

COLOUR PERCEPTION IN CAMPER VAN INTERIOR DESIGN USING VIRTUAL REALITY TECHNOLOGY

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Abstract

Virtual reality (VR) technology has been developing progressively and rapidly in the past decades. VR technology is used to create 3D models of rooms and spaces, which can be used to create more accurate and detailed designs. Colours used in interior design have the ability to create specific moods, create harmony, and change the perception of how large or small a space may look or feel. The purpose of this study is to explore the application of virtual reality technology in the interior design of a camper van considering the role of colour perception. We aim to determine the effect of colour on the interior design creating professional-looking 3D camper van layout. The results show that any non-professional in 3D design can design a functional and comfortable living space in the camper van using Vanspace 3D software. It was found that light colours and shades create the feeling of space, light, comfort and cosiness. When choosing colours for the interior design of a small limited space, as is the case with a camper van, it is advisable to combine warm earth colours, white and beige colours.

Key words: virtual reality (VR) technology, interior design, 3D modelling, colour perception, camper van

Introduction. Virtual reality (VR) technology has been developing progressively and rapidly in the past decades. LAVALLE [1] defines virtual reality as:

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“Inducing targeted behaviour in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interference”. Virtual reality is a simulated 3D environment that enables users to interact and explore virtual surroundings in a way that approximates reality. The environment is built with computer hardware and software, even though users might also need to wear some devices such as helmets or goggles. VR technology can be used in various areas: gaming, training, education, science, healthcare, retail, real estate, entertainment, cooperative working, telepresence and teleoperating, etc.

The main features of VR technology are: immersion, interactivity, conceptuality, action, and autonomy [2].

VR software for interior design allows users to get a better sense of how a space will look and feel in a 3D representation of a room or space in a virtual environment. Users can walk around and view the space from different points and angles, experiment with various colours, add furniture and decoration, and change different layout options using VR technology. This type of tool can be used by interior designers, architects, and homeowners can use this tool in order to create and visualize designs before making any physical changes to the space. VR technology is used to create 3D models of rooms and spaces, which can be used to create more accurate and detailed designs.

A camper van is a van that is equipped with beds and cooking equipment so that one can live, cook, and sleep in it. You need to be creative and inventive when designing your furniture because you have very limited space in the camper van. Indeed, in a small space it is necessary to place a bed, a dining table, a storage space, a kitchen with the necessary appliances, a bathroom with a toilet, etc. This is why 3D modelling software would be extremely useful in the interior design of a camper van, and more specifically in creating a comfortable and functional living space; for positioning all furniture and appliances; and to select the appropriate colour combinations.

One of the definitions of colour is “different sensations on the eye as a result of the way objects reflect or emit light” [3]. Colours are connected with certain associations and qualities due to their natural occurrence, specific usage and cultural context [4]. Colours generally affect both physical and psychological levels, and colour perception is a matter of personal taste and preference. Individual differences may vary by gender, age, and culture. Colour perception is very often accompanied by a strong emotional impact and has the ability to influence a person’s physical condition.

Colour perception is unique and unusual because it is the result of our neural structure and visual physiology, rather than something that can be measured in the physical world. Particularly, “It’s all in your head.” [1]. Colour perception for humans is three-dimensional considering the fact that there are three different classes of light-receptive cells in the retina. Three numbers, or terms, are necessary to define a colour stimulus for the visual system under standard conditions [5]. For

instance, we may describe a colour by its hue, its colourfulness, and its brightness or we may identify a stimulus by the XYZ tristimulus values of the CIE system [6].

The way the interior space we live, stay, or work in is designed has a certain impact on an individual. In addition to the suitable practical solution and choice of furniture, the colours implemented in the interior design may change the overall impression. Besides, the purpose of a space may determine the choice of appropriate colours [7]. Colours used in interior design may have the ability to create definite moods, establish unity, and change the perception of how large or small a space may feel or look [8]. Colour planning does not stop with individual colours but necessarily extends to colour combinations and groupings. Additionally, colour appearance is influenced by factors, such as lighting conditions and texture, that have implications for designing interiors [9].

The purpose of this study is to explore the application of virtual reality technology in the interior design of a camper van considering the role of colour perception. We aim to determine the effect of colour on the interior design creating professional-looking 3D camper van layout.

