

Scene-based Metadata Generation and Open API Provisioning Method for Smart Broadcast Service

Seung-Hee Kim, Deokkyu Jung, Sang-Yun Lee, Sun-Joong Kim

ETRI (Electronics and Telecommunications Research Institute), Korea

seung@etri.re.kr, jdk30621@etri.re.kr, syllee@etri.re.kr, kimsj@etri.re.kr

Abstract—To cope with the new media paradigm era toward user-centric service by using scene-based broadcast content, this paper proposes the scene-based metadata automatic generation method on small-size segmented unit, and open API provisioning method for metadata and its related video clip retrieval function. In order to fulfil this proposed essential technology, the smart broadcast platform is composed of following four enablers such as informal data management, semantic cluster, convergence-type metadata generation, and service control management. Through the opening of metadata resource in smart broadcast platform, the diverse and innovative broadcast media service that attracts users or business operators will provide more easily and conveniently. Eventually, it will also contribute to construction of smart media ecosystem with a virtuous cycle.

Keywords— Smart Broadcast Service, Scene, Metadata, Open API, Smart Broadcast Platform

I. INTRODUCTION

Traditionally, broadcasting station operators have an individual broadcast service platform, and they have been providing service by the exclusive and closed way. Moreover, they can only use the self-defined metadata of basic and deficient level, which has been generating manually by a person. As the advent of increasing internet access and mobile smart devices propagation, user's service usage environments and media consuming attitudes have been changing into rapid information selection among enormous broadcast content whatever they want, and directing toward short video clip preference pattern [1]. To cope with this emerging trend, it is urgently required the scene-based metadata automatic generation and open API provisioning method to enhance usability and accessibility for a versatile smart broadcast content application.

This paper represents the core technology that solves the requirements to respond with new media paradigm era toward user-centric service. In chapter 2, we propose scene-based metadata automatic generation method and broadcast content metadata structure that is composed of elements. In chapter 3, we propose open API provisioning method and API function that everyone can use the open interface. In chapter 4, we represent smart broadcasting platform enablers that consist of informal data management, semantic cluster, convergence-type metadata generation, and service control management. This will be possible to implement a variety of smart broadcast service such as media commerce, advertisement,

and video clip curation service. Besides, we show implementation case of scene studio executing the shot/scene/topic metadata generation as a one-stop. Finally, we review anticipated effects and future R&D issues.

II. SCENE-BASED METADATA GENERATION & SMART BROADCAST CONTENT METADATA STRUCTURE

Legacy metadata has been generated by manual method which directly inputted by person using an authoring tool for each broadcast company. Due to a monotonous and laborious operation, the legacy metadata is difficult to construct large amount of repository and to occur an error occasionally. Advanced technologies, including content recognition, automatic tagging, and topic model learning, have recently progressed to generate new metadata automatically like scene or topic.

The novel scene-based metadata on small-size segmented unit by mechanical operation is differentiated the conventional content-based metadata on big-size program unit by personal operation. Because of using broadcast content together related information such as caption/script and blog/twitter/news, it has named convergence-type metadata as an alias. Especially, it provides topic metadata expressing the meaning of the scene by adopting the topic model learning as an effective tool. For analyzing text data, natural language processing and machine learning techniques are used. Besides, the scene-based metadata supports additional information such as product/person/location/music related to the interesting object in the scene. Accordingly, it is possible to provide a customized broadcast-linked additional service that more suitable to a preference of user in comparison with the utilization of merely broadcast program metadata. This will be a good opportunity to break away from the fixed income condition of an immediate broadcast market and give a chance for new value-added service creation.

The figure 1 shows the structure and elements of smart broadcast content metadata, which is composed of existent basic content metadata, newly advanced content metadata including scene-based information and additional information metadata [2]. Three categories are as follows:

- Basic Content Metadata: The general and basic information of program/episode based content.

- Advanced Content Metadata: The detail and abundant information of scene/shot based content.
- Additional Information Metadata: The specific information of product/person/location/music object of on-viewing scene content.

