Proceedings of the 9th World Congress on Electrical Engineering and Computer Systems and Sciences (EECSS'23)
Brunel University, London, United Kingdom - August 03-05, 2023
Paper No. CIST 107
DOI: 10.11159/cist23.107

A Multi-Viewpoint Approach For Semantic Multimedia Documents Adaptation

Farida Bettou[1], Bouchra Boulkroun[2]
[1]Higher Normal School El Katiba Assia Djebar (ENSC),
Constantine, Algeria
[1]bettou.farida@ensc.dz; [2]b.boulkroun@ensbiotech.edu.dz
[2]National School of Biotechnology Taoufik Khaznadar (ENSB),
Constantine, Algeria

Abstract **-** Multimedia documents have to be played on multiple device types. Hence, a user not disabled or handicapped requires document adaptation according to execution contexts. Currently, advanced technological hardware can offer mobile devices, which fit in the hand with the capacity to consult documents at anytime and anywhere. Multiple user context constraints as well as mobile device capabilities may involve the adaptation of multimedia content.

In this article, the authors propose a new Multi-viewpoints ontological-based method for adapting multimedia documents; each viewpoint of de multimedia document could correspond to a physical handicap and therefore triggers an adaptation action using multi-viewpoint ontological reasoning. Our proposed ontology has the great advantage to offer to users a flexible infrastructure to easily govern the response time and the quality assembly of their applications at runtime.

Keywords**:** Multimedia documents, Ontology, Multi-Viewpoints, Adaptation, Semantic.

1. Introduction

Currently, mobile access to the Web surpass personal computer access. This includes access to multimedia content from mobile phones as well as other emerging environments, such as set-top boxes, PDAs, tablet PCs, interactive television, and even automobiles. However, mobile Web access still lacks the necessary flexibility needed for the usability of multimedia content on various devices [1]. Pervasive systems help access to multimedia documents at any time, from anywhere and through several devices (smart TV, laptop, tablet, etc.). Nevertheless, due to changes in users' contexts (e.g. noisy environment, preferred language, public place, etc.), restrictions on correct access to these documents may be imposed. One possible solution is to adapt their contents using adaptation services so that they comply, as far as possible, with the current constraints [2].

The emergence of ubiquitous computing and user mobility leads to the need for dynamic adaptation of user interaction on the documents (which generally are multimedia oriented). The exchange of multimedia documents has a special place. A multimedia document is composed of several media such as images, texts or videos with synchronization points between spatial and temporal organization. Therefore, any Internet user should have access to the content of multimedia documents and receive them in a format appropriated to the current context in which they work , their personal characteristics (language, disability, etc) , their preferences, the capacity of their terminal (screen size, battery, etc) and the characteristics of the network (type, bandwidth, etc) , but also according the spatio-temporal context (adaptation information according to its geographical location or time he has to devote to reading the document)[3].

In the literature, the existing multimedia documents adaptation approaches can be classified, essentially, into four main categories [4]:

(1) Server-Side Adaptation where clients(devices) may request adaptations from the server which is responsible of such task;

(2) Client-Side Adaptation where each device adapts documents by itself;

(3) Proxy-Based Adaptation where a proxy acts as a mediator between a client and a server;

(4) and Peer-to-Peer Adaptation. Some of these frameworks exploit semantics benefits to describe profiles' information. However, they do not use Rule-based reasoning mechanisms upon such information to assist the adaptation process and to

deduce efficient adaptation actions from profiles according to dynamic changes affecting the current contextual situations [5].

In order to identify the user situations in pervasive computing environments there are various approaches available such as fuzzy logic, and machine learning. The ontology-based approach has been widely used for modelling large and heterogeneous physical concepts (i.e. smart object, device) with highly abstract concepts (i.e. context, situation, service). To ensure a precise representation of various user's needs under several moving locations in multi-smart domains, temporary or permanent situations rules are semantically specified into an ontology model within the context domain. Later situation is identified to trigger the appropriate services associated with this situation. Moreover, semantics is essential in order to identify situations of users within a given smart domain regardless of the situation's categories or context sources [6].

