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Original article

One pilot application of mobile Raman spectroscopy and information technologies for cultural heritage inventory studies

Ozan Unsalan^{a,*}, Alpaslan H. Kuzucuoglu^b, Caglar Cakir^c, Ersin Kaygisiz^d

^a Physics Department, Science Faculty, Ege University, 35100 Bornova, Izmir, Turkey

^b Occupational Health and Safety Department, Istanbul Yeni Yüzyıl University, 34010 Zeytinburnu, Istanbul, Turkey

^c Antalya Museum, 07050 Antalya, Turkey

^d Physics Department, Faculty of Science, Istanbul University, 34134 Vezneciler, Istanbul, Turkey

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ABSTRACT

With the improvement of the technology, new methods are being produced for documentation of library materials. By using written, visual and auditory methods for documentation of library materials, all of the stages regarding the material are recorded. By this way, transferring information and data to next generations that is the basic aim of the documentation is targeted. Besides, documentation of the works within the library building before/after the restoration is also crucial. Documentation without giving harm to primary materials like paper or leather (without an intervention), taking the decision of intervention by damage assessment, protection of the works by digitalization and sharing with the concerned parties are provided. Many alternative softwares are used in accordance with the implementations and documentations that are desired to be performed. Digitalization stage covering all of the details of a book from the binder of the book to inner pages provides conveying of the work to many users without giving harm. Additionally, these studies help restorators on the restoration of the books. On the other hand, Raman spectroscopy is extensively used in analysis of the cultural heritage artefacts. In order to protect heritage materials by "spectroscopic cryptology techniques" (Infrared and Raman spectroscopy) play a crucial role in understanding and differentiating the fake/artificial materials from each other. The aim of this study is to bring spectroscopic methods and other visual documentation methods together and produce a cultural heritage inventory. In this study, by formation of a written, visual and spectroscopic database for rare books at Recai Mehmet Efendi Library, documentation study regarding dye pigments of leather binder of the book, paper quality, definition of both paper and leather original materials, definition of deterioration level and restoration proposal of the books were studied.

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1. Research aims

This research aims to:

- identify of rare books' paper & binder deterioration level by Raman spectroscopy;
- define original materials (paper & binder);
- define possible deterioration cause;
- digitize all pages and binders of rare books by information technologies;
- extend restoration proposals for restorers.

Detection of factors cause rare books deterioration such as environmental, biological, man-made and disasters, damage detection of library/archive buildings and library/archive materials, identification of original materials, detailed documentation were discussed. By this way, diagnostics and treatment of rare books can be carried out. Institutions, organizations related to protection of libraries and archives, administrators, library and archive experts, curators, conservators, restorers and researchers working on the field by attracting their attention and their contribution to the documentation works are scope of the study.

2. Introduction

Rare books and manuscripts are cultural heritage treasures which are bridges from past to future generations. Books are so vulnerable to natural disasters such as earthquakes, fires, floods etc. and environmental conditions. Deterioration causes may be

* Corresponding author. Tel.: +905332336794.
E-mail address: physicistozan@gmail.com (O. Unsalan).

categorized as “external” or “internal” factors. External factors are poor environmental conditions, unsuitable storage procedures, risky handling, unauthorized exposure, theft, vandalism and natural or accidental disasters. Internal factors are poor quality of materials making up documents or the poor quality of assembly of these materials [1]. Visual techniques, softwares and spectroscopic analyses give chance to understand original materials, which are, used for paper and binder and their deterioration levels. It is also important for conservators to understand certain materials such as artistic materials, pigments, technical producing skills. These methods offer user friendly, cost efficient features and non-destructive working on rare books. Many studies are carried out on identification of rare books deterioration causes by non-destructive methods. One of these studies three different and complementary spectroscopic methods are used on the 16th century printed book. The main goal is to identify the pigments used in the coloration of the miniatures. PIXE and Raman Spectroscopy methods are used on binder, papers and motives [2] even they can be regarded as semi-destructive techniques at atomic level. An iron gall ink manuscript, a handwritten memo on a legal land description from the year 1769 was analyzed at ANKA in collaboration with the Institute for Instrumental Analysis of the Forschungszentrum Karlsruhe. In that study, ink composition is revealed by the infrared spectroscopy [3]. Another project is carried out by the Analytical Research Laboratory at the Canadian Conservation Institute. On the prayer book dated 1800s, visual examination was undertaken with the Visual Spectral Comparator imaging system in the ultraviolet and infrared regions of the electromagnetic spectrum to determine any possible fluorescence or luminescence of the iron gall, blue, and red inks [4]. National Library of India was carried out Digitization of Manuscripts Project from 1999–2001. In that project, the digital restoration of the images of the manuscript was done using the state-of-art image editing software, Adobe Photoshop [5]. A geocommunication study for the preservation of cultural heritage with the help of multimedia technology was done [6]. Digital representation and management of cultural heritage materials were also introduced [7]. Technical guidelines for digitizing cultural heritage materials was published by Federal Agencies Digitization Guidelines Initiative [8]. Mata et al. studied St. Domingo de Silos church by applying photogrammetric recording method [9]. Scanning techniques were also applied in cultural heritage field [10]. For a manuscript of eighteenth century, Adobe Photoshop was applied for digital paleography [11]. Digitized medieval manuscripts database was developed recently and one can see there is a lack of these kind of digitalization studies in Turkey [12]. It is apparent that this type of study when especially combined with Raman spectroscopy is needed. In a recent study, portable Raman spectrometer was also used on core extractions and excavated human mandibles from Nafpaktos castle [13]. An analysis of an artist’s paint palette was also investigated by both portable and laboratory Raman instruments on a 16th century wood panel painting [14].

