International Journal of Research in Engineering, Science and Management
Volume 7, Issue 8, August 2024
https://www.ijresm.com | ISSN (Online): 2581-5792


# Applications of Matrix in Engineering and Science

Satinder Pal Kaur[1*], Kirti Girdhar[2]
[1,2]*Department of Mathematics, Guru Nanak College, Sri Muktsar Sahib, Punjab, India*

***Abstract*: Among various topic Matrices is generally interesting. Matrices have a long history of application in solving linear equations. Matrices are incredibly useful things that crop up in many different applied areas. Matrix mathematics applies to several branches of science, as well as different mathematical disciplines such as engineering mathematics. Matrices can be applied in human daily life. That is, they may be applied not only in various engineering problems. Before computer Graphics, the science of optics used matrix to account for reflection and for refraction. In mathematics, one application of matrix notation supports graph theory. This article explains the various applications of matrices in different areas.**

***Keywords*: matrices, calculus, determent, reflection, refraction, cryptography.**

## 1. Introduction

A two-dimensional array of characters, integers, or other items is called a matrix. Typically, a matrix's numbers are arranged in rows and columns. Real or complex numbers can be found in a matrix. The dimensions of a matrix are its number of rows and columns. Matrices are nothing but the rectangular arrangement of numbers, expressions, symbols which are arranges in columns and rows. The numbers present in the matrix are known as entities or entries. A crucial component of mathematics are matrices. Matrices have a long history of application in solving linear equations. Matrix was developing by English mathematician, poet and musician James Sylvester in 1850 and first use by Japanese in the 10th century. Only in 1858, an independent matrix concept resembling the contemporary idea was developed. This was the first instance of using matrix methods to solve simultaneous equations, which included the concept of determinants. Matrices have a long history of applications in solving linear equations, between 300BC and 200AD. Approximately 4000 years ago, the people of Babylon knew how to solve a simple the system of linear equations with two unknowns.

In 19th century, Gauss introduced a procedure of the theory of linear transformations in 1855 and 1858. Gaussian elimination still proves to be the best way known to solve a system of linear equations (Tucker, 1993). Matrices were connected with physics issues and for mathematicians, more attention was given to vectors as they proved to be basic mathematical elements [2].

In this research paper, we are going to explain the application of matrix in development of technology in different field of real life for human being like entertainment, science, medical, computer, camera, geography, satellite, electrical engineering, computer engineering, mechanical engineering etc. [3].

## 2. Applications of Matrices

There are many different applications of matrices, some of which are listed below.

1. Linear Algebra – Matrices are used in linear algebra to solve systems of equations, to find eigenvalues and eigenvectors, and to perform other mathematical operations.
2. Physics – Matrices are used in physics to solve problems involving linear equations and to model physical systems.
3. Engineering – Matrices are used in engineering to solve problems involving linear equations and to model physical systems.
4. Statistics – Matrices are used in statistics to solve problems involving linear equations and to model statistical data.
5. Economics – Matrices are used in economics to solve problems involving linear equations and to model economic data.

## 3. Use of Matrices in Different Areas

Matrix analysis, for instance, can be utilized to resolve linear equation systems. They are employed in a wide range of applications, including as physics related problem solving, transformation representation, and equation system solution. Solving equation systems is one of the most popular uses of matrices. A system of equations can be represented as a matrix, and the solutions to the system can be found by solving the matrix. Representing transformations is another typical use for matrices [3]. A transformation, like a translation or rotation, can be represented by a matrix, and the resulting transformation can be computed using the matrix. Also, physics problems frequently involve matrices.

Many branches of mathematics, such as probability, differential equations, linear algebra, and numerical analysis, heavily rely on the use of matrices. Matrix analysis is used in

*Corresponding author: satinder_pk@yahoo.com

physics to answer problems related to electrodynamics, quantum mechanics, and classical mechanics [8]. Matrix analysis is a tool used in engineering to simulate the behavior of physical systems. Matrix analysis is used in economics to tackle linear programming and game theory problems [2]. In data representation and manipulation, matrices are employed in computer science.

We see the result of matrix in every computer- generated image that has a reflection distortion effects such as light passing through rippling water also the science of optics used in matrix to account for reflection and refraction [3]. In an Adjacency matrix, the integer value of each element indicates how many connections a particular node has.

### *A. Uses of Matrices in Social Science*

In the social sciences, matrices are widely utilized for the study of various data sets, including survey, and voting data. A matrix, for instance, can be used to compare the viewpoints of several groups of people on a range of subjects.

