WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Systematic Review of User Engagement with 2D and 3D Web Graphics: Evaluating the Application of Kansei Engineering in Web Design

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A B S T R A C T

In this era, visual appeal has become a crucial factor in a user's experience, an analysis of relevant literature on the comparative effects of digital 2D and 3D graphics on user engagement is achieved using the emotional and psychological perspective of Kansei Engineering (KE). The paper examines research reports from 2018 to 2024, and the authors analyse the type of visual design that affects user satisfaction, interaction, and behaviour in the website hero section. The results suggest that 2D graphics are simpler and compatible and can be used faster while 3D graphics are headmost in providing the user with a rich and immersive experience even though they also have several problems like being slower to load and limited by the browser. Kansei Engineering is proposed as the most efficient idea of web interface emotional affectivity design which, however, in the literature, appears to be very little developed. There are only a few papers on the differences between 2D and 3D graphics based on the use of KE available in the literature, although this method has proved to be very effective in the past when used in other areas of design research. This study demonstrates the lack of empirical research that was carried out to combine KE principles with web design evaluation and visualizes emotion-centered design strategies as the future directions of the study. The work moves further to illustrate how, through inserting psychological insights in the visual web development, UX design can be emotionally intelligent.

Keywords: 2D Graphics, 3D Graphics, Kansei Engineering, User Engagement, Website Hero Sections

1. Introduction

User experience enhancement is a crucial aspect when it comes to web pages. The environment of the internet design evolves faster every year and after the advent of full screen hero sections came into play, since these are typically one-page interface elements, they are now crafted to get the maximum number of user interactions. When arriving at the destination, aesthetic appeal exerts a considerable impact on user engagement [1]. This argument is backed by facts indicating that attractive web designs are claimed to provide positive emotions and satisfaction, which finally leads to purchasing intentions [2]. With the use of visual elements (colours, graphics) it can attract more users but also affects how these visitors will see and feel about the website. It has been researched that websites with attractive appearances are simple to hold users longer and through it, the overall user level of satisfaction also should be built [3]. These sections have a very significant function in capturing the audience's attention and the essence of a particular brand is conveyed concisely [4].

The transition from static web design to dynamic web design has significantly influenced the development of user engagement strategies. In the past web interfaces tended to generally use 2D designs, as they were easier to create and load more quickly. We made the graphs effectively typing them clear, brief data which is proper for making users concentrate and navigating smoothly. As things advanced in technology, the desire for a more engaging experience grew as well, driving 3D graphics to provide 13 some depth and realism [5]. Three-dimensional graphics are increasingly being used in various industries, as they allow for enhanced product visualization and enhance user interactivity [6]. Web design can influence the engagement of users depending on whether two-dimensional or three-dimensional graphics are used. Though analytics have proven that two-dimensional graphs tend to be more effective and quicker to comprehend, the experience with visualization graphs would be significantly improved if we could mimic real-world interactions with virtual objects moving around [7]. Three-dimensional graphics have also been utilized in the past in virtual reality applications to build worlds that can be explored and manipulated. Yet we also discovered that the use of 3D graphics agility has some disadvantages, such as loading time and resource demands, which in turn impact usability and accessibility [5].

Two-dimensional or three-dimensional graphics in web design were a common addition once technology was enhanced. developments made it possible for them, providing new means to enhance user experiences [8]. The transition from traditional 2D designs to more immersive 3D Graphics has been a thought in web design. While two-dimensional images can be more complex to adapt and faster to draw, many argue that the extremely detailed and engaging experience provided by 3D graphics more effectively engages the users. which enhances immersion in a game or simulation. For instance,

3D optical effects and Non-Photorealistic Rendering (NPR) can improve immersion by guiding the visual attention of players with deeper emotional bonds [4].

2D graphics have been a highlight of web designing for a considerable period wherein it gained API tools utilized on websites. Icons, illustrations and infographics, these are typically traditional use-case They need to display information quickly and clearly. The benefits of two-dimensional graphics, such as higher speed, loading times, the simplicity of creation or development, and compatibility across all devices and browsers [8]. But naturally, the utilization of 3D graphics is not smooth in web designing. As Fenech et al. [9] have argued, while three-dimensional graphics can create very interactive experiences, they present problems like suffering, quality rendering, and poor browser support. Omar Al Hashimi et al. [10] have the same view, noting that 3D materials of high quality can be hazardous. Rendering times contribute significantly to the user experience overall. Yet, for all these problems, the potential of 3D graphics to directly engage the end user's senses has in no way been reduced; the interactive nature, together with its excellent dynamic capabilities, by far exceeds those of all conventional 2D designs.

