

Design and Implementation of Fingerprinting-based Broadcasting Content Identification System

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Abstract— The existing fingerprinting technologies are not appropriate for broadcasting content identification services which identify broadcasting content in real-time because of the low fingerprint extraction speed and long DB update time. Thus, to apply fingerprinting to the second screen service, it needs a fingerprinting technology which can extract fingerprint while playing the content and update fingerprint DB in real-time. In this paper, we propose a fingerprint-based second screen framework which can identify broadcasting content in real time by on-time content identifier. We define this fingerprint as on-time identifier, and content identification system using on-time identifier as the identification system.

Keywords— fingerprinting, content identification, second screen

I. INTRODUCTION

As the proliferation of smart devices such as smartphone, tablet, users using smart devices while watching TV, to resolve the immediate questions and to share their feelings and the related information through SNS, is increasing. Depending on such environmental changes, dissemination of second screen services that provide additional information related to the content through smart devices is expected.

For the second screen services, a technique for identifying content that is broadcast on TV in real-time is essential. One of the available technologies for this purpose is fingerprint technology

Fingerprinting is a technique for identifying the content using the fingerprint which is a content-specific attributes that may be used to confirm the identity of the content. The existing Fingerprinting techniques used to identify the content are unable to identify content currently being broadcast in real time because of the technical limits such as slow fingerprint extraction speed and long duration for updating DB.

In order to apply the fingerprinting technology to second screen services, the fingerprinting technique which can extract fingerprint simultaneously with reproduction of the content and update fingerprint DB in real-time is necessary.

In this paper, we propose a fingerprint-based second screen framework which can identify broadcasting content in real time by on-time content identifier. We define this fingerprint as on-time identifier, and content identification system using on-time identifier as the identification system.

II. SYSTEM OVERVIEW

Automatic detection system for illegal broadcast content is intended to identify the latest broadcast content entering into the Internet and to block uploading the illegal broadcast content. The existing Fingerprinting techniques used to identify the content are unable to identify content currently being broadcast in real time because of the technical limits such as slow fingerprint extraction speed and long duration for updating DB.

Therefore, by building a filtering system which can filter the illegal broadcast content from broadcast time to filtering preparation time of the existing filtering system, it is possible to complement vulnerability the existing filtering systems .

Meanwhile, the technology of On-Time identifier used by real-time broadcast identification system can be applied to the second screen service. The second screen system based on the on-time identifier provides the additional information related to live broadcasting content by recognizing the audio signal of the content at mobile smart devices. To this end, the second screen is composed of meta-information system real-time broadcasting content identification system. Figure 1 shows the concept of the second screen system.

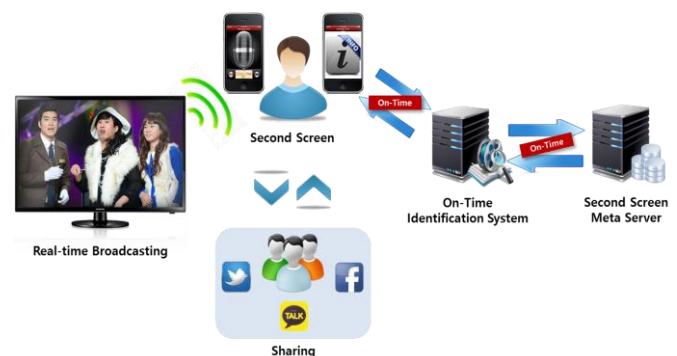


Figure 1. Concept of the second screen system

The real-time broadcasting content identification system is composed of real time content feature registers which extract fingerprints from the live broadcast stream and send them to the server, real-time broadcast content identification servers

which simultaneously process the requests for fingerprint registration from multi-channel and the requests for content search, and search clients which request identification of the live broadcast content with the TV audio signal. Figure 2 shows the concept of the real-time identification system for second-screen service.