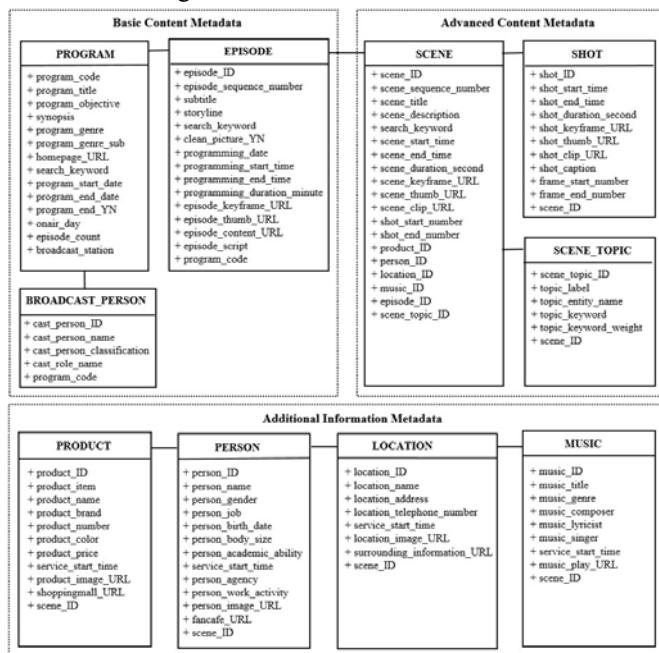


Figure 1. Structure and elements of smart broadcast content metadata

The scene belonging to the advanced content metadata is composed of the series of consecutive shots. They are represented by the similar image/sound/text through similarity analysis among shots with considering physical factor of location or time, and semantic factor of continuous conversation. As shown in figure 2, scene metadata consists of the scene-related detail information such as title, description, keyword, start time, end time, duration, keyframe image and video clip.

Group	Content	Element	Description
Scene	Identifier	scene_ID	Identifies the scene
		scene_sequence_number	Describes the order of the scene
	Scene Information	scene_title	Describes the title of the scene
		scene_description	Describes the simple description of the scene
		search_keyword	Describes the keyword for searching the scene
		scene_start_time	Describes the time when the scene starts playing
		scene_end_time	Describes the time when the scene ends playing
		scene_duration_second	Describes the duration of playing time for the scene
	Scene Additional Information	scene_keyframe_URL	Describes the URL of the key frame image representing the scene
		scene_thumbnail_URL	Describes the URL of the thumb image representing the scene
		scene_clip_URL	Describes the URL of the video clip representing the scene
		shot_start_number	Describes the start number of the shot that is bound to the scene
		shot_end_number	Describes the end number of the shot that is bound to the scene
Additional Service Information	Reference Identifier	product_ID	Identifies the product
		person_ID	Identifies the person
		location_ID	Identifies the location
		music_ID	Identifies the music
	Reference Identifier	episode_ID	Identifies the episode containing the scene
		scene_topic_ID	Identifies the topic that is bound to the scene

Figure 2. Elements and attributes of scene metadata

III. OPEN API PROVISIONING METHOD & SMART BROADCAST API FUNCTION

Until now, the broadcast service had provided mainly by using proprietary defined API and individual broadcasting service platform. Even if small-scale business operators want to provide application-based additional services, the platform resources are not to allow access. To solve this presenting problem, it has progressed toward open API provisioning that freely sharing by various operators.

So to speak, the open API explains as a standardized interface format for a reusable service component. A service company where operates a website opens an access method to the outside. Because many specific service component functions of the platform are available to utilize for everyone that wants to share the open API. By combining open API, it is easy and convenient to develop a new service. The open API provisioning method in this paper provides metadata and video clip retrieval function for diverse service providers as shown in figure 3. This open interface accomplishes an effective usability and accessibility for smart broadcast content metadata. Moreover, it is possible to create smart broadcast service by any third-party provider or prosumer, including terrestrial broadcasting station operators, CATV/IPTV operators, and small-scale broadcast companies. In accordance with an overcome of obstacles to enter broadcast media industry, it will be possible to expand into heterogeneous convergence industry areas, which will accelerate to promote innovative services in multi-lateral aspects.