A systems approach known as Kansei Engineering, designed exclusively to understand and apply human emotions, emotional reactions from psychology points of view to design can give you an idea about how these graphic elements add or not to the increase of the user Interactions in relation to them [11][12]. Kansei Engineering (KE) is a special method which considers emotional and sensory responses while designing. This kind of thinking has been applied in design in numerous ways throughout the years, from items and interfaces that appear as substitutes. Kansei Engineering enables designers to test affective experience and emotional responses, thereby giving them foresight into the kind of sentiments that visual components Inculcate in people the goal of focusing efforts on user engagement [13].

According to the research conducted by Francesca da Rimini et al. [14], In perhaps all software is this It is a recognized fact that user participation is a significant aspect of the web development procedure. Design which meets both emotional and aesthetic expectations of users. This is in concordance with the principles of Kansei Engineering wherein it proposes designing interfaces that are intellectually and emotionally engaging to the users, Hailin Li et al.'s study [15] emphasizes the significance of anticipatory computing within user-centered interactions and the necessity to investigate these behavioural patterns drastically improves consumer satisfaction. In the realm of in their paper, Burkhard C. Wünsche et al. [16] illustrate how interactive three-dimensional graphics can offer not just instructional merit but also enhance learning and user experience.

This study fills the gap by using Kansei Engineering (KE), a user-cantered approach that quantifies emotional responses to design characteristics. By studying how users emotionally engage with 2D and 3D designs, this study aims to identify which design style is more effective at enabling meaningful digital interactions. The findings are anticipated to enlighten users on the development of web interfaces that are not only eye-catching but also engage users effectively, thereby enhancing the quality of user experience.

The purpose of this literature review is to answer below questions:

- **RQ01:** What is the comparative effectiveness of 2D and 3D graphics in enhancing user engagement within website hero sections?
- **RQ02:** How do 2D and 3D graphics impact emotional and psychological responses of the users, evaluated through Kansei Engineering principles?
- **RQ03:** How can Kansei Engineering principles be effectively integrated into web design to enhance user engagement and emotional connection with website hero sections?

This systematic survey of literature is set forth in the subsequent manner: The methodology part details the means of identifying, selecting, and analysing the related studies. The results section supports the research questions by presenting the main findings of the literature that has been reviewed. The discussion part of the study analyses these findings in connection with the existing literature and industry trends. The conclusion part describes the possible use of this research for theory and practice, as well as those areas that may need future research.

2. Methodology

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed as the systematic literature review method in this paper. The PRISMA template ensures the review's transparency, reproducibility, and alignment. Each unknown factor of the research questions was exhaustively explained.

2.1 Eligibility criteria

For a study to be accepted in this systematic literature review, it was required to fulfil several requirements that matched the purpose and the goal of this research. These conditions were set up for the study to determine the most relevant and high-quality ones:

2.1.1 Inclusion criteria (IC)

Studies eligible for this systematic review are needed to comply with the following criteria:

- **IC1:** Articles published between the years 2018 and 2024.

- **IC2:** Studies discussing or related to Kansei Engineering.
- **IC3:** Research involving the use or analysis of 2D and 3D graphics.
- **IC4:** Works examining human psychology in relation to visual elements or visual design.

2.1.2 Exclusion criteria (EC)

An article was not considered for this review if it did not satisfy any of the conditions:

- **EC1:** Studies that are available only as abstracts.
- **EC2:** Studies that are not relevant to the main topics of interest (e.g., Kansei Engineering, 2D/3D graphics, human psychology with visuals).
- **EC3:** Studies written in languages other than English.

2.2 Information sources

This SLR's information was collected from well-known academic databases and digital libraries. The main one, the IEEE Xplore, was included in the list, as well as SpringerLink, ACM Digital, Science Direct, Emerald, Wiley and Taylor & Francis.

