Practical Applications of Vedic Mathematical Techniques in Modern Computation

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Abstract: ***Vedic Mathematics in algebra employs 16 main sutras and 13 sub-sutras that provide ingenious shortcuts to tackle intricate mathematical problems with ease. This research delves into these ancient sutras and highlights their effective application in simplifying a wide range of algebraic expressions and equations. The concept of unified mathematics emphasizes the seamless integration of various methods, enhancing overall mathematical comprehension. By illustrating Vedic techniques with lucid examples, the study covers fundamental operations such as addition, subtraction, multiplication, and division. These methods not only accelerate computations but also cultivate analytical thinking and prompt problem-solving abilities. Vedic Mathematics minimizes the dependence on memorization, offering a logical, intuitive framework celebrated for its clarity and practical utility across diverse mathematical challenges.***

Keywords: Vedic mathematics, Sutras, Subsutras, Veda, Multiplication

1. Introduction

The term "Veda" originates from Sanskrit and translates to "knowledge" or "wisdom. " The Vedas are ancient Indian scriptures regarded as the oldest written texts known to humanity. Among them, the Atharva Veda is often referred to as the “Veda of magical formulas. ” Vedic Mathematics is an ancient mathematical system derived from these scriptures, known for enhancing speed and accuracy in calculations. It offers simplified and faster methods to solve arithmetic, algebraic, and reasoning problems through 16 main Sutras and 13 sub-Sutras, each with specific techniques for mental computation.

1) **Ekadhikena Purvena** – “By one more than the previous one”; useful in finding squares of numbers ending in 5.
2) **Nikhilam Navatashcaramam Dashatah** – “All from 9 and the last from 10”; a shortcut method for multiplication close to base values.
3) **Urdhva-Tiryagbhyam** – “Vertically and crosswise”; a general multiplication formula suitable for all types of numbers.
4) **Paravartya Yojayet** – “Transpose and adjust”; often applied in division and algebraic simplification.
5) **Sunyam Samyasamuccaye** – “If the total is the same on both sides, that total is zero”; useful in solving equations.
6) (**Anurupye) Sunyam Anyat** – “If one is in proportion, the other is zero”; applied in solving simultaneous equations.
7) **Sankalana-Vyavakalanabhyam** – “By addition and subtraction”; used in solving equations and finding squares.
8) **Puranapuranabhyam** – “By the completion or non-completion”; applied in simplification and arithmetic operations.
9) **Calana-Kalanabhyam** – “Differences and similarities”; helpful in differential calculus and algebra.
10) **Yavadunam** – “Whatever the deficiency”; useful in squaring numbers near base values.
11) **Vyashti-Samashti** – “Part and whole”; applicable in algebraic expansions.
12) **Shesanyankena Charamena** – “Remainder by the last digit”; used in divisibility rules.
13) **Sopantyadvayamantyam** – “Ultimate and twice the penultimate”; helps in solving special equations.
14) **Ekanyunena Purvena** – “One less than the previous”; helpful in multiplication operations.
15) **Gunitasamuccayah** – “The product of the sum equals the sum of the product”; relates to factorization and identities.
16) **Gunakasamuccayah** – “The factors of the sum equal the sum of the factors”; used in mathematical identities and simplification.

And the list of sub-sutras (corollaries) from Vedic Mathematics, each explained briefly with its interpretation or application:

