

## COMPUTER MODELING AND ARDUINO UNO IMPLEMENTATION OF A 6D HYPERCHAOTIC SYSTEM WITH FOUR QUADRATIC NONLINEARITIES

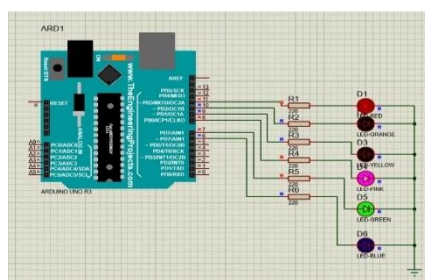
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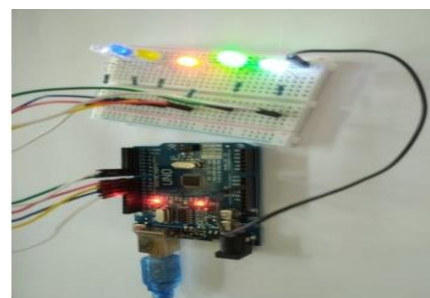
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Chaotic systems with an attractor of dimensions above 3D have a much wider practical application. Therefore, computer simulation of chaotic signals and the search for a circuit implementation of chaotic oscillation generators is an important problem. This paper presents the results of our dynamic analysis, circuit implementation, and computer simulation of a six-dimensional (6D) system of nonlinear dynamic equations. This system of equations has four quadratic nonlinearities and describes the process of magnetic field generation, which serves as an alternative to the Rikitake dynamo system [1]. This gives grounds to assume that a new 6D system will have more chaotic behavior than the one we considered in [2].

In this paper, we investigated the fundamental properties of the system such as Lyapunov exponents and Kaplan-Yorke dimension, as well as its phase portraits, were described in detail. We designed Matlab-Simulink and LabVIEW models for numerical simulation of equations of nonlinear dynamics. According to the phase portraits obtained as a result of Matlab-Simulink and LabView simulation, it was found out that the oscillations arising in the systems have a complex chaotic character. For the 6D hyperchaotic system, an electronic circuit of a chaos generator was designed. The performance of this electronic circuit was tested in the Multisim environment. To visualize and realize the new 6D chaotic system practically, an Arduino UNO board and six LEDs are used (see Fig. 1). Additionally, the ability to simulate the new 6D chaotic system in the Proteus 8 environment using the Arduino UNO microcontroller is presented (see <https://wokwi.com/projects/360091803244720129>).



(a)



(b)

Picture 1 – a) circuit schematic of the microcontroller-based circuit of 6D chaotic generator depicted in Proteus 8, b) photo of the experiment's realization using an Arduino UNO board

### References:

1. Kopp M. I., Tur A. V., Yanovsky V. V. Chaotic dynamics of magnetic fields generated by thermomagnetic instability in a nonuniformly rotating electrically conductive fluid. *J. Phys. Stud.* 2023. Vol. 27. P. 2403.
2. Michael Kopp and Andrii Kopp: A New 6D Chaotic Generator: Computer Modelling and Circuit Design. *Int. J. Eng. Technol.* 2022. Vol. 12. P. 288-307.