Developing a Novel Paradigm for the Distributed Storage of Digital Information

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In today's data-driven world, where 2.5 quintillion bytes are generated every day, reliably storing and accessing vital information is crucial. However, as technologies evolve, traditional methods struggle to effectively counter threats such as cyberattacks, data breaches, and system failures. This research introduced the novel concept of "infinite redundancy" using the discrete Fourier transform (DFT) to map data throughout a finite physical memory. Despite arbitrary corruption, the data could be reconstructed from only one uncorrupted memory subset by analyzing frequency spectrum patterns, much like a full holographic image could be reproduced from just a fragment of a holographic film. The proposed model demonstrated remarkable fault tolerance compared to traditional redundancy models, being able to reconstruct up to 89% data corruption with 98% accuracy through the software-based techniques. This comes with a tradeoff of 3.55x storage usage compared to the 3x storage overhead of the state-of-the-art triple-modular redundancy, while traditional methods cannot withstand more than 50% corruption. The proposed model aims to revolutionize data storage, providing novel approaches to handle the increasing importance of data in the modern world. This includes applications like enabling long-term deep space probes to survive without failure in the harsh radiation environment. By pushing the boundaries of data storage, new possibilities can be unlocked enabling transformative advancements in how data is perceived, utilized, and benefited from.

Awards Won:

Association for Computing Machinery: Second Award of $3,000