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A Multiples Method for Number System Conversions

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Abstract—Number systems are the technique, to represent numbers in the computer system architecture, every value that you save into computer memory has a defined number system. To understand computers, knowledge of number systems and knowledge of their inter conversion is essential. Computer architecture supports Binary number system, octal number system, Decimal number system and Hexadecimal number system. In this paper, the conversion of number systems is given as multiples. By using multiples method, we can easily convert one number system into another number system without taking too much time and in the multiples method you have not to consider integer and fractional as two parts, all will be converted in a single method. It is easy to understand as well as memorize.

Keywords*—Number System, binary, octal, decimal, hexadecimal, inter conversions, base, radix.*

I. INTRODUCTION

Any system that is used for representing numbers is a number system, also known as numeral system. The modern civilization is familiar with decimal number system using ten digits. However digital devices and computers use binary number system instead of decimal number system, use only two digits namely, 0 and 1. 0 represents 'off' and 1 represents, 'on'. Various other number system is also used, for example hexadecimal number system using sixteen digits which are, 0 to 9 and A to F. Some of the other number systems are described in section 2. The knowledge of number systems and their inter conversion is essential for understanding of computers. [1]

All of us know the decimal (base 10) number system, and are very comfortable with using this number system, but it is not only the number system. Some of other number systems such as binary (base2), quaternary (base4), senary (base6), octal (base8), unodecimal (base11), duodecimal (base12), tridecimal (base13), quadrodecimal (base14), pentadecimal (base15), hexadecimal (base16) and so forth is also. And, number system used in modern computer is binary number system. All other number systems are converted to binary number system for accessing computer data. [2], [5]

In this particular paper, I introduce a “Multiples Method” for conversions. You need only three steps, to convert any number to decimal number and decimal number to any number. The main speciality of this method is that all number system conversion is possible by using only one technique, which is a multiples. And the rules are same for, integer and fractional part of number system.

This paper is designed in such a way that it consists of three sections. Section I covers the introduction of number systems, awareness of various number systems, and need of their inter conversion. Section II covers the overview of the number systems and their representation. Section III defines the related work. Section IV defines the methodology with examples, which has been used for both integral and fraction parts of numbers and Section V concludes research work.

II. OVERVIEW OF NUMBER SYSTEMS

In this section, we will talk about the some common words, which is related to number system and their conversion. As we know that computer does not understand the words and letters. All information is stored in computer, in the form of 1 and 0. And, it is well known that the design of computers begins with the choice of number system. But number system used in modern computer is binary number system. And other number systems (like octal, hexadecimal etc.) are converted to binary number system for accessing computer data. Before explaining the conversions, we should familiar with some concept, which are radix or base, digits, most significant bit, least significant bit, and binary, decimal, octal, hexadecimal number system. [3]-[5].

A. Radix/Base

Basically, Radix is a term used to describe the number of digits used in a number system. For example, in the base10 number system, a total of 10 digits is used (zero to nine), therefore, its radix is 10. And the most important thing is that the base of a number system is indicated by a subscript. For example: $(56)_{10}$. [2], [5].

B. Digits

To express different numbers, its digits can be determined by its radix or base. It should be kept in mind that digits start from 0, and will upto 9, after that we will take alphabet. For example, the decimal system (base 10) requires ten digits (from 0 to 9), the binary system (base 2) has two digits (from 0 to 1), the octal system (base 8) has eight digits (from 0 to 7) and hexadecimal system (base 16) has sixteen digits (0 to 9 and A to F). And finally, we can also say that, the digits and radix are the two main components to design or define a number system. [2], [4].

C. Most significant bit and, Least significant bit

The MSB (Most Significant Bit) is a bit of the highest digit, and the LSB (Least Significant Bit) is a bit of the lowest digit. Digital data is binary, and in ordinary numerical notation, the left end is the highest digit, while the right end is the lowest digit. For example, 97 in the decimal system is expressed as (MSB) 01100001 (LSB) in the binary system. In this case, the MSB is 0 and the LSB is 1. [5].

D. Binary Number System

The number system with base 2 is known as the binary number system. Only two symbols are used to represent numbers in this system, which are 0 and 1 known as bits. Hence any binary number cannot have any digit, greater than 1. Its number has two parts the Integral part or integers and fractional part or fractions. [1], [2] For example: $(110.10)_2$. The digits of this number system are shown in figure: 1.

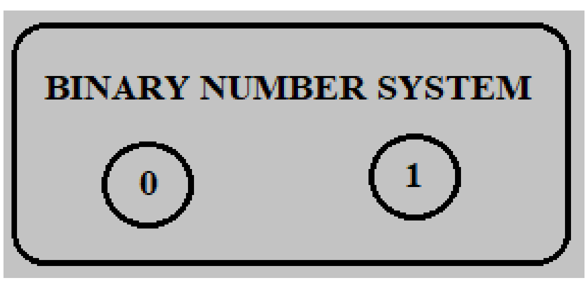

Figure: 1. Digits in Binