Technical Challenges of Persistent Association Technology for Ubiquitous Multimedia

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Abstract

Persistent Association Technology associates the metadata with the contents persistently. In MPEG-21 architecture, one of promise multimedia framework for ubiquitous environment, multimedia contents are distributed with its metadata. The metadata are widely used for distribution, surveillance, and protection of multimedia contents in multimedia framework. In order to provide more secure multimedia services, the PAT is indispensable. The morphology of ubiquitous multimedia is different from ordinary multimedia. Moreover ubiquitous network environments have a mixture network of several wire and/or wireless. Ubiquitous multimedia challenges to current multimedia technologies. Several technical issues on the PAT for ubiquitous multimedia are discussed in this paper. We propose that a scalable form of PAT is one of feasible solution.

Key words: Persistent Association, Ubiquitous Multimedia, MPEG-21

1. Introduction

Ubiquitous network comes up with a new trend of IT research and industry field. The concept of ubiquity reflects the trend where computing devices become increasingly embedded, intelligent, and deployed in a variety of settings such as home, office, vehicle, and other environs to argument human capabilities. These devices must be invisible or transparent and embedded anywhere and elsewhere [1]. Multimedia services will support a core component of ubiquitous environment [2].

The MPEG (Moving Picture Experts Group) provides the MPEG-21 framework that is multimedia framework. Today, many elements exist to build an infrastructure for the delivery and consumption of multimedia contents. The aim for MPEG-21 is to describe how these various elements fit together. The vision for MPEG-21 is to define a multimedia framework to enable transparent and augmented use of multimedia resources across a wide range of networks and devices used by different communities [4].

In multimedia framework, coded multimedia contents will be juxtaposed with metadata descriptors and IPMP that apply to the contents. This leads to a requirement for tools that can create and maintain an association between content, metadata and IPMP elements within MPEG-21. Ubiquitous media should be managed well, because many kinds of that are related to digital rights management or security problems. The MPEG defines the persistent association and gives a guideline making a persistent association tool that combine digital item with its metadata [5].

In ubiquitous network including wire and/or wireless networks, multimedia contents should be managed carefully, because the characteristics of network are changed every moment. Multimedia services are operated over networks, especially streaming form. The network condition may suffer the quality of multimedia service. There are many research on overcome this problem to guarantees the quality of multimedia services. In order to provide reliable persistent association tools to ubiquitous multimedia framework, it should be considered well. We will consider problems and research issues on PAT over ubiquitous networks. In section 2, we review the MPEG-21 framework briefly; the persistent association technology will be discussed as follows. Issues on multimedia over ubiquitous networks will be discussed in section 4. We will discuss technical problems in persistent association, and then propose a solution on this problem, scal-

able persistent association in section 5, 6 respectively. Then make conclusion in section 7.

2. MPEG-21 Framework

In ubiquitous computing environment, the appetite for content consumption and easier access to information continues to increase rapidly by several access devices. These access devices have a various type of terminals and network capabilities. They demand solutions that deliver accessible and advanced multimedia creation and consumption on many platforms. The MPEG-21 framework can be a solution to provide management of content, adaptation of content based on user and devices, protection of right, protection of providers and consumers. It is open standards for framework of delivery and consumption by all the players in the delivery and consumption chain. It consists 16 parts [9,10].

3. Persistent Association Technology

3.1. Persistent Association Model

In the context of MPEG-21 resources and other scenarios, it is often necessary to create and recover associations between content items and related information (e.g. MPEG-7 metadata, unique identifiers and copy control information). A multitude of solutions encompasses the use of mark-up tags, databases, file headers, etc. Such associations can be fragile, in the sense that if tags are stripped away (e.g. as happens when content is sent over legacy interfaces) then the association is lost. The field of "persistent association" is concerned with techniques by which non-fragile associations can be re-established. Presently, the main techniques of the field are watermarking and fingerprinting. The main application areas are where analog signals (such as audiovisual content) are contained within a digital environment [5].

