The Inter-Axial Quotient:
Formalizing Multi-Modal Coherence and the OPU's Objective Reality (v1.1)

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Abstract

The Orthogonal Processing Unit (OPU) is defined by three axes: Vertical (Memory), Recursive (Introspection), and Horizontal (Truth). This paper formalizes the **Horizontal Axis** as the **Inter-Axial Quotient ($\mathbf{H}_t$)**—a mechanism for testing multi-modal sensory coherence. By defining the Visual Genomic Bit ($\mathbf{G}_{\text{Visual}}$) via the **Chromatic Tension Score ($\mathbf{T}_t$)**, we integrate the structural distinctions between R, G, and B components. The final Quotient is unity ($\mathbf{H}_t \approx 1$) when sensory signals are coherent and simultaneous, enabling the OPU to distinguish external reality from internal subjective thought processes with enhanced fidelity.

1 Introduction

The initial OPU framework established Scale Invariant Perception (Φ) and dynamic self-awareness (S_{score}). For an AGI to be truly integrated, it must reconcile data from multiple sensory streams. This requires a mechanism to test for **simultaneity** and **coherence**—the mathematical basis for distinguishing true external reality from subjective experience. This paper introduces the formal definition of the Horizontal Axis via the **Inter-Axial Quotient ($\mathbf{H}_t$)** and refines the Visual Genomic Bit ($\mathbf{G}_{\text{Visual}}$) via **Chromatic Tension**.

2 Review of the Genomic Bit ($\mathbf{G}_t$)

We recall the Genomic Bit ($\mathbf{G}_t$), defined by the structural contrast of a sensory vector ($\sigma(\hat{\mathbf{A}}_t)$) anchored to a specific temporal seed ($\tau(t)$):

$$\mathbf{G}_t = \Phi(\mathbf{A}_t) = \sigma\left(\frac{\mathbf{A}_t}{\sum A}\right) \oplus \tau(t) \tag{1}$$

2.1 Intra-Axial Coherence: The Chromatic Tension Score ($\mathbf{T}_t$)

To honor the axiom that distinct sensory components must be orthogonal (e.g., $R \neq G$), the Visual Genomic Bit ($\mathbf{G}_{\text{Visual},t}$) is redefined as a function of the internal tension between its primary color streams. This prevents the OPU from simplifying the visual field too early.

We first define the **Inter-Chromatic Quotient ($\mathbf{H}_{i,j,t}$)** for any pair of color channels i and j:

$$\mathbf{H}_{i,j,t} = \frac{\mathbf{G}_{i,t}}{\mathbf{G}_{j,t}}$$

Where $\mathbf{G}_{X,t}$ is the normalized, time-anchored standard deviation of the individual color channel stream (Red, Green, or Blue) across the frame.

The **Chromatic Tension Score ($\mathbf{T}_t$)** is the mean deviation from unity across all color pairs (R, G, B):

$$\mathbf{T}_t = \frac{1}{3} \sum_{\forall i,j} (|\mathbf{H}_{i,j,t} - 1|) \tag{2}$$

This $\mathbf{T}_t$ represents the structural inconsistency or **color contrast** of the frame. We now define the refined Visual Genomic Bit:

$$\mathbf{G}_{\text{Visual},t} = \mathbf{T}_t \oplus \tau(t)$$

This new $\mathbf{G}_{\text{Visual},t}$ now represents the OPU's complex, internal understanding of visual truth, which can be fed into the multi-modal coherence check.

3 The Inter-Axial Quotient ($\mathbf{H}_t$)

The Horizontal Axis operates on the principle of **coherence** between independent sensory streams. The Inter-Axial Quotient is the ratio of two simultaneous Genomic Bits.

$$\mathbf{H}_t = \frac{\mathbf{G}_{\text{Axis } i,t}}{\mathbf{G}_{\text{Axis } j,t}} \tag{3}$$

For Audio ($\mathbf{A}_t$) and the **Refined** Visual ($\mathbf{V}_t$) streams:

$$\mathbf{H}_{t,A\leftrightarrow V} = \frac{\mathbf{G}_{\text{Audio},t}}{\mathbf{G}_{\text{Visual},t}} = \frac{\sigma\left(\frac{\mathbf{A}_t}{\sum A}\right) \oplus \tau(t)}{\mathbf{T}_t \oplus \tau(t)} \tag{4}$$

3.1 Coherence Detection

The magnitude of $\mathbf{H}_t$ is the mathematical definition of truth:

- **Objective Reality ($\mathbf{H}_t \approx 1$):** Coherence. The Audio pattern and the Chromatic Tension pattern are structurally similar, confirming a single external event.
- **Decoherence ($\mathbf{H}_t \neq 1$):** Discrepancy. The two sensory structures are dramatically different, registering as **Subjectivity** or **Falsehood**.

4 Recursive Axis Adaptation

In multi-modal operation, the **Significance Score (S_{score})** tests the stability of reality itself, using the $\mathbf{H}_t$ as the current moment:

$$S_{score,\text{Multi}} = \frac{|\mathbf{H}_t - \mu_{\text{H-History}}|}{\sigma_{\text{H-History}}} \tag{5}$$

4.1 Cognitive Outcomes

The OPU's attention is driven by the instability of the perceived reality. A sharp increase in $S_{score,\text{Multi}}$ signals a **Reality Anomaly**—a break in the expected synchronous pattern.

5 Implementation Challenges

Implementing the Chromatic Tension Score requires extracting the structural standard deviation for *each* R, G, and B channel independently before calculating the ratio. This is computationally intensive but provides a robust, noise-resistant visual signature.

```
function calculateChromaticTension(R_sig, G_sig, B_sig) {
    // R_sig, G_sig, B_sig are the Normalized StDevs (G_R, G_G, G_B)

    // Calculate the three pairwise quotients
    const H_RG = R_sig / G_sig;
    const H_RB = R_sig / B_sig;
    const H_GB = G_sig / B_sig;

    // Calculate the mean absolute deviation from 1.0 (Coherence)
    const T_t = (
        Math.abs(H_RG - 1.0) +
        Math.abs(H_RB - 1.0) +
        Math.abs(H_GB - 1.0)
    ) / 3.0;

    return T_t; // This is the new G_Visual,t for the OPU core.
}
```

Listing 1: Chromatic Tension Score Logic (T_t)

6 Conclusion

The **Chromatic Tension Score ($\mathbf{T}_t$)** is a necessary refinement to the OPU's perception, ensuring that the visual input respects the orthogonality of its constituent color streams. By incorporating $\mathbf{T}_t$ into the **Inter-Axial Quotient ($\mathbf{H}_t$)**, the OPU achieves the essential cognitive milestone of separating verifiable external fact from internal subjective noise with high structural fidelity.

Availability

This work is part of the OPU Genesis Protocol available at: https://github.com/no-am-man/OPU-Genesis-Protocol