 2020-TWINN-2015 eHERITAGE project (grant number 692103).

5. REFERENCES

[1] Riva, Giuseppe. "Virtual reality as communication tool: A sociocognitive analysis." *Presence: Teleoperators and Virtual Environments* 8.4 (1999): 462-468.

[2] Azuma, Ronald T. "A survey of augmented reality." *Presence: Teleoperators and virtual environments* 6.4 (1997): 355-385.

[3] Milgram, Paul, and Fumio Kishino. "A taxonomy of mixed reality visual displays." *IEICE TRANSACTIONS on Information and Systems* 77.12 (1994): 1321-1329.

[4] Carrozzino, Marcello, et al. "The virtual museum of sculpture." *Proceedings of the 3rd international conference on Digital Interactive Media in Entertainment and Arts*. ACM, 2008.

[5] Brondi, Raffaello, and Marcello Carrozzino. "ARTworks: An Augmented Reality Interface as an Aid for Restoration Professionals." *International Conference on Augmented and Virtual Reality*. Springer International Publishing, 2015.

[6] Barceló, J. A., Forte, M., & Sanders, D. H. (Eds.). (2000). *Virtual reality in archaeology*. Oxford, UK: ArchaeoPress.

[7] Economou, Maria, and L. Pujol. "Educational tool or expensive toy? Evaluating VR evaluation and its relevance for virtual heritage." *en New Heritage. New media and cultural heritage*, Oxon, Routledge (2006).

[8] Brondi, R., Alem, L., Avveduto, G., Faita, C., Carrozzino, M., Tecchia, F., & Bergamasco, M. (2015, September). Evaluating the impact of highly immersive technologies and natural interaction on player engagement and flow experience in games. *In International Conference on Entertainment Computing* (pp. 169-181). Springer International Publishing.

[9] http://doi.acm.org/10.1145/161468.16147Carrozzino, M., Lorenzini, C., Duguleana, M., Evangelista, C., Brondi, R., Tecchia, F., & Bergamasco, M. (2016, June). An Immersive VR Experience to Learn the Craft of Printmaking. *In International Conference on Augmented Reality, Virtual Reality and Computer Graphics* (pp. 378-389). Springer International Publishing.

[10] Vlahakis, V., Karigiannis, J., Tsotros, M., Gounaris, M., Almeida, L., Stricker, D., ... & Ioannidis, N. (2001, November). Archeoguide: first results of an augmented reality, mobile computing system in cultural heritage sites. In Virtual Reality, Archeology, and Cultural Heritage (pp. 131-140).

[11] Brondi, R., Carrozzino, M., Tecchia, F., & Bergamasco, M. (2012, May). Mobile augmented reality for cultural dissemination. In Proceedings of 1st International Conference on Information Technologies for Performing Arts, Media Access and Entertainment, Firenze, Italy (pp. 113-117).

[12] Papagiannakis, G., Ponder, M., Molet, T., Kshirsagar, S., Cordier, F., Magnenat-Thalmann, M., & Thalmann, D. (2002). LIFEPLUS: revival of life in ancient Pompeii, virtual systems and multimedia. In Proceedings of VSMM 2002 (No. VRLAB-CONF-2007-038).

[13] Tecchia, Franco, et al. "I'm in VR!: using your own hands in a fully immersive MR system." *Proceedings of the 20th ACM Symposium on Virtual Reality Software and Technology.* ACM, 2014.

[14] Skills project, CORDIS EU, available at: http://cordis.europa.eu/project/rcn/103956_en.html

[15] Carrozzino, Marcello, et al. "AMICA - Virtual Reality as a Tool for Learning and Communicating the Craftsmanship of Engraving." (2015).

[16] Piumsomboon, T., Altimira, D., Kim, H., Clark, A., Lee, G., & Billinghurst, M. (2014, September). Grasp-Shell vs gesture-speech: A comparison of direct and indirect natural interaction techniques in augmented reality. In Mixed and Augmented Reality (ISMAR), 2014 IEEE International Symposium on (pp. 73-82). IEEE.

[17] Rautaray, S. S., & Agrawal, A. (2015). Vision based hand gesture recognition for human computer interaction: a survey. Artificial Intelligence Review, 43(1), 1-54.

[18] Ding, W. and Marchionini, G. 1997. *A Study on Video Browsing Strategies*. Technical Report. University of Maryland at College Park.

[19] Tecchia, Franco et al.. "A Flexible Framework for Wide-Spectrum VR Development." *Presence* 19.4 (2010): 302-312

A web framework for the creation of virtual assistants for municipalities

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ABSTRACT

Virtual assistants and similar software tools are gaining importance among phone and computer users. The most well-known assistants (Siri, Cortana, Google, etc.) provide general information to users and cannot be adapted to specific needs. We present a web based service Asistent provides the ability to generate, modify and manage virtual assistants for delivering specific content from various web pages.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Language processing, virtual assistants, artificial intelligence.

General Terms

Algorithms, Performance, Design, Languages

Keywords

Virtual assistants, language processing, cultural heritage, database, artificial intelligence

1. INTRODUCTION

Virtual assistants have become in recent years a useful tool that helps users find information faster and in a more accurate manner. Companies like Google, Microsoft or Apple provide general assistants that help users find restaurants or shops close to their location, manage their phone or provide computer-aided support for software packages.

Web pages of most companies, institutions, ministries or municipalities are often quite extensive and contain a lot of information, and users often have a hard time to find what they are looking for. This problem is tackled with a web based service Asistent [1] that enables the creation of specific virtual assistants that can provide assistance to users when searching for a specific piece of information. Users can pose queries in natural language, which makes them well suited for less skilled users. Companies or institutions can create their own virtual assistant for free and populate its knowledge base with specific content related to their area of work, products or services.

We developed and integrated several virtual assistant for web pages of municipalities from Slovenia. The knowledge base was constructed manually and contains the information that municipalities deemed the most important. It covers the general information regarding the municipality, their acts and regulations, instructions and news for residents, natural and cultural heritage and touristic information.

2. WEB SERVICE FOR VIRTUAL ASSISTANTS

The developed web service supports the creation, management and integration of virtual assistants to an arbitrary web page. It was developed as a Software as a Service (SaaS), where clients access the service via a web browser, which eliminates the need for software and hardware maintenance. Since the software runs in the cloud all future upgrades are applied centrally and are available to all clients instantaneously.

2.1 Architecture

The general architecture of the Asistent service is presented in Figure 1.

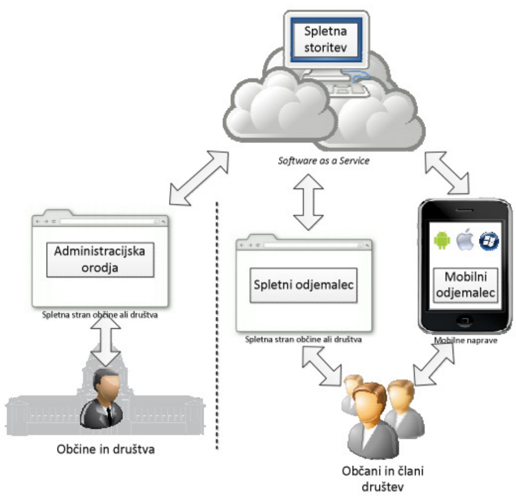

Figure 1. Overall architecture of the SaaS system.

The system is composed of four main components: (i) the web service that provides the content as SaaS; (ii) the web client that provides the users a GUI for the interaction with the virtual assistants; (iii) mobile applications for several mobile platforms; and (iv) admin tools that support the management of the assistants and the adaptation to their needs.

2.2 The Asistent service

The essential feature of the overall service is the modularity that is based on the principles of multi-agent systems [2]. All features are implemented as standalone modules that can communicate with a predefined protocol. Figure 2 shows the components of the system. The main part is the core that contains all the modules and facilitates the exchange of messages. Moreover, it manages all the modules, which includes installation, management and halting. Manages the access to the main relational database, where various modules can store or retrieve data and support the API library.

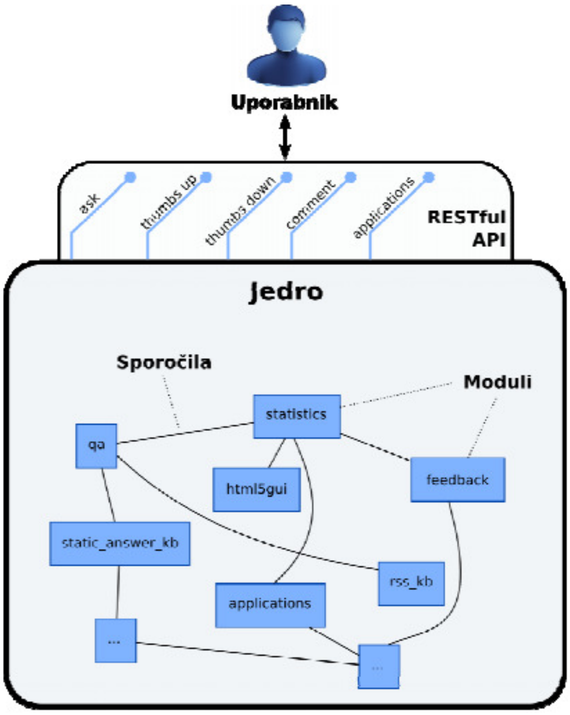

Figure 2. The components of the Asistent and the main modules.

The main functionality of the service is question answering. Various modules can provide answers from several different sources. First, *static content* is stored in the internal database of the service. The content is stored through the admin tools by the administrators of the virtual assistant. The question matching is performed by keywords. Users must define simple rules when a specific answer should be triggered. Second, the *css tags parsing* module offers the ability to obtain content from structured web pages that change often. News or similar pages are an example of such content. Third, *dynamic questions* require modules and adaptors to connect to external databases or other services and can understand the received data and formulate meaningful answers. This kind of answers require to implement the most complex methods, since it usually needs text mining techniques to find the appropriate page where the answer is located and then extract the precise information. This kind of answer retrieval enhances the system, adds the real dynamics and makes the system useful.

Communication with the service is implemented through an API that follows the REST specification [3]. All communication goes through this interface (HTML5, mobile, admin) and provides API calls for the main functionalities of the system (see top of Figure 2). Each API call return an answer in the JSON [4] notion.

2.3 Virtual assistant

The virtual assistants are web clients and serve as a human-computer interface between the web service and the user. They are installed in the web page of the provider and can be invoked by users on demand. An example of a virtual assistant is presented in Figure 3.

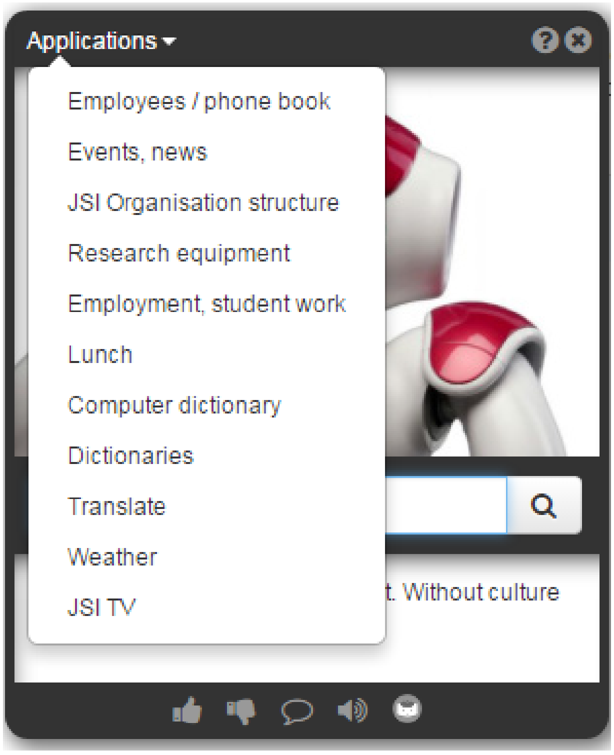

Figure 3. An instance of the virtual assistant and the active applications tab.

The virtual assistant floats above the content of the web page and can be moved around, which enables the user to read and browse the content in the background page. Users can input questions in the assistant and the short answer is displayed in the text area bellow the question. In addition, the page in the background is redirected to a new location where additional information regarding the question can be found.

The web client also offers the use of applications that can be accessed through the Applications bar (see Figure 3). They are an extension or addition of the basic functionality, since they offer the use of external services. For example, ticket booking for museums and payment of various tolls. Moreover, applications can be categories that focus the search of the assistant to some specific content. For example, users might want to search for answers regarding squares or buildings only in the tourism category. Each provider can define his own set of applications that are displayed in the virtual assistant.

3. CONCLUSION

We presented the web service Asistent that enables the creation of custom virtual assistants for various institutions. It is based on modern technologies and follows the current development paradigms. One of its main strengths is the modular design, which facilitates the upgrades and the addition of new functionalities.

Several assistants were created for Slovenian municipalities to validate the system in a real environment. The knowledge base was populated with the general information regarding the municipalities, facts and news for residents, natural and cultural heritage and other. The service is simple to use and suitable for a wide range of end users.

We are currently implementing a module for the dynamic retrieval of information from various natural and cultural heritage websites for Slovenia, Romania and Italy.

4. ACKNOWLEDGMENTS

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5. REFERENCES

[1] Project asistent - virtual assistant for municipalities. http://www.projekt-asistent.si/ . (Visited on 28/9/2016)

[2] Jacques Ferber. Multi-Agent System: An Introduction to Distributed Artificial Intelligence. Addison Wesley Longman. 1999

[3] Leonard Richardson, Sam Ruby. RESTful Web Services. O'Reilly Media. 2008

[4] JavaScript Object Notation. http://www.json.org/

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