To overcome these limitations, we aim at representing conflicts, multimedia contents, and service qualities semantically thanks to Semantic Web languages and a multi-viewpoint approach. Later situation is identified to trigger the appropriate services associated with this situation. Moreover, The heterogeneity of these devices and the diversity of the preferences of the users impose the adaptation of these contents only the point of view of the user, it is for this reason that we propose to integrate the notion of points of view in the ontology to accelerate the adaptation process through the rapid selection of multimedia document adaptation service.

The rest of the article is organized as follows. Section 2 reviews and discusses some related works about semantic multimedia adaptation and provides an overview of the multi-viewpoints approach.

Section 3 details our ontology of multimedia document adaptation based on the multi-viewpoint approach and provides details about the adaptation process used by our ontology. Section 4 summarizes and analyzes the experiments. Finally, Section 5 provides some conclusions and final remarks.

2. Some Related Works

We present in this section a review of semantic adaptation approaches. After that, we present several works that allow the introduction of multi-viewpoints in ontology.

2.1. Review of semantic adaptation approaches

In the last decade, several works have been performed for semantic multimedia document adaptation and the use of notion ontology.

In the literature, several multimedia document adaptation approaches are proposed. These approaches take as input profile information and multimedia documents in order to provide adapted documents [7, 8, 9, 10, 11]. In what follows, we examine some relevant works in the field.

The authors in [12], the authors propose a new approach for adapting multimedia documents that extends HaMA [2]. their main contribution focus on, solving the problem of inconsistency between deduced actions in order to efficiently select the set of consistent ones, using graphs. These proposed graphs allow the selection of the best instances of services for executing consistent actions according to QoS (Quality of Service) parameters. In [4], the authors overcome the limitations of their previous approaches; they propose a self-organizing multi agent based architecture for adapting multimedia documents. Their agents cooperate in a decentralized structure to optimize the selection, composition, and execution of service plans.

In [3, 13], the authors have proposed a mechanism allowing dynamic generation of user conditions by including multi modal technologies. In [14], the authors have introduced a context-based multimedia adaptation approach that combines multi-agent systems with semantic web services to predict the current context of the user. The agents collect information, determine the current user context and generate a set of adaptive actions. However, the system requires more work since it is not implemented and evaluated. However, the systems in [3, 13, 14] require more work since it is not implemented and evaluated.

In [8, 15, 16], the authors have proposed an architecture dedicated to adapting documents based on formal definitions of concepts. Nevertheless, they did not take advantage of the potential of semantic techniques to express context constraints and the selection of adaptation services.

2.2. Review of representation of the multi-viewpoint in the ontology

Several works are interested in the notion of viewpoint and other works are interested in the use of this notion to solve solve interesting problems. Nevertheless, the definition of the notion of the viewpoint differs from work one another. In some some works, the viewpoint corresponds to the position of the actor that observes an object in the real world. In some others, others, the viewpoint focuses on some properties of an object in the real world.

In [17] the authors have considered that the viewpoint is interested in some set of properties of the object too. However, they have assumed that some other properties of this object are consensual (these properties are seen in all the viewpoints). For that, they proposed two new notions that are related to the viewpoint: the global and the local viewpoints. The global viewpoint represents the consensus in the domain. The set of local viewpoints represents the heterogeneity in the domain. Therefore, the multi-viewpoints according to [18] and [19] are complementary and consistent, but they are not independent. The multi-viewpoints according to [20] and [21] are independent and may collectively be inconsistent and not complementary. In our work, we consider the definition of [17].

