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3D Modeling the Work Space with a Lidar Sensor-Supported Camera and Designing the Designs with Genius Loci Concept in Design Programs

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Abstract
Furniture, colors and designs used in work spaces affect working performance and quality of working life. This study works with the Genius Loci concept, which expresses the original atmosphere and air of the work space. The work space was scanned with a lidar sensor-supported camera as part of the study. The obtained scanning file was transferred to a computer platform and made usable with the relevant design program. The relevant design program made it easy to adjust and see the positive effects of the changes in the re-designed work space on work performance and the person using the work space after the changes in the re-designed work space were implemented. By referencing this study, the positive direct effect on performance increase in work space can be seen in the re-designed work space.
Keywords: Genius Loci; Lidar Sensor; 3D Designing; Architecture and Technology; Work Space

1. Introduction
The design and organization of the workspace are critical for increased efficiency and overall job satisfaction. A carefully designed and arranged work environment enhances both the performance of employees and the overall work atmosphere (Vischer, 2007). This is of even greater importance when considering that the workspace plays a significant role in shaping the overall brand identity and culture of the business. Technological advancements have brought with them new and exciting tools in this field. Innovative technologies such as Lidar sensor cameras and 3D modeling programs help model workspaces in a more detailed and realistic manner and understand the use of these spaces more effectively (Guo et al., 2020; Ibrahim & Khalil, 2021, Amen, 2021; Aziz Amen, 2022; Amen et al., 2023; Amen & Nia, 2020). Alongside these technological strides, the principles applied in workspace design hold substantial significance. More precisely, the concept of "Genius Loci" denotes the distinct traits that establish a place's character and spirit, and it can serve as a potent tool in workspace design (Norberg-Schulz, 1980). The essence of Genius Loci outlines the natural, historical, and cultural setting of a place, bolstering the infusion of these characteristics into the design. In this frame, the capacity to perceive a workspace's natural attributes and blend these elements into the design can heighten work productivity and employee job gratification. This paper emphasizes on workspace modeling employing Lidar sensor cameras and 3D modeling software, while also examining the potential involvement of the Genius Loci concept in this procedure. Specifically, it will focus on how these tools shape the design and use of the workspace, how they promote a more operational and effective space, and in the end, how they impact work productivity and effectiveness.

2. Genius Loci Concept
Central to the concept of Genius Loci lies the principle of comprehending and embodying the spirit and character of the encompassing physical and social milieu of a particular locale. This notion offers a framework to decipher and narrate the tale of a place through contemporary design approaches. Emulating the essence of a place encompasses various aspects, such as the historical evolution and present condition of the locale, its purpose and utilization, along with the life and cultures of the inhabitants or users of the place (Tuan, 1979). The application of Genius Loci in today's design practices serves as a means to understand and mirror a place's spirit within its historical and cultural backdrop. This approach incorporates endeavors to respect and conserve the physical and social ambiance of a place while preserving its distinctive persona.

2.2. Lidar Sensor Cameras
Stressing the influence of Lidar sensors within the architecture and construction industry is critical for appreciating the value of this innovation. Lidar operates on the Time of Flight (ToF) principle, a method of measuring distance based on laser technology. It estimates the distance by calculating the time taken for a laser

pulse to reach its target and return. This duration ascertains the speed of the pulse, thereby determining the distance (Sithole & Vosselman, 2004). The exactness and precision of data amassed with Lidar technology facilitates the swift and efficient completion of projects. Specifically, employing Lidar camera sensors enables architects and designers to perceive the intricacies of a space with a higher degree of accuracy and incorporate this intelligence into their novel designs.

2.3. 3D Modeling

3D modeling, notably within computer-aided design (CAD), holds a pivotal place in contemporary architectural and design practices. This technology grants the ability to visualize, modify, and optimize a building or space entirely within a virtual setting. 3D models serve a crucial purpose during a project's preliminary stages to experiment with and visualize design concepts. They can also be employed to demonstrate the end appearance of a design to customers and stakeholders. Integrating Lidar sensors with 3D modeling technology affords a unique prospect for a profound exploration and reflection of the Genius Loci concept. While Lidar data can generate a highly realistic and detailed 3D representation of a space, the Genius Loci concept can be utilized in the model's design process and in presenting the finalized design in a meaningful and impactful way.

