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3D Multispectral Imaging for Cultural Heritage Preservation: The Case Study of a Wooden Sculpture of the Museo Egizio di Torino

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Abstract: Digitalization techniques, such as photogrammetry (PG), are attracting the interest of experts in the cultural heritage field, as they enable the creation of three-dimensional virtual replicas of historical artifacts with 2D digital images. Indeed, PG allows for acquiring data regarding the overall appearance of an artifact, its geometry, and its texture. Furthermore, among several image-based techniques exploited for the conservation of works of art, multispectral imaging (MSI) finds great application in the study of the materials of historical items, taking advantage of the different responses of materials when exposed to specific wavelengths. Despite their great usefulness, PG and MSI are often used as separate tools. Integrating radiometric and geometrical data can notably expand the information carried by a 3D model. Therefore, this paper presents a novel research methodology that enables the acquisition of multispectral 3D models, combining the outcomes of PG and MSI (Visible (VIS), Ultraviolet-induced Visible Luminescence (UVL), Ultraviolet-Reflected (UVR), and Ultraviolet-Reflected False Color (UVR-FC) imaging) in a single coordinate system, using an affordable tunable set-up and open-source software. The approach has been employed for the study of two wooden artifacts from the Museo Egizio di Torino to investigate the materials present on the surface and provide information that could support the design of suitable conservation treatments.

Keywords: photogrammetry; multispectral imaging; data fusion; 3D multispectral model; digitalization; cultural heritage; digital twin; digital methods

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1. Introduction

The study of artifacts belonging to the field of Cultural Heritage (CH) has always been a challenging task. Indeed the methodologies aimed at studying such artifacts require several conditions to be satisfied to avoid any possible damage to the items. When possible, it has to be preferred to investigate an artifact using techniques that can be non-invasive, i.e., involving no sampling, and that can be performed where the object is stored or exhibited [1]. Therefore, there is increasing interest in the development and application of analytical techniques that can satisfy the above-mentioned requirements and provide useful insights into the state of artwork preservation [2].

In this context, digitalization techniques are gathering the interest of experts in the field of Cultural Heritage. The creation of a 3D model of artifacts, without doubt, brings several advantages. Firstly, the possibility of fully documenting an item and creating a