1) **Anurupyena** – “Proportionally or by appropriate ratio”; useful in simplifying calculations by choosing a suitable base.
2) **Sisyate Sesasamjnah** – “The remainder remains constant”; helpful in division and number theory.
3) **Adyamadyena Antyamantyena** – “First with the first and last with the last”; often used in polynomial multiplication.
4) **Kevalaih Saptakam Gunyat** – “For the divisor 7, multiply with 143”; a special case for divisibility checks.
5) **Vestanam** – “By osculation (cyclic method) ”; applied in checking divisibility by prime numbers.
6) **Yavadunam Tavadunam** – “Subtract by the extent of deficiency”; used in squaring numbers below the base.
7) **Yavadunam Tavadunikritya Vargamcha Yojayet** – “Subtract by deficiency and add the square of the deficiency”; useful for squaring numbers near base values.
8) **Antyayor Dasake’pi** – “If the last digits add to 10”; applies to multiplication shortcuts.
9) **Antyayoreva** – “Only the last terms are considered”; simplifies operations in specific cases.
10) **Samuccaya Gunitah** – “Multiply by the common factor or total”; aids in algebraic identities.
11) **Lopanasthapanabhyam** – “By elimination and retention”; used in solving simultaneous equations.
12) **Vilokanam** – “By observation or inspection”; encourages intuitive calculation.

13) **Gunitasamuccayah Samuccaye Gunitah** – "The product of the total equals the total of the product"; reaffirms the consistency in multiplication outcomes.

The procedures of Vedic Mathematics combine principles from both modern and ancient mathematical systems. Each sutra offers simple and intuitive concepts that can be easily understood and applied. These formulas are designed to solve a wide range of mathematical problems, especially those involving variations and complex calculations, with greater speed and clarity, making them highly effective and accessible.

2. Literature Review

Students often encounter difficulties in performing fast calculations, even when they are familiar with the underlying solutions. Competitive exams frequently involve complex computations such as cube roots, decimal operations, multiplication, division, and square roots. These tasks can be time-consuming using conventional methods. However, Vedic Mathematics offers simplified techniques that significantly reduce calculation time. This paper highlights the effectiveness of Vedic methods in accelerating mathematical operations. It aims to support research and practical applications for enhancing calculation speed in higher-level examinations and competitive assessments.

Several researchers have extensively studied the impact and utility of Vedic Mathematics in improving computational efficiency and reducing the time required to solve mathematical problems. Kumar & Basha present a compact 8-bit Vedic multiplier model, emphasizing reduced propagation delay and improved speed, efficiently utilizing FPGA resources. Similarly, Pawale & Ghodke also report enhanced performance in multiplier speed and area optimization using Vedic techniques over conventional approaches. Jumde et al. extend the concept by integrating Fast Fourier Transform (FFT) with Vedic methods for parallel polynomial multiplication, suggesting significant improvements in computational efficiency. Srimani et al. explore the applicability of Vedic Sutras beyond multiplication, demonstrating their usefulness in DSP operations, showcasing how Vedic designs can contribute to faster arithmetic logic implementations. Anjana et. al. implement a floating-point multiplier using Vedic algorithms, revealing its advantage in precision-intensive operations. Collectively, these studies affirm the relevance of Vedic mathematics in high-performance arithmetic units, offering efficient, resource-saving alternatives suitable for modern hardware platforms and embedded systems. Kumar & Basha (2015) designed and implemented a high-speed 8-bit Vedic multiplier on FPGA, demonstrating reduced propagation delay and optimized area usage. Their work validates how Vedic multiplication techniques can enhance performance in reconfigurable hardware.