Hence, much work has been done recently towards extending the adaptation of the multimedia document with advanced tools such as using graphs, using multi-modal technologies, and combining multi-agent systems with semantic web services. All these extensions require more flexible and powerful constructs than are currently supported by existing approaches, the motivation of this paper is to address a novel semantic approach to multimedia document adaptation based on ontologies and viewpoints paradigms.

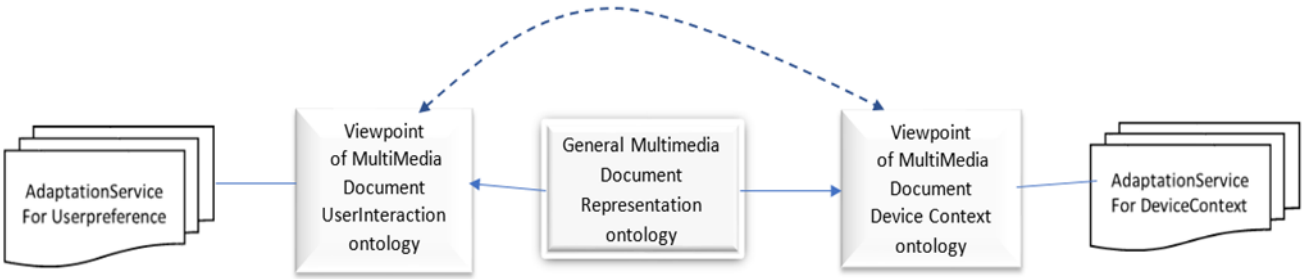

Fig. 1: The viewpoint schema for Multimedia document adaptation.

3. Semantic Multi-Viewpoint Profile for Adaptation of Multimedia Documents

Nowadays, the viewpoint concept has been used with diverse senses in various domains such as databases, knowledge representation, semantic web, etc. [22]. In this paper, we are particularly interested in the use of viewpoints in ontology modelling for multimedia document adaptation.

The proposed adaptation model is a multimedia document adaptation model with an extension by concepts and mechanisms, which allow the multiple, evolutionary, and distributed representation of a multimedia, document adaptation ontology. This representation confers to [9], which is based on several partial and complementary representations. Each partial ontology is based on a global ontology of the multimedia document and adapts according to a given viewpoint. The adapted representation of multimedia documents fulfills the context of the user (see Fig.1). The methodology of our adaptation model relies on the following ideas:

- The viewpoint concept is considered an augmented mechanism of the multimedia document adaptation ontologies.
- A viewpoint schema for Multimedia document adaptation is multiple descriptions of the same multimedia document according to various viewpoints (See Fig .1).

• A viewpoint is an abstraction of a certain perception (vision) of the document. A schema for Multimedia document adaptation is thus viewed as a set of viewpoint schema, as shown in Fig 1. Each viewpoint schema represents an aspect of the context device and it is held by a set of user preferences

Adaptation services usually require specific types of media and generally transform the multimedia content characteristics. In this context, it may lead to several input and output incompatibilities, such as media resolution data types, formats, and so on [11]. One of the objectives of our contribution is to improve the semantic service to give more precision to document adaptation and to facilitate and expedite the search for services. An adaptation service is represented by a set of information describing the necessary contextual constraints.

The adaptation service semantic enables comparison with other services of the same type. Semantic information on the input/output type of media of service represents a criterion for service selection and allows its assembly with other services for generating an adaptation process. For this reason, we define two types of media related with the adaptation services, called: InputMedia and OutputMedia (See Fig .2).

The proposed approach gives more precision for adaptation services functioning and allows more precision in their output. Several rules may be defined semantically according to the context of the user or the used devices by the latter. For example, adapting a multimedia document for a blind user is a completely different operation from a healthy one. Thus, the definition of some viewpoints to treat different contexts that may impact the adaptation service functioning are necessary to guarantee more adequate adaptation according to user preferences and profiles.

if (client is deaf client) then all sounds are adapted to text or images or

if (client is blind client) then all text/images/videos are adapted to sound.

