

# Compare Bitrate of Proposed Geometry Mesh Coding Methods

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## Порівняння швидкості потоку запропонованих методів сіткового кодування геометрії

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**Abstract** – In this article coding of vertices in selected 3D mesh model using methods, namely residue number system (RNS) and Fibonacci numbers, is considered. The efficiency of these coding methods is analyzed, and also comparison with existing ones is conducted. As a result, most optimal variant coding of mesh vertices with quite low bitrate and sufficient noise immunity was chosen.

**Анотація** – У даній статті розглядається кодування вершин вибраної сіткової 3D моделі за допомогою таких методів, як система залишкових класів (СЗК) і числа Фібоначчі. Аналізується ефективність таких методів кодування, а також проводиться порівняння з уже існуючими. В результаті був вибраний найбільш оптимальний варіант кодування вершин сітки з досить низькою швидкістю цифрового потоку і достатньою завадостійкістю.

**Keywords** — 3D mesh, geometry coding, Residue numeral system, Fibonacci sequence, bitrate, noise-resistant

**Ключові слова** — 3D сітка, кодування геометрії, система залишкових класів, ряд Фібоначчі, швидкість цифрового потоку, завадостійкість

### I. INTRODUCTION

The choice of coding system is an important factor in digital processing. Nowadays binary positional encoding methods are widely used. But the new non-positional or mixed coding techniques are implemented well, such as RNS (Residue numeral system), Fibonacci sequence, Galois fields and others. Although they are characterized by redundancy, but

they are also enough noise immunity and can detect errors and correct them in some cases.

### II. COMPARISON OF DIFFERENT GEOMETRY CODING METHODS

In previous papers [1,2] we examined geometry coding of selected part on mesh model using Residue numeral system, Fibonacci sequence and joint use of them. The result you can see in the Table 1. The theory of Residue numeral system and Fibonacci sequence can be found at [3, 4].

Using program Mashlab, a portion of mesh model was selected and vertices of this portion were identified. This can be seen in Figure 1.

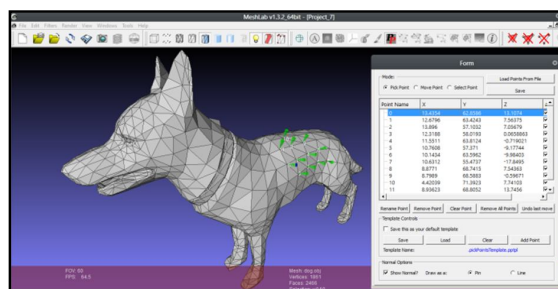


Fig. 1. Chart bitrate comparison of different geometry coding methods

Next, the coding of obtained vertices was conducted using different geometry coding methods. The result of encoding the first two vertices can be seen in Table I.

TABLE 1. Result of different geometry mesh coding methods

Coordinate	951 464 980	872 499 804
Binary representation	1110110111 111010000 1111010100	1101101000 111110011 1100100100
Residue numeral system (RNS)	110 101 010 0010 0010 1001 000 001 101	100 011 001 010 100 101 0110 0001 1011
Fibonacci sequence	01011 10011 0011 0011 0011 010011 11 011 10011	00011 1011 011 0011 00011 10011 01011 011 101011
Modified Fibonacci sequence	100101000101011 00101010100011 100001010101011	000010100001011 10101010010011 001001010010011
RNS + Modified Fibonacci sequence	010011 000011 0011 0011 0011 0100011 11 011 000011	01011 00011 011 0011 01011 000011 010011 011 0001011

Moreover we found values of bitrate in each case. The result you can see in the Table II.

TABLE 2. BITRATE OF DIFFERENT GEOMETRY MESH CODING METHODS

Geometry mesh coding method	Bitrate, bits/coordinate
Binary representation	8.980
Residue numeral system (RNS)	11.212
Parallel processing of RNS	2.290...3.0
Fibonacci sequence	13.422
Modified Fibonacci sequence	14.421
Residue numeral system + Fibonacci sequence with shift	15.0
Residue numeral system + Modified Fibonacci sequence	16.614
Parallel processing of RNS+ Modified Fibonacci sequence	4.429...5.538

Using non-positional encoding methods allow obtaining the capacity for self-correction, increase reliability, accuracy, noise immunity and also uniquely define the encoding ending of each number.

Initially in geometry coding each component of coordinate was indicated with the number 32-bit IEEE floating point. But as this accuracy is over the ability of human visual perception and far more than necessary for most applications, so it was decided to start finding more optimal and effective methods. Some of them are specified in Figure 2. Also there are all of the previously discussed methods.

The most optimal variant was obtained joint using Residue numeral system and Fibonacci sequence. Moreover when we use Residue numeral system, it is necessary to involve separate encoders for each residue. Thus we achieved bitrate

4.429...5.538 bits/coordinate while maintaining advantages of both numeral systems.

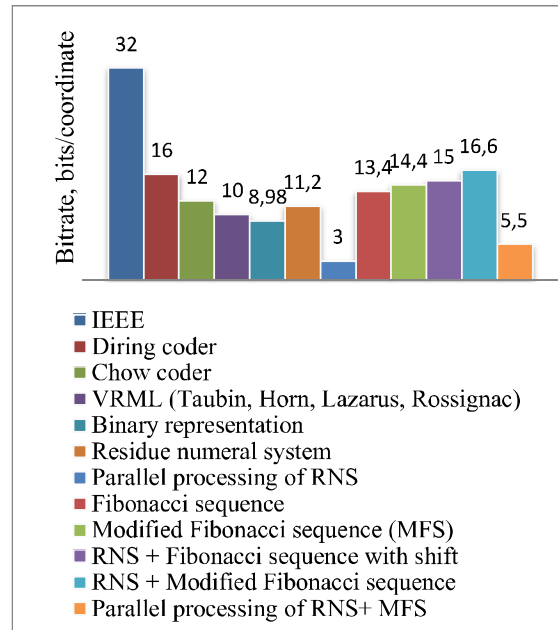


Fig. 2. Chart bit rate comparison of different geometry mesh coding methods

## CONCLUSION

Therefore, in this paper not typical methods of encoding images, videos and proper mesh models were considered, such as Residue numeral system and Fibonacci sequence, their modifications and combinations.

Parallelization of codes in Residue numeral system allowed us to obtain a short combination that will not lead to significant errors. Coding Fibonacci sequence allowed getting the opportunity to find and correct errors. It's greatly increases the noise immunity of coding methods geometry.

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