### *B. Uses of Matrices in Commerce*

In trade, matrices are utilized to tackle a variety of issues. One of the most crucial instruments in business is the matrix. For instance, a business utilizes a matrix to address a pricing issue. A matrix can also be utilized to resolve a supply and demand issue. The most typical application of matrices in business is the solution of linear equation systems. A system of linear equations can be expressed as matrices. A matrix algorithm, like the Gauss-Jordan or Gauss-Seidel can be used to solve a system of linear equations [10]. Spreadsheet programmes or computer programmes can use these algorithms. Data representation is yet another typical application of matrices in business. Within a table, data can be represented using a matrix.

### *C. Use of Matrices in Computer Graphics*

Computer graphics heavily relies on matrices. A square matrix is a simple way to represent linear object transformations. In the realm of graphics, matrices are used to project three-dimensional images into two-dimensional planes. To begin with, a digital image is treated as a matrix in graphics [7]. They are employed in the representation of 3D scene geometry, in the computation of object lighting and shading, and in the deformation of scene objects [5]. The matrix's rows and columns correspond to the rows and columns of pixels, and the numerical entries correspond to the colour values of the pixels. In video game graphics, manipulating a point with matrices is a typical mathematical strategy. Graphs are also expressed using matrices

### *D. Use of Matrices in Wireless Communication*

The estimation of signals and detecting problems on wireless communication heavily relies on matrices. In wireless communication, matrices are frequently used for decoding, equalization, and channel estimation. Wireless signals are modelled and optimized using matrices. Matrixes are used to detect, extract, and process the information encoded in signals. We all know that a significant part of the telecommunication business is wireless communication [9]. We can find the application of matrices over here, as it is useful for processing and displaying digital images.

### *E. Use of Matrices in Science and Engineering*

In science, and engineering, matrices are widely employed. Matrix analysis and representation are common applications in physics and engineering, where they are used to solve issues and analyses outcomes [1]. Matrix analysis is used in describing the coding and decoding.

### *F. Use of Matrices Steganography*

Matrices are used for steganography, channels, null cyphers, hidden files in plain sight, and concealed tents within web pages [6]. These days, a wireless application protocol (wap) connection made via a mobile phone also makes use of matrices in the form of stenography.

### *G. Use of Matrices in Cryptography*

Cryptography is the process of encrypting data so that only the appropriate individual has access to it and can draw conclusions. The process of encryption is carried out with the help of an invertible key. In this method, matrices are used. Digital audio or video signal is first viewed as a series of integers that indicate an acoustic audio signal's variation in air pressure over time [4,11]. In this method, filtering techniques are employed, which are based on matrix multiplication. These technologies conceal data during transmission or storage.

## 4. Conclusion

Matrix theory as a whole is a valuable and useful concept in the field of engineering, physics, economics, statistics and various branches of mathematics. Determinant of a matrix is used much before the idea of matrix as an algebraic entity emerged. In this article, we focused on some special application areas of matrix which serves as a powerful tool for solving real life problems. Finally, matrix have many applications in the field of commerce, computer graphics, steganography

## References

[1] Bradley, I., & Meek, R. L. (2014). *Matrices and society: matrix algebra and its applications in the social sciences* (Vol. 501). Princeton University Press.

[2] Devi, N. U., Medichalam, S. D., & Tanuja, K. (2021). Matrices and Its Various Applications. *Turkish Online Journal of Qualitative Inquiry*, *12*(7).

[3] Gantmacher, F. R., & Brenner, J. L. (2005). *Applications of the Theory of Matrices*. Courier Corporation.

[4] Kabashi, F., Shkurti, L., Qehaja, B., Leka, H., & Selimaj, M. (2022). Using matrices in cryptography. *UBT Knowledge Center*, 7.

[5] Loncaric, N., Kecek, D., & Kraljic, M. (2018). Matrices in computer graphics. *Tehnicki glasnik*, *12*(2), 120-123.

[6] Mao, Q. (2014). A fast algorithm for matrix embedding steganography. *Digital Signal Processing*, *25*, 248-254.

[7] Steinbuch, K., & Piske, U. A. (1963). Learning matrices and their applications. *IEEE Transactions on Electronic Computers*, (6), 846-862.

[8] Theint, D., & Soe, S. (2019). Application of Matrices in Human's Life". *International Journal of Science and Engineering Applications*, *8*(10), 438-443.

[9] Wang, X., & Serpedin, E. (2016). An overview on the applications of matrix theory in wireless communications and signal processing. *Algorithms*, *9*(4), 68.

[10] Yu, W., Yan, C., Ding, Z., Jiang, C., & Zhou, M. (2016). Analyzing E-commerce business process nets via incidence matrix and reduction. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, *48*(1), 130-141.

[11] Zeriouh, M., Chillali, A., & Boua, A. (2019). Cryptography based on the matrices. *Bol. Soc. Paran. Mat*, *3*(3), 75-83.