Personal Content Management on PDA for Health Care Applications

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Abstract

The content technology need to approach new forms and formats with more intelligence and more flexibility to enable a set of new features for the final users with respect those that are present on market standards. In this paper, an evolved content model and tools that allow the personal content management on PDA are presented. The proposed solution has been developed by expanding the AXMEDIS MPEG-21 content format with semantic information and processing tools directly hosted on mobile device, PDA and PC.

1. Introduction

There exists integrated content models such MPEG-21 [1], [2], MXF, AXMEDIS [3], [4], [5], NewsML, SCORM/IMS [6], MPEG-4, and proprietary formats such as Macromedia, Adobe, etc., that put together a set of multimedia content and other information. Most of these formats have been invented to offer advanced experiences to the final users in terms of media usage, while are not supporting the user with semantic information. Some of them wrap different kinds of digital resources/files in a container/package with their related information (e.g., content metadata and descriptors, relationships among resources, etc.) and they make such resources ready for delivery (streaming and/or downloading), in plain (clear-text) and/or protected forms. The metadata are frequently defined together with content ID codes. Among the metadata: Dublin Core, TVAnyTime are typically used. The adoption of more sophisticated descriptors in MPEG-7, RDF, to allow arranging them into general taxonomies, ontologies, etc., are practically delegated to fit of their traditional classification into the database or with respect to a general ontology. The content behavior is in few cases formalized in Java and/or Javascript.

Among the standard formats, MPEG-21 is focused on the standardization of the content description related to digital rights management aspects [8], [9]. AXMEDIS is an extended version of MPEG-21 proposing content packing and integrating presentation aspects in HTML, FLASH and SMIL. SCORM is a comprehensive standard for the organization and delivery of learning packages. Other examples of intelligent content are: ACEMEDIA [10], X-MEDIA [11], EMMO [12] and KCO [13]. ACEMEDIA defined a new format of content to enable creating personalized content collections. X-MEDIA model is mainly focused on semantic aspects in content that can be managed by ontologies and RDF. X-Media is oriented towards knowledge management for text and image contents with objects having a very limited autonomy of work that are not proactive with the user. EMMOs [12] encapsulates relationships between multimedia objects and maps them into a navigable structure. An EMMO contains media objects, semantic aspect, associations, conceptual graphs, and functional aspect. KCO [13] is based on the DOLCE foundational ontology and have semantic aspects to describe the properties of KCOs, including raw content or media item, metadata and knowledge specific to the content object and knowledge about the topics of the content (its meaning). The semantic information in a KCO includes: content description; propositional description (Semantic Description and Content Classification); presentational description; community description (the purpose); business description (the trade, price…); trust and security description, and self description (the structure).

The paper is organized as follows. Section 2 reports the requirements analysis for smart content management on mobile applications for medical applications. The analysis has permitted to identify the limits of many diffuse formats and tools and the effective enabling technologies needed to cope with them. Section 3 reports the AXMEDIS intelligent content model overview and the map of the features needed to the application specific. Section 4 reports an overview of the solution proposed for intelligent content management for Medical applications. Conclusions are drawn in Section 5.

2. Requirements of Mobile Medicine

Recently, the marketing of powerful mobile devices such as smart phones, PDA, iPhone, has posed the basis for the adoption of mobiles in health care applications. This is particularly useful when it is possible to put intelligent information in the hands of doctors and assistant people for example to cases:

A. support Continuous Medical Educations, CME, during the doctor life and continuous update;
B. support classical medical University/School level education/formation phases;
C. help medical personnel during emergency intervention, to take decision and remind possibilities, procedures, instruments settings, etc.;
D. collect data from patients that cannot be easily collected or that are too expensive to be collected with mobile instruments that cannot be massively used for the whole population, at least now;
E. access to patient data such as the Electronic Patient/Health Record, single patient local record, or its whole health life record.

