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OPTIMIZED ELLIPTIC CURVE CRYPTOGRAPHIC COMPUTATIONS USING ANCIENT INDIAN VEDIC MATHEMATICS TECHNIQUES

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ABSTRACT

This study investigates the integration of Ancient Indian Vedic Mathematics (AIVM) into contemporary cryptographic frameworks, with a particular emphasis on Elliptic Curve Cryptography (ECC). Cryptographic computations in ECC require substantial computational resources and execution time, especially during core operations such as point addition, point doubling, and modular multiplication. The AIVM system, based on sixteen Sutras and fourteen Sub-sutras, offers efficient and high-speed arithmetic techniques. This paper examines the applicability and performance benefits of the Urdhva-Tiryagbhyam *sutra for multiplication, the* Dvandva-Yoga *sutra for squaring operations, and the* Nikhilam Navatashcaramam Dashatah *sutra for handling large-number computations. By implementing these ancient techniques, the computational latency and hardware complexity of systems like RSA and ECC can be significantly reduced. The survey demonstrates that Vedic algorithms not only accelerate encryption and decryption processes but also optimize hardware resource utilization, making them highly suitable for high-speed security applications.*

Keywords: *ECC, Vedic Mathematics, Dhvajanka, Cryptography, Dvandva-Yoga, Urdhva-Tiryagbhyam, Nikhilam Navatashcaramam Dashatah.*
MSC: *94A60.*

1. INTRODUCTION

In the modern digital era, secure communication has become a fundamental requirement due to the exponential growth of data exchange across open and insecure networks. Cryptography plays a vital role in ensuring data confidentiality, integrity, authentication, and non-repudiation. Among various public key cryptographic schemes, Elliptic Curve Cryptography (ECC) has emerged as a highly efficient and secure alternative to traditional cryptosystems such as RSA and DSA, owing to its smaller key size, reduced

computational overhead, and strong resistance to cryptanalytic attacks. Despite its advantages, ECC involves computationally intensive arithmetic operations, including point addition, point doubling, and scalar multiplication over finite fields. These operations rely heavily on modular multiplication, squaring, and inversion, which significantly affect execution time, power consumption, and hardware area, particularly in resource-constrained environments such as smart cards, Internet of Things (IoT) devices, embedded systems, and wireless sensor networks. Therefore, optimizing the arithmetic computations at the core of ECC remains an active and critical area of research. Ancient Indian Vedic Mathematics (AIVM), derived from the ancient Indian scriptures and systematically presented through sixteen Sutras and fourteen Sub-sutras, offers powerful techniques for fast and efficient arithmetic computation. These sutras provide alternative mathematical approaches that reduce computational complexity, enhance parallelism, and improve speed compared to conventional arithmetic methods. In recent years, Vedic Mathematics has gained attention in the field of digital signal processing, computer arithmetic, and cryptographic hardware design due to its simplicity and efficiency. This paper explores the application of selected Vedic Mathematics techniques to optimize elliptic curve cryptographic computations. Specifically, the Urdhva-Tiryagbhyam sutra is employed for high-speed multiplication, the Dvandva-Yoga sutra is utilized for efficient squaring operations, and the Nikhilam Navatashcaramam Dashatah sutra is applied to handle large-number calculations effectively. By integrating these Vedic techniques into ECC arithmetic operations, the proposed approach aims to reduce computational delay, improve throughput, and enhance overall system performance. The primary objective of this study is to analyze and demonstrate how Ancient Indian Vedic Mathematics can be effectively integrated with modern cryptographic algorithms to achieve optimized ECC computations without compromising security. The findings of this research contribute to the development of high-performance and low-complexity cryptographic systems suitable for next-generation secure communication technologies.

RSA and Diffie-Hellman Key Size (bits)	ECC Key Size (bits)
1024	160
2048	224
3072	256
7680	384
15360	384
15360	512

Fig. 1: Comparison of key size for ECC and RSA

The primary advantage of Elliptic Curve Cryptography (ECC) lies in its significantly higher security strength compared to RSA at equivalent or smaller key sizes. For instance, a 256-bit ECC key provides a security level approximately 10,000 times greater than that of a 2048-bit RSA key and is comparable in strength to a 3072-bit RSA key. As computational capabilities available to attackers continue to advance, RSA-based systems require increasingly larger key sizes to maintain adequate security. In contrast, ECC key lengths scale more efficiently, increasing linearly with security strength. Consequently, future RSA key sizes are expected to

grow rapidly, whereas ECC offers a more scalable and computationally efficient solution, as illustrated in Fig. 1.