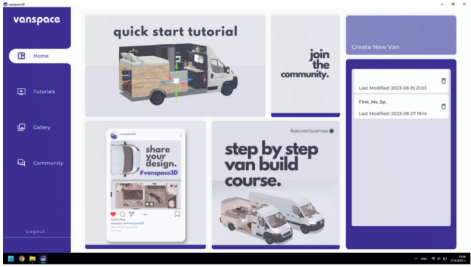
Literature review. LIU et al. [10] claim that through virtual reality (VR) technology, traditional interior design methods and concepts can be transformed in order to satisfy customers and fulfil all of their needs. IFTEKHAR and PRAJAPATI [11] establish that VR technology allows interior designers to create more accurate representations of their projects, and create visually appealing and more functional spaces. PHOMMALY and YU [12] prove that virtual reality technology can improve the technical content of the home design industry, providing brand new impetus for the development and success of the whole industry. CAI [13] argues that through immersive VR experiments, one can intuitively see the real-time behaviour and response of users in different positions and different visual angles in virtual space. The author establishes that the design of some areas can be improved in order to meet the physiological and psychological needs of users. FAKAHANI et al. [14] claim that virtual reality can be used to analyse furniture arrangements. Also, designers can access VR furniture databases and examine how they can fit in the environments for both aesthetic and space considerations [15]. KALEJA and KOZLOVSKÁ [16] prove that virtual reality technology is an effective tool for the visualization of architectural and urban projects in processes of participatory design. PRABHAKARAN et al. [17] present an innovative approach to interior designing in virtual reality, using the latest hardware and software information and communication technologies (ICT) in VR. HIDAYETOGLU et al. [18] establish that distributed and single-user VR has become crucial to digitalizing the Furniture, Fixture, and Equipment (FFE) sector's design communication with improved design communication.

STAHRE [19] designs a VR experiment and a questionnaire to explore how hotel guests' emotional experience can be influenced by the colour scheme of hotel

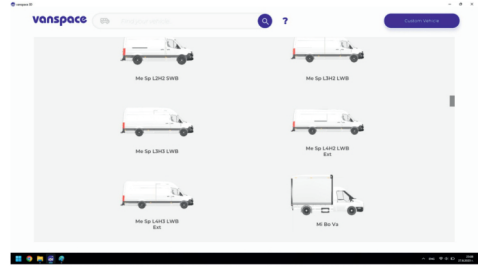
interior colour design. The results show that hotel rooms decorated in yellow have a pleasurable effect, the rooms decorated in grey have a calming effect, and those decorated in blue have a relatively neutral effect. BILLGER et al. [20] point out the significance of inter-reflections, the perceived colour of light, colour variations, and shadowing for the visual appearance in real rooms.

Bibliometric analysis. Bibliometric analysis is a popular and robust approach for examining and analysing extensive quantities of scientific data. Bibliometrics is a statistical technique that includes scientific publications, citations, patent documents, and reports. We use VOSviewer software tool in order to construct and visualize bibliometric networks. Keywords co-occurrence analysis is often used to analyse the strength of links between different keywords in a large number of documents. We apply VOSviewer to create a map which visualize the relationship between the keywords: “virtual reality” and “interior design”. A total of 1830 documents were retrieved from Scopus database in February 2024. A total of 11 165 keywords appeared in all the collected literature. Seven hundred and thirty-two keywords with a frequency of more than five appearances are recognized by the VOSviewer software. The visualization map of the keyword network is presented in Fig. 1. VOSviewer software calculates the total strength of the co-occurrence links with other keywords and also selects the keywords with the greatest total link strength. The visualization of the keywords co-occurrence formed six clusters. There is a significant correlation between the keywords in each cluster. The main items in the eight clusters are: virtual reality; architectural design; human; humans; interior designs; augmented reality. The distance between the two circles indicates the proximity of the two keywords. The connecting lines in Fig. 1 depict the relationships between the elements. Also, the thicker the line, the stronger the relationship between the items. The link strength of the keyword “virtual reality” is the strongest one and it is 4834 points. The link strength between keywords “virtual reality” and “interior designs” is 135 points.