We may also define some rules to consider some properties of the client.

if (action=drive) then (client is blind client); all text/images/videos are adapted to sound.

if (language = Incomprehensible) then (client is Blind and Deaf client), media translation.

if (location=lab or location=meeting) then (client is deaf client),all audio adapts to texts, and all video adapts to video in the subtitle.

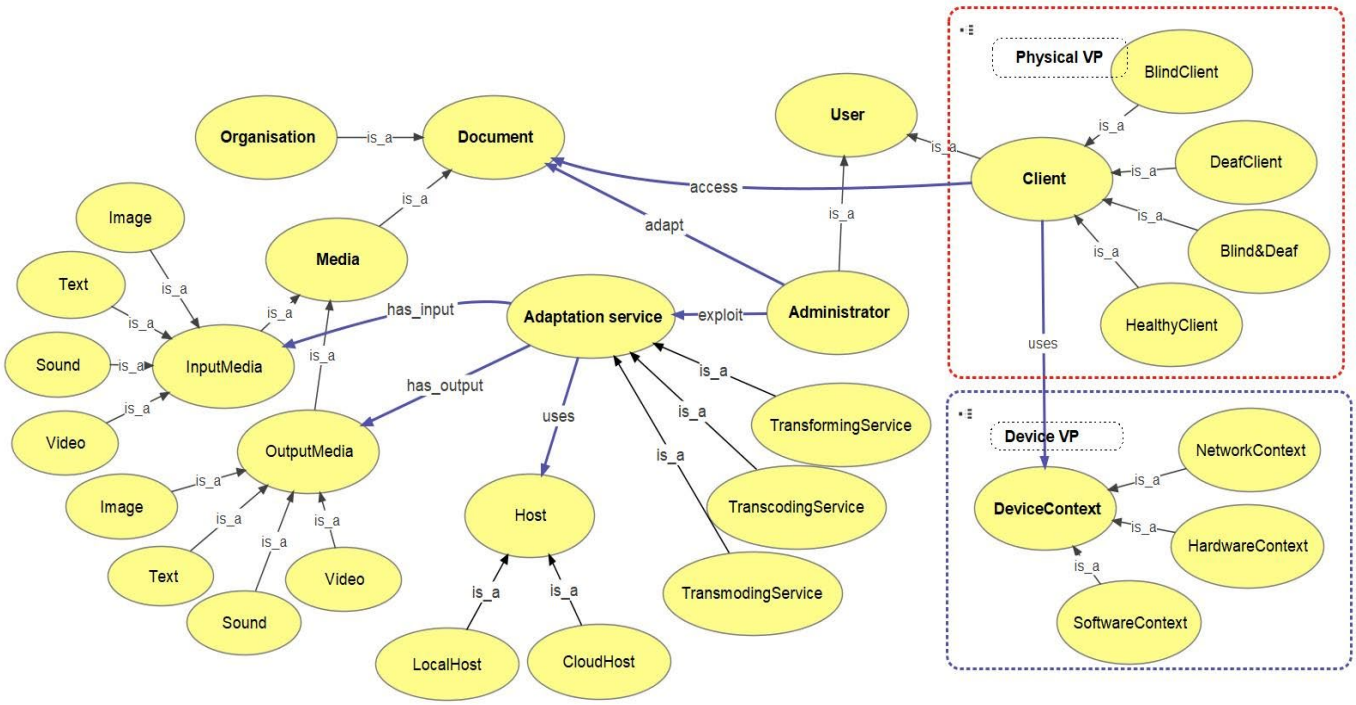

Fig. 2: A snapshot of adaptation service global ontology.