Fig. 2: Performance of RSA and ECC

Elliptic Curve Cryptography (ECC) is preferred over RSA primarily due to its significantly smaller key size while providing equivalent or higher levels of security. Owing to this efficiency, ECC has emerged as one of the most effective public-key cryptographic techniques for secure communication. Compared to conventional cryptographic algorithms such as RSA, ECC offers superior performance with reduced computational overhead, making it particularly suitable for modern security applications. Consequently, ECC is widely adopted in various security protocols, including IP data security, transport layer security, email security, secure terminal connections, conferencing services, and related communication systems [1-6].

2. VEDIC MATHEMATICS

The ancient method of Indian mathematics known as Vedic Mathematics uses a distinctive computational approach to perform calculations based on 16 Sutras [12]. When compared to formal methods, using these Sutras to solve problems saves a lot of time and effort. The following are the sixteen Sutras:

S.No	Name of Sutras	Sub-Sutras	Meaning
1	Ekadhikina Purvena	Anurupyena	By one more than the previous one
2	Nikhilam Navatasheranam Dashatah (NND)	Sisyate Sesasamjna Adyamadyenantyamen	All from 9 and the last from 10
3	Urdhva-Tiryagbhyam	Kevalain Saptakam	Vertically and crosswise
4	Paravartya Yojayet	Gunyat	If one is in ratio, the other is zero
5	Paravartya Yojayet Shunyam	Antyayoroashake kpi Ena	By addition and by subtraction
6	Paravartya Yojayet	Vestanam	By completion or by aon-
7	Puranapuranabhyam Chalana-Kalanabhyam	Yavadunaim Tavadunam Vyaadrikirtya Varga Yojayet	Differencies and the non-completion
8	Yaavadunamabhyam	Antyayordaske'pi	By conpletion or by noncompletion
9	Yaavandunamhyam	Antyayordaskee'pi	Whatever the extent of its deficiency
10	Yaavandunam	Lopanasthapanabhyam	Part and Whole
11	Chalana-Kalanabbhyam	Vilokanam	The remainder by the last digit
12	Yaavadunam Purvena	Gunitasamuccayah	Gunitasamuccayah
13	Whyathisamastih	Lopanatthapanabhyam	By one less than the previous one
14	Gunitsamuchyah	Dvandva-Yoga	The product of the sum is equal
16	Gunakasmuchyah	Adyam Antyam Madhyam	The factors of the factors

Fig. 3: The Sutras and Sub Sutras of AIVM

The ancient Indian mathematics system that Jagadguru Sankaracarya Swami Sri Bharati Krsna Tirthaji Maharaja (1884-1966) rediscovered from the Vedas between 1911 and 1918 is referred to as "Vedic Mathematics" [12]. According to this research, the entire framework of Vedic Mathematics is founded on sixteen Sutras, or concise word formulas, that encapsulate fundamental mathematical principles. One such sutra, *Urdhva-Tiryagbhyam* (meaning “vertically and crosswise”), exemplifies the intuitive nature of these methods. These sutras reflect the natural functioning of the human mind and thus serve as effective guides for researchers in identifying efficient problem-solving strategies. One of the most remarkable features of the Vedic system is its inherent coherence and unity. Rather than consisting of a collection of disconnected techniques, it represents a well-integrated and systematic mathematical structure. For example, the same principles used in simple squaring and general multiplication can be readily reversed to derive one-line methods for square root extraction and division, respectively. Moreover, these techniques are easy to comprehend and apply. This unifying characteristic makes mathematics more engaging and accessible, fostering creativity and analytical thinking. The Vedic approach often yields immediate solutions to complex problems involving large numbers and multiplication. These elegant and powerful techniques form part of a comprehensive mathematical system that is considerably more structured and methodical than conventional arithmetic approaches. The coherent and unified structure of mathematics is exemplified by Vedic mathematics, and the methods are complementary, straightforward, and simple. Vedic mathematics is unique in that it is easy to understand and manipulate complex numbers in simple steps. If the idea behind it is understood, then this is something that anyone can do. As a result, constructing any intelligent mathematical model is simple. Using this analogy, we can reduce the amount of time spent manipulating point addition and point multiplication, which are essential to elliptic curve cryptography (ECC). The Vedic method of multiplication uses fewer operations than conventional methods, resulting in a faster and more efficient multiplier.