3. Material and Methods

3.1. Material

3.1.1. Lidar (Light Detection and Ranging)

As a form of remote sensing technique, Lidar collects information by measuring the reflection of laser light off an object or surface. The properties of the light dispatched towards and reflected back from the target shed light on its features. Lidar finds extensive usage in diverse fields, including geography, geology, forestry, transportation, and architecture. A typical Lidar system consists of a laser, a receiver (usually a photodiode or photomultiplier), and a timer. The Lidar system primarily launches laser light and measures the timing of its reflection back from the target. This particular technique, known as Time of Flight (ToF), utilizes the speed of light to calculate the distance traveled by light itself (Sithole and Vosselman, 2004). Offering remarkable precision and accuracy, Lidar sensors find applicability across a wide range of fields. One prominent use case involves the precise mapping of geographical terrain features, vegetation structures, and buildings (Lichti, 2007). Indeed, Lidar technology's capacity for assessing atmospheric conditions is highly beneficial in the fields of meteorological prediction and climate change studies (Kaspari et al., 2015). The execution of high-resolution Lidar scans facilitates the creation of intricate 3D renditions of edifices and infrastructures, thus substantially improving the effectiveness and continuity of the stages involved in planning, designing, and constructing buildings.

3.1.2. Genius Loci Concept

The incorporation of the Genius Loci notion into the design workflow commences with the comprehension and articulation of a specific location's quintessence. This requires an in-depth exploration of its historical, physical, and societal surroundings, its role, and its user's culture. Investigation is carried out via thorough scrutiny of diverse sources like architectural records, historical repositories, photographs, space-specific observations, and interviews (Sepe, 2013). Upon the identification of the Genius Loci, it is assimilated into the design progression. The design matures by mirroring the space's unique attributes and personality, amplifying functionality and usability whilst accentuating its distinguishing features. In the concluding phases of the design progression, the Genius Loci application is assessed. This appraisal might entail collecting feedback and initiating dialogues with end-users, clients, or stakeholders. By employing and evaluating the Genius Loci concept, architects and designers can better grasp a place's essence and effectively integrate it into their designs. This approach carries the potential to conserve a space's distinguishing characteristics and personality while accentuating these aspects in creative designs.

3.1.3. 3D Modeling

The aim of this investigation is to conceive an intricately fashioned and lifelike digital portrayal of a designated region utilizing 3D modeling methodologies. 3D modeling, a prevalent technique in computer-aided design (CAD), facilitates the development of three-dimensional illustrative depictions of entities or constructs (Sourin, 2011). The initial phase of this research comprises the production of an exhaustive 3D point cloud, sourced from data gleaned from Lidar sensors in the designated area. This point cloud delivers a comprehensive and accurately scaled 3D representation of the space (Sithole and Vosselman, 2004). Subsequently, this point cloud undergoes a transformation into a 3D model through the use of chosen 3D modeling software. This process typically comprises several stages, commencing with the cleaning of raw point cloud data, followed by the application of point cloud meshing algorithms to fabricate a 3D model (Rusu & Cousins, 2011). This model serves as the foundational design model to be utilized throughout the design process. The 3D model is then designed and optimized in accordance with the Genius Loci concept. This procedure involves making design decisions that resonate with the original spirit and character of the space.

3.2. Methodology

3.2.1. Selection and Installation of Environment Browser Software

Third-party software leveraging the LiDAR sensor positioned beneath the third camera of the new generation iPhone models was utilized as the environment scanner. Scanning in LiDAR mode was carried out using the trial version of an application known as Polycam (Image 1), which possesses object recognition capabilities, over a span of three days. The scanned data was subsequently saved and exported in both STL and FBX formats (Image 2, Image 3).

polycam

Image 1

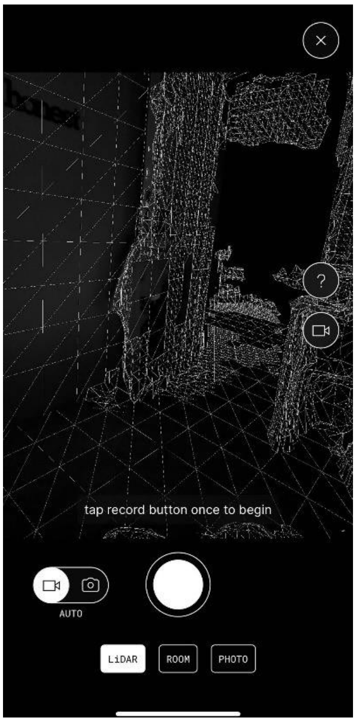

Image 2

3.2.2. 3D Modeling and Design Process Using Blender

Following the scanning procedure, the acquired data in varied formats can be controlled and inspected using the "3D Viewer" software available in the Windows operating system store. This software permits the manipulation of the scanned data, thereby achieving a visual representation akin to the one displayed in Image 4.