Because context is a direct cause to adapt the content of multimedia documents so that they comply with the current constraints. In this respect, several adaptation approaches have already been proposed, in which adaptation services are often often selected from a global list of services. Practically speaking, adaptation services are provided in various instances, thus thus making the selection task more difficult and taking a lot of time. To deal with this issue, we propose:

- To group the services of the same point of view in a database and create his ontology (the services of adaptation of the media to solve the conflicts of the context of device or preference of the user) to accelerate the adaptation service selection process (see Fig.2).

-An approach of adaptation in parallel with the media for the conflicts, which do not have a semantic relation between them.

3.1. Adaptation service global ontology

In this work, we propose a novel generic ontology (see Fig .2) that handles semantic rules allowing the automatic generation of a dynamic and quality composition of heterogeneous adaptation services. This ontology provides a semantic description multi-viewpoint (provides a semantic and multi-viewpoint description), allows a dynamic and parallel selection of adaptation services based on physical context viewpoint parameters (BlindClient, DealClient, Blind&DealClient, HealthyClient), and describes semantic relationships between adaptation services, such as the dependency, the substitution (i.e. a service has the same role as another one) and the equivalence.

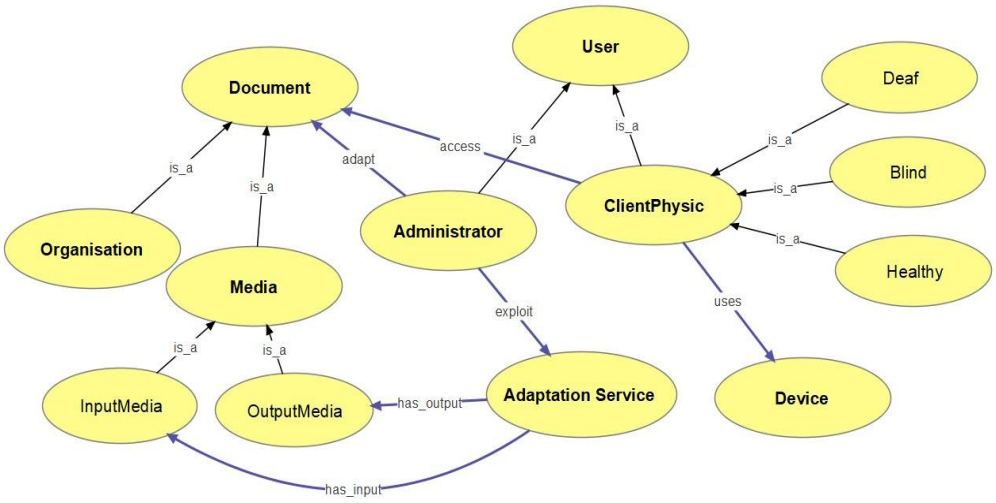

Fig. 3: An extract of Physical State Viewpoint Ontology.

3.2. Physical State Viewpoint Ontology

In our Multi Viewpoint Semantic Profile for Multimedia documents Adaptation; a profile can be defined as a structured set of viewpoints that cover different domains to characterize the user. Such viewpoint can be user preference context, Hardware Context, Software Context, and Network Context. In this article, we only deal with the point of view of the physical state of the user (See Fig. 3).

In Table 1, we use the vocabulary of the OMPV, to present the assertions of classes (Description of equivalences between the classes of the global ontology and the viewpoint ontologies) and Assertions of properties (Description of equivalences between the properties defined in the global ontology and the viewpoint ontologies).

Table 1: Example of correspondence assertions between global ontology and viewpoints.