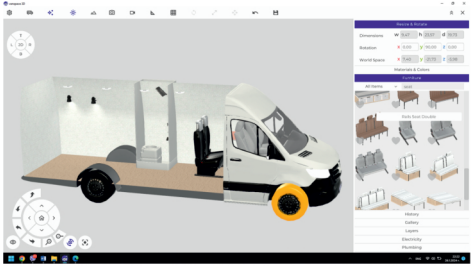
Methodology. Vanspace 3D software was used for analysis purposes. Using 3D modelling various designs and layouts can be created for vans that will be converted into campers. Vanspace 3D software is used by both professional designers and constructors, architects and novice users. One can design a functional and comfortable living space in the camper van using Vanspace 3D software. First, when you open the program, you have to choose the exact model of the camper van that you are going to convert. Second, you have to choose the furniture – bed(s), bench seats, swivel seats, table(s), cabinets, and “garage” (storage space). Also, you can design your bathroom and kitchen by adding all the necessary appliances. The software allows you to resize these components, move them around, and change their colours and textures. Third, you can add power and water systems. After that, you can utilize the roof space, placing roof storage boxes, solar panels, roof fans, and skylights. Last, but not least, you should choose the colour of the walls, roof, floor, and furniture, make the decorations, and add some extra



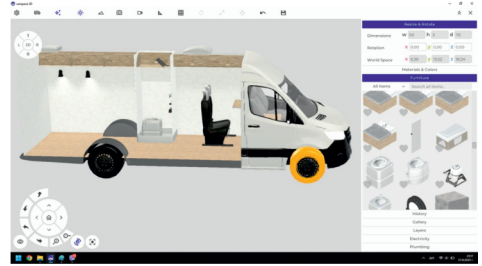
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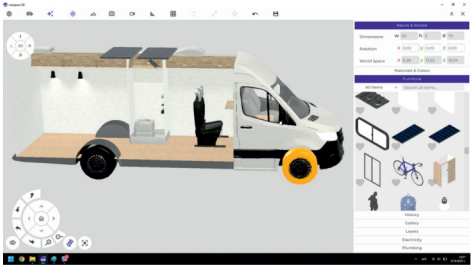
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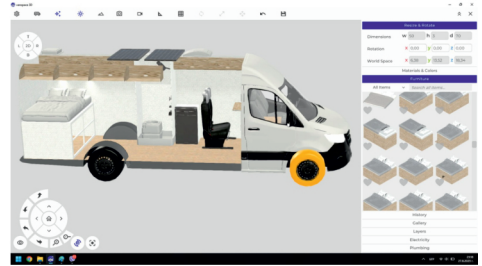
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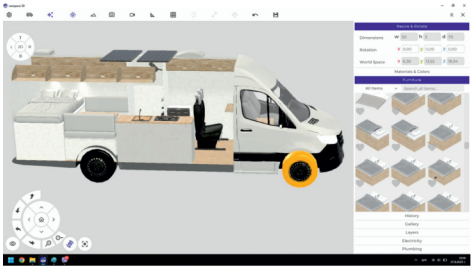
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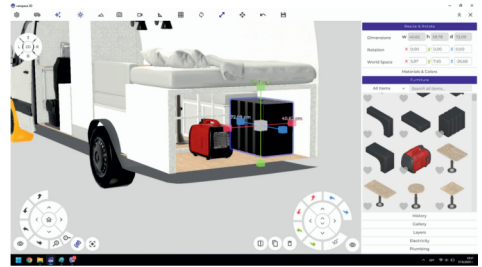
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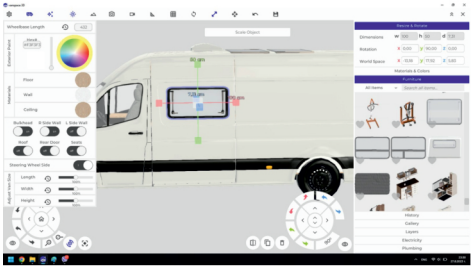
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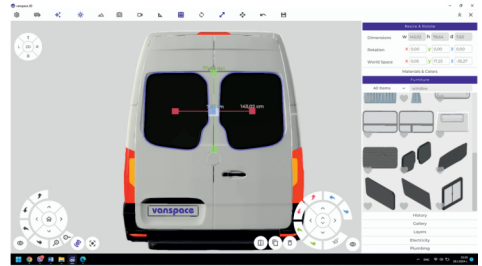
(g)



(h)



(i)



(j)

Fig. 2. 3D visualization in Vanspace 3D Software. Source: Author's presentation. (a) Vanspace 3D Software model of van, (b) 3D visualization of choosing the interface, (c) 3D visualization of adding additional seats, bathroom and lights, (d) 3D visualization of toilet and fans, (e) 3D visualization of solars, (f) 3D visualization of bed and upper cabinets, (g) 3D visualization of kitchen and sofas, (h) 3D visualization of organizing the storage place, (i) 3D visualization of adding side windows, (j) 3D visualization of adding rear windows

cabinets above the bed (Fig. 2f). Figure 2g presents how we can arrange our kitchen together with the sofas and the dining table. Figure 2h illustrates how the space under the bed can be utilized as a luggage compartment, as well as for housing the electrical panel, diesel stove, inverter, clean water container, and other items. We created a 3D visualization of window installation (Fig. 2i) and rear windows installation (Fig. 2j). It is crucial to mention here that estimating the dimensions of the windows is very important. This also depends on how the second row of seats will be positioned because it is essential for the comfort of the passengers sitting there.

