Customized and Geolocated TV Channels about The Way of Saint James

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***Abstract*—The technical and procedural state of the art in video distribution and computer-mediated collaboration is mature enough to revisit the traditional television concept. The evolution of the state of the art made possible the concept of personal television, understood as viewers configuring what they wish to watch assisted by a smart recommendation system that proposes content adapted to their personal profile. We introduce a personalized interactive service platform intended to enhance the experience of completing the Way of Saint James. This platform can be accessed using devices like TV sets, mobile terminals or personal computers, and it is technologically supported by a blend of interactive TV, mobile communications, geolocation and semantic recommendation technologies. This proposal enhances the online provision of multi-technology services, the final users' experience by providing accurate, personalized and geolocated multimedia content on the Way of Saint James as well as the promotion of tourism initiatives related to the Way, a key aspect in the promotion of Galice and Spain as touristic destinations.**

Keywords- TV Channels; customization; geolocation; The Way of Saint James; recommendation semantic model.

I. INTRODUCTION

The Way of St. James as a framework for personal and spiritual development has not been conveniently addressed from a technological point of view. Along the Way, pilgrim-targeted services are mainly focused on weather forecast, alternateroutes, difficulties to overcome, places to visit, etc. In turn, the platform discussed in this paper is intended to provide interactive, personalized online information services according to the profile and location of individual pilgrims. More specifically, it facilitates the creation, management and visualization of customized content channels fed from a broad range of content providers. In line with the very concept of completing the Way of St. James, this proposal tackles some aspects with relevant social impact, like accessibility, personalisation and ubiquity.

The development of this service platform was initiated with a thorough analysis of the state of the art, which is discussed in Sect. II. This analysis was focused on the technologies supporting the development of the system, namely Internet TV, mobile technologies, geolocation, and semantic technologies. Then, we discuss in Sect. III the application of semantic technologies and smart recommendation techniques to develop personalized services and to provide access to geolocated content using mobile terminals, which will guarantee the ubiquity of the services provided. We also discuss there collaborative tagging of resources as a tool to implement automated personalized content programming, which basically consists on utilizing a collectively generated knowledge base to develop algorithms to generate a personalized programming grid targeted to final users, namely pilgrims and pilgrim hostels along the Way. A content revision system has also been implemented to address issues like the verification of author rights, age classification of content, or tag validation.

Section IV is devoted to introduce the platform's main features, architecture, services deployed, and some implementation feedback. Geolocated and personalized multimedia channels may be accessed using mobile devices or smart TV sets in hostels. In this later case, the hostel management will define the actual programming grid. We will also discuss the main characteristics of the system back-end, that is, a multimedia content repository fed from different sources, including official content providers (e.g., public administrations, public broadcasters); hostels along the Way providing news, information about hostel facilities or specific recommendations; and the pilgrims themselves, as they have available a personal space to socialise and share videos according to the Web 2.0 concept.

Finally, Section V provides some conclusions and lessons learnt from the implementation of the platform and the provision of multiple services.

In a nutshell, this platform illustrates the application of state-of-the art and novel information and communication technologies to contribute to the advance of tourism-related services, a strategic sector for the Galician and Spanish economy.The development of a semantic recommendation engine in this context is the most relevant novel contribution of the research presented in this paper.

II. STATE OF THE ART

There are several information systems available related to the Way of St. James. Most of them are web portals like the Pilgrim's Web [1], caminodesantiago.com [2] or xacobeo.es [3]. All these systems provide as their main feature information about the Way, including route alternatives, points of interest, or weather forecast information. In some

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cases, they also provide functionalities to facilitate communication among pilgrims though discussion fora, comments or ratings. The information provided is mostly static and is never personalized according to the pilgrims' profile or their location. Thus, we can conclude that the pilgrims' experience could be dramatically improved by providing a multimedia-based, multi-platform information service. For this, we will rely on three base technologies to build the foundation of this proposal:

1) Internet-TV: it facilitates access to Internet services through TV sets. This technology blends information transmission and multimedia content broadcasting through IP networks, and supports the visualisation of content using a broad range of devices, including smartphones, tablets, game consoles, Internet-enabled TV sets, or HTPCs, that is, small, low-cost computers embedding a media centre (e.g., Mediaportal [4], Windows Media Center [5], MooVida [6] or XBMC [7]) to facilitate multimedia content visualisation, Web access, and additional Internet TV services.