Assertions		
Assertions of classes (Description of equivalences between the classes of the global ontology and the viewpoint ontologies)	(?p rdf :type ompv :ClientPhysic) ← (?p rdf :type opvp :Client) (?p rdf :type ompv :ClientContext) ← (?p rdf :type opvd :Client) (?p rdf :type ompv :Document) ← (?p rdf :type opvp :Document) (?p rdf :type ompv :Document) ← (?p rdf :type opvd :Document) (?p rdf :type ompv :DeviceContext) ← (?p rdf :type opvd :DeviceContext) (?p rdf :type ompv :AdaptationService) ← (?p rdf :type opvp :AdaptationService)	/** “ompv:”, “opvp:”, “opvd:”, prefixes refer to the OMPV vocabulary, OPV Physical State, OPV Device Context **/
Assertions of properties (Description of equivalences between the properties defined in the global ontology and the viewpoint ontologies)	(?p ompv :id_service ?id_service) ← (?p opvp :id_service ?id_service) (?p ompv :auteur ?auteur) ← (?p opvp :auteur ?auteur) (?p ompv :action ?action) ← (?p opvp :action ?action) (?p ompv :localisation ?localisation) ← (?p opvd :localisation ?localisation)	

3.3. Adaptation service global ontology including viewpoints definition

Each viewpoint represents a set of characteristics that describes specific classes and some properties according to the context of use. To do so, some assertions (equivalences) are needed to describe the relation between the original class and its corresponding class in each viewpoint. For example, the class “ClientPhysic” is the description of the general class “ Client” according to the “Physical State Viewpoint” which has three sub-classes (Deaf, Blind and Healthy). These assertions are used later to identify the most pertinent treatment according to client situation and select the correspondent adaptation service. The following description is an extract of the adaptation service global ontology including viewpoints definition used MVP-OWL language. In this case, we define the following classes:

- Viewpoint definition in the global ontology
- Definition of class « ClientPhysic » which represents the class « client » but in « Physical_State_VP »
- Definition of class « Deaf » which is a sub-class of « ClientPhysic » (which represents the class « client ») in « Physical_State_VP »
- Definition of class « Blind» which is a sub-class of « ClientPhysic » (which represents the class « client ») in « Physical_State_VP »
- Definition of the relation « Uses » and its invers « Used_by » between the two classes « Client » and « Device »

4. Conclusion

The heterogeneity of devices and user preferences has raised the problem of multimedia document adaptation according to user context and condition. This paper defines a semantic multi-viewpoints approach to multimedia documents and their adaptation through an approach that allows the interaction of the user and his devices to satisfy his preferences and according to his context, which is presented in ontology in the form of viewpoints that allows acceleration and more precision of the adaptation process.

In this article, we have presented only the multimedia document adaptation model based on the viewpoints ontology, there remains more work to be carried out for covering all the aspects of adapting multimedia documents and for improving our semantic and multi-viewpoint approach by integrating the agents. Another work aims to build a context-based agent architecture in which autonomous agents supervise various viewpoint.

References

[1] Laborie S., Euzenat J., N. Layaïda. Semantic adaptation of multimedia documents. *Multimedia Tools and Applications, Springer Verlag*, 2011, 55 (3), pp.379-398.

[2] Laboudi Z., A. Moudjari,A. Saighi, H N. Hamri, Efficient Service Selection in Multimedia Documents Adaptation Processes, *Springer Nature Switzerland AG 2021*. MedPRAI 2020, CCIS 1322, pp. 170–187, 2021.

[3] Khallouki H., Bahaj M., Roose P., & Laborie S. (2014). SMPMA: Semantic multimodal profile for multimedia documents adaptation. *5th Workshop on Codes, Cryptography and Communication Systems (WCCCS),* 2014.

[4] Saighi, A., & Laboudi, Z. (2020). A novel self-organizing multi agent-based approach for multimedia documents adaptation. *2020 International Conference on Electrical, Communication, and Computer Engineering* (ICECCE).

[5] Benchikha F., Boufaïda M., "The Viewpoint Mechanism for Object-Oriented Databases Modelling, Distribution and Evolution", *J. of Computing and Inform. Technology,* vol. 15, no. 2, pp. 95–110, 2007.

[6] Lakehal A., Alti A., Roose P.,Context-Aware Multi-layered Ontology for Composite Situation Model in Pervasive Computing, *Ingénierie des Systèmes d'Information* Vol. 25, No. 5, October, 2020, pp. 543-558.