3. LITERATURE REVIEW

Vedic Mathematics has gained significant attention in recent years for its potential to improve computational efficiency in digital systems and cryptographic applications. Derived from ancient Indian mathematical principles compiled by Jagadguru Sankaracharya Swami Sri Bharati Krishna Tirthaji Maharaja, Vedic Mathematics provides a set of sutras that simplify arithmetic operations and reduce computational complexity (Tirthaji, 2013). Several researchers have explored the application of Vedic Mathematics in high-speed and low-power arithmetic unit design. Anchalya et al. (2015) demonstrated that the application of Vedic sutras to arithmetic operations leads to significant improvements in computational speed. In a related study, Aneesh and Mohan (2014) developed a 32×32-bit multiply-accumulate (MAC) unit based on Vedic Mathematics, achieving higher operating speed and reduced hardware area compared to conventional multiplier architectures. Extending this approach, Anjana et al. (2015) applied Vedic techniques to floating-point multipliers and reported enhanced synthesis performance in terms of reduced delay and improved hardware utilization. A considerable volume of existing research has focused on the implementation of Vedic multipliers in VLSI and FPGA-based systems. Studies by Bathija et al. (2012), Kanhe et al. (2012), and

Poornima et al. (2013) consistently reported that multipliers based on the *Urdhva-Tiryagbhyam* sutra exhibit lower power consumption and faster computation compared to traditional array multipliers. Further enhancements using compressor-based and LUT-optimized architectures were proposed by Sameer et al. (2015), Zakaria and Abbasi (2013), and Panda et al. (2015), confirming the scalability and suitability of Vedic multipliers for modern hardware platforms. The role of Vedic Mathematics in cryptographic systems has also been extensively investigated. Bhaskar et al. (2012) and George and Bonifus (2013) integrated Vedic multipliers into RSA encryption systems, achieving notable reductions in computation time and hardware complexity. Salim and Lakhotiya (2015) further validated that RSA cryptosystems implemented using Vedic arithmetic outperform conventional implementations in terms of speed and efficiency. These findings highlight the suitability of Vedic Mathematics for public-key cryptographic algorithms that rely heavily on large integer multiplication. Elliptic Curve Cryptography (ECC), which offers equivalent levels of security with significantly smaller key sizes than RSA and Diffie-Hellman schemes, has emerged as a prominent area of cryptographic research. The theoretical foundations of modern public-key cryptography were established through the seminal contributions of Diffie and Hellman (1976), Rivest et al. (1978), Koblitz (1987), and Miller (1986), whose works laid the groundwork for the development and widespread adoption of ECC-based security mechanisms. Menezes (1993) and Hankerson et al. (2004) provided comprehensive analyses of ECC principles, implementations, and security considerations. Recent studies have combined ECC with Vedic Mathematics to optimize scalar multiplication and finite field arithmetic. Barman and Saha (2015) applied the Nikhilam Sutra to ECC arithmetic and demonstrated improved computational efficiency. Shylashree et al. (2015) proposed an optimized scalar multiplication technique using Vedic Mathematics over GF(p), achieving faster execution and reduced resource utilization. Maria and Anitha (2017) emphasized the importance of lightweight ECC-based cryptographic algorithms for mobile and financial applications, reinforcing the relevance of optimized arithmetic techniques. Beyond cryptography, Vedic Mathematics has been successfully applied in digital signal processing and FFT implementations. Gaikwad and Chavan (2015), Raman et al. (2010), and Ramya et al. (2017) showed that Vedic arithmetic enhances DSP operations by reducing latency and improving throughput. Applications in convolution, factorial computation, and ALU design further confirm the versatility of Vedic Mathematics in high-performance computing systems (Haveliya, 2012; Saha et al., 2011; Manjunath et al., 2016). Overall, the reviewed literature clearly indicates that Vedic Mathematics-based computing techniques offer significant advantages in terms of speed, power efficiency, and hardware optimization. When integrated with cryptographic algorithms such as RSA and ECC, these techniques not only improve performance but also support lightweight and secure implementations suitable for modern resource-constrained environments. However, there remains scope for further research in integrating advanced Vedic sutras with contemporary cryptographic protocols and emerging hardware platforms.

4. MATHEMATICAL BACKGROUND OF ELLIPTIC CURVE CRYPTOGRAPHY

In this section, we will discuss the mathematical background of elliptic curve cryptography.

Elliptic Curves: Let F_p be a finite field of prime modulo p and let $a, b \in F_p$ such that $(4a^3 + 27b^2) \bmod p \neq 0$.

