## Title:

## "Dynamic Stochastic Synthesis and *Spica*: Exploring Iannis Xenakis's GenDyn algorithm through a Pure Data Performance Instrument"

Download Link (*spica.pd*):
https://drive.google.com/drive/folders/1Ft8Tu6kBDjoi_IETVCGcybw3SUXQ-GUL?usp=sharing

Video Presentation:
https://youtu.be/60cL-H09YUs?si=fl-iUjy0T1aYKhfy


### Abstract

This paper investigates the impact of Iannis Xenakis's Dynamic Stochastic Synthesis (DSS) on contemporary sound synthesis through the lens of the SPICA performance instrument, a Pure Data (PD) patch based on the GENDYN algorithm. By examining Xenakis's DSS concepts and their implementation in SPICA, this study aims to illuminate how historical compositional techniques can be adapted for modern performance contexts. The paper provides an overview of Xenakis's theoretical contributions, a detailed analysis of the SPICA instrument, and a discussion on the implications of integrating historical techniques with contemporary technology.


### 1. Introduction

Iannis Xenakis's contributions to music composition, particularly his development of stochastic techniques, have had a profound impact on electronic and experimental music. His introduction of Dynamic Stochastic Synthesis (DSS) represents a significant advancement in the stochastic manipulation of sound. This paper focuses on the SPICA performance instrument, a Pure Data patch inspired by Xenakis's GENDYN algorithm, which embodies the principles of DSS in a modern, performance-oriented context. By exploring SPICA, this study aims to bridge the gap between Xenakis's innovative theories and their practical application in contemporary music.

### 2. Background: Iannis Xenakis and Dynamic Stochastic Synthesis

Iannis Xenakis, renowned for his integration of mathematical models in music composition, developed Dynamic Stochastic Synthesis as an evolution of his stochastic methods outlined in *Formalized Music* (1992). DSS involves the stochastic alteration of waveforms through linear interpolation of breakpoint pairs, with each breakpoint defined by values for duration and amplitude. Random walks, influenced by various probability distributions, modulate these parameters, enabling complex variations in sound.

Key aspects of DSS include:

- **Waveform as Fundamental Unit:** The waveform is treated as the primary element for stochastic alteration, allowing for intricate manipulation of both duration and amplitude (Xenakis, 1992).
- **Elastic Barriers:** These barriers confine the random walks within predefined limits, providing control over frequency and amplitude variations (Xenakis, 1992).
- **Stochastic Modulation:** Random walks enable variations that can range from subtle timbral changes to more pronounced shifts, including noise (Xenakis, 1992).

This framework allows Xenakis to shape sound dynamically, from white noise to structured waveforms, reflecting his ambition to explore the full spectrum of musical possibilities.

## 3. SPICA: A Modern Implementation of Xenakis's Techniques

SPICA is a performance instrument developed using the GENDYN algorithm, based on Xenakis's principles of DSS. The instrument utilizes Pure Data (PD) to create an interactive tool that embodies Xenakis's stochastic methods in a live performance setting. The following sections provide a detailed analysis of SPICA, including its technical implementation, user interface, and performance capabilities.

**3.1. Technical Implementation** SPICA is designed to leverage mobile phone sensors for real-time control of GENDYN parameters. The setup involves:

- **Hardware Requirements:** An Android device with the Sensors2OSC app and a computer running Pure Data with required libraries (e.g., Else, Cyclone).
- **Sensor Mapping:** Gravity and linear acceleration sensors on the mobile device are mapped to control breakpoints, amplitude, frequency steps, and other GENDYN parameters via OpenSoundControl (OSC).
- **Patch Setup:** The PD patch integrates a Euclidean sequencer for low frequencies, along with GENDYN and impulse generation controls for mid to high frequencies (Pure Data Documentation, n.d.).

**3.2. User Interface and Controls** SPICA's interface allows for intuitive manipulation of sound parameters:

- **Sensor Data Integration:** Real-time sensor data from the mobile phone influences the stochastic modulation of sound.
- **Parameter Controls:** Users can adjust frequency, amplitude, and sequencing parameters through the PD patch, creating a dynamic and responsive performance environment.
- **Performance Features:** The instrument supports tempo adjustments, and delay effects, enabling versatile sound generation.