Jumde et al. (2015) reviewed a parallel polynomial multiplier using FFT and Vedic Mathematics, noting its potential for high-speed computations in signal processing by blending ancient methods with modern algorithms. Pawale & Ghodke (2015) presented another FPGA-based Vedic multiplier, showcasing lower latency and better utilization of logic blocks compared to traditional approaches, reinforcing the viability of Vedic logic in hardware design. Srimani et al. (2015) focused on DSP operations using Vedic sutras, providing a high-performance multiplier design while promoting the broader utility of Vedic methods across arithmetic logic units. Panda & Sahu (2015) introduced a Vedic divider architecture with reduced delay tailored for VLSI applications, emphasizing efficient circuit-level implementation of ancient division techniques. Barik & Pradhan (2017) proposed a time-efficient signed Vedic multiplier using redundant binary representation, published in The Journal of Engineering. Their design significantly improves multiplication speed by reducing carry propagation delay, making it suitable for real-time arithmetic processors and VLSI applications. Arish & Sharma (2017) presented a run-time reconfigurable floating-point multiplier supporting multi-precision arithmetic, emphasizing high-speed and low-power operation. Their design, grounded in Vedic principles, is particularly relevant for applications like signal processing and scientific computing where dynamic precision and power efficiency are critical. Sharma, Singh & Yadav (2017) developed an efficient division technique based on Vedic Mathematics implemented in Verilog HDL. Their method simplifies complex division logic and demonstrates faster execution in FPGA environments, emphasizing the relevance of Vedic division sutras in digital logic design. Shubhaker & Amareswar (2018) contributed a high-speed Vedic multiplier using FPGA platforms. Their work highlights significant improvements in delay and area metrics when Vedic algorithms are employed, supporting the feasibility of Vedic logic for real-time and embedded applications. Barve et al. (2018) designed and implemented square and cube architectures using Vedic sutras on FPGA, published under IEEE iSES. Their design leverages the compactness and speed of Vedic methods to reduce computational complexity, showcasing strong performance advantages in both basic and advanced arithmetic units.

Alaspure, Dixit & Edle (2019) proposed a parallel Vedic processing architecture using an ASIC design methodology, targeting speed and power efficiency. Their work, published in IJI-SAE, emphasizes scalable hardware acceleration using Vedic principles for modern digital systems. Arish & Sharma (2019) introduced an efficient floating-point multiplier combining Karatsuba algorithm with the Urdhva Tiryagbhyam sutra, implemented on Spartan 3E and Virtex 4 FPGAs. The hybrid design improves computational speed and reduces area consumption, indicating strong potential in embedded and real-time applications. Eshack & Krishnakumar (2019) developed a pipelined low-power Vedic multiplier, presented at ICOEI 2019. Their architecture reduces dynamic power consumption while maintaining high throughput, making it suitable for battery-powered and mobile hardware. Biji & Savani (2021) performed a detailed performance analysis of Vedic Mathematics algorithms on reconfigurable hardware platforms, published in Sādhanā. Their comparative study confirms that Vedic algorithms outperform traditional arithmetic approaches in delay and power efficiency on FPGAs. Kumar & Raj (2022) presented a hybrid Vedic multiplier combining Karatsuba and Urdhva Tiryagbhyam algorithms. Published in Advances in Intelligent Systems and Computing, their work focuses on delay analysis, showing measurable performance gains for larger operand multiplications in intelligent computing systems.

Patil et al. (2025), in their paper Efficient VLSI Architecture Integrating Vedic Mathematics for Square Computation, present an innovative VLSI architecture that incorporates Vedic mathematical techniques, specifically for the rapid computation of squares. Their design demonstrates improved speed and reduced power consumption in comparison to conventional methods, making it suitable for real-time digital systems. The research concludes that integrating Vedic Mathematics into hardware design leads to more efficient, cost-effective, and reliable systems.

3. Multiplication

Vedic Mathematics presents a set of powerful and elegant sutras that greatly simplify multiplication and other arithmetic operations. These sutras, derived from ancient Indian texts, include methods such as Urdhva-Tiryagbhyam (vertically and crosswise), Nikhilam Navatashcaramam Dashatah (all from 9 and the last from 10), Ekanyunena Purvena (one less than the previous), Yavadunam Tavadunikritya Varganca Yojayet (whatever the extent of deficiency, lessen it and set up the square), and Anurupyena (proportionality). Each technique is suited to a specific numerical pattern and can be applied strategically to obtain results faster than conventional methods. For instance, Urdhva-Tiryagbhyam is a general multiplication formula applicable to all cases, offering a vertical and crosswise approach that can be used for multiplying numbers of any size. Nikhilam is especially useful when multiplying numbers close to powers of 10. These sutras not only reduce the number of steps involved in multiplication but also enhance mental calculation and mathematical insight, making Vedic Mathematics a highly effective and intellectually engaging system.