2) Mobile and Geolocation technologies: they providegeographically contextualized information to final users. The present-day market of mobile devices is an especially dynamic one, and technological innovations from major players in this sector (e.g. Samsung, Apple, Nokia, HTC, etc.) are constantly being introduced. Besides, the integration of GPS and movement detection support enables the development of novel geolocation applications and services like Google Latitude [8], Fire Eagle [9]orPlazes[10].

3) Semantic technologies: they support the semantic description and processing of content, resources and services, their adaptation to users' profiles, and the provision of personalized recommendations. As this is the main technological contribution of this work, the application of semantic technologies in the framework of this project is discussed in more detail below.

III. SEMANTIC MODEL FOR RECOMMENDATION

A. General Overview

Knowledge representation techniques support the explicit declaration, using sentences and logic rules, of the factual and tacit knowledge in a given domain of interest. This knowledge may be manipulated and semantically queried using an inference engine, which in turn facilitates its automated processing and the extraction of new knowledge from already existing one (i.e., to perform inference processes). In turn, this enhances the quality of the recommendations to final users.

The formal foundations of knowledge representation are being addressed in the framework of Artificial Intelligence since the '60, but their mainstream usage in practical applications was only possible after the introduction of the Semantic Web concept [11]around ten years agoby the World-Wide Web Consortium (W3C**¡Error! No se encuentra el origen de la referencia.**).Presently, W3C supports the standardisation of logic sentence declaration languages like Resource Description Framework Schema (RDF/S [12])andWeb Ontology Language (OWL [13]), logic rules (Semantic Web Rule Language, SWRL [14]) and semantic queries (SPARQL Protocol and RDF Query Language, SPARQL [15]). These languages are supported by several software development frameworks (e.g., Jena [16]) and by several inference engines like Racer [17], Fact [18]or Pellet [19]. Racer and Pellet are used in this proposal.

B. Ontology Development Process

To construct the semantic models that eventually will support the smart programming systems to provide content recommendations according to pilgrims' profiles, we followed a methodological approach based on Menthonlogy[20], including some adaptations extracted from Uschold-King, Noy-McGuinnesandUPON[21]. The construction of these models has been organized according to a series of stages, each of them providing a specific (sub)model:

1) Specification model: it states the objectives and the scope of the semantic model by means of *competence questions*. These artefacts are questions expressed in natural language to which the system being developed should provide responses. Competence questions are extremely useful because they make the scope of the underlying ontology explicit, and provide an instrument to facilitate quality assessment in evaluation processes. In the framework of this research, competence questions like the ones collected in Table I have been defined.

2) Conceptualisation model: it identifies concepts and relations among concepts, as illustrated in Figure 1 representing the model produced along this project.

3) Formalisation model: instantiates the Conceptualisation Model through descriptive logic and Horn formalisms.

*4) Coding model:*translates the Formalisation Model into executable code. More specifically,ontology coding in our case was supported by the W3C-recommended language OWL and the Protégé software platform.