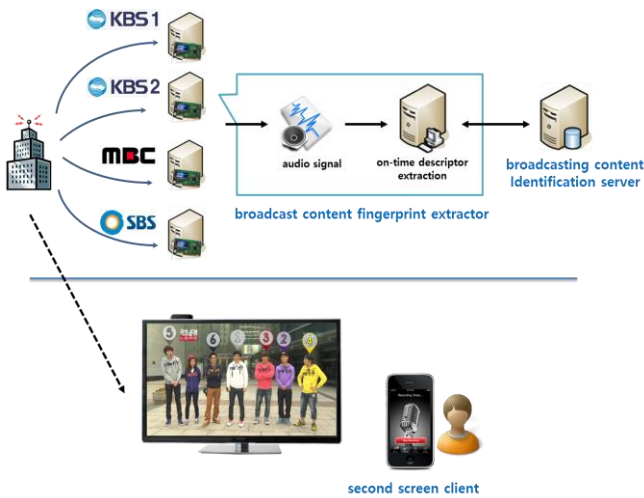


Figure 2. Concept of the real-time content identification system

III. SYSTEM COMPONENTS

A. broadcasting content feature register

The real-time broadcasting content feature register performs the functions such as receiving the broadcasting content through TV capture cards, extracting the feature from received broadcasting streams, and sending the extracted feature to the content identification system. Figure 3 shows the structure of the content feature register.

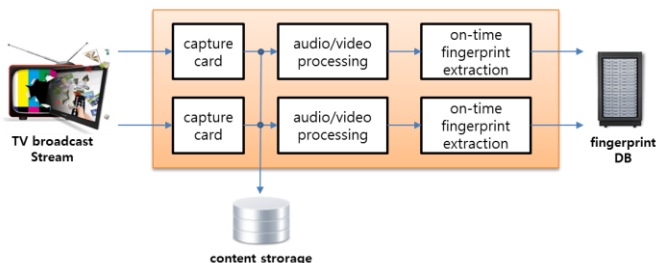


Figure 3. Structure of the content feature register

The main functions of the broadcast content feature register are as follows.

- Broadcast stream pre-processing
: Function to process the live broadcast content received via a TV tuner card, and to generate the data format appropriate to extracting audio fingerprint
- Audio fingerprint extraction
: Function to extract fingerprint (on-time identifier) from the preprocessed audio data (1 second or less delay time due to fingerprint extraction, processing of two channels per node)
- Meta-data and fingerprint transfer

: Function to send data to a specific server periodically in order to register the fingerprint and the metadata like the channel information at fingerprint DB

- Save and playback of broadcast stream
: Function to play and store the broadcast stream received by the TV tuner card
- Setting the fingerprint information
: Providing an interface for extracting fingerprint and setting the information necessary to register fingerprint to a server

B. content identification server

The real-time content identification server gets and manages the fingerprints and metadata sent from the content feature extractors. Also, it provides the result about the request from the client. It consists of directors, sub-directors, and workers.

Figure 4 show the relationship among them.

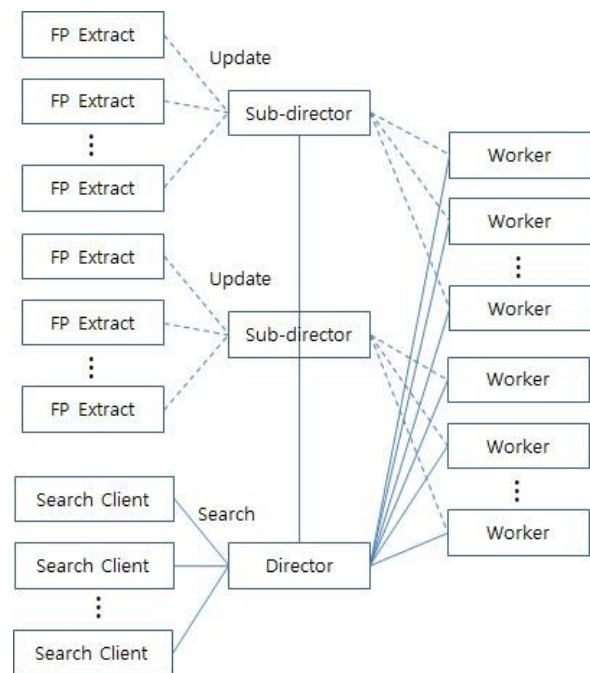


Figure 4. Structure of the content identification server

A sub-director provides the functions to register fingerprint for each channel through communication with the fingerprint extractors. It also provides a web-based interface to find service logs and metadata, and to control the workers for each channel.

