A Nonstandard Neutrosophic Model for Aesthetic Response in Interactive Device Decorative Art Design

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Abstract-This paper introduces a new mathematical model called the Nonstandard Neutrosophic Aesthetic Dynamics (NSNAD). It is built using nonstandard neutrosophic theory, which allows us to work with values that are greater than 1, less than 0, or undefined. These unusual values help us better describe how users feel about decorative and interactive digital devices feelings that are often uncertain, extreme, or mixed. The model defines a new way to measure how much a person likes, dislikes, or is unsure about visual elements like light, color, shape, or movement. We use many refined equations and detailed examples to explain how the model works. We also apply the model to interactive device decoration to show its usefulness. This work helps designers better understand user emotions and build more personalized and engaging digital experiences.

Keywords: Nonstandard Neutrosophy, Aesthetic Modeling, Interactive Design, Emotional Response, Decorative Art, User Perception

1. Introduction

In modern digital environments, decorative design is no longer just visual. It is also interactive and emotional. Devices like smartwatches, interactive lamps, and digital assistants now use colors, patterns, lights, and animations that respond to user actions. These designs aim to create a strong aesthetic and emotional experience [1].

However, human emotions are complex. A user may enjoy a design but still feel unsure about certain parts of it [2]. They might find something beautiful but overwhelming. These feelings are not easy to express using traditional logic or simple numbers [3].

Most existing design models use binary logic (true or false) or fuzzy logic (degrees of truth). While these are helpful, they are limited when it comes to handling emotions that are extreme, uncertain, or contradictory [4]. For example, how can we model the feeling: "I love this animation, but it also makes me feel slightly confused"?

To solve this, Smarandache (2018) introduced the concept of Nonstandard Neutrosophic Logic to handle situations involving extreme uncertainty, over-acceptance, or deep rejection [5,6]. This logic allows truth, falsehood, and indeterminacy to go beyond standard values like 0 and 1. They can even be:

1. Greater than 1 (over-acceptance)
2. Less than 0 (strong rejection)
3. Undefined or infinite (deep uncertainty)

This is exactly what we need to describe real human reactions to digital decorative designs. In this paper, we introduce a new model NSNAD This model uses nonstandard neutrosophic values to represent how people emotionally respond to interactive design elements.

By using this model, designers and researchers can:

1. Understand complex user feelings more accurately
2. Improve device personalization
3. Create more emotionally intelligent visual experiences

2. Construction of the NSNAD Framework

This section defines the Nonstandard Neutrosophic Aesthetic Dynamics (NSNAD) model, which uses extended mathematical logic to represent how users perceive and emotionally respond to decorative features of interactive devices. The core of this model is built on nonstandard neutrosophic triplets with overstandard, understandard, and hyperreal components.

Neutrosophic Representation of Aesthetic Response

Let:

$$\mathcal{R} = (\boldsymbol{T}, \boldsymbol{I}, \boldsymbol{F})$$

Be the neutrosophic aesthetic response triplet for a user's reaction to a given design element.

Where:

$\boldsymbol{T} \in [\mathbf{0}, \mathbf{1}^{+}]$ is the degree of aesthetic liking (can exceed 1), $\boldsymbol{I} \in [\mathbf{0}, \boldsymbol{\omega}]$ is the degree of uncertainty or confusion and $\boldsymbol{F} \in [-\mathbf{0}, \mathbf{1}]$ is the degree of aesthetic rejection (can be negative)

Refined Response Model

For detailed evaluations across multiple sensory dimensions, we define a refined nonstandard neutrosophic triplet:

$$\boldsymbol{\mathcal{R}_{ref}} = (\boldsymbol{T_v}, \boldsymbol{T_m}; \boldsymbol{I_v}, \boldsymbol{I_m}; \boldsymbol{F_v}, \boldsymbol{F_m})$$

Where

$\boldsymbol{T_v}$ ≡ Visual Truth

$\boldsymbol{T_m}$ ≡ Motion truth

$\boldsymbol{I_v}, \boldsymbol{I_m}$ ≡ Visual and motion indeterminacy

$\boldsymbol{F_v}, \boldsymbol{F_m}$ ≡Visual and motion-based rejection

Weighted Aesthetic Score

We compute a Weighted Aesthetic Compatibility Score (WACS) for a design component:

$$\boldsymbol{WACS} = \boldsymbol{\alpha} \cdot \boldsymbol{T} - \boldsymbol{\beta} \cdot \boldsymbol{F} + \boldsymbol{\gamma} \cdot (\mathbf{1} - \boldsymbol{I})$$

Where

$\boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma} \in \mathbb{R}^{+}$ ≡ Weighting coefficients based on user profile

$\boldsymbol{T}, \boldsymbol{I}, \boldsymbol{F}$ ≡ Values from the neutrosophic triplet

$\boldsymbol{I} = \mathbf{1}$ means full uncertainty → reduced score

Example 1

The user sees a gently glowing blue light:

$$\boldsymbol{T} = \mathbf{1.2}, \boldsymbol{I} = \mathbf{0.2}, \boldsymbol{F} = -\mathbf{0.1}, \boldsymbol{\alpha} = \mathbf{1}, \boldsymbol{\beta} = \mathbf{0.8}, \boldsymbol{\gamma} = \mathbf{1}$$
$$\boldsymbol{WACS} = (\mathbf{1} \cdot \mathbf{1.2}) - (\mathbf{0.8} \cdot (-\mathbf{0.1})) + (\mathbf{1} \cdot (\mathbf{1} - \mathbf{0.2})) = \mathbf{1.2} + \mathbf{0.08} + \mathbf{0.8} = \mathbf{2.08}$$

This shows very high aesthetic compatibility.