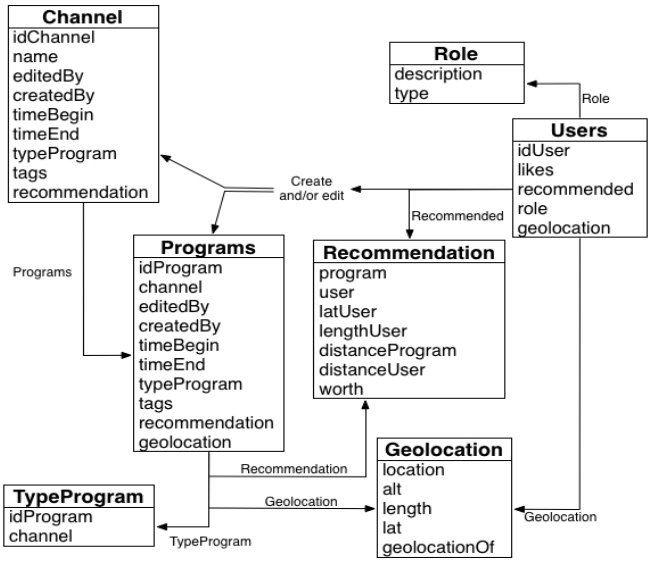

Figure 1. Excerpt of the conceptualisation phase's outcome

TABLE I. EVALUATION MODEL

	Evaluation Model – Competence questions	
	Natural language	***SPARQL sentences***
1	Which programmes (P) are relevant to user (U)?	*PREFIX channelTV:<http://193.146.210.125/canleTV/ontology.owl#> SELECT DISTINCT ?P WHERE {?UserchannelTV:idUser ?U . ?UserchannelTV:interests ?I . ?PchannelTV:tags ?e . Filter(regex(?U,"U")). Filter (regex(?I,?e))}*
2	Which relevant programmes (P) are broadcast in the vicinity of user (U)?	*PREFIX channelTV:<http://193.146.210.125/canleTV/ontology.owl#> SELECT ?P WHERE { ?User channelTV:idUser ?U. ?UserchannelTV:recommended?R. ?RchannelTV:distanceProgramme ?D. ?RchannelTV:distanceUser ?DU. ?RchannelTV:programme ?P Filter(regex(?U,"U")). Filter(?D < 5). Filter(?DU < 10)}*
3	Which programmes (P) are available to user (U)?	*PREFIX channelTV:<http://193.146.210.125/canleTV/ontology.owl#> SELECT ?P WHERE { ?User channelTV:idUser ?U. ?UserchannelTV:recommended ?R. ?RchannelTV:programme ?P. ?RchannelTV:value ?v. Filter(regex(?U,"U")). Filter(?v<10)}*

5) Evaluation model: it supports the verification of the final system prior to its deployment using the competence questions defined in the specification stage. In this phase, competence questions are expressed in a semantic query language, namely *SPARQL*, as illustrated in Table I.

IV. A MULTI-DEVICE SYSTEM TO SUPPORT TOURISM SERVICES

The final outcome of this project consists of a multi-device application to provide information to pilgrims walking the Way by means of a network of personalized and geolocated TV channels. These channels' programming grids are configured according to the pilgrims' profiles, that is, their mother tongue, their interests (e.g., gastronomy, nature, religion, etc.), and their specific location along the pilgrimage route. Users' interests are captured from the information provided by users upon registration, and this information is updated every time users actualize their profile or visit relevant landmarks along the route. In other words, users' interests are modelled as a blend of static and dynamic data organised as objects and classes according to the developed ontological model (cf. Sect. III).

Thus, the foundation of this proposal is a multi-platform video distribution and access system configured as a network of personalized channels able to provide smart recommendations using sematic algorithms.

This system provides a triple path to content:

- Anywhere, anytime, using a mobile device with 3G/3G+ connectivity (e.g., smartphone, tablet).
- At hostels along the way, using a mobile device (e.g., smartphone, tablet) with Wi-Fi connectivity.
- At hostels along the way, through standard TV sets where pilgrims may access, besides standard broadcasted channels, a specific TV channel customized to each accommodation facility.

This work involves several interacting agents that provide multiple services through the network. More specifically, the main actors involved in the platform are:

a) Pilgrims: they use their mobile devices to access the provided personalized TV channels.

b) Hostels: they may configure their own channel to provide information through standard TV sets.

*c) City councils:*they produce and broadcast thematic channels with information on services, places of interest, celebrations, etc. within their influence area.

d) Public administrations at regional and national level: they produce specific channels to promote and provide detailed information on routes and places along the Way.

e) Small/mediumentrepreneurs: they create commercials to promote their products and services (e.g., rural accommodation, souvenirs, local gastronomy, local produce, etc.).