Table 1 - Online sources used in this work

No.	Source	URL
1	IEEE Xplore	https://ieeexplore.ieee.org/
2	SpringerLink	https://link.springer.com/
3	ACM Digital	https://dl.acm.org/
4	Science Direct	https://www.sciencedirect.com/
5	Emerald	https://www.emerald.com/insight/
6	Wiley	https://onlinelibrary.wiley.com/
7	Taylor & Francis	https://www.tandfonline.com/

2.3 Search strategy

The search strategy aimed to identify a set of studies which is inclusive of those that match the objectives of the review. A group of keywords was input for the search like "User Engagement", "2D graphics", "3D graphics", "Web design", "Kansei Engineering" and "User experience" Boolean operators (AND, OR) were employed to strengthen the search specificities and ensure the retrieved articles are relevant. For instance, "Digital Twin AND Sustainability AND Construction" where the sorts of searches were performed repeatedly, but across all databases.

Independent reviewers screened the titles and the abstracts to ensure the completeness of the search, and the citation tracking in both directions was performed to find the material not covered in the initial search. The search was conducted in a proper way, both the titles and the abstracts were scrutinized for relevance, and the citation tracking in both directions was done to possibly find more studies which might have been overlooked in the process.

2.4 Selection process

The selection process was executed in several steps. The first phase of the process was the screening of the articles, which involved reading the titles and abstracts to check if they were related to the research questions of the review. The next phase was the full-text review of those articles which were considered relevant. The purpose of this review was to help evaluate the eligibility of the research based on the inclusion and exclusion criteria. In case there were any differences in the selection process, the reviewers used a discussion forum to reach a consensus and to check that the process was accurately carried out.

To ensure that the selection process was handled efficiently, a pre-made template was utilized to record all the stages of decision-making. This template was intended to be used in case a need for exclusion was encountered during the process hence it would be the one to provide reasons for exclusion where necessary.

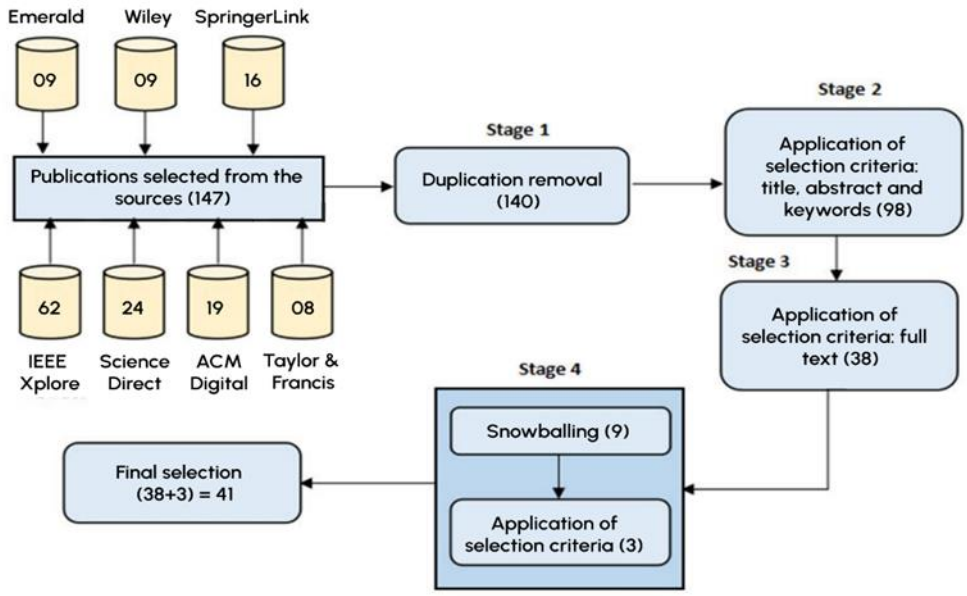

Fig. 1 - Selection process.

2.5 Data collection process

Data from the selected studies were systematically gathered using a pre-determined data extraction format. The template was devised to extract the main information from each study, such as the data of publication (author, year, title, and type of publication), research objectives, methodology, key findings, and conclusions. The study parts were screened with a particular focus on the details that contributed to the research questions, directly.

2.6 Data extraction and synthesis

The data that were harvested were then examined to find out all things necessary for the research by means of patterns, themes, and gaps in the literature. Categorized according to the research questions, the key findings allowed for the structured synthesis of the evidence. Consequently, the discussion involved a comprehensive comparison of the benefits, challenges, and overall impact of Kansei Engineering on sustainable web design. In this way, through the identification of recurring themes, the insight into the knowledge field was achieved and the path for further study was pointed out.