3.1Antyayordasakaepi

This corollary is referred to as "Last digits totaling 10, " where the key condition is that the unit digits (last digits) of the two numbers must add up to 10, such as in pairs like 42 and 48, 61 and 49, 83 and 17, etc. An additional requirement is that the digits to the left of the unit digits (i. e., the remaining part of the numbers) must be the same. In such cases, we apply the sutra Ekadhikena Purvena—meaning “one more than the previous”—to the common left-hand digits. To find the left part of the product, we multiply the common left digits by one more than themselves. The right part of the product is obtained by multiplying the last digits, which add up to 10. This method allows quick and accurate multiplication when the numbers satisfy the given conditions, and it significantly reduces computational effort.

(i) Multiply 215 × 215
Since both numbers are the same and end with 5, we apply *Ekadhikena Purvena*.
Take the digits before 5, which is 21. Apply one more than 21:
(21 + 1) × 21 = 22 × 21 = 462.
Now multiply the last digits: 5 × 5 = 25.
Hence, the final answer is **46225**.

(ii) Multiply 114 × 116
The last digits 4 + 6 = 10, and the left digits (11) are the same. So, apply *Antyayordasake'pi*.
Left part: 11 × (11 + 1) = 11 × 12 = 132.
Right part: 4 × 6 = 24.
So, 114 × 116 = **13224**.

(iii) Multiply 763 × 767
Ends in 3 and 7; sum is 10, and the left digits (76) are the same.
Left side: 76 × 77 = 5852
Right side: 3 × 7 = 21
So, the result is **585221**.

(iv) Multiply 946 × 954
Here, the last parts 46 and 54 add up to 100. We use **Ekadhikena Purvena** on the left side and **Anurupyena** on the right.
Left digits: 9 × (9 + 1) = 9 × 10 = 90
Right side:
46 – 4 = 42
54 + 4 = 58
Take average: (46 + 54) /2 = 50
Base = 100, so we divide by 2:
50 ÷ 2 = 25
Right: -4 × 4 = -16 → 100-16 = 84
So, right side: 2484
Final multiplication: 90 + carry (from 2484/100) = 92
Final answer: **922484**

3.2 Yavadunam Tavadunikritya Varganca Yojayet

This formula refers to the sutra **"Yavadunam Tavadunikritya Vargamcha Yojayet"**, which translates to: **"Whatever the deficiency, lessen it by that amount and set up the square of the deficiency. "** It is used primarily for squaring numbers that are close to a base of a power of 10, such as 10, 100, 1000, etc. This method works efficiently for both numbers slightly below and slightly above the chosen base.

1) For numbers just below the base:
Take the example of squaring 988.
Here, the nearest base is 1000.
The deficiency from the base is: 1000 – 988 = 12
Now subtract this deficiency from the original number: 988 – 12 = 976
Next, square the deficiency: $12^2 = 144$
So, the final result is: **976144**
(Hence, $988^2 = 976144$)

2) For numbers above the base of power of 10:
Let's take 1003^2.
Here, the base is 1000, and the surplus is: 1003 – 1000 = 3
Now, add the surplus to the original number: 1003 + 3 = 1006
Then square the surplus: $3^2 = 009$ (as base is 1000, we need 3 digits)
So, the answer is: **1006009**
(Thus, $1003^2 = 1006009$)

This Vedic method uses a combination of two powerful sub-sutras—Yavadunam Tavadunikritya Vargamcha Yojayet (meaning “whatever the deficiency, lessen it by that amount

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and add the square of the deficiency") and Anurupyena (meaning "proportionality") —to find the square of numbers close to bases that are multiples of powers of 10 (like 20, 300, 5000, etc.).