3. Materials and methods

In this study, a Rare Books Inventory Model (RBIM) is proposed by means of combination of Digitization and Raman spectroscopy techniques (Fig. 1). According to this model:

- documentation such as photography, digitizing has been processed by the one of the visual documentation techniques Adobe Photoshop CS® image process program. Three-dimensional (3-D) image acquisition, the identification of damaged areas of inner pages and binder, the binder color detection from non-perishable portions of the original parts are

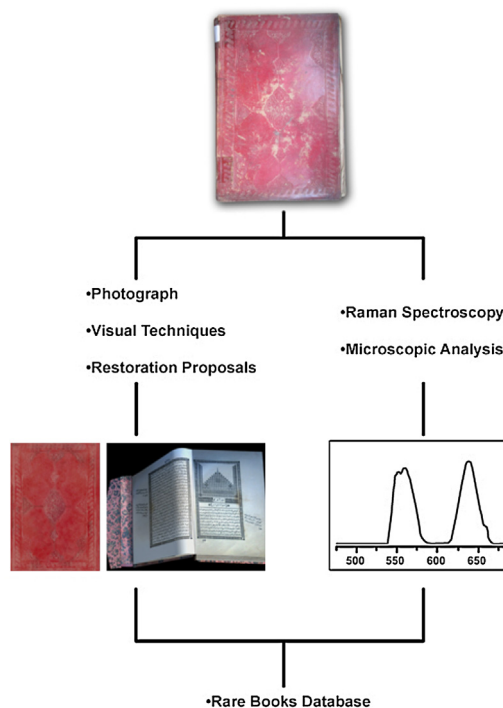


Fig. 1. Rare Books Inventory Model (RBIM).

provided with this technique and thus binder restoration proposal is given according to the original color of the binder;

- Raman Spectroscopy has been used in order to contribute documentation and diagnostic methods and;
- optical microscopic analysis is also included in study.

In this way, a database has been obtained which consists of existing rare books in the library, determining the current situation of studied rare books and restoration recommendations.

In order to create study model, Muhyiddin İbnü'l-Arabî Tefsir-i (explanation of Holy Quran) Volume 2 (Inventory Number: 297.211 ARA.T. (K.2) is used which exists in İlim Yayma Foundation Recai Mehmed Efendi Library. This book is dated to 730/1329 Hijri. (1911). Original size is: 17 × 24 cm. Binder colour is red (Fig. 2). It is coded as ARA2. The other rare books, which are used for comparison with the ARA2, are (with the codes):

- MUH: Mektubat-ı Hacı Muhammed Ma'sum. Writer: Hacı Muhammed Ma'sum; Translation. Süleyman Müstakimzade. 1277 Hijri (1860) (Inventory Number: 297.7 MUH.M);
- SIR: es-siracü'l-münir. Writer: Şemseddin Hatib Muhammed b. Ahmed Kahiri Şafii Şirbini, 1304 Hijri (1886) (Inventory Number: 6.297.211 ŞİR.S. (K.1);
- HUS: Mevakib tefsiri (explanation of Holy Quran) Writer: Mevlana Kemaleddin Hüseyin b. Ali-i Beyhaki-yi Sebzevari Hüseyin Vaiz-i Kaşifi, Translation. İsmail Ferruh Efendi, 1504–1505 Hijri (1864) (Inventory Number: 297.211 HÜS.M).

3.1. Study site: Recai Mehmed Efendi Library

Managed by the İlim Yayma Foundation, the Library is located on the Cemal Yener Tosyalı Avenue in the Vefa neighbourhood of Istanbul's Fatih district in Turkey. It was functioning as a primary school (in Islamic countries, “mektep” means the building where primary education is delivered, and those for kids were called “Sıbyan Mektebi” (primary school) during the Kara-Khanid Khanate, the Seljuk Dynasty and the Ottoman period [15]) and “sebil” (Small structure

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