In medical applications, the content type are typically of several kinds, which may range from single files: audio, video, images, documents and animations; to complex and complete supportive experiences:

- **sliding show** (images) with synchronized audio; typically used for training activities or to remind a procedure;
- **interactive guided work flows** to help users remind the correct procedures and actions to be performed according to the specific case and pathology they have encountered (similar to flow charts in some measure); e.g., what has to be done in case of each specific emergency case. Presently, more than 400 different flows have been identified in our case;
- **calculators**: which are forms in which the user may insert medical data collected from the patient (such as: age, weight, pressure, temperature, habits, symptoms, past status, etc.), to obtain from the device some estimation/suggestions. For example, the probability of pulmonary emboli, the percentage of fat, a prescription of what he could eat, etc. Presently, more than 220 different algorithms for medical calculus have been identified.

In most cases, the medical applications are complex for simple mobile and present a certain internal intelligence and have to be organized into the mobile device to the recalled in short time at the attention of the medical personnel using the device. Examples of these applications are available for the iPhone and for classical Windows Mobile devices. On the other hand, they are not supported by a semantic modeling that could allow Users to identified them, to suggest them, to update them, from the mobile device, in emergency, visits, and educational applications.

For these applications, mobile devices and applications have to provide a set of challenging features that cannot be covered without the injection of certain intelligence into device's tools and semantics descriptors into content since content may arrive into the devices in several manners. Thus a package such as MPEG-21 or SCORM can be very useful for this purpose. Among the features, the users on the mobiles have to be capable to:

- access to their collection of content in any network conditions, immediately without the needs to be connected with some server;
- collect content applications on the mobile device: putting the items into the mobile via the computer, downloading them from the network from dedicated web pages, etc.;
- make queries on the mobile device content collection. These queries may be full text or advanced taking into account content: classifications, file naming, grouping for types, taxonomy based, ontologies, etc., and general more complex semantic descriptors and organizations;
- navigate into the collected content on the device by using a medical taxonomy/ontology organized for arguments or for intervention type to be performed (for example the pathology), or on the basis of other models and structure, etc.; Commonly accepted medical ontologies are accessible;
- access to the lists of collected content according to different views such as: the most played, the less played, the most recently played, the less recently played, the alphabetic order, etc.; Updating the descriptors of content on the basis of User Behavior;
- access to certain content only if they are specifically authorized, for example with some Conditional Access or better with some Digital Rights Management. The content may have to be protected, since if the device/content is lost: the content itself should be blocked to prevent the access to sensitive information. This features is particularly important for the Cases (D) and (E) in which the patient information and/or record is accessed via mobile;

- fully customize the presentation layer of the content collection as well as for the single content element into the Mobile device;
- access to the same mobile content on the traditional PC to have the possibility of using t he same tools on personal computer and on their mobile.

The solution has to be user friendly, medical personnel does not have to take care about content/application life cycle that:

- **have to be indexed** with all its metadata and semantic information into the local database to exploit search/query/reasoning facilities for the final user on the mobile;
- **may arrive into the device** via any channel: computer connection (e.g., USB, Bluetooth, IRDA), network connection (e.g., HTTP from a web page download), to be indexed for the local database and search facilities; The semantic descriptors and information have to be contained into the content package;
- **has to be automatically updated** into the device without the user intervention; The solution has to keep trace about last date and/or version obtained;
- **may present links with other content** elements, for example to link one content to another; e.g., to go in deep on some argument, to create complex paths, etc.;
- **may change behavior** on the basis of user preferences, device capabilities, network capabilities, general context description, device status: GPS positioning, device orientation (e.g., vertical and horizontal), etc.; The content model may take into account of the different status and conditions, while the device has to provide functionalities to extract profiles and capabilities, and to process them in real time.
- **may communicate with some central server** some messages; for example to mark that a certain content segment has been completed, some decisions and information has been communicated to the user; for example by using SCORM/LMS standard;
- **may go in full screen** and that modality may be blocked to prevent the usage of other commands; very important if the PDA is based on a general operating system in which the user may insert any application;
- **may integrated in the content body a range of media types:** audio, video, images, documents and presentations layers to create the user interface and the glue among these media files such as: SMIL, HTML, Laser, etc.**;**
- **may proactively request to the users to provide information;** for example: for the collection of remote patient data, to remind of performing certain actions on some checklists, to make annotations, to create a multimedia scrapbooks, to provide user generated content, etc

3. AXMEDIS MPEG-21 Overview

The AXMEDIS format has a set of capabilities that permits its usage as intelligent content. AXMEDIS format extended the MPEG-21 format with a set of features: binary file format, package, extended processing, metadata, semantic descriptors, and tools.