Example 1: Find the square of 607
Here, the nearest convenient base is 600 = 6 × 100.
Since 607 is **above** the base:
607 – 600 = 7 (surplus)
Now, add the surplus to the number: 607 + 7 = 614
Multiply 614 by 6 (since base = 6 × 100):
614 × 6 = 3684
Now, square the surplus: $7^2 = 49$
So, write the answer as: **3684 / 49**
Final result: **368449** (since the base is a multiple of 100, use two digits for the right part)

Example 2: Find the square of 792
Nearest base = 800 = 8 × 100
Here, 792 is **below** the base:
800 – 792 = 8 (deficiency)
Subtract this from the number: 792 – 8 = 784
Multiply by 8: 784 × 8 = 6272
Square of 8 = 64
Answer is: **6272 / 64**
So, 792^2 = **627264**

Example 3: Find the square of 10008
Nearest base = 10000 (which is a clean power of 10)
10008 – 10000 = 8
Add 8 to 10008 = 10016
Square of 8 = 64 → write as 0064 (since base is 10000, use 4 digits on the right)
Final answer = **10016 / 0064** = **100160064**

Example 4: Find the square of 6995
Nearest base = 7000 = 7 × 1000
Since 6995 is **below** the base:
7000 – 6995 = 5
Subtract 5 from the number: 6995 – 5 = 6990
Multiply 6990 by 7: 6990 × 7 = 48930
Square of 5 = 25 → write as 025 (since base = 1000, right side should be 3 digits)
So, the result is: **48930 / 025** = **48930025**

3.3 Nikhilam Navatascharam Dasatah
This sutra, known as "**Nikhilam Navatashcaramam Dashatah**", translates to "**All from 9 and the last from 10**." It is an incredibly efficient method used in Vedic Mathematics to simplify multiplication, especially when the numbers involved are close to powers of 10—such as 10, 100, 1000, and so on. This technique drastically reduces the complexity of the multiplication process, often allowing solutions to be arrived at mentally in seconds.

The sutra works for numbers both greater than and less than the chosen base. When a number is less than the base, the deficiency is considered as negative and is indicated with a minus sign. When the number is greater than the base, the surplus is considered positive, and no sign is needed. The trick lies in subtracting each number from the base to get their respective surpluses or deficits, and then cross-subtracting and multiplying to find the final answer. This method is not only fast but also helps develop mental agility in calculations.

(i) When both numbers are above the base
Let's multiply **104 × 109**, with the base being **100**:

Now cross-add:
104 + 9 = 113 or 109 + 4 = 113 (both give the same result)

Then multiply the surplus values:
4 × 9 = 36

So, final result: **113 / 36 = 11336**

(ii) When both numbers are below the base
Let's multiply **96 × 98**, with the base as **100**:

Now cross-subtract:
96 – 2 = 94 or 98 – 4 = 94

Then multiply the deficits:
(–4) × (–2) = 8 → written as 08 (since the base is 100, use two digits)

So, the final result: **94 / 08 = 9408**

(iii) When one number is above and the other is below the base
Let's multiply **102 × 97**, base = 100:

Now cross-subtract:
102 – 3 = 99 or 97 + 2 = 99

Multiply the surplus and deficit:
(+2) × (–3) = –6 → Take the complement of 6 for base 100 = 94

So, result: **99 / –06 = 9894**

(iv) A higher base example: Multiply 1004 × 1008, base = 1000:

Cross-add: 1004 + 8 = 1012
Multiply surplus values: 4 × 8 = 32 → written as 032 (3 digits, base is 1000)
Final result: **1012 / 032 = 1012032**

(v) Case with opposite sides: Multiply 995 × 1006, base = 1000:

Cross-subtract: 1006 – 5 = 1001 or 995 + 6 = 1001
Multiply: (–5) × (+6) = –30 → complement of 30 for base 1000 is 970
So, result is: **1001 / 970 = 1001970**

3.4 EKANYUNENAPURVENA

(a) When multiplying a number by 9, 99, 999, etc.
We apply **Ekadhikena Purvena** to compute the left-hand side (by subtracting 1 from the multiplicand) and derive the right-hand side by subtracting that result from 9, 99, 999, etc., depending on the base.

