Chapter 44
Personalized Real-Time Virtual Tours in Places With Cultural Interest

Emmanouil Skondras
University of Piraeus, Piraeus, Greece

Konstantina Siountri
University of Piraeus, Piraeus, Greece

Angelos Michalas
Technological Educational Institute of Western Macedonia, Kastoria, Greece

Dimitrios D. Vergados
University of Piraeus, Piraeus, Greece

ABSTRACT

Virtual tours using drones enhance the experience the users perceive from a place with cultural interest. Drones equipped with 360o cameras perform real-time video streaming of the cultural sites. The user preferences about each monument type should be considered in order to decide the appropriate flying route for the drone. This article describes a scheme for supporting personalized real-time virtual tours at sites with cultural interest using drones. The user preferences are modeled using the MPEG-21 and the MPEG-7 standards, while Web Ontology Language (OWL) ontologies are used for metadata structure and semantics. The Metadata-Aware Analytic Network Process (MANP) algorithm is proposed in order to weigh the user preferences for each monument type. Subsequently, the Trapezoidal Fuzzy Topsis for Heritage Route Selection (TFT-HRS) algorithm ranks the candidate heritage routes. Finally, after each virtual tour, the user preferences metadata are updated in order in order the scheme to continuously learn about the user preferences.

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INTRODUCTION

Virtual tourism (Beck J. & Egger R., 2018) reduces time or spatial limitations of real tourism. Services such as 360º video streaming (Qian, Ji, Han & Gopalakrishnan, 2016), 3D animation (Bustillo, Alaguero, Miguel, Saiz & Iglesias, 2015), Augmented Reality (AR) (Marques, Tenedório, Burns, Romão et al., 2017) and mixed reality (MR) (Debandi, Iacoviello, Messina et al., 2018) are used to construct a virtual world for the user. Drones (Mirk & Hlavacs, 2015) could be used for the 360° video capture of places with cultural interest. The video can be streamed to users in real time, enriched with additional audio descriptions, 3D, AR or MR content. To support such services, fifth generation (5G) (Akpakwu, Silva, Hancke & Abu-Mahfouz, 2018) mobile infrastructures could be used, providing plenty of networking, computational and storage resources. Indicatively, the enriched 360° video is streamed to the user through a 5G Mobile Edge Computing (MEC) or Fog (Roman, Lopez & Mambo, 2018) infrastructure, which assures the satisfaction of its strict constraints in terms of throughput, delay, jitter and packet loss. The 5G infrastructure could support heterogeneous network access technologies, such as the 3GPP Long Term Evolution Advanced (LTE-A) (TS36.300-V13.2.0., 2016), the IEEE 802.11p Wireless Access for Vehicular Environment Road Side Units (WAVE RSUs) (1609.3-2016, 2016) and the IEEE 802.16 WiMAX (802.16q-2015, 2015).

Virtual tours with drones can be used in numerous cases dealing with protection, preservation and enhancement of tangible heritage, as well as servicing special groups of people, i.e. the elderly, children, persons with disabilities that cannot reach inaccessible monuments. Each drone is remotely controlled by the user or it is autonomous navigated (Kan, Okamoto & Lee, 2018). A critical task of the autonomous navigation service is the selection of the most appropriate flying route for the drone, as in heritage sites where multiple monument types exist, the user preference for each type should be considered, in order personalized user experience to be provided.

User preferences could be modeled using the MPEG-21 (Metta,S., Montagnuolo,M. & Messina,A., 2015) standard, which defines a framework for both multimedia resources and user preferences manipulation. MPEG-21 uses the architectural concept of the Digital Item (DI), which is a combination of resources (such as audiovisual content), metadata (such as descriptors) and structures describing the relationships between resources. DIs are declared using the Digital Item Declaration Language (DIDL). The MPEG-21 Digital Item Adaptation (DIA) architecture and the MPEG-7 (Park, Hong, Lee & Lee, 2014) Multimedia Description Schemes (MDS) for content and service personalization provide a Usage Environment that models user preferences. Additionally, description of the multimedia that enriches the 360º video is required in order the appropriate content to be retrieved and placed in certain places into the video. This description could be performed using the MPEG-7 standard.

Both MPEG-21 and MPEG-7 (MPEG-21/7) metadata are stored in XML format allowing efficient indexing, searching and filtering. The metadata structure could be described using Web Ontology Language (OWL) (Sengupta & Hitzler, 2014). OWL is a knowledge representation language used for composing ontologies. The ontologies are described in OWL documents by defining classes, attributes and individuals. Classes are collection of concepts, attributes are properties of classes and individuals represent the objects of a class. Thus, the system will be intelligent enough to autonomous retrieve information of the metadata files without requiring additional information about the metadata structure from the user. OWL ontologies could be queried using the SPARQL (Peng, Zou, Özsu, Chen & Zhao, 2016) language. SPARQL features include conjunctive or disjunctive patterns as well as value filters. Subsequently, when the system has learned about the metadata structure, it can query them using Mpeg