Figure 3 demonstrates how we can modify the colour of each element to manipulate the overall colour perception of the viewer. Different colour combinations can have a positive or negative impact on our overall experience and stay.

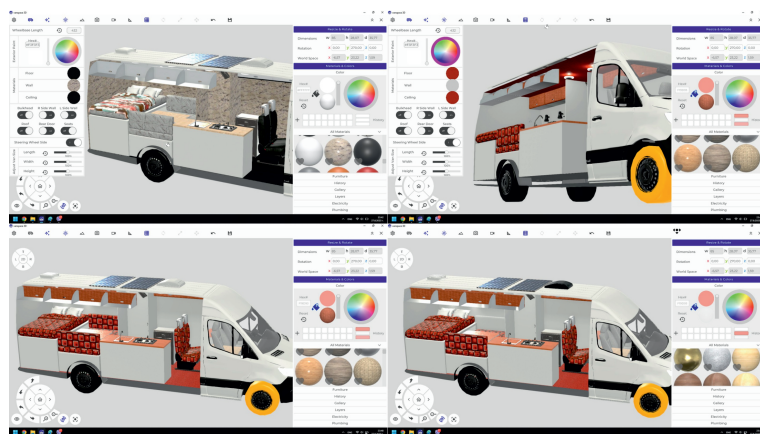


Fig. 3. 3D visualization of changing the colours and texture of furniture. Source: Author's presentation

Finally, we created a 3D visualization showing the changes in wall colours and lighting in the camper van (Fig. 4). As shown in Fig. 4, dark colours create the illusion of a smaller space, while light colours give the impression of a more open and visually appealing area. This is important because the space in any camper is small, and using light colours will make it appear more spacious and larger.

Conclusion. Virtual reality technology is being applied in the interior design of camper vans. One of the important features of Vanspace 3D Software in camper

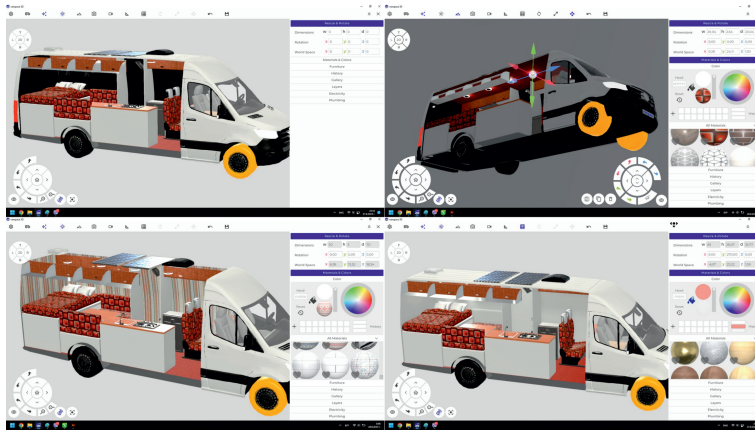


Fig. 4. 3D visualization of changing the colours of walls and lights

van design is its ability to showcase interior furnishings, suggest colour schemes, and provide guidance on colour combinations. This study examines how individuals perceive the same camper van with different colour combinations. When dark colours are used in interior design, the space tends to appear smaller. However, when the colours are changed to lighter shades such as white, natural wood, or warm earth tones, the perception of space changes, and the area appears much more spacious. When selecting colours for the interior design of a small, confined space, such as a camper van, it is recommended to blend warm earth tones with white and beige hues.

Also, by utilizing Vanspace 3D Software, we can create custom furniture that aligns with our preferences and dimensions, following a step-by-step process. The library is quite extensive and provides options for designing various systems such as the electrical system (including solar panels, controller, and battery), water installation, wet room (bathroom with toilet), gas system, additional seating for more passengers, and many other finished items. Each item, such as a bed, table, or kitchen, can be customized to fit the available space if you have already purchased the product and want to determine its exact dimensions. Each element can also be rotated from 0 to 360 degrees and positioned both horizontally and vertically. Vanspace 3D Software is incredibly user-friendly, making it accessible to users with no prior experience or knowledge in 3D Modelling Software.

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