A director provides the functions to search for content through communication with the search clients, and to control the entire server. It also provides a web-based interface to find service logs and metadata, and to control the sub-directors and workers. Further, it determines the results of the content search by comparing the search results transmitted from each Worker.

Worker performs the process of building, updating, and searching an actual fingerprint DB, Worker is established for

each TV channel and maintains a fingerprint DB certain length of time.

The main functions of the real-time content identification server are as follows.

- Fingerprint DB registration and update
: Function to create a fingerprint DB for each broadcast channel, and to update both metadata and fingerprint data that is periodically transmitted from the broadcasting content feature register
- Content Search
: Providing search results to a search client by comparing the requested fingerprint and fingerprint on DB
- Web-based server management
: Providing functions that can start or stop the server and check the state of the system using the Web-based interface
- Management of log information
: Providing Web-based interface that allows users to check the log information of the fingerprint registration and content search process

C. search client application

A search client requests content search with the fingerprint extracted from the audio signal of TV broadcast content input through the microphone of smart devices, and receives the corresponding result from the content identification server.

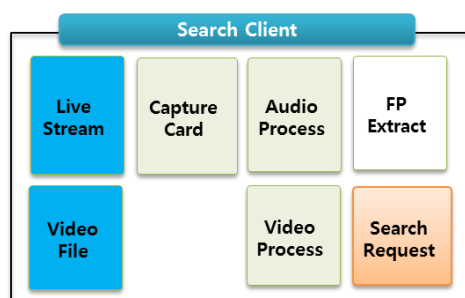


Figure 5. Structure of the search client

The main functions of the search client application are as follows.

- Audio/Video preprocessing
: Conversion function of decoding and resampling audio signal in a form that can be extracted fingerprint
- Request for the fingerprint extraction and search
: Function to request the content identification by sending the extracted the fingerprint of the content to be searched to the content identification server
- User Interface
: Providing a user interface for identification of the broadcast content

IV. FINGERPRINT MANAGEMENT

A. fingerprint registration

The process of registering the fingerprint extracted by the broadcast content feature extractor into the fingerprint DB of the identification server is shown in Figure 6.

As shown in figure 7, after creating a fingerprint DB is completed, the fingerprint data is loaded into memory continuously in time order. At the same time, metadata including update time information and an index table to be used when searching for the loaded fingerprint DB are also generated

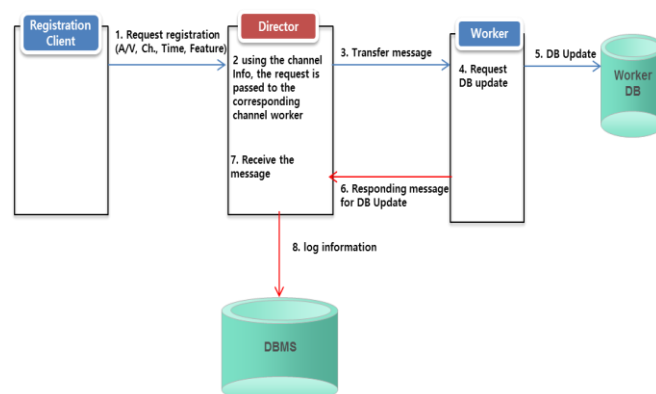


Figure 6. Sequence of the fingerprint registration

B. fingerprint search

Searching for the audio fingerprint at the search client application is performed by a fingerprint extraction step and a message sending step. The fingerprint extraction step is the same process as the feature extraction of the broadcasting content feature register. The result of a search process using the extracted fingerprint obtained through the process as shown in Figure 7.