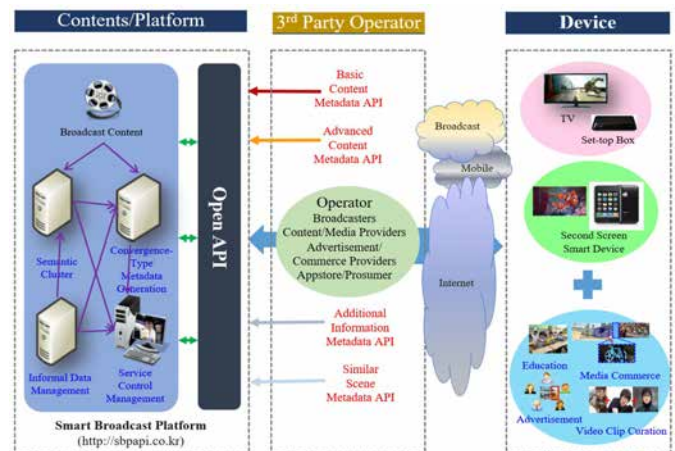


Figure 3. Open API provisioning method for smart broadcast service

The smart broadcast open API provides the metadata resource sharing in the platform that maintains the correlation with the smart broadcast content metadata as mentioned in chapter 2. The table 1 shows the open API categories and specific function.

- Basic Content Metadata API: The retrieval function of program/episode/broadcast person metadata belonging to the basic content metadata category.

- Advanced Content Metadata API: The retrieval function of scene/scene_topic metadata belonging to the advanced content metadata category.
- Additional Metadata API: The retrieval function of product/person/location/music metadata related to an object appearing in a scene belonging to the additional information metadata category.
- Similar Scene Metadata API: The retrieval function of topic-related similar scene metadata belonging to the advanced content metadata category [3].

Table 1. Open API classification and function of smart broadcast

Category	API Name	Description
Basic Content Metadata API	getProgramList	Retrieval of every program identifier list
	getEpisodeList	Retrieval of every episode identifier list in the specific program
	getActorList	Retrieval of every broadcast person identifier list in the specific program
	getProgramMeta	Retrieval of metadata for the specific program
	getEpisodeMeta	Retrieval of metadata for the specific episode
	getActorMeta	Retrieval of metadata for the specific broadcast person
Advanced Content Metadata API	getSceneList	Retrieval of every scene identifier list in the specific episode
	getSceneMetaByID	Retrieval of metadata for the specific scene
	getSceneTopicMetaByID	Retrieval of topic metadata for the specific scene
	getSceneMetaByTime	Retrieval of metadata for the specific scene with consistent time in the episode
	getSceneTopicMetaByTime	Retrieval of topic metadata for the specific scene with consistent time in the episode
	getSceneListByKeyword	Retrieval of identifier list for the scene associated with keyword in the episode
	getSceneListByTopic	Retrieval of identifier list for the scene associated with topic in the episode
Additional Information Metadata API	getSceneMetaByDescription	Retrieval of metadata for the specific scene associated with description
	getProductList	Retrieval of every product identifier list in the specific program
	getPersonList	Retrieval of every person identifier list in the specific program
	getLocationList	Retrieval of every location identifier list in the specific program
	getMusicList	Retrieval of every music identifier list in the specific program
	getProductMetaByID	Retrieval of metadata for the specific product
	getPersonMetaByID	Retrieval of metadata for the specific person
	getLocationMetaByID	Retrieval of metadata for the specific location
Similar Scene Metadata API	getMusicMetaByID	Retrieval of metadata for the specific music
	getSimilarSceneListByTime	Retrieval of similar scene identifier list based on topic similarity for the specific scene with consistent time in the episode
	getBestSceneListByTime	Retrieval of the best similar scene identifier list based on topic similarity for the specific scene with consistent time in the episode

IV. SMART BROADCAST PLATFORM ENABLER & IMPLEMENTATION CASE

The innovative up-to-date service by using high-quality broadcast content, such as drama, documentary, and entertainment, is recently playing an important role to create profit and to lead smart media ecosystem construction. To deal with these trends, as mentioned in figure 4, we represent four enablers of smart broadcast platform to implement core technology.

- Informal Data Management: It collects informal data, analyses morphemes, and extracts named-entity. The informal data generally describes as unstructured data, which means data structure and its range such as blog/twitter/news SNS data.