Aesthetic Drift Function

We define the aesthetic drift - how perception changes over time as:

$$\boldsymbol{\Delta\mathcal{R}(t)} = \left(\frac{\boldsymbol{dT}}{\boldsymbol{dt}}, \frac{\boldsymbol{dI}}{\boldsymbol{dt}}, \frac{\boldsymbol{dF}}{\boldsymbol{dt}}\right)$$

This allows modeling real-time feedback during user interaction.

Composite Device Response

If a device has multiple design features (color, sound, motion), we combine their scores:

Let $\boldsymbol{\mathcal{R}_i} = (\boldsymbol{T_i}, \boldsymbol{I_i}, \boldsymbol{F_i})$, for $\boldsymbol{i} = 1,2, \ldots, n$

Then the Total Aesthetic Match Score (TAMS) is:

$$TAMS = \frac{1}{n}\sum_{i=1}^{n} [\alpha_i \cdot T_i - \beta_i \cdot F_i + \gamma_i \cdot (1 - I_i)]$$

Saturation Detection Condition

We introduce a threshold condition:

If

$$T > 1.5 \text{ or } F < -0.5 \text{ or } I > 0.9$$

Then the system flags aesthetic saturation meaning the user is either overwhelmed, confused, or emotionally detached. To better understand how the model works, let us go through a real example using the NSNAD equations. We want to calculate how much a user emotionally likes or dislikes a visual effect in a smart interactive device, for example, a glowing animated ring on a smartwatch.

Calculating Aesthetic Compatibility (WACS)

A user interacts with the device and responds to a certain glowing animation. Based on their emotional feedback, we assign neutrosophic values as follows:

Truth (T): 1.15 → The user strongly likes it, even more than usual (a case of over-truth).

Indeterminacy (I): 0.3 → The user is a little unsure about the speed of the animation.

Falsehood (F): -0.05 → There is no real dislike, maybe even unconscious comfort (a case of underfalsehood).

We also assume the following weights:

$\alpha = 1$: full weight on liking

$\beta = 0.9$: strong attention to dislike

$\gamma = 1$: full sensitivity to uncertainty

Now we plug these into the WACS equation:

$$WACS = \alpha \cdot T - \beta \cdot F + \gamma \cdot (1 - I)$$

Being as:

1. First, compute $\alpha \cdot T$ =

$$1 \cdot 1.15 = 1.15$$

2. Then compute $\beta \cdot F$ =

$$0.9 \cdot (-0.05) = -0.045$$

3. Subtract this value, so it becomes positive in the expression:

$$-(-0.045) = +0.045$$

4. Now compute $\gamma \cdot (1 - I)$ =

$$1 \cdot (1 - 0.3) = 1 \cdot 0.7 = 0.7$$

5. Add all components together =

$$1.15 + 0.045 + 0.7 = 1.895$$

So, the Weighted Aesthetic Compatibility Score is 1.895, which shows a very high positive emotional reaction from the user. The design works very well for this individual.

Example of Negative Reaction

Let's consider another case where a user sees a flashing red light pattern on the same device and reacts negatively.

Here are the neutrosophic values:

T $= 0.4$: Mild appreciation

$I = 0.6$: Quite a bit of uncertainty

$F = 0.7$: Strong dislike of the flashing effect

Where Weights are :

$\alpha = 0.8$, $\beta = 1.2$ and $\gamma = 1$

Now we apply the same expression as:

1. $\alpha \cdot T = 0.8 \cdot 0.4 = 0.32$
2. $\beta \cdot F = 1.2 \cdot 0.7 = 0.84$
3. $\gamma \cdot (1 - I) = 1 \cdot (1 - 0.6) = 0.4$

then

$$WACS = 0.32 - 0.84 + 0.4 = -0.12$$

This calculation shows a slightly negative emotional match. The user is not satisfied, mainly because the dislike (F) has a high weight and the uncertainty is strong.

Using this model, designers can test different visual elements and get numerical feedback that includes positive feelings, uncertainty, and rejection - all at once. The special part here is that we allow values greater than 1 or less than 0, so we can even capture extreme emotions, not just average ones.

3. Application in Interactive Device Art Design

In this section, we apply the NSNAD model to a real-world example: designing a smart device with decorative features such as light, color, sound, and animation. We want to measure how well each feature matches the user's aesthetic preferences and calculate a final Total Aesthetic Score using the model we built earlier.

