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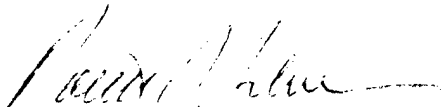
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From: Director, Office of Naval Research, Seattle Regional Office, 1107 NE 45th St., Suite 350,  
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To: Defense Technical Center, Attn: P. Mawby, 8725 John J. Kingman Rd., Suite 0944,  
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Subj: RETURNED GRANTEE/CONTRACTOR TECHNICAL REPORTS

1. This confirms our conversations of 27 Feb 97 and 11 Jul 97. Enclosed are a number of technical reports which were returned to our agency for lack of clear distribution availability statement. This confirms that all reports are unclassified and are "APPROVED FOR PUBLIC RELEASE" with no restrictions.
2. Please contact me if you require additional information. My e-mail is [silverr@onr.navy.mil](mailto:silverr@onr.navy.mil) and my phone is (206) 625-3196.

  
ROBERT J. SILVERMAN

**To: Regional Director  
Team Leader  
ACO**

**This technical report was sent to me by DTIC because it does not include the DD-1498 form with the proper disclosure/distribution statement.**

**Please obtain this form with proper instructions and return it and the technical report directly to DTIC.**

**Also implement procedures with the contractor to correct this problem.**

**Thank You,**

A handwritten signature in black ink that reads "Jim Carbonara". The signature is written in a cursive, flowing style with a large initial "J".

**Jim Carbonara,  
Director, Field Operations**

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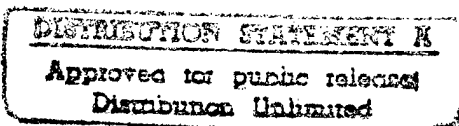
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Stochastic Motion in Many Degrees of Freedom

AASERT Annual Progress Report  
June 1, 1994 - May 31, 1995

Professor Allan J. Lichtenberg, Principal Investigator  
Wayne Wonchoba, Graduate Student Researcher

Office of Naval Research  
N00014-93-1-0828



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**Annual Report 1994–1995**

AASERT Award for Proposal  
Grant No. N00014-93-1-0828

**Stochastic Motion in Many Degrees of Freedom**

Principal Investigator

*Allan J. Lichtenberg*

Department of Electrical Engineering and Computer Sciences  
and the Electronics Research Laboratory  
University of California, Berkeley, CA 94720

In the first year of the research under the AASERT Grant we have developed a more rigorous approach to studying the synchronization of coupled digital oscillators, the bifurcations in the system, and the transition to chaotic dynamics. We have developed a mapping for a general class of coupled digital oscillators, which we call *coupled phase graph* (CPG) dynamical systems; coupled digital phase-locked loops (DPLL's) is a special case of the CPG dynamics. By enforcing symmetries on the dynamics of these mappings we can prove results about phase locking (periodic behavior) and have demonstrated (although not rigorously proved) the existence of horseshoes (chaotic behavior). We have derived results concerning the existence of period-1 and period-2 orbits in the *matched* CPG dynamics and have applied these results to the coupled DPLLs. This work resulted in a paper "The Dynamics of a Class of Coupled Digital Oscillators" by W. E. Wonchoba, M. A. Lieberman, and A. J. Lichtenberg, *Nonlinearity*, **7**, 1695–1715 (1994).

In the second year of the grant the work has been generalized to include large numbers of coupled oscillators, connected in various topological configurations. Rigorous results on the fixed points and their stability has been obtained. The combined work of the two years has resulted in a PhD thesis by Wayne E. Wonchoba, "The Dynamics of a Class of Coupled Digital Oscillators," University of California, Berkeley, May 1995.

The third year of the grant will support the work of another continuing student, Peter Khoury, on a related topic, the effect of noise on the dynamics of digital systems.