- Semantic Cluster: It extracts multi-feature information such as video/audio/text from the beginning of shot partition, and splits semantic-based scene through similarity comparison among shots. Semantic cluster describes an assembly of inter-connected scenes for meaning a certain story.
- Convergence-type Metadata Generation: Creating scene-based topic metadata automatically by using broadcast content and its related gathering data through the topic model learning as text analysis tool. Topic describes a meaning of the scene that is composed of set with keyword and keyword weight.
- Service Control Management: Metadata/informal data/video clips are stored and managed in the DBMS repository. The retrieval function of metadata and video clip is performing through open API, and on-viewing content mashups with supplementary information such as product/person/location/music appeared in the scene.

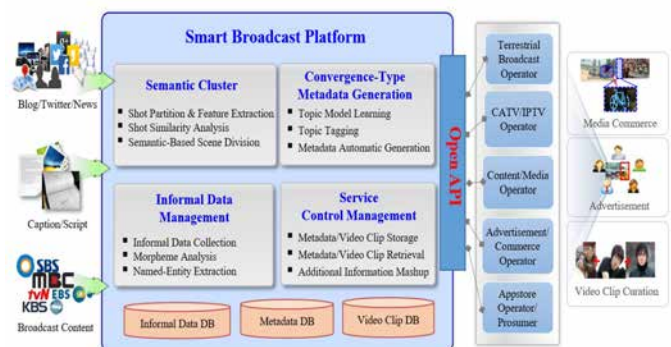


Figure 4. Smart broadcast platform enabler

In addition, we introduce a case of viewing situation-aware adaptive service that can implement by using smart broadcasting platform enabler that may attract the interest from the operator or the user.

- Media Commerce Service: This provides a viewing broadcast content related product information without internet searching. It furnishes costume product of performing actor, sound product of background music, local product of shooting location, and hairstyle or makeup product of performing actor.
- Advertisement Service: The target advertisement is focused on the interest to viewers instead of uniform advertisement. It furnishes cooked product advertisement to viewers who enjoy cooking program, or performance reservation advertisement to viewers who enjoy movie or music program.
- Video Clip Curation Service: This provides selective video clip desired by the user. It is performed basis on specific issue, particular character, sport highlight, and so on. It furnishes a set of character related video clips which selects only acting images of the actor, or collection of video clips which related to selected topic [4].

Now, while watching TV program or movies, it is natural the simultaneous usage of screen-device such as smart phone, smart pad. Therefore, broadcasting station operators are trying for users to consume their own video content more frequently on these devices. Moreover, these operators want to provide additional services such as advertisement or supplementary information. For example, a scenario of above-mentioned video clip curation service is as follows.

- Informal data management collects and analyses of caption/script and blog/twitter/news.
- Semantic cluster partitions shots from broadcast content and divides into the scenes. In addition, it describes scene semantic graph to configure topic-related similar scene group.
- Convergence-type metadata generation creates scene-based topic metadata through topic model learning by using gathered informal data together.
- Service control management stores the generated metadata/video clip/open API in the repository of smart broadcast platform. Like this, smart broadcast platform is all ready for supporting of service provision.
- If a user wants to watch VoD drama, the broadcast content is transmitted through internet. This displays on the TV screen.
- Simultaneously, if the user wants to watch only own desired video clip collection, the synchronization procedure for paring between TV and smart phone is activated on the second-screen.
- Then, operator provides the video clip curation service based on topic-related similar video clip selection by using open API.

The figure 5 shows the example of getSceneMetaByID API. In order to activate the smart broadcast open API, we connect to smart broadcast platform API server (<http://sbbapi.co.kr>) and call the specified open API procedure.

http://129.254.179.253:3000/getSceneMetaByID?program_code=KBS2_T2016-01&episode_ID=KBS2_T2016-01-03&scene_ID=KBS2_T2016-01-03-02

```
{
  "program_code": "KBS2_T2016-01",
  "episode_ID": "KBS2_T2016-01-03",
  "scene_ID": "KBS2_T2016-01-03-02",
  "scene_sequence_number": "2",
  "scene_title": "Reunion of Yoo Si-jin and Kang Mo-yeon",
  "scene_description": "Yoo Si-jin was sent to Uruk and met Kang Mo-yeon again",
  "search_keyword": "Yoo Si-jin, Kang Mo-yeon, scarf",
  "scene_start_time": "00:00:29",
  "scene_end_time": "00:01:16",
  "scene_duration_second": "48",
  "scene_keyframe_URL": "129.254.179.253:8888/KBS2_T2016-01-03-Descendants of the Sun-03/SCENE/KEYFRAME/KBS2_T2016-01-03-02-SCENE_KEYFRAME.bmp",
  "scene_thumb_URL": "129.254.179.253:8888/KBS2_T2016-01-03-Descendants of the Sun-03/SCENE/THUMB/KBS2_T2016-01-03-02-SCENE_THUMB.bmp",
  "scene_clip_URL": "129.254.179.253:8888/KBS2_T2016-01-03-Descendants of the Sun-03/SCENE/CLIP/KBS2_T2016-01-03-02-SCENE_CLIP.mp4",
  "shot_start_number": "20",
  "shot_end_number": "41",
  "product_ID": "KBS2_T2016-01-03-PRODUCT001",
  "person_ID": "",
  "location_ID": "",
  "music_ID": ""
}
```