Design Scenario

Imagine a company is developing a wearable smart ring. This ring glows, changes colors, emits soft tones and uses subtle motion patterns. A test user interacts with the ring, and we collect their emotional responses to four main design elements:

1. Color shifting glow
2. Smooth motion animation
3. Ambient sound effect
4. Interactive vibration

Each feature will be scored using a nonstandard neutrosophic triplet:

$$R_i = (T_i, I_i, F_i)$$

Where

T_i ≡ Level of liking

I_i ≡ Level of uncertainty

F_i ≡ Level of rejection

We also assign different weights to reflect how important each component is to the user as shown in Table 1.

Table 1: Collected Data

Design Feature	$\boldsymbol{T_i}$	$\boldsymbol{I_i}$	$\boldsymbol{F_i}$	Weights: $(\boldsymbol{\alpha_i}, \boldsymbol{\beta_i}, \boldsymbol{\gamma_i})$

Color glow	1.10	0.2	-0.1	(1.0, 0.8, 1.0)
Motion animation	0.95	0.4	0.2	(0.9, 1.0, 1.0)
Ambient sound	1.05	0.1	-0.05	(1.0, 0.6, 0.9)
Interactive vibration	0.60	0.7	0.4	(0.8, 1.2, 1.0)

We use the WACS equation for each feature:

$$WACS_i = \alpha_i \cdot T_i - \beta_i \cdot F_i + \gamma_i \cdot (1 - I_i)$$

We will calculate each one as:

1. Color Glow

$$WACS_1 = (1.0 \cdot 1.10) - (0.8 \cdot -0.1) + (1.0 \cdot (1 - 0.2))$$
$$= 1.10 + 0.08 + 0.8 = 1.98$$

2. Motion Animation

$$WACS_2 = (0.9 \cdot 0.95) - (1.0 \cdot 0.2) + (1.0 \cdot (1 - 0.4))$$
$$= 0.855 - 0.2 + 0.6 = 1.255$$

3. Ambient Sound

$$WACS_3 = (1.0 \cdot 1.05) - (0.6 \cdot -0.05) + (0.9 \cdot (1 - 0.1))$$
$$= 1.05 + 0.03 + 0.9 \cdot 0.9 = 1.05 + 0.03 + 0.81 = 1.89$$

4. Interactive Vibration

$$WACS_4 = (0.8 \cdot 0.6) - (1.2 \cdot 0.4) + (1.0 \cdot (1 - 0.7))$$
$$= 0.48 - 0.48 + 0.3 = 0.30$$

Total Aesthetic Score

We calculate the average of all four scores as:

$$TAMS = \frac{1}{4}(1.98 + 1.255 + 1.89 + 0.30) = \frac{5.425}{4} = 1.356$$

The final Total Aesthetic Match Score is 1.356, which indicates a good emotional match between the user and the decorative design. Most features were well received, especially the color glow and ambient sound. The vibration effect had the lowest score, so designers might consider adjusting or removing it.

4. Theoretical Insights

The results we got from the NSNAD model help us understand the user's emotional reaction more deeply. Instead of just saying the user "likes" or "dislikes" a design, we now have a full picture: of how much they like it, how unsure they are, and how much they may dislike certain parts all at the same time. This is possible because nonstandard neutrosophic logic lets us work with values that go beyond normal limits.

In our example, the user had a strong positive reaction to the glowing color and soft sound. These features had truth values greater than 1, showing that the user felt more than just a normal liking almost an emotional connection. Also, some features like vibration had high indeterminacy, meaning the user wasn't sure how to feel. This is important for designers to notice because it can point to areas that are confusing or not well-accepted.

What makes this model special is how it separates liking, disliking, and uncertainty into independent parts. In regular models, these feelings might get mixed or lost. But here, we can see which features are loved, disliked, or simply unclear. This makes design decisions more accurate and more personal.

Another benefit is the model's flexibility. Designers can change the weights for liking, disliking, or uncertainty depending on the user's preferences. For example, if a product is made for kids, designers might care more about reducing confusion (uncertainty). But for artists or creative users, some confusion may even be welcome.

Finally, this model works in real time. If a device updates its visuals or sounds while a person is using it, the system can keep calculating new emotional scores. This means products can learn and adapt to each person, making the experience more human and more meaningful.

5. Conclusion

In this paper, we introduced a new model called NSNAD. This model helps us understand how people emotionally respond to interactive design elements, like colors, lights, motions, and sounds in smart devices. Unlike normal models that only measure how much a person likes something, the NSNAD model gives us a complete view of how much they like it, how unsure they feel, and how much they dislike it all separately.

We used special numbers called nonstandard neutrosophic values, which can be greater than 1, less than 0, or even infinite. This allowed us to capture strong emotions that regular systems cannot. We then created equations to calculate how well each design element matches the user's feelings. Our example showed how this model can help designers choose better features and improve the overall user experience.

This model is very flexible. It can be used not only in smart devices but also in art, fashion, apps, or any product where people interact emotionally. In the future, this model can be part of smart systems that learn how each person feels and adjust the design in real-time. That way, every user gets a more personal, beautiful, and emotionally satisfying experience.

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Received: Dec. 3, 2024. Accepted: June 1, 2025