Then an elliptic curve over F_p denoted by $E(F_p)$ is defined as the set of points $(x, y) \in F_p$, satisfying the equation $y^2 = (x^3 + ax + b) \bmod p$, i.e.

$E(F_p) = \{(x, y) : y^2 = (x^3 + ax + b) \bmod p\} \cup \{O\}$.

The point O is the point at infinity, and it serves as the identity element (under the addition operation), i.e. $P + O = O + P = P \quad \forall P = (x, y) \in E(F_p)$.

Actually, the elliptic curve is not an ellipse; they are so-called because they are described by the cubic equation similar to those used for calculating the circumference of an ellipse.

Addition of two points on an elliptic curve $E(F_p)$: If $P = (x_1, y_1) \in E(F_p)$ and $Q = (x_2, y_2) \in E(F_p)$ then the $R = P + Q = (x_3, y_3) \in E(F_p)$ is defined by the following expressions: $x_3 = (\lambda^2 - x_1 - x_2) \bmod p$ and $y_3 = (\lambda(x_1 - x_3) - y_1) \bmod p$.

Where $\lambda = \left(\frac{y_2 - y_1}{x_2 - x_1}\right) \bmod p$ *if* $P \neq Q$ and $\lambda = \left(\frac{3x_1^2 + a}{2y_1}\right) \bmod p$ *if* $P = Q$.

The additive inverse element of a point on an elliptic curve $E(F_p)$: If $P = (x, y) \in E(F_p)$ then the additive inverse of P denoted by $-P$ is defined $-P = (x, -y \bmod p) \in E(F_p)$, i.e. $(x, y) + (x, -y \bmod p) = O$.

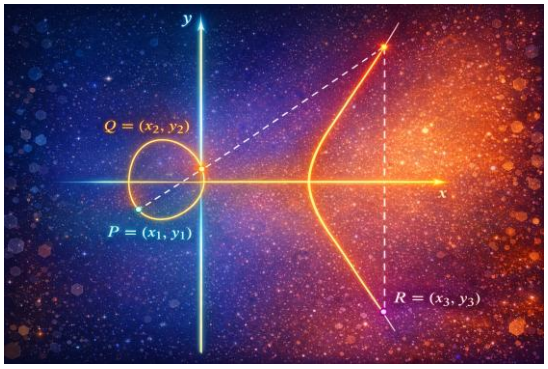

Fig. 4: The addition of P and Q is P + Q = R.

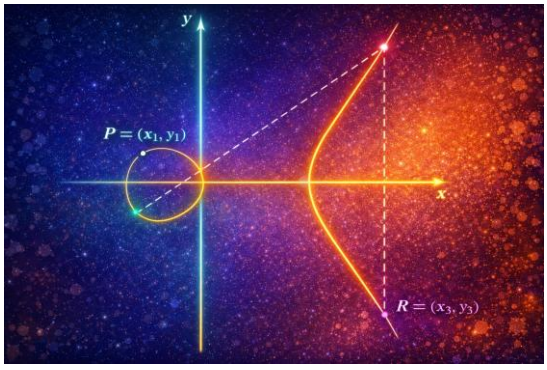

Fig. 5: The doubling of P is P+P = 2P

Quadratic Residue Modulo p : Let p be an odd prime and x be an integer such that $1 \le x \le p-1$. Then x it is defined as a quadratic residue modulo p if the congruence $y^2 \equiv x \pmod{p}$ has a solution $y \in Z_p$.

Example 1: The quadratic residues modulo 11 are 1, 3, 4, 5, and 9 because

$(\pm 1)^2 = 1, (\pm 2)^2 = 4, (\pm 3)^2 = 9, (\pm 4)^2 = 5$ and $(\pm 5)^2 = 3$ where all arithmetic is in Z_{11}.

Example 2: Suppose p is an odd prime and x is an integer such that $1 \le x \le p-1$. It x is a quadratic residue modulo p. The answer to the above problem can be determined from the following result:

Euler's Criterion: x is a quadratic residue modulo p if and only if $x^{\frac{p-1}{2}} \equiv 1 \pmod{p}$.