Example 1: Multiply 76 × 99
- Step 1: Subtract 1 from 76 → 76 – 1 = **75**
- Step 2: Subtract 75 from 99 → 99 – 75 = **24**
- Combine both parts: **75 / 24 = 7524**

Hence, 76 × 99 = **7524**

Example 2: Multiply 425 × 999
- Step 1: 425 – 1 = **424**
- Step 2: 999 – 424 = **575**
- Final Answer: **424575**

So, 425 × 999 = **424575**

Example 3: Multiply 603 × 999
- Step 1: 603 – 1 = **602**
- Step 2: 999 – 602 = **397**
- Result: **602397**

Therefore, 603 × 999 = **602397**

Example 4: 736 × 999
- **Step 1:** Subtract 1 from 736 → 736 – 1 = **735**
- **Step 2:** Subtract 735 from 999 → 999 – 735 = **264**
- **Result:** 735 / 264 = **735264**

So, 736 × 999 = **735264**

Example 5: 482 × 99
- Base = 100
- **Step 1:** Remove the last two digits of 482 → 4 (i. e., 482 ÷ 100 = 4)
- **Step 2:** 4 + 1 = 5 → Subtract from 482 → 482 – 5 = **477**
- **Step 3:** 100 – 82 = **18**
- **Result:** 477 / 18 = **47718**

Hence, 482 × 99 = **47718**

Example 6: 1205 × 9999
- **Step 1:** 1205 – 1 = **1204**
- **Step 2:** 9999 – 1204 = **8795**
- **Result:** 1204 / 8795 = **12048795**

Therefore, 1205 × 9999 = **12048795**

Example 7: 5471 × 999
- **Step 1:** 5471 – 1 = **5470**
- **Step 2:** 999 – 5470 = (Here the number is more than the base, so we take 5470 from 9999 instead)
- Base = 1000 (adjusted): 999 – (remove first digit of 5471 → 547) = 999 – 547 = **452**
- **Result:** 5470 / 529 = **5470529**

Hence, 5471 × 999 = **5470529**

4. Discussion

This study delves into the practical implementation of Vedic Mathematics in simplifying a range of arithmetic operations. Vedic Mathematics is rooted in ancient Indian knowledge systems, with the word "Veda" signifying “knowledge” in Sanskrit. A historical perspective is presented by comparing traditional Hindu mathematical techniques with contemporary Indian mathematics. The origin of Vedic Mathematics is traced back to the Atharvaveda, one of the four principal Vedas—Rigveda, Samaveda, Yajurveda, and Atharvaveda—which together form the foundation of ancient Indian wisdom. The system of Vedic Mathematics is structured around sixteen primary sutras (formulas) and thirteen sub-sutras (sub-formulas), each designed to offer swift and efficient solutions to mathematical problems. This discussion focuses on the application of these sutras to basic operations such as addition, subtraction, multiplication, and division, demonstrating their utility through detailed examples. The study highlights how these ancient principles can enhance mental calculation, foster number sense, and streamline problem-solving methods in both academic and real-life contexts.

5. Conclusion

This study concludes that Vedic Mathematics plays a crucial role in developing faster and more efficient mathematical problem-solving abilities. By analyzing various sutras and their practical applications, the research underscores the relevance of Vedic techniques in modern education, particularly in improving calculation speed and mental agility. The findings of this study are valuable for educators and curriculum designers seeking to integrate innovative teaching strategies into mathematics instruction. Evidence gathered demonstrates that Vedic methods significantly benefit learners, especially in the context of time-bound tasks such as competitive examinations. The simplicity, logical structure, and versatility of the sixteen sutras and thirteen sub-sutras make Vedic Mathematics a powerful alternative to conventional methods. This ancient system offers not only computational ease but also strengthens conceptual understanding, allowing learners to perform complex calculations mentally with confidence and precision.

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