A. Architecture

The deployment of this video distribution system requires the design, development and deployment of several sub-systems, each of them providing a specific functionality. This section describes the most relevant characteristics of the main logical subsystems in the system architecture depicted in Figure 2:

*1) Backend:*it is the central repository providing a storehouse for all relevant system's data. Information is kept about user profiles, programming grid status, programming schedule, active channels, service identification, multimedia content, metadata used for channel customisation, etc.

*2) Content repository (CR):*it stores program content and associated metadata needed for classification and location by external search engines. Content providers access this component to upload new content or to update existing content, and programmers fetch programmes to be included in programming grids. This repository has been implemented as a multimedia content management system (CMS) and ancillary subsystems. It supports several interfaces adapted to different content sources (e.g., TV-HTPC, mobile devices, etc.)

*3) Channel generator (CG):*it processes content descriptions stored in content repositories and creates personalized playlists according to users' profiles, including the most relevant content depending on user preferences and user (geo)location along the Way.

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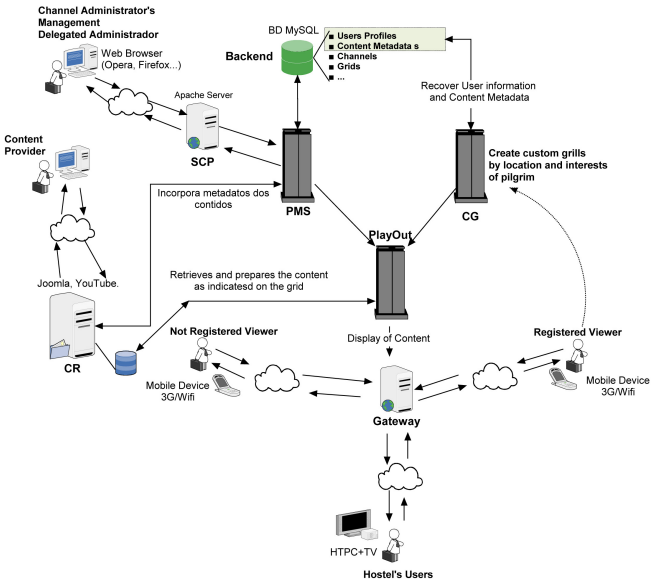

Figure 2. System's architecture

*4) Programming Management System (PMS):*it is used to manage the programming grid associated to each channel, providing concurrent access to programmers according to their profiles (e.g., role, authentication level, etc.). This subsystem also supports the implementation of programming scopes (i.e., the assignment of programming slots to specific programmers) and guarantees the coherence of the overall programming grid.

5) Programming Front-End (PFE): implements a Web-based user interface to the PMS. It provides programmers' authentication, the assignment of programming scopes to programmers, and concurrent access to the PMS.

*6) Play-Out:*this system feeds to video terminals the video content in each programming grid slot. This module also conditions the piece of content according to each specific user platform (i.e., TV-HTPC or mobile terminal) performing the required conversions (e.g., applicable codec, aspect ratio, video container, etc.) to guarantee the best possible user experience.

7) Access portal: it provides a front-end for users' video terminals. It embeds a streaming video viewer matching the user's terminal and receives content from the Play-Out module. It also displays information about the content being visualized (e.g. starting and ending time, duration, synopsis, etc.) and a simple electronic programme guide (EPG).

B. Services

Users have access to a portfolio of multi-platform services. These services are classified according to the user platform:

1) PC interface: it is a Web portal where users may configure a programming grid for a given channel. Figure 3 depicts an example of a weekly programming grid. This grid may also be visualized according to specific time intervals (horizontal view) or specific days (vertical view).The main activities that can be performed through the PC interface are:

*a) Programming grid management:*As discussed above, users may populate with content a channel's programming grid.

*b) Channel management:*encompasses all tasks related to the channels' life cycle: creating, listing, searching, modifying, and deleting channels.

c) Channel Administrator's management: includes all activities related to the management of the individuals that may manage channels and their programming grids: create, modify and delete administrators; assign channels to administrators; enable and disable programming slots (scopes) to be managed by administrators, etc. Figure 4 illustrates the channel administration functionalities.

