CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)

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Project Number

31507

Project Title

Plotting Muon Pathways as a Source of Randomness

Abstract

Objectives/Goals

Truly random numbers are integral to various fields, ranging from cryptography to statistics. Many modern true random number generators (TRNGs), which extract random values from physical phenomena, are intrinsically biased. This project aims to create a novel TRNG by utilizing computer vision algorithms to analyze the position of muon pathways in a cloud chamber, since the emission of cosmic radiation is random.

Methods/Materials

A 99-percent isopropanol cloud chamber was constructed that allowed for the observance of muons. Muon streaks were photographed as RAW files. An OpenCV-based application was written to isolate the streaks by utilizing Gaussian blur and Canny edge detection algorithms. The same application was then used to extract the x and y coordinates of the midpoints of the streaks. The Cartesian coordinates were concatenated and used as input for ten tests from the NIST Statistical Test Suite.

Results

P-values greater than .01 were considered to imply randomness. Seven of the NIST tests indicated that 128-bit numbers generated from the x and y values were random, two indicated that 3000-bit numbers were random, while one indicated that 1000-bit numbers were random.

Conclusions/Discussion

The high success rate of the statistical tests strongly suggests that the data obtained is random. Since seven tests verified the randomness of 128-bit numbers, it can be concluded that the cloud chamber can be used to generate random 128-bit numbers. This project proves the viability of this cloud chamber as a novel, cost-effective TRNG while simultaneously providing insight into the random nature of cosmic radiation. Further research will focus on the automation of the entire process, including rendering the cloud-chamber self-sustainable and optimizing the computer vision algorithms for efficiency.

Summary Statement

This project constructs a novel, reliable true random number generator through the utilization of muon pathways in a cloud chamber.

Help Received

Photography of the chamber was facilitated with the help of Gennadiy Magidin and Christophe Haubursin. The image processing procedure was advised by Dr. Ram Charan, Dr. Narendra Ahuja, and Ajay Agrawal. The procedure for the construction of the chamber was adapted from QuarkNet.