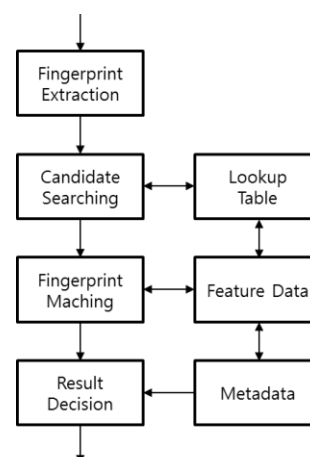


Figure 7. Fingerprint searching process

The fingerprint search request for a broadcasting content identification is performed sequentially in a certain predetermined time. Thus, session management for each search request is required in the director process of the content identification server. The session management is reset when the search result is successful, when it exceeds the predefined request count, or when the session timeout occurs. Figure 8 shows the sequence diagram of a search session management.

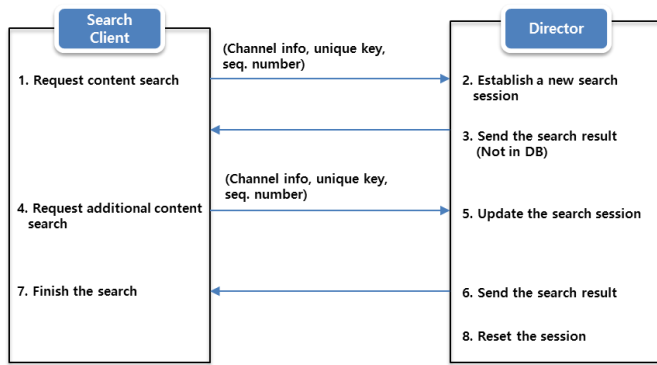


Figure 8. Sequence diagram of a session management

V. IMPLEMENTATION

Figure 9 shows a screen shot of the content identification server which consists of directors, sub-directors, and workers. The implemented server is operated on 64bit Ubuntu Linux platform.

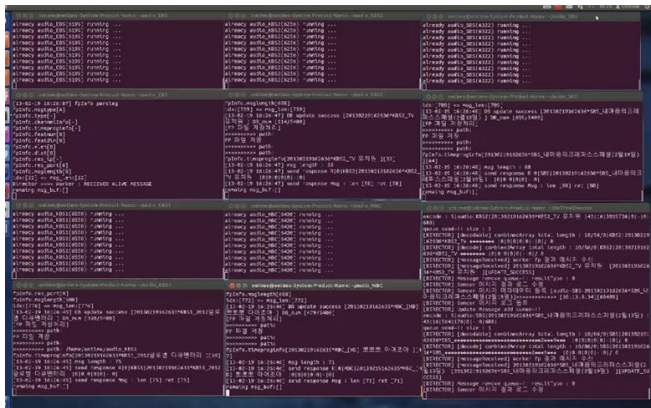


Figure 9. Screen shot of the content identification server

Figure 10 is a screen shot of the content feature register. The implemented content feature register can process 4 channels on one PC.

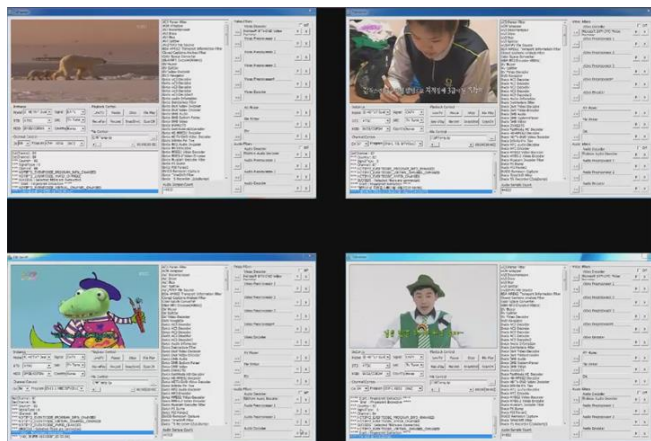


Figure 10. Screen shot of the content feature register

VI. CONCLUSIONS

In this paper, we propose a fingerprint-based second screen framework which can identify broadcasting content in real time by on-time content identifier. We define this fingerprint as on-time identifier, and content identification system using on-time identifier as the identification system.

We described the system structure, system components, and fingerprint management scheme of our system. And finally we showed the implemented fingerprinting-based broadcasting content identification system

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