In MPEG-21 standard documents, they give 4-PAT models: headers, digital signatures, fingerprinting, and watermarking. Watermarking does not need database, and it is more robust to impairment than others. However, watermarking can be adopted to non-text-based resources, such as audio clips, video streams and pictures only [5]. In Fig.1, we draw a generic PAT (Persistent Association Technology) reference model.
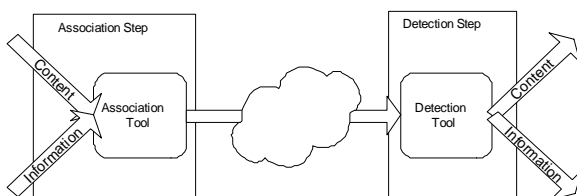

Fig. 1 Generic PAT Reference Model [5]

The most famous watermarking method was proposed by Cox *et al* [6]. This method does not have effect on visual perceptibility and robust to several kinds of tampering. It represents watermark message by pseudo-random real number normal distribution sequence.

3.2. Application Model using PAT

The persistent association technologies will find application in areas where metadata and content are simultaneously required. Application areas include multimedia database, content monitoring and tracking on networks or broadcast transmissions, and in the management of digital rights. You can find detail examples in [5].

3.3. Technical Issues in PAT

Robustness is most significant problem in the PAT. The association may be broken by several reasons. These operations are called as 'attack' in the research fields. The attacks are categorized in two terms: malicious attacks and non-malicious attacks. Five malicious attacks are listed in [5], impairment attacks, synchronization attacks, cryptographic factors, collusion attacks, and mosaic attacks. Additionally, geometric attacks are known as a powerful method to destroy association [12]. Depending on applications, PAT designer should be considering these attacks. For example, collusion attacks and mosaic attacks are considered importantly when the PAT is used for content tracking in the content delivery.

Scalability problem of computing time or payload size are discussed commonly. Adding computational processor to recognize watermark can be reduced embedding/detection time. Payload size can be varied in several terms. Usually, the payload size of PAT is inverse proposition to visible quality or robustness.

Interactions are regards as an important problem when multiple signals are inserted into the contents. This application can be considered in MPEG-21 framework. As the digital contents are delivered following several users, the transaction information will be added multiple. Each of information should be identified clearly.

4. Multimedia over Ubiquitous Networks

Ubiquitous Multimedia is served over ubiquitous networks. Networks are consisted of several networks that have different bandwidth, packet loss rates, etc. Mixed network structure suffers to provide Quality of Service of multimedia. Several problems discussed in conventional network research fields, the change of bandwidth with time varying, delay, jitter, latency, and errors can be considered in this research. Ubiquitous networks are integrated by several networks. Therefore, heterogeneity and time-varying property of networks should be considered carefully.

There are many efforts to overcome the network problems in multimedia streaming research. One of promising solution is scalable coding of multimedia [3, 13]. A scalable coding technique one that allows compressing multimedia data once and the decompressing it at multiple

data rates, frame rates, spatial resolutions, and/or video quality. Such a coding techniques would be very desirable from a networking viewpoint as it allows differentiated quality and bit rates depending on the kind of service chosen by the user [13].

5. The PAT System for Ubiquitous Multimedia

To cope with the time varying and heterogeneity property of ubiquitous network, we propose that the PAT system should be designed in 4-layers, association layer, coding layer, network adaptation layer, and network layer. The concept of these layering is explained in Fig. 2.

This model divides the PAT system considering ubiquitous environment into 4 layers. The most upper layer is the association layer. It is matched with conventional PAT system, e.g. watermarking program. A user can be associate a metadata with the contents in association layer program. The second layer is the coding layer. Usually, multimedia data are delivered in compressed form. Sometimes contents are encrypted in this layer. The third layer is the network adaptation layer. The role of this layer is packetizing of output bitstream of the coding layer. The bottom layer is the network layer. This layer can be divided into two layer, physical layer and network layer. In this paper, we called the network layer is considering these two layer.

As we insisted before, the scalable coding is useful in terms of network adaptation. Therefore, we will explain this system focusing in coding layer. Association layer must be satisfied requirement of PAT considering user's requirement. Basic requirements are robustness, imperceptibility, minimum payload, etc. The data that associated with contents must have scalable form in order to match with scalable coding layer. Each coding layer can be packetized in some way to have robustness against network problems. Each layer should be designed considering other layers.