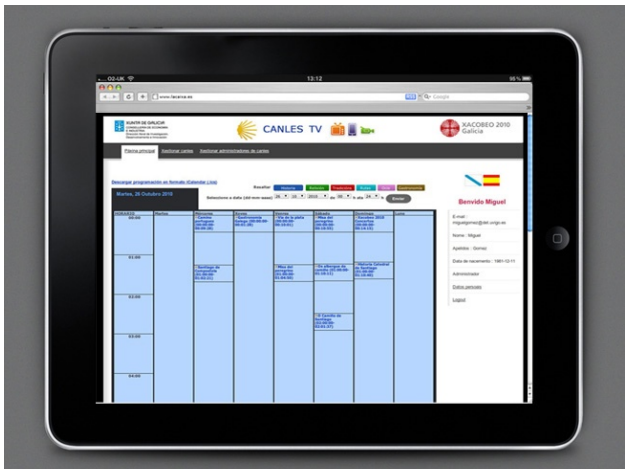

Figure 3. Example I of the PC Interface

2) Mobile interface: to access this interface, users (typically pilgrims) should have an Android-based smartphone with Internet access. Figure 5 illustrates the mobile interface. Through this interface, users may access customized and geolocated services according to their profile along the Way. The most relevant services available through the mobile interface are:

a) Visualisation of multimedia channels availablein a given geographical range, according to users' location.

b) Geolocation services supported by an embedded GPS device or through Google Maps[1].

c) Multimedia content upload.Content submitted will be supervised by system administrators prior to being stored in the content repository.

d) Content geolocation. Users may indicate a range for the validity of the uploaded content along the Way of St. James.

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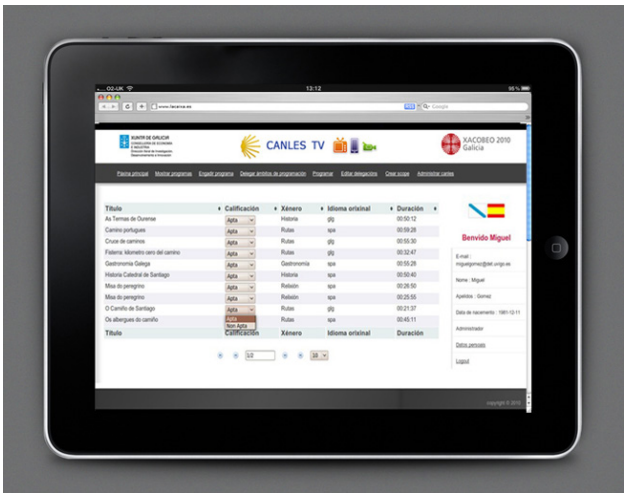

Figure 4. Example II of the PC Interface

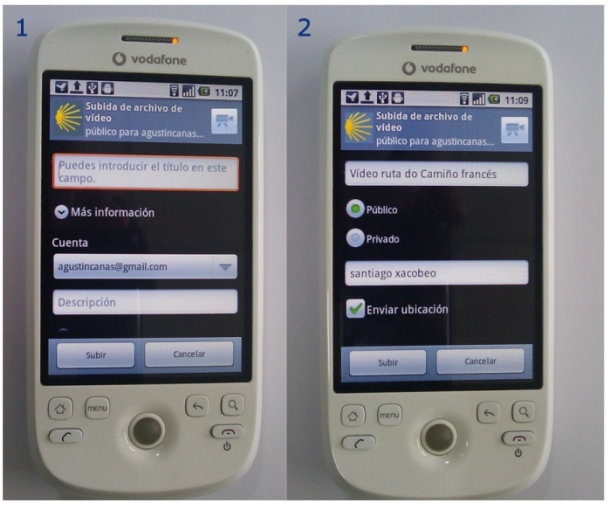

Figure 5. Example of the mobile interface

3) TV-HTPC interface: this access interface is targeted to users (i.e., pilgrims) staying in a hostel along the Way. Besides traditional TV channels available in the area, users may visualize specific channels providing multimedia content to prepare and enhance their experience. Figures 6, 7 and 8 provide some examples of this interface. The main services in this case are:

a) Searching of channels in the geographical vicinity of a given hostel, or relevant to it.

b) Multimedia content visualisation.

c) Access to specific content slots in a programming grid.

