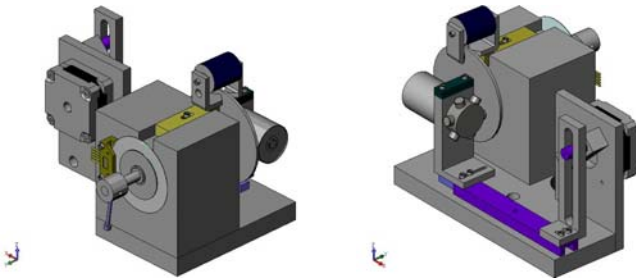


Quantifying Chaos: Creating and Analyzing Chaotic Movement on a Physical System

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System Overview

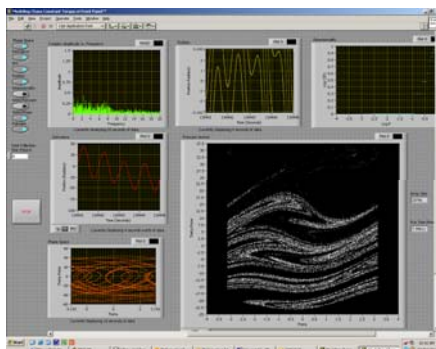
The experimental system consisted of a pendulum mounted to an eddy disk being sinusoidally driven by an eddy motor via a scotch yoke. There was also a magnetic braking system mounted on the eddy disk that allowed us to increase the complexity of motion. The position of the pendulum was read in by an angular encoder and was sent to the computer for analysis.



Analysis of System

Once the position had been read in, we were able to develop programs that could calculate the derivative, frequency spectrum, phase space and Poincare section. One of our main achievements over the summer was to develop a new LabView program that could very quickly calculate and store these values.

Our Program's User Interface

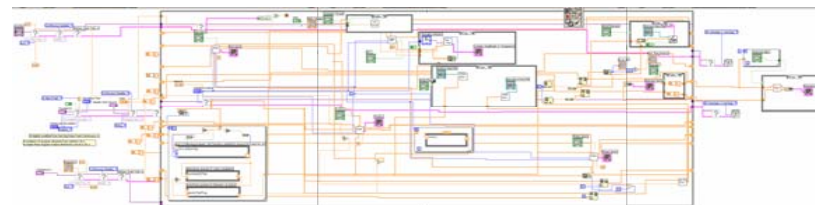


"...physics understood perfectly the fundamental mechanisms of pendulum motion but could not extend the understanding to the long term. The microscopic pieces were perfectly clear; the macroscopic behavior remained a mystery. The tradition of looking at systems locally – isolating the mechanisms and then adding them together – was beginning to break down. For pendulums, for fluids, for electronics, for lasers, knowledge of fundamental equations no longer seemed to be the right kind of knowledge at all."
James Gleick, *Chaos*, 1987

Feedback

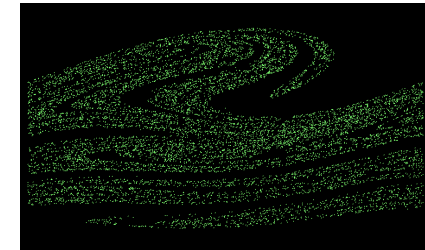
Another major accomplishment this summer was the integration of feedback into our system. Our system had variations in torque due to the relative motion between the eddy motor and eddy disk. To correct this problem we recalculated the voltage sent to the eddy motor 20 times a second based on the speed of the motor. Our final system required two computers to run and required several gigabytes worth of data for each run.

Block Diagram



Poincare Movies

Another major achievement we had during the summer was to develop a program using the binary data stored that could display multiple Poincare sections in an animation that would allow us to analyze the complexity of motion as a function of the phase.



Binary Storage

Our experimental analysis required **2000 pieces of information to be stored every second for 24 hours**. This required an extremely efficient data storage system. Over the course of the summer, we developed several ways to store and analyze data in a binary format. The diagram below is an example of program utilizing this system.



Next Step

Our next step will be to accurately match our physical system with our theoretical system. Only once we have matched both of these systems we will have shown that we understand chaos.