In AXMEDIS, the **structural aspects** are modeled by using the MPEG-21 DI. Any kind of digital essences/files can be enforced into the package including: metadata, digital resources, presentation layers, descriptors, annotations, and javascript methods, the extended DIP. The structure allows the navigation, the creation of nesting levels and the direct access to the resources via links and references. The structural model is a key issue for content **distribution** and usage since multiple and non linear paths are not simple to be accessed in real time when played, neither simple to be streamed. See for example the problems related to the direct play of SCORM, NewsML, and of other formats. In AXMEDIS, multiple **identification** and **classification** metadata can be hosted in addition to: Dublin Core and AXInfo, a set of identification codes and descriptors. The AXInfo is a set of metadata used to manage the content life-cycle. **Descriptors** are included into the content package and referred to internal essences. So that the indexing and the semantics search can be performed on this information. Descriptors may be formalized in MPEG-7, XML, RDF. An intelligent content may have multiple **presentational** models in the same package. For example, it may alternate HTML/CSS/JS, XML, SMIL, MPEG-4 and FLASH in dominating the main canvas the player. HTML and other XML formats may use style sheets and digital essences (text, video, audio, image, etc.) directly hosted into the AXMEDIS content package. On AXMEDIS PC tools, presentation layers such as SMIL, HTML, and FLASH may put in execution AXMethods written in Javascript for activating behavioral actions allowing to inspect and modify the content structure (e.g., add new resources), control the resources rendering, perform calls to web services, etc. **The annotations** in the extended AXMEDIS model are based on the Annotation of the MPEG-21 DIDL. An AXMEDIS annotation can be a complex content modeled as a cross media AXMEDIS object or a simple part. **The interaction aspects** in the

AXMEDIS model are delegated to the presentation layer. Interaction implies the definition of actions to be performed on the basis of the user actions. Typical stimulus for user actions can be button pressings, mouse movements, text input, voice, etc. The interactivity of AXMEDIS objects can be at client and server sides, but also object/package side. This allows to pass parameters from one essence to another and to create sophisticated user generated content. **The behavioral aspects** are covered in allowing to code the business logic intelligence with javascript. P**rocessing capabilities** are inherited from the backoffice content processing formalism, AXCP [3], which includes transcoding, filtering, conversions, and many other features. The **AXMEDIS File format** can be saved in binary or XML. The binary format includes the packaged table to the fast access to digital essences [3]. This allows AXMEDIS content to be downloaded, streamed or progressively downloaded with the support of AXMEDIS DRM [3], [4]. The AXDRM is MPEG-21 derived, defining licenses with multiple rights and conditions according to MPEG-21 REL standard. It can be used as a simple Conditional Access or as a full DRM and permits to put in black lists users, licenses, devices, etc.

4. Mobile Medicine Solution

The proposed solution has been realized to cope with the above mentioned features and requirements. It is presently under trial at the University of Florence health care area. Presently, only a mockup version is publicly visible at Http://mobmed.axmedis.org, as Mobile Medicine Portal. The internal powerful version will be visible for public from the same link since the mid of July 2009.

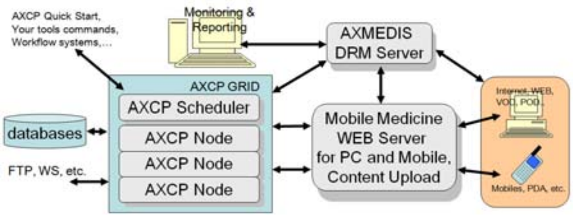

Figure 1 – Mobile Medicine Social Network

The Mobile Medicine Portal is substantially a Social Network for medical content ingestion and discussion derived from Http://xmf.axmedis.org . Both of them can be accessed via PC, PDA, iPhone and mobiles as well. In the trial, a number of mobile PDA devices (based on Windows Mobile 6) have been provided by Vodafone and endowed with two main applications: AxObjectFinder and the AxPDAPlayer.