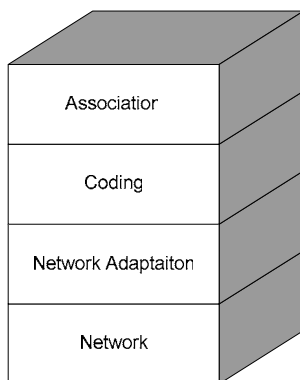## 6. Scalable Persistent Association Technology

We propose a new watermarking method as a persistent association technology considering scalable coding algorithm. Comparing with conventional digital watermarking methods, our method is able to scale the size of watermark payload. Conventional watermark has fixed-size watermark payload. For the purposes of storage or transmission of multimedia data, compression is essential. The lossy compression is widely used in common compression algorithm, for example JPEG, MPEG. It uses the human visual property that we can not recognize the change of some part in image where rapidly changed region. These regions are removed during the compression is applied.

Most of watermarking algorithms use the human visual property also. They use the high frequency part as a region of watermark embedding. When the compression is applied to watermarked image, the watermark must be altered by lossy compression, quantization. Therefore, it is regarded as a kind of attacks to watermark. There are a lot of research results on robust watermarking algorithm against the compression.

Our method has somewhat different concept of watermarking and compression. Both of them are considered simultaneously in watermarking embedding process. Moreover, we choose coding architecture as scalable form with considering the adaptation ability. The bit-plane architectures are used in several scalable coding. Our watermarking embedding process is applied in the procedure of compressing. The 8x8 DCT, lossy quantization, and bitplane coding are adopted in our system. Detail algorithm is described in [11]. In Fig.3, we draw our idea, scalable persistent association data inserting algorithm briefly. We can get a scalable property of embedded information with quantization parameters. Fig.4 represents the result.

Fig. 2 The PAT Layer Model for Ubiquitous Multimedia
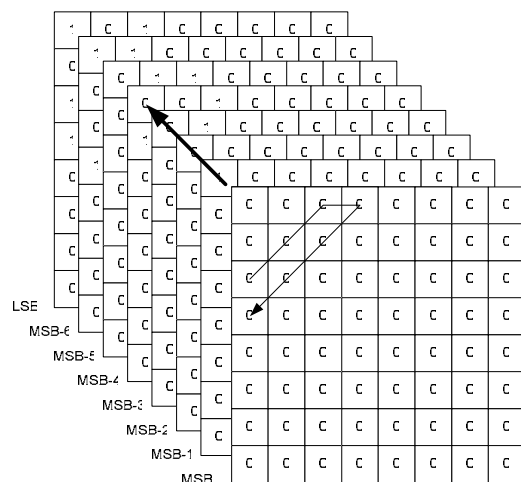

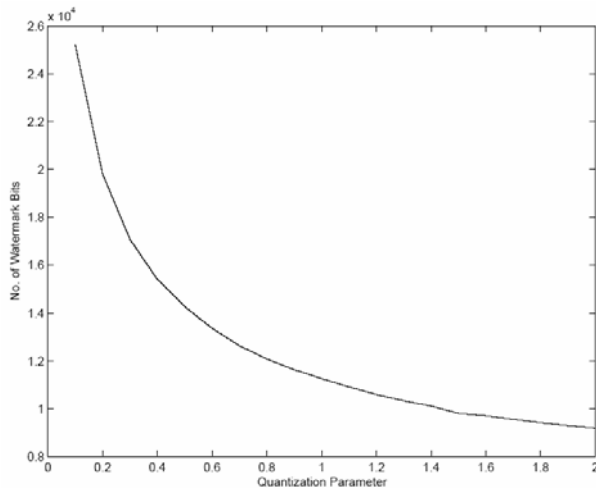Fig. 3 Information Embedding Order in DCT Bit-plane

Fig. 4 Number of Watermark Bits

7. Conclusion

In this paper, we reviewed Persistent Association Technology, MPEG-21 framework, ubiquitous network property, in order to make a persistent association technology for ubiquitous media. The scalable coding method has several merits considering network environments. We conceptualize the ubiquitous PAT system in four layers. Each layer should be designed consider neighborhood layers. Research issues in each layer are discussed. Proposed algorithm has a scalable property of metadata with varying quantization parameters.

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