Example 3: Let E be an elliptic curve $E: y^2 = x^3 + x + 6$ defined over Z_{11} with $a = 1, b = 6$ and $p = 11$. For each value $x \in Z_{11}$, we compute $x^3 + x + 6 \pmod{11}$ as follows:

x	$x^3 + x + 6 \pmod{11}$	Quadratic residue?	y
0	6	No	
1	8	No	No
2	5	Yes	4,7
3	3	Yes	5,6
4	8	No	
5	4	Yes	2,9
6	8	No	
7	4	Yes	2,9
8	9	Yes	3,8
9	7	No	
10	4	Yes	2,9

Fig. 6: Calculation of points on the elliptic curve $E: y^2 = x^3 + x + 6 \pmod{11}$

Thus E has 13 points, including O. If we take two distinct points $P = (5,2)$, and $Q = (2,7)$ then their sum $R = P + Q = (x_3, y_3)$ can be explained as $\lambda = \frac{7-2}{2-5} = \frac{5}{-3} \equiv \frac{16}{8} = 2 \pmod{11}$

$x_3 = 2^2 - 5 - 2 = -3 \equiv 8 \pmod{11}$ and $y_3 = 2(5-8) - 2 = -8 \equiv 3 \pmod{11}$ hence $R = P + Q = (8,3)$.

A further doubling $P = (5,2)$ can be described as $\lambda = \frac{3(5)^2 + 1}{2 \times 2} = \frac{76}{4} \equiv 19 \equiv 8 \pmod{11}$

$x_3 = 8^2 - 2 \times 5 = 54 \equiv 10 \pmod{11}$ and $y_3 = 8(5-10) - 2 = -42 \equiv 2 \pmod{11}$

Hence $R = P + P = 2P = (10,2)$.

Example 4. : For $p = 23, a = 1$ and $b = 4$, the elliptic curve over Z_{23} is given by

$E: y^2 = x^3 + x + 4$ since $4a^3 + 27b^2 = 4 + 432 = 436 \equiv 22 \pmod{23}$. Therefore, the above curve is well defined, and it has 28 points, which are given by

$(0,2), (0,21), (1,11), (1,12), (4,7), (4,16), (7,3), (7,20), (8,8), (8,15), (9,11), (9,12), (10,5), (10,18), (11,9), (11,14), (13,11), (13,12), (14,5), (14,18), (15,6), (15,17), (17,9), (17,14), (18,9), (18,4), (22,5), (22,19)$.

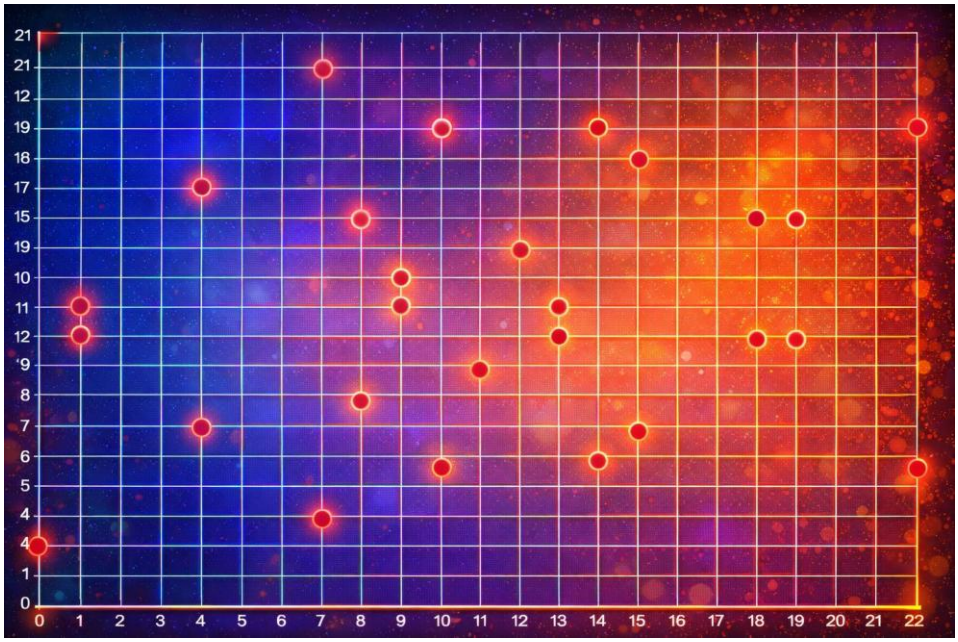

Fig. 7: Points on the elliptic curve $y^2 = x^3 + x + 4 \pmod{23}$

5. PROPOSED VEDIC MATHEMATICS-BASED ECC COMPUTATION MODEL

This section presents the proposed computational model that integrates Ancient Indian Vedic Mathematics techniques into Elliptic Curve Cryptography (ECC) arithmetic operations. The objective of this model is to enhance computational efficiency by optimizing the core arithmetic components of ECC, such as modular multiplication and squaring, which dominate the overall execution time in elliptic curve operations.

