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ANALYZING THE IMPACT OF ALGEBRAIC GEOMETRY ON THE DEVELOPMENT OF ROBUST ERROR-CORRECTING CODES

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ABSTRACT

This paper analyzes the transformative role of algebraic geometry in the development of robust error-correcting codes, essential for maintaining data integrity in digital communication and storage systems. By leveraging the mathematical structures of algebraic curves over finite fields, algebraic-geometric (AG) codes have emerged as powerful alternatives to classical codes, such as Reed-Solomon and BCH. We explore how key geometric properties—such as genus and rational points—contribute to the construction of codes with enhanced error-correction capabilities, outperforming traditional methods in terms of minimum distance and code length. Additionally, recent advancements in decoding algorithms for AG codes are discussed, addressing challenges related to computational complexity. Through a detailed comparative analysis, the paper highlights the practical advantages of AG codes in modern communication systems, demonstrating their potential for improving data reliability in high-noise environments. Finally, we consider future directions for research, emphasizing the continued relevance of algebraic geometry in advancing error-correcting code technologies.

KEYWORDS: *Algebraic-Geometric (AG)*

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