3. Results and Discussion

The results and discussion part combines the results of the literature review, which focuses on Kansei Engineering, user engagement, and use of 2D/3D web graphics in web design. All such outcomes are theoretically corresponding to the systematic literature review main research questions while the qualification of results in the discussion section investigates the meaning of these findings for user digital interface emotional and psychological connections.

3.1 Kansei Engineering in Web Design

The incredible intersection of web design and user interaction has been provoked time and again, focusing mainly on the way visuals have become part of working well with successful methods like 2D and 3D graphics. The literature review was done by conducting prior work on the aforementioned areas and aimed at the use of Kansei Engineering to improve user interaction. Kansei Engineering is a design methodology where user emotions and psychological inputs are integrated into the designing process. The technique was born in Japan, where it started to be used in the automobile sector and later spread to other fields such as product design or web. It is about a user's subjective emotions and feelings of the product or interface. Kansei Engineering translates these subjective responses into design elements systematically, boosting user experience and satisfaction. As an example, in product design research, it has been used to introduce harmony of emotional impressions (i.e., colours and forms) to that of intended target users through which improved products project are developed as a response concerning users' emotional needs and thus as a growing market rating [8]. Kansei Engineering is used for assessing user characteristics like emotions, preferences or experiences and input them into the design process. Here, in recliner manufacturing process, we can consider affective factors (ease of use functionality look) from user inputs and reflexively input them at design stage with a positive impact on customer satisfaction [17].

Kansei Engineering directly impacts how a website is emotionally perceived by users and thus forms a key player in the user experience. This method can assist designers in creating new and emotional experiences by having a high intuitive level in user interaction. To illustrate, Kansei Engineering has

also been used in the context of determining whether 2D or 3D graphics is preferable in web designing but on basis of comparison between various visuals on basis such as connecting user affect as well as emotional expectation [18]. The linear process of KE bears witnesses to its universal appeal, as along with increased exposure in the body of solutions for users. The basic concept of KE is to comprehend the feelings that users have while and after interacting with design elements collecting this robust information facilitates by designers while designing interfaces which evoke some emotions, induce different actions from human behaviour provide better quality user experience [19]. Findings showed that users reacted positively to designs with warmer colours intuitive designs and were more satisfied with deeply engaged efforts. Another case study evaluated to improve the beauty of a website by maximizing graphical elements' colour and texture, it proved to have an immense boost of user satisfaction and wellbeing score with the use of Kansei Engineering [9]. And the capability of controlling these elements to evoke a desired emotional response is what gives Kansei Engineering such a strong capability within UX design. And besides, KE results provide a systematic method for analysing user feedback that can be used to improve and refine web designs in continuous development [14]. For example, KE was utilized in a case study of the design of an e-commerce website to examine user affect towards different interface elements (e.g., navigation items, layout schemes and colour schemes [20].

Web design has utilized Kansei Engineering to create interfaces that engage the user on a individual level, evoking interaction and enhancing end-user experience. In the second example, door-to-door delivery service design has been furthered to serve emotional and preference needs as the outcome from user' Kansei perception that moved this from the theory based through establishing knowledgebase that guided by data-records [21]. The second application of Kansei Engineering in web design is how aesthetic appeal can be optimized (by controlling the colour scheme, layout etc.) to evoke some emotional responses like trust, enjoyment and thrill among users, thus bringing content or service providers closer towards creating websites which are more effective in satisfying user needs [22]. The same mechanism is used to drive the development of web design components such that even as technology and user behaviours evolve, it will always be on course to evoke a positive emotional response from the site visitors [23]. Kansei Engineering was utilized to analyse a few website interfaces, examining how colour influenced user satisfaction and affective response. The study proved that precise visual elements could do wonders to enhance user interaction and satisfaction by targeting users' emotional needs [24]. We further found that in a close competitive market like Iran, with simple UX design comprising well-structured layout and navigation interaction could improve user satisfaction & usability of national online banking websites [25].