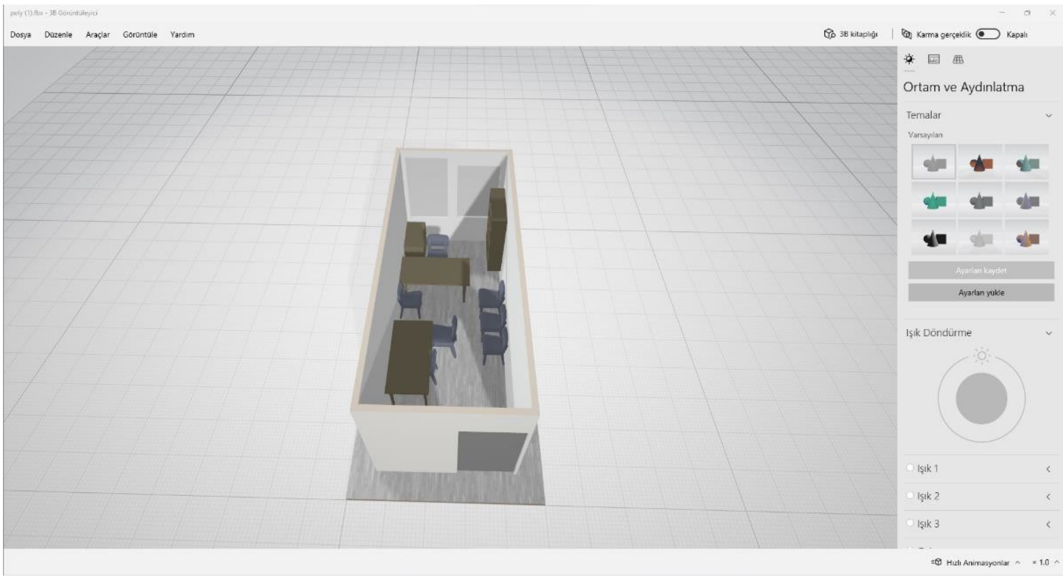

Image 4

The verified scanned file is transferred to a scanning program named Blender. In order for the objects (Table, Cabinet, Chair, etc.) in the imported file to be individually positioned, they need to be detached from the whole. For this process, the relevant menu in the Blender design program (Image 5) facilitates the import of the .FBX file extension. After importing the file, you can proceed to the modeling tab, where individual parts can be viewed and accessed separately using the side panel (Image 6). This will permit their separate placement.

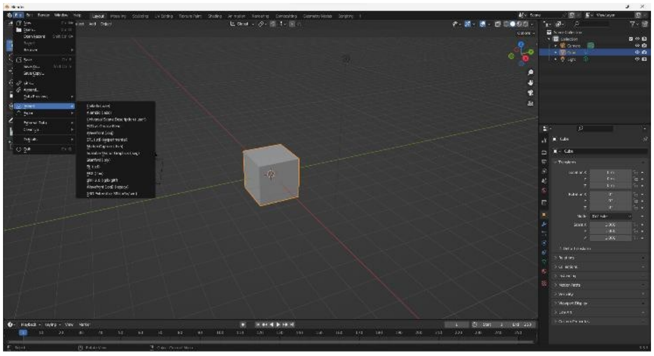

Image 5

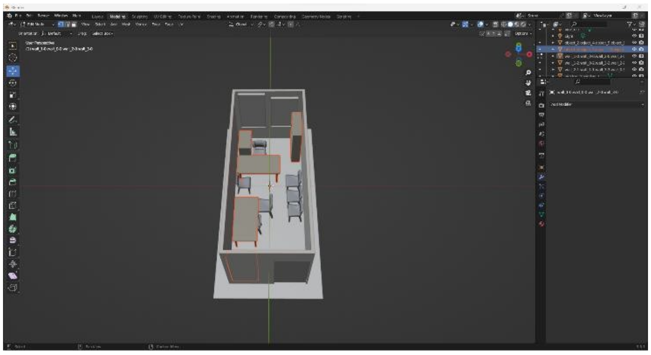

Image 6

To facilitate the organization and manipulation of each individual component, the models are grouped together and renamed using the panel. Grouping and renaming process has been carried out to provide independence to the components that form a whole and prepare them for repositioning. After the models have been grouped and renamed, as shown in Figure 7, they have gained the freedom to be easily placed in desired locations. This has enabled efficient management and customization of the components in the workspace.

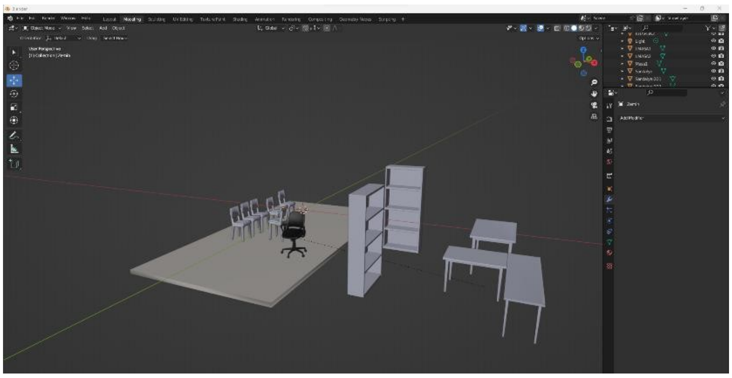

Image 7

3.2.3.The Role and Implementation of the Genius Loci Concept in the Design Process

3.2.3.1. Research and Observation:

During the development process of workspaces, a comprehensive research has been conducted to explore and evaluate the characteristics of the space, user habits, and needs. This research took into consideration the physical dimensions and layout of the space, determined the lighting requirements by considering the lighting needs, and examined the existing furniture and personal usage habits. Additionally, the usage patterns of the current furniture were analyzed, and expectations were evaluated in order to design a new layout that enhances usability and satisfaction, taking into account the desired functionality of an academic workspace.