Motivation for Optimization

Although ECC provides high security with smaller key sizes, its practical implementation involves computationally expensive operations, particularly point addition, point doubling, and scalar multiplication. These operations rely heavily on repeated modular multiplication and squaring over finite fields. In conventional implementations, these arithmetic operations introduce significant computational delay and resource overhead. Therefore, optimizing these fundamental arithmetic processes is essential to improve the overall performance of ECC, especially in time-critical and resource-constrained applications such as IoT devices, smart cards, and embedded systems.

Integration of Vedic Algorithms with ECC Arithmetic

This subsection describes how selected Vedic Mathematics sutras are incorporated into ECC arithmetic operations. The *Urdhva-Tiryagbhyam* sutra is utilized for efficient multiplication, the *Dvandva-Yoga* sutra is applied to optimize squaring operations, and the *Nikhilam Navatashcaramam Dashatah* sutra is employed for handling large-number calculations. These sutras enable parallel computation, reduced carry propagation, and simplified arithmetic logic. By embedding these Vedic techniques into the ECC computational framework, the proposed model achieves faster and more efficient finite-field arithmetic without altering the underlying cryptographic security.

Optimized Modular Multiplication

Modular multiplication is the most frequently executed operation in ECC and has a major impact on overall performance. In the proposed model, modular multiplication is optimized using the *Urdhva-Tiryagbhyam*

sutra, which allows partial products to be generated simultaneously rather than sequentially. This parallelism reduces computation time and improves throughput. When combined with modular reduction techniques, the Vedic-based multiplier significantly enhances the speed of ECC point operations compared to conventional multiplication methods.

Optimized Squaring and Large Number Operations

Squaring operations are also extensively used in ECC point doubling and scalar multiplication. The proposed approach employs the *Dvandva-Yoga* sutra to optimize squaring, reducing redundant computations and improving execution efficiency. Additionally, the *Nikhilam Navatashcaramam Dashatah* sutra is used to efficiently manage large-number arithmetic, which is critical for cryptographic key sizes. Together, these optimized techniques contribute to lower computational complexity, reduced delay, and improved performance of ECC implementations.

6. PERFORMANCE ANALYSIS AND RESULTS

This section evaluates the effectiveness of the proposed Vedic Mathematics-based Elliptic Curve Cryptography (ECC) computations. The performance of the optimized approach is analyzed using multiple parameters and is compared with conventional ECC implementations to demonstrate improvements in efficiency, speed, and resource utilization.

Computational Complexity Analysis

This subsection examines the computational complexity of the proposed ECC arithmetic operations. It analyzes the number of basic operations, such as additions, multiplications, and squaring, required during point addition, point doubling, and scalar multiplication. By integrating Vedic Mathematics techniques, the proposed method aims to reduce the overall number of arithmetic operations and lower algorithmic complexity compared to traditional approaches.

Speed and Delay Comparison

This subsection presents a comparison of execution speed and computational delay between the proposed Vedic-based ECC implementation and conventional ECC methods. Metrics such as execution time, latency, and throughput are evaluated to show how Vedic algorithms improve the speed of modular multiplication and squaring, resulting in faster ECC computations.

Area and Power Consumption Analysis

For hardware-based implementations, this subsection analyzes the area utilization and power consumption of the proposed design. Parameters such as logic gate count, lookup tables (LUTs), flip-flops, and overall power usage are measured. The use of Vedic arithmetic is expected to reduce hardware complexity and power consumption while maintaining high performance, making the design suitable for resource-constrained environments.

Comparison with Conventional ECC Implementations

This subsection provides a comprehensive comparison between the proposed Vedic Mathematics-based ECC implementation and conventional ECC implementations. Performance metrics such as computational

efficiency, speed, area, power consumption, and scalability are compared to highlight the advantages and improvements achieved through the proposed optimization techniques.