In the area of customer experience, Kansei Engineering influences a product's design factors to tailor them to what users feel and expect, therefore. KE measures how a user feels when utilizing each aspect of the design and thus allows the building of extremely emotional experiences with any interface. Users will be content with product or service and engaged. In yet another interesting study in this category, KE was used with children's control information systems and learned emotional concepts like "funny", unique ", cheerful" or informative as central to appropriate design of user interface. Usability study of applying KE to personalize web interfaces with respect to user demographics proved to be a good example for particular attention, indicating towards the management of general users' satisfaction [26]. Studies on public administration eGovernment portals in Indonesia reveal that application of KE principles to visual design and customer service factors could have positive effects on the user trust and intention to use the services as well [27].

3.2 2D vs. 3D Graphics in Web Design

Web development is built with 2D graphics, the web's building block. They are used because of their ease, portability during creation and fast loading with a down-scale rate, ideally suited for numerous varieties of web applications. Flat 2D items like images, icons and flat component parts provide a clear and usable display of information rendering website orientation smooth [13]. However, one of the techniques in which 2D graphics may be used well is within the user interface of flat design deployments, for instance, Metro from Microsoft. Simple approach to design with minimalism, flat components and colours make it neat and user-friendly. Likewise, on a case study regarding learning websites we can see how the use of 2D graphics and how the graphical simplicity lowered cognitive load and improve reading retention with that site [18]. Changes in user perception due to emotions and behaviours because both 2D as well as 3D graphics have considerable psychological effects. The raw capability you receive from 3D graphics can create a sense of presence and immersion which help keep the user more steadfastly into content. As a result, the effect is useful especially for applications such as virtual tours and simulations [24][19][28]. 2D and 3D graphics in web design in the context of web design, there are some traits that make 2D as well as 3D graphics interactive in nature to the users. To designers who try to create good and understandable digital interfaces, it is important to know about these differences very much [29].

Most importantly, the core feature of 3D graphics is one that creates engaging user experiences that can hold more attention than traditional 2D ones. Yet it is hard to use 3D graphics since it results in slow loading and high resource consumption, aside from the need for a new device or browser [21]. Studies show that 3D graphics can increase engagement with immersive interactions, but on the other hand of affairs 2D is simpler to interact and perform better. Context and metrics (click-through rate or time on page, user satisfaction) can differ in the case of 2D and 3D graphics as one area for testing [30][31]. 3D Graphics have seen radical growth with the advent of web technologies towards more accurate and immersive interactivity between humans. 3D elements in product visualization, virtual reality (VR) environments, web-based interactive stories are emerging trends [15][17]. Since WebGL and HTML5 are included in common web technologies, 3D graphics in web development are becoming more popular. They produce a more engaging visual perception and focus through dynamic animations when the user is involved with them. Trends in the future that are emerging: 3D models for ecommerce product visualization, VR experience and interactive stories [23].

3D Graphis is the main advantage because it will make user experience interactive, more vibrant such that customers will be in matriculation to their project. 3D graphics are not the same job, though, they bring about loading times and a great deal of resources, which can bring about compatibility problems among devices as well as different machine browsing versions. Second, since 3D design is more complex and a different set of abilities to draw

or paint in two dimensions, using 3D design, it helps make the technology accessible as tools evolve [22]. Some other research reports that the implementation of 3D graphics was found to work well in interacting with users more, offering high interactivity and an immersive environment. In internet shopping, 3D product visualizations enable users to understand its features and better fit resulting in greater user satisfaction which will have a direct impact on the likelihood of purchase [32]. Likewise, by adopting virtual tours on websites user retention rates are significantly increased because of the interactive way in which users can engage with 3D environments causing them to spend more time engaging with content [33].

Dealing with 3D graphics is also difficult. This has caused a jump in computational requirements, as 3D graphics are much more resource-hungry than their flatland equivalent to the other axes of isometric and orthographic 2D village ridges. This can cause increased loading times and compatibility issues which are even more apparent on older hardware, or due to slow internet connectivity [34]. On the other hand, though, 3D graphics work only in a game if they perform perfectly and lag neither nor take forever to load because bad executions of 3D content are offending players making corresponding player interaction less [35]. As much as wonderful looks are important to making a site interactive and attractive, such images can negatively affect caching time. Web applications that load slowly will experience reduced interaction, can expect fewer users waiting for content and are likely to be abandoned by the user [35][36].