C. Validation

At the time of writing this paper the developed platform is in its validation stage, and more specifically in the second stagebelow. A collection of mechanisms has been designed to test the usability and evaluate the users' degree of satisfaction. Validation has been organized around two stages:

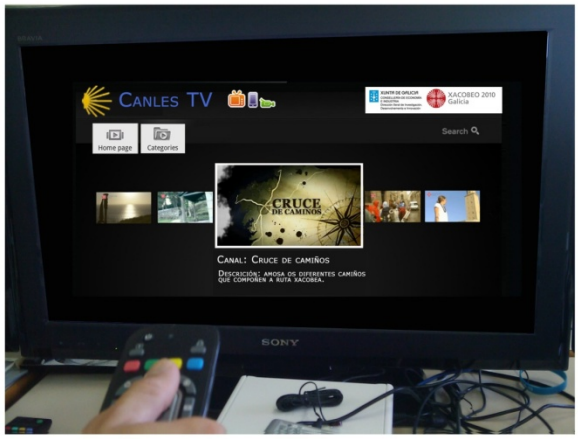

Figure 6. Example I of the TV-HTPC interface

Figure 7. Example II of the TV-HTPC interface

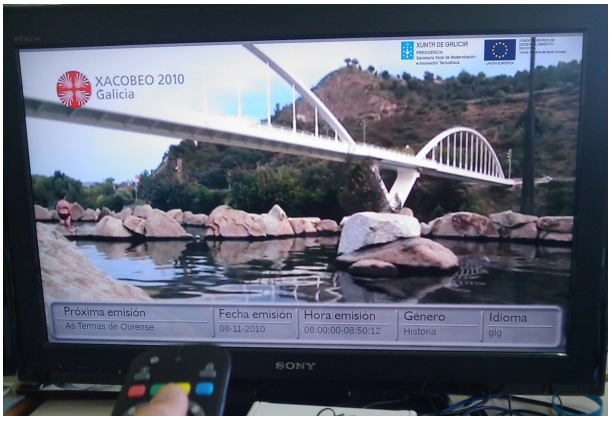

Figure 8. Example II of the TV-HTPC interface

- The members of the research group performed the final testing phases of any software project. This testing also included usability assessment. This phase produced a fully functional beta release that was transferred to the second stage.

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- Once the beta release has been produced, it was transferred to field test. For that, a representative user sample has been selected including all user profiles in the final system (i.e., pilgrims, administrators, content producers, and programmers). Instruments being used along this validation stage include users' perception surveys about usability and functionality; analysis of user interactions from collected system logs; direct observation of user interactions; and analysis of users' satisfaction in relation to pilgrims not using this system.

V. CONCLUSIONS

The focus of this work is the development of multi-technology, multi-platform multimedia online services. We may consider its outcome as a proof-of-concept that will be eventually deployed to enhance users' experience in the framework of one of the key elements of the Spanish tourism sector, namely the Way of St. James.

This proposal blends some of the most relevant state-of-the-art information and communication technologies to provide anovelonline service. For example, it introduces semantic technologies to characterize user profiles for advanced customisation, and to contribute smart planning algorithms for multimedia content broadcasting. It also integrates later developments in content adaptation and interfacing to configure a multi-device system to enable access to personalised multimedia content from smartphones, TV-HTPC sets and personal computers. The system also supports collaborative content tagging and geolocation.

Privacy of personal data is a major concern in any modern online application. In our case, data collected in the central server about users' interests is utilized to provide personalised recommendations. Apart from the validation of the security mechanisms implemented to protect this information, we are also defining a privacy policy to be eventually enforced when the final system is deployed. The perception surveys performed during the validation phase are also relevant to obtain feedback about users' privacy concerns.

Finally, and besides the technical contributions, this system dramatically improves the quality and relevance of the information available to pilgrims in the Way of St. James, which in turn contributes to the touristic promotion of this world-relevant pilgrimage way.

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