3.2.3.2. Concept Development

The data obtained during the research phase has been evaluated comprehensively, and based on the results, assessments have been made. It is known that the furniture should be more spacious and the lighting should be stronger, which is why light-colored furniture has been preferred. In addition, efforts have been made to create more spacious working and storage areas. By evaluating the needs, an appropriate number of items have been selected, and the avoidance of overcrowding with excessive furniture has been ensured. The gained spaces have been embellished with modern design elements. Taking habits into consideration, motivational elements have been added. It has been concluded that by adding plants, a spacious and peaceful working environment can be achieved.

3.2.3.3. 3D Modelling

A 3D model of the workspace was devised using the Blender application. The positioning of objects was executed with consideration for the users' mobility within the room and their most needed elements. During the object placement, factors were taken into account for the academician occupying the room, such as the necessity of a second computer for visitors to the academician's office and the routine of coffee consumption. Hence, a coffee machine was integrated into the design. Chairs furnished for the room's visitors were chosen with the aim of achieving consistency with the overarching design. Particular emphasis was put on distinguishing specific areas within the workspace. Secluded storage units were situated near the academician's workspace to furnish storage benefits while remaining out of easy reach for visitors. (Image 8, Image 9).

Image 8

Image 9

3.2.3.4. Evaluation and Improvement

Finally, the design was evaluated, and the extent to which it successfully reflected the spirit of the workspace, the genius loci, was assessed. The design was improved, and the floor plan of the room was exported. Throughout this process, the goal was to effectively integrate the genius loci into the design of the workspace. This not only enhanced the aesthetic appeal but also strengthened the users' connection to the space. It was ensured that the design reflected the users' needs and captured the unique character of the room. By carefully considering the genius loci and incorporating it into the design, the workspace became a more meaningful and engaging environment for its users.

4. **Results**

This study underscores the critical role of workspace design and organization in enhancing employee performance and overall job satisfaction. The furniture, colors, and designs employed in workspaces significantly influence work performance and the quality of work life. The study engages with the Genius Loci concept, which encapsulates the original atmosphere and ambiance of the workspace. The workspace was scanned using a Lidar sensor-supported camera, and the obtained scanning file was made usable with the corresponding design program. This design program facilitated the adjustment and visualization of the positive impacts of changes in the redesigned workspace. By referencing this study, the direct positive effect on performance increase in the workspace can be observed in the redesigned workspace. In conclusion, this study focuses on workspace modeling using Lidar sensor cameras and 3D modeling software. It also explores the potential involvement of the Genius Loci concept in this process. Specifically, it concentrates on how these tools shape the design and use of the workspace, how they foster a more functional and effective space, and ultimately, how they impact work productivity and efficiency. This study demonstrates that effectively integrating the Genius Loci into the design of the workspace not only enhances aesthetic appeal but also strengthens the users' connection to the space. It ensured that the design reflected the users' needs and captured the unique character of the room. By carefully considering the Genius Loci and incorporating it into the design, the workspace becomes a more meaningful and engaging environment for its users.

In the continuation of this study, a system can be developed to redesign the design using virtual reality (VR) technology, which is one of the advanced technologies. Virtual reality is a technology that can immerse users in computer-based simulations, providing an interactive experience. With this technology, it is possible to create a virtual model of the existing workspace and allow employees to make changes to this model to experience different design options. Through virtual reality technologies, different furniture arrangements, colors, and designs can be tested and experienced without the need for physical changes to the workspace, in order to assess their impact on work performance and the quality of work life. This innovative system can enable employees to have a real experience, better understand the outcomes of the design, and make more informed decisions. With the use of virtual reality technologies, employees will be able to actively participate in the design process and customize their workspaces according to their needs. Additionally, the design process becomes more efficient and allows for the identification of incorrect design decisions before they are physically implemented. This innovative approach enables workspaces to be redesigned more quickly and flexibly. It also encourages employees to be involved in the design process and takes into account their original ideas and needs. As a result, a system that can redesign the design using virtual reality technologies can be used as a valuable tool to enhance work performance and productivity. In future research and studies related to workspace design using this innovative approach, we plan to further examine the effects of virtual reality technology in more detail and explore how this technology can be more widely adopted in workplaces.

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