**3.3. Performance Capabilities** SPICA's design emphasizes spontaneity and creativity:

- **Live Interaction:** The use of mobile sensors facilitates immediate control over sound parameters, making the instrument well-suited for live performances.
- **Sound Generation:** The integration of GENDYN and Euclidean sequencing provides a range of sound textures, from structured sequences to complex stochastic variations.

## 4. Discussion: Integrating Historical Techniques with Modern Technology

The development of SPICA highlights the enduring relevance of Xenakis's stochastic methods in contemporary music technology. By adapting DSS principles to a performance instrument, SPICA demonstrates how historical compositional techniques can be revitalized through modern digital tools. The instrument's ability to produce rich and varied soundscapes reflects the successful translation of Xenakis's theoretical concepts into practical applications.

**4.1. Theoretical Implications** SPICA's implementation of DSS principles provides insight into the practical challenges and opportunities of using stochastic techniques in performance contexts. The real-time control afforded by mobile sensors opens new avenues for exploring stochastic sound generation, aligning with Xenakis's vision of dynamic and evolving music.

**4.2. Practical Considerations** While SPICA effectively embodies Xenakis's principles, the complexity of stochastic modulation requires careful calibration and user familiarity. The instrument's performance potential is contingent upon the effective integration of sensor data and parameter control, highlighting the need for continued refinement and user training.

## 5. Conclusion

SPICA represents an advancement in the application of Iannis Xenakis's Dynamic Stochastic Synthesis to modern performance environments. By integrating Xenakis's stochastic techniques with contemporary technology, SPICA offers a novel platform for exploring and performing complex sound synthesis. This study underscores the value of revisiting historical compositional innovations through modern tools, contributing to the ongoing evolution of electronic and experimental music.

Future research could further investigate the adaptation of stochastic techniques in other digital performance contexts and explore additional applications of DSS principles in contemporary sound synthesis. The continued development of instruments like SPICA holds promise for expanding the creative possibilities of stochastic music and honoring the legacy of Iannis Xenakis.

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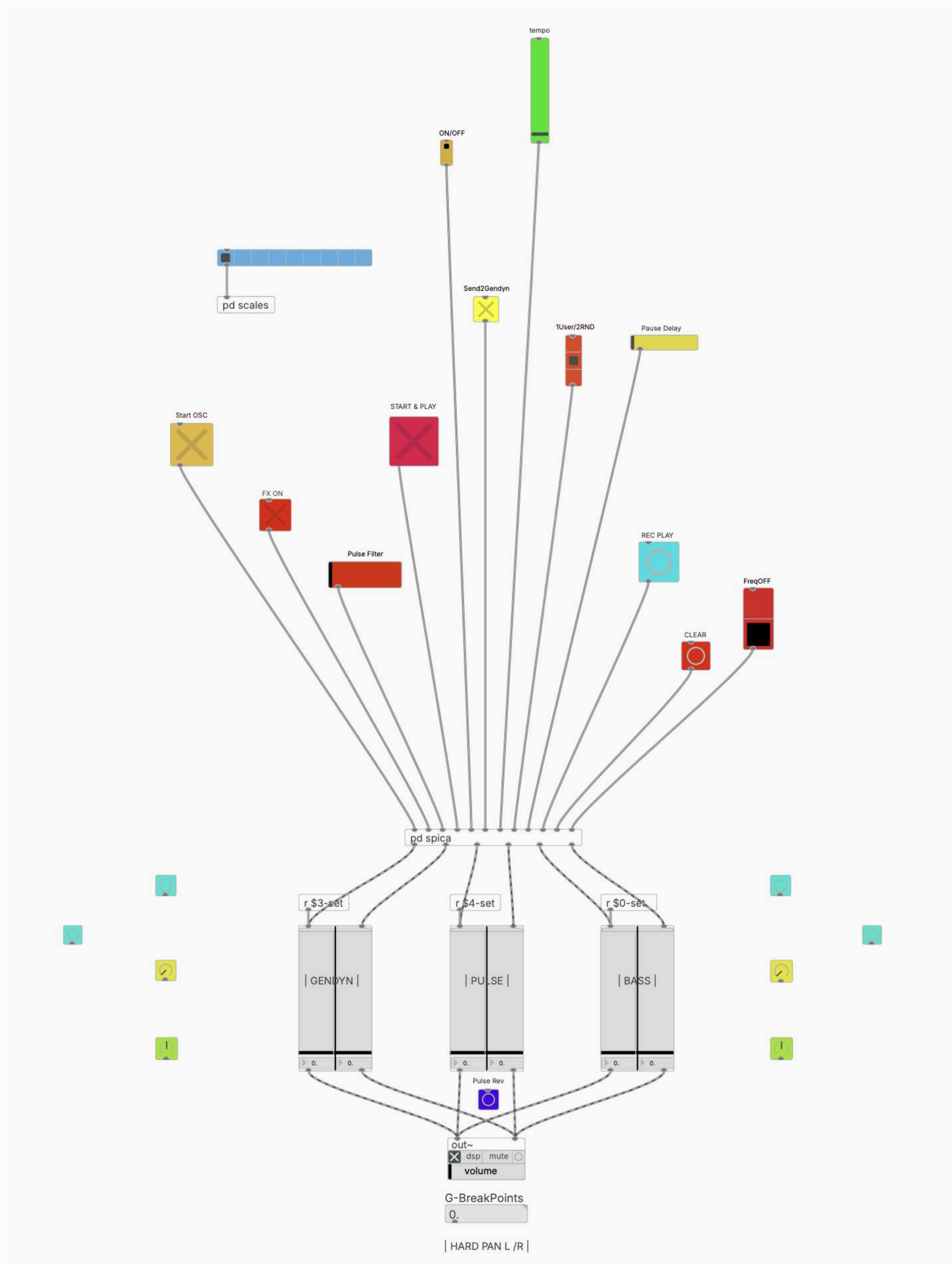
**References**