The **AxObjectFinder** for PDA has been designed to enforce semantic processing and intelligence, and support the users to collect, index, organize, update, search and retrieve content on the basis of their metadata, IDs, semantic descriptors, user behavior (number of plays/executions, time of plays), user preferences for accessing, searching, playing, etc.

Figure 2 -- AxObjectFinder

The AxObjectFinder provides a direct usable interface based on Icons for main functionalities: Web, local search, taxonomy, open file from file system, etc.; and for content play with a single finger click. From Web icon it leads users to access at the Mobile Medicine portal for direct download, publication and discussion about mobile medical content. The AxObjectFinder has also the capability of automatically indexing content and files which are into the device and perform their automated update: both single files and MPEG-21 files are indexed and managed. The **AxPDAPlayer** is an enhanced version of the PDA AXMEDIS player which is capable to execute MPEG-21 content with and without DRM [3].

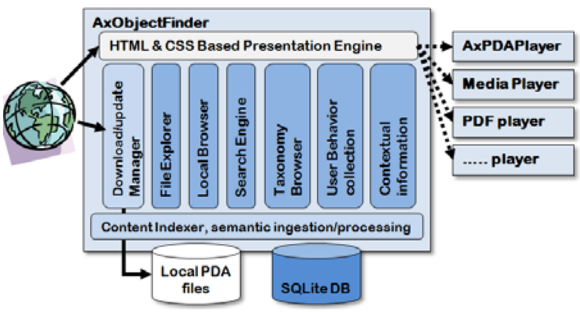

Figure 3 – AxObject Finder Architecture

The AxObjectFinder (see Figure 3) is a client side semantic engine of the solution since it processes the content items to index them according to the taxonomy and to the internal content descriptors and provides support for querying and organizing content according to the user requests. Browsing and searching via taxonomy means to make hierarchical queries and reasoning about the descriptors. To this end, taxonomy and other content descriptors are added into the MPEG-21 package of content during the content production on the Mobile Medicine portal by the AXCP Grid (see Figure 1). The user uploading the content performs a semantic tagging while technical descriptors about digital resources are added during the automated adaptation and icon production. The adaptation is performed taking into account MPEG-21 DIA: user preferences, device capabilities, network capabilities, general context description, etc.

The **Presentation Engine** is based on Pocket IE and it uses a custom protocol to access to locally generated HTML pages, it allows to run the viewer (AxPDAPlayer for MPEG-21 files) to view the selected content. It allows also to access to Mobile Web portal and to intercept the requests for downloading AXMEDIS Objects allowing to check if the same object is already present in the local files, avoiding the need to download the object each time. The **Content Download/Update Manager** module allows to download AXMEDIS objects, updated them, store them locally. Any store is intercepted by the Content Indexer that extract the semantic information from the content and perform the minimal content processing to extract descriptors even from non MPEG-21 files. The extracted info is stored into the local database together with Usage Data coming from the user behavior. The **Local Files Explorer & Indexer** module, explores regularly the PDA storage to find new media files, it extracts metadata/descriptors and stores them in the local DB. The **Search engine** module is used to perform the queries on the DB to search for local content and the **Taxonomy Browser** module allows to browse local content on the basis of the medical taxonomy defined.

5. Conclusions and future tasks

In this paper, a model and solution to cope with medical mobile applications are presented. The content model has been derived extending the MPEG-21/AXMEDIS format with semantic data. A certain intelligence has been enforced into the mobile players by designing and developing a specific application that can be installed in any Windows Mobile devices and it is tuned for medical semantics applications/contents. The solution is under extensive trial at the University of Florence medical center. The application can be downloaded for trial from: http://mobmed.axmedis.org/mobilemedicine-pda-player-and-content-june-2009-v1-6.zip

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