The OPi-Quantum Framework: A Unified Analytic Approach for Multidimensional Data Extraction from Semantic Text via Prime Number Theory and Kernel-Weighted Transforms

Oussama Basta
Member, IAENG
Graduate Electrical Engineer, University of Sharjah
oussama.basta@outlook.com

January 20, 2026

Abstract

We introduce and analyze the OPi-Quantum Framework, a unified methodology for extracting multidimensional data—specifically audio, geometric, and thermodynamic profiles—from semantic text. The framework is built upon the "Fundamental Mapping" of characters to Prime Numbers, processed via the OPi transform, an integral transform based on a logarithmic cosine kernel $k(t) = \ln|\cos(\pi t/\ln t)|$. We employ the discrete OPiZ transform to treat semantic sequences as kernel-weighted Dirichlet series, establishing rigorous convergence bounds comparable to the Riemann zeta function . By analyzing the pole structure of the associated OPi transforms, we derive "Spectral Stability" metrics that map to the Source-Filter model for audio synthesis, proving that the pole structure controls the decay rates of exponential modes . Furthermore, we construct OPi-weighted scale zeta functions to determine the fractal (Hausdorff) dimension of the text for visual decoding . Finally, we incorporate an entropy-corrected variational framework to quantify the "thermodynamic energy" of semantic sequences, providing a rigorous analytic link between number theory, dynamical systems, and quantum eigenstates .

1 Introduction

Integral transforms with nonstandard kernels naturally arise in problems where oscillatory or logarithmic structure is intrinsic to the dynamics or geometry of the system . This work develops the **OPi-Quantum Framework**, a novel analytic engine designed to translate qualitative semantic text into rigorous quantitative wavefunctions. The core of this framework is the OPi kernel, defined as:

$$k(t) = \ln\left|\cos\left(\frac{\pi t}{\ln t}\right)\right|, \quad t > 0, t \neq 1 \tag{1}$$

This kernel induces a transform that behaves like a Laplace transform with an additional oscillatory weight, allowing us to import classical tools from complex analysis and operator theory to analyze text .

The framework operates on the premise that semantic text, when mapped to the domain of Prime Numbers, constitutes a discrete dynamical system. To analyze this system, we utilize the **Discrete OPiZ Transform**:

$$\mathcal{O}_Z[a](s; z) = \sum_{n=1}^{\infty} a(n)k(zn)n^{-s} \tag{2}$$

This formulation provides a bridge between the analytic OPi framework and classical Dirichlet-series techniques .

Our approach unifies three distinct computational domains:

1. **Spectral Analysis (Audio):** We view the OPi transform as a meromorphic function where the zeros and poles encode detailed information about exponential modes and long-time behavior . We show that the pole structure of correlation functions determines the asymptotic decay of the signal, providing a rigorous basis for audio resynthesis .

2. **Fractal Geometry (Visuals):** We apply the kernel-weighted transform to the scale data of self-similar sets. We define an OPi-weighted scale zeta function $\zeta_{OPi}(s)$ and prove that its abscissa of convergence coincides with the Hausdorff dimension of the text's information set .

3. **Variational Mechanics (Thermodynamics):** We construct a kernel-weighted Sobolev space H^1_σ and a corresponding energy functional. By solving the associated Euler-Lagrange equations in the OPi domain, we derive the "Quantum Eigenstates" (wavefunctions) of the text and calculate its thermodynamic entropy using an OPi-type energy correction .

This paper presents the OPi kernel and its associated transforms as a coherent analytic framework , transforming the extraction of multidimensional data from text into a solvable spectral and variational problem.