3.3 User Engagement in Web Design

This section considers the user experience in 2D vs. 3D graphics design practices, both of which have their pros and cons for some. 2D graphs are usually the best way to achieve fast load speed and professional design, making the bounce rates low while session length longer. 3D graphics, however, have excelled when it comes to grabbing the user's attention and creating a more graphically stimulating environment which can lead to greater engagement indicators such as longer average time spent on pages or greater CTRs (clickthrough rates) so well suited for large full screen content [37]. Aesthetically pleasing designs help improve user experience since they allow a good initial impression of the online site and motivate them to find out more. Studies prove the visual design of a web page has a dramatic impact on usability impressions, user satisfaction and trust that lead to higher levels of user engagement [22]. Colour is the basis of design; it controls the way users think and feel. Colour options can be used to push the user visually towards calls-to action in hero sections- this is both a control focus means and emotion, forming identity.

A website hero section is one of the most conspicuous places on a site because it also provides users with their first point of contact with virtual space. This part needs to be brief, engaging and try connecting this story with the rest of the website. Bold headlines and images perform better for this tactic. This allows the hero section to highlight the value proposition and convince users to learn more [37]. With a hero section, the top half of the home page communicates with strong imagery, supported by copy that reinforces what is being uncovered by these images. Strong content approaches, however, wrap all these elements up and deliver them in a strong headline with supporting imagery aimed at intended user convergence [38].

In addition, Content personalization is the creation of content, and its delivery (including tone, style) based on attributes or behavioural information known about the user. We have learned before that it has been found that personalized rules set for a site's audience improve their engagement with the website [40]. Interactivity engages the user by providing them with some degree of control and participation in the virtual environment. Animations, hover effects and graphical clicks are all examples of interactive elements that can be used as a vehicle to better preserve interactivity within the designs [40]. There have been dozens of case studies proving the benefit that interactivity has added in helping websites engage visitors for longer durations, creating a chain effect. Sites that use interactive product demonstrations or virtual try-ons, are two typical examples where more and qualified user engagement results in increased conversion rates [33]. For an example on an e-commerce Web site, the effect of interactive functionalities such as zoomable product shots and customizable features on user satisfaction and purchase intentions has been validated in a study [41].

Although the literature review clarifies the potential of both 2D and 3D graphics in captivating users, there are limited studies with direct comparisons especially on website hero sections. Additionally, while Kansei Engineering provides a framework for clarifying user emotions regarding design, this web design application is underexploited. This research identified serves as the motivation for performing a study aimed at determining the way in which these two groups vary in effectiveness at user engagement improvement, with the guidance of Kansei Engineering principles.

4. Conclusion

The aim of the systematic review was to explore how 2D and 3D web graphics could be used for the purpose of increasing the user's engagement, directing the researchers' attention to how the Kansei Engineering (KE) concept comes into play in building satisfied emotional users within web design, and namely in hero sections. The paper has unveiled that it is 2D and 3D graphics that come with individual advantages and disadvantages. As for 2D graphics, they are faster in terms of a load time, they are more widely available, they are easier to implement, but, on the other hand, they are not to be compared with 3D graphics in the ability of one to the set of activities immersion and interaction, which can drive higher user involvement. On the downside, 3D models are even more challenging to be implemented technically as they require more computing power for rendering and are chip-device dependent.

It is from this that Kansei Engineering has become the centrepiece of the user emotional interface design. Even though it has demonstrated remarkable success in such application areas as product design, and industrial UX, it has not yet been widely used in web design, particularly in the field of visual elements, such as colour, layout, and dimension, emotional and psychological effects). This research is a matter of fact since it presents the big hole in 2D versus 3D web graphics that is informed by KE principles. The current literature tends to take these factors separately, and only a very small number of comprehensive frameworks that measure emotional engagement through the lens of KE can be identified. In addition, the research on the performance, usability, and compatibility with various devices of 3D web experiences is insufficient.

The results highlighted that merging 3D web graphics with KE methods is a feasible way to create emotional and interactive user experiences. Subsequent enquiry can examine 2D and 3D hero sections using Kansei-based metrics to measure the emotions of users with the aim of identifying methods to visually inform and comfort users as well as encourage proactive participation. Moreover, the use of the adaptation in the design to minimize the technical difficulties in the realization of 3D implementation might be able to offer a practical solution for the establishment of mainstream web design. Ultimately, this review contributes to a growing body of knowledge at the intersection of emotional UX, visual design, and interactive technology encouraging designers and developers to adopt emotion-centred frameworks like Kansei Engineering for more meaningful, personalized, and engaging web experiences.

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