Figure 5. getSceneMetaByID API call procedure and JSON format output

Besides, we implement the scene studio that is software solution of generating shots, scenes, and topics. Figure 6 shows the scene studio as the authoring tool, which can accomplish automatically series of process such as shot extraction, scene division, topic metadata generation, and metadata/video clip storage. Thus, we can establish effective large-scale database for smart broadcast content metadata rapidly and economically.



Figure 6. Implementation case of scene studio

As for the technology development of smart broadcast platform, smart broadcast service is working on the web browser environments, and node.js is using fundamental development framework. As well, to store and manage smart broadcast content metadata, we use in parallel both MySQL to handle structured data such as program/episode/scene/shot, and MongoDB to handle unstructured data such as topic [4].

The R&D project for this proposed core technology is proceeding from the beginning of March 2015 until February 2018.

V. CONCLUSIONS & FUTURE WORK

We mention the guideline and technological solution for a desirable evolutionary direction of metadata focused on broadcast content. We propose a method to generate scene-based metadata, and smart broadcast metadata structure. As well as, we propose open API provisioning method and its specific function. This technology can derive innovative services creation connected with broadcast content, which is likely to extend to heterogeneous convergence industries such as commerce, advertisement, education, infotainment, healthcare, publication, and so on.

However, the expected effect is still insufficient and there are many challenges to solve. Therefore, it is necessary for continuous and in-depth study on following issues from now on. First, we intend to provide not only content context based on broadcast content itself but also viewer context based on content consuming behavior for tailored user-centric service. Second, we intend to provide issue-based storytelling service along with the theme/character/location/time/event by related similar scene grouping. For measuring of similarity and association degree among scenes, it is necessary to describe the meaning of scene into semantic graph. Third, we want to improve the accuracy of scene division by applying multi-

feature of shots and to enhance the quality of topic for satisfying operator needs. Fourth, we want to provide differentiated excellent service by constructing more detail and abundant metadata through object recognition and object identification with deep learning method [5]. Finally, we try to provide more expended open API standard specification by reflecting requirements from various broadcast media operators.

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Seung-Hee Kim received the B.S. and M.S. degrees in electronic engineering from Korea University, Seoul, Korea in 1982 and 1988 respectively. Since 1982, she has been with Broadcasting & Telecommunications Media Research Lab., ETRI, Daejeon, Rep. of Korea, where she is currently principal researcher. Her research areas are open smart broadcast service platform, situation-aware based personalization service, and broadcast content metadata technology.



Deokkyu Jung received his B.S. in Computer Engineering from Korea Polytechnic University, Rep. of Korea in 2014. He received his M.S. in Computer Science and Engineering from UNIST, Rep. of Korea in 2017. He joined ETRI, Rep. of Korea in 2017, where he is currently research intern. His research areas are deep learning, media platform, and distributed system.



Sang-Yun Lee received his MS and Ph.D. degrees in electronics and telecommunications engineering from Hanyang University, Seoul, Rep. of Korea in 1996 and 2007 respectively. Since 2011, he has been with Broadcasting & Telecommunications Media Research Lab., ETRI, Daejeon, Rep. of Korea. He focuses on embedded software, smart TV software platform, and Web technology.



Sun-Joong Kim received her BS degree in computational statistics and her MS degree in computer science from Chungnam National University, Daejeon, Rep. of Korea, in 1989 and 2000 respectively. In February 1989, she joined ETRI, Daejeon, Rep. of Korea, where she is currently principal researcher and director. Her research interests include convergence service control, smart TV, content knowledge mining.