7. CONCLUSION

The integration of ancient Indian Vedic Mathematics into the architecture of Elliptic Curve Cryptography (ECC) demonstrates a significant leap in computational efficiency, particularly for resource-constrained environments. By leveraging sutras like Urdhva-Tiryagbhyam and Nikhilam for modular multiplication and point addition, this study proves that high-speed arithmetic can be achieved with reduced power consumption and lower latency compared to conventional algorithms. These techniques optimize the underlying finite field operations, making hardware implementations of ECC more robust and scalable. Future research may explore the extension of these Vedic Mathematics-based algorithms to Post-Quantum Cryptography (PQC) frameworks in order to enhance computational efficiency while ensuring resilience against emerging quantum-era security threats. Additionally, there is a promising scope for developing specialized VLSI architectures and FPGA-based accelerators that natively support Vedic arithmetic, further enhancing the performance of real-time secure communication in IoT devices and blockchain technology.

REFERENCES

[1]. Anchalya R., Chiranjeevi G. N., Kulkarni S., Efficient Computing Techniques using Vedic Mathematics Sutras, International Journal of Innovative Research in Electrical, Electronic Instrumentation and Control Engineering, 3(5), 24-27, May 2015.

[2]. Aneesh R., Mohan S. K., Design and Analysis of High-Speed, Area Optimized 32x32-Bit Multiply Accumulate Unit Based on Vedic Mathematics, in International Journal of Engineering Research and Technology, 3(4), 1-5, April 2014.

[3]. Anjana S., Pradeep C., and Samuel P., Synthesis of High-Speed Floating-point Multipliers Based on Vedic Mathematics, Procedia Computer Science, 46, 1294-1302, 2015.

[4]. Barman P. and Saha B., An Efficient Elliptic Curve Cryptography Arithmetic Using Nikhilam Multiplication, The International Journal Of Engineering And Science (IJES), 4(4), 45-50, 2015.

[5]. Bathija R. K., Meena R. S., Sarkar S., and Sahu R., Low Power High-Speed 16x16 bit Multiplier using Vedic Mathematics, International Journal of Computer Applications, 59(6), 41-44, Dec. 2012.

[6]. Bhaskar R., Hegde G., and Vaya P. R., An efficient hardware model for RSA Encryption system using Vedic mathematics, Procedia Engineering, 30, 124-128, Jan. 2012.

[7]. Diffie W. and Hellman M., New Directions in Cryptography, IEEE Transactions on Information Theory, 22(6), 644-654, Nov. 1976.

[8]. Gaikwad K. M. and Chavan M. S., Vedic Mathematics for Digital Signal Processing Operations, International Journal of Computer Applications, 113(18), 10-13, March 2015.

[9]. George D. and Bonifus P.L., RSA Encryption System Using Encoded Multiplier and Vedic Mathematics, (ICACCS -2013), Dec. 19-21, Coimbatore, INDIA, 2013.

[10]. Hankerson D., Menzes A., and Vanstone S., Guide to Elliptic Curve Cryptography, Springer-Verlag, New York, 2004.

[11]. Haveliya A., FPGA implementation of a Vedic convolution algorithm, International Journal of Engineering Research and Applications, 2(1), 678-884, Feb. 2012.

[12]. Jagadguru Sankaracarya Swami Sri Bharati Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Pvt. Ltd., Delhi, 2013.

[13]. Kadu D. R. and Dhok G. P., A novel efficient technique for data security using Vedic Mathematics, International Journal of Application or Innovation in Engineering & Management (IJAIEM), 4(5), 87-93, May 2015.

[14]. Kanhe A., Das S.K. and Singh A.K., Design and implementation of low power multiplier using Vedic multiplication technique, International Journal of Computer Science and Communication, 3(1), 131-132, June 2012.

[15]. Kapse Y. D., Sarangpure P. R., and Lokhande K. M., Review on a Compressor Design and Implementation of Multiplier using Vedic Mathematics, International Journal of Advanced Research in Computer and Communication Engineering, 6(2), Feb. 2017.

[16]. Koblitz N., Elliptic curve cryptosystem, Mathematics of computation, 48, 203-209, 1987.

[17]. Kumar G. G. and Charishma V., Design of high-speed Vedic multiplier using Vedic mathematics techniques, International Journal of Scientific and Research Publications, 2(3), 1-8, March 2012.

[18]. Liz-Jose G. and John S., VLSI Implementation of Vedic Mathematics and Its Application in RSA Cryptosystem, International Journal of Innovative Research & Development, 2(10), 297-303, Oct. 2013.

[19]. Madke D. and Zafar S., Polynomial Multiplication Using Karatsuba and Nikhilam Sutra, International Journal of Advanced Research in Computer Science and Software Engineering, 4(6), 1423-1428, June 2014.