[7] Saighi, A., Philippe, R., Ghoualmi, N., Laborie, S., & Laboudi, Z. (2017). HaMA: A Handicap-based Architecture for Multimedia Document Adaptation. *International Journal of Multimedia Data Engineering and Management*, 8(3), 55–96.

[8] Bettou, F., & Boufaida, M. (2017). An adaptation architecture dedicated to personalized management of multimedia documents. *International Journal of Multimedia Data Engineering and Management*, 8(1), 21–41

[9] F. Benchikha and M. Boufaïda, "The Viewpoint Mechanism for Object-Oriented Databases Modelling, Distribution and Evolution", *J. of Computing and Inform. Technology*, vol. 15, no. 2, pp. 95–110, 2007.

[10] Nawrocki, P., & Sniezynski, B. (2020). Adaptive Context-Aware Energy Optimization for Services on Mobile Devices with Use of Machine Learning. Wireless Personal Communications, *Wireless Personal Communications*.

[11] Adel, A., Laborie, S., & Roose, P. (2013). Automatic Adaptation of Multimedia Documents. *Procedia Computer Science*, 19, 992–997.

[12] Saighi, A., Laboudi, Z., Roose, P., Laborie, S., & Ghoualmi-Zine, N. (2020). On Using Multiple Disabilities Profiles to Adapt Multimedia Documents. *International Journal of Information Technology and Web Engineering*, 15(3), 34–60.

[13] Khallouki H., Baha M., Multimodal Generic Framework for Multimedia Documents Adaptation, *International Journal of Interactive Multimedia and Artificial Intelligence*, Vol. 5, Nº 4, pp.122-127 (2014).

[14] H. Khallouki, and M. Bahaj, "A Context-Based Multi-Agent Approach For Multimedia Documents Adaptation," *International Conference on Engineering and Information Technology*, 2017.

[15] Bettou.F, Boufaida.M, An adaptation technique for multimedia applications based on the user context to manage the service quality, *2nd International Conference on Multimedia and Human-Computer Interaction* (MHCI'14),pp. 63-1--63-8 August 14-15, 2014, Prague, Czech Republic.

[16] Bettou .F, Boufaida M. and Labed I. (2013). An adaptation architecture of multimedia documents for management of the quality of service, *"the 15th International Conference on Enterprise Information Systems ,"(*ICEIS),4-7 July,ESEO,Angers Loire Valley,France,pp.105-110.

[17] Hemam M. An extension of the ontology web language with multiviewpoints and probabilistic reasoning. *Int J Adv Intell Paradig*. 2018;10(3): 247–265.

[18] Hemam M, Djezzar M, Boufaida Z. Multi-viewpoint ontological representation of composite concepts: a description logics-based approach. *Int J Intell Inf Database Syst.* 2017;10(1/2):51–68.

[19] Djezzar M, Boufaida Z. Ontological classification of individuals: a multi viewpoints approach. *Int J Reas Based Intell Syst*. 2015;7(3/4):276–285.

[20] Dieng R, Corby O, Grandon F, et al. Méthodes et outils pour la gestion des connaissances: une approche pluridisciplinaire du knowledge management [Methods and tools for knowledge management: a multidisciplinary approach to knowledge management]. 2nd ed. Paris: Dunod; 2005; Chapter 6, Gestion de multiples points de vue [*Management of multi viewpoints];* p. 372.

[21] Falquet G, Mottaz CL. Navigation hypertexte dans une ontologie multipoints de vue. *Conference NîmesTIC'2001*; 2001 Dec 12–14; Nîmes, France; 2001.
[22] Bouchra, B., Fouzia, B., & Chahinez, B. (2015). Data Sources Integration Using Viewpoint-Based Approach. *Proceedings of the International Conference on Intelligent Information Processing, Security and Advanced Communication* - IPAC '15.