'Noise' tunes logic circuit made from virus genes

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In the world of engineering, "noise" – random fluctuations from environmental sources such as heat – is generally a bad thing. In electronic circuits, it is unavoidable, and as circuits get smaller and smaller, noise has a greater and more detrimental effect on a circuit's performance. Now some scientists are saying: if you can't beat it, use it.

Engineers from Arizona State University in Tempe and the Space and Naval Warfare Systems Center (SPAWAR) in San Diego, Calif., are exploiting noise to control the basic element of a computer – a logic gate that can be switched back and forth between two different logic functions, such as ANDOR – using a genetically engineered system derived from virus DNA. In a paper accepted to the AIP's journal Chaos, the team has demonstrated, theoretically, that by exploiting sources of external noise, they can make the network switch between different logic functions in a stable and reliable way.

The scientists focused on a single-gene network in a bacteriophage λ (lamda). The gene they use regulates the production of a particular protein in the virus. Normally, there are biological reactions that regulate the creation and destruction of this protein; upsetting that balance results in a protein concentration that is either too high or too low. The scientists assigned a "1" to one concentration and a "0" to the other. By manipulating the protein concentration, the team could encode the logic gate input values and obtain the desired output values.

Researchers modeled the system as two potential energy "wells"

separated by a hump, corresponding to an energy barrier. In the presence of too much noise, the system never relaxes into one of the two wells, making the output unpredictable. Too little noise, on the other hand, does not provide the boost necessary for the system to reach a high enough protein concentration to overcome the energy barrier; in this case, there is also a high probability that the biological logic gate will fail to achieve its predicted computation. But an optimal amount of noise stabilizes the circuit, causing the system to jump into the "correct well" – and stay there. This proof-of-concept work offers the possibility of exploiting noise in biologic circuits instead of regarding it as a laboratory curiosity or a nuisance, the researchers say.

More information: "Logical stochastic resonance with correlated internal and external noises in a synthetic biological logic block" is accepted for publication in *Chaos: An Interdisciplinary Journal of Nonlinear Science.*

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