[20]. Manjunath K. M., Muralidhara K. N., Chigateri M. K., and Manjuvani K. M., An Exhaustive Research Survey on Vedic ALU Design, International Journal of Innovative Research in Computer and Communication Engineering, 4(7), 13027-13034, July 2016.

[21]. Maria R. and Anitha V., Light Weight Asymmetric Cryptographic Algorithm for Financial Transactions through Mobile Application, International Journal of Computer Applications Foundation of Computer Science, N.Y., USA, 170(3), 37-41, 2017.

[22]. Menezes A. J., Elliptic Curve Public Key Cryptosystems, Kluwer Academic Publishers, Springer, July 1993.

[23]. Miller V. S., Uses of elliptic curves in cryptography, Proceedings 85 Advances in Cryptology 218, 417-426, 1986.

[24]. Nanda A. and Behera S., Design and Implementation of Urdhva-Tiryakbhyam Based Fast 8×8 Vedic Binary Multiplier, International Journal of Engineering Research & Technology, 3(3), 1856-1859, March 2014.

[25]. Palata K. N., Nadar V. K., Jethawa J. S., Surwadkar T. J., and Deshmukh R. S., Implementation of an Efficient Multiplier based on Vedic Mathematics, International Research Journal of Engineering and Technology, 4(4), 494-497, April 2017.

[26]. Panda S. K., Das R., Raheman S., and Sahoo T. R., VLSI Implementation of Vedic Multiplier Using Urdhva-Tiryakbhaym Sutra in VHDL Environment: A Novelty, IOSR Journal of VLSI and Signal Processing, 5(1), 17-24, Feb. 2015.

[27]. Pawar A., Sahu A. K., and Sinha G. R., Implementation of High-Speed Vedic Multiplier, International Journal of Innovative Research in Advanced Engineering, 1(10), 396-401, Nov. 2014.

[28]. Poornima M., Patil S. K., Kumar S., Shridhar K. P., and Sanjay H., Implementation of multiplier using Vedic algorithm, International Journal of Innovative Technology and Exploring Engineering, 2(6), 219-223, May 2013.

[29]. Raman A., Kumar A., and Sarin R. K., High-Speed Reconfigurable FFT Design by Vedic Mathematics, Journal of Computer Science and Engineering, 1(1), 59-63, May 2010.

[30]. Ramya D. K., Revathy R., and Hemanandh S., Design of Complex Multiplier for FFT implementation using Vedic Mathematics, International Research Journal of Engineering and Technology, 4(4), 446-449, April 2017.

[31]. Rivest R., Shamir A. and Adleman L., A Method for Obtaining Digital Signatures and Public-Key Cryptosystems, Communications of the ACM, 21 (2), 120-126, Feb. 1978.

[32]. Sadanandan S. and Anjali V., Design of Advanced Encryption Standard using Vedic Mathematics, International Journal of Innovative Research in Advanced Engineering, 1(6), 322-325, July 2014.

[33]. Saha P., Banerjee A., Dandapat A., and Bhattacharyya P., ASIC design of a high-speed low power circuit for factorial calculation using ancient Vedic mathematics, Microelectronics Journal, 42(12), 1343-1352, Dec. 2011.

[34]. Salim S. M. and Lakhotiya S. A., Implementation of RSA Cryptosystem Using Ancient Indian Vedic Mathematics, International Journal of Science and Research 4(5), 3221-3230, May 2015.

[35]. Sameer G., Sumana M., and Kumar S., Novel High-Speed Vedic Mathematics Multiplier using Compressors, International Journal of Advanced Technology and Innovative Research, 7(2), 0244-0248, Feb. 2015.

[36]. Shylashree N., Reddy D. V. N., and Sridhar V., Efficient Implementation of Scalar Multiplication for Elliptic Curve Cryptography using Ancient Indian Vedic Mathematics over GF (p), 49(7), 46-50, July 2015.

[37]. Stallings W., Cryptography and Network Security Principles and Practices, Pearson Education Ltd., Fourth Edition, Nov. 2005.

[38]. Thenmozhi C., and Sonti K., Analyzing the performance of RC6 using Complex Vedic Multiplier, International Journal of Research in Engineering & Advanced Technology, 1(1), 1- 4, March 2013.

[39]. Zakaria Z., and Abbasi S. A., Optimized Multiplier Based upon 6-Input Luts and Vedic Mathematics, International Scholarly and Scientific Research & Innovation 7(1), 26-30, 2013.

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