- OpenSoundControl. (n.d.). *OpenSoundControl Specification*. Retrieved from http://opensoundcontrol.org/spec-1_0
- Pure Data Documentation. (n.d.). *Pure Data Documentation and Libraries*. Retrieved from https://puredata.info/docs
- Xenakis, I. (1992). *Formalized Music: Thought and Mathematics in Music*. Indiana University Press.



**Dimitris Barnias**
PhD Candidate, Hellinic Mediterranean University
dbarnias@gmail.com


tempo
ON/OFF
pd scales
Send2Gendyn
1User/2RND
Pause Delay
Start OSC
START & PLAY
FX ON
Pulse Filter
REC PLAY
FreqOFF
CLEAR
pd spica
r $3-set
r $4-set
r $0-set
| GENDYN |
| PULSE |
| BASS |
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| HARD PAN L /R |

## Setting up the patch:

**Requires**: Else, Cyclone libraries.
(Android) Sensors2OSC app.

1. Make sure your Android phone and the computer running the PD patch are on the same wifi network. Better to establish a direct wifi connection.
2. On Sensors2OSC app goto setting and input the ip address of the wifi network. Set the port to 8000.
3. On the app activate Gravity and Linear Acceleration sensors. Start Send Data.
4. On the PD patch [Start OSC]. You should be able now to see sensor values changing.
5. Pan each of the three volume sliders hard left and right.
6. Raise volume sliders ¾.
7. On the patch Set FreqOff at the upper position to activate the sequencer [bass] or lower position to select a steady note.
8. [Pulse] passes through a Low Pass Filter therefore you should raise [Pulse Filter] to have a sound.
9. On [Gendyn] activate [FX On]. Sounds much better.
10. Select desirable scale [pd scales] for [bass] generation.
11. Introduce an extra delay for [bass] with [Pause Delay] and position of [1User/2RND].
12. Adjust tempo of [bass] generation through [tempo].
13. Introduce an extra tempo deviation through [on/off].
14. Use [bass] frequency output to define Gendyn frequency bandwidth with [Send2Gendyn].
15. Use your mobile phone to control Gendyn.
16. Have fun!

A more detailed report will follow when I will find some time to make it. In the meantime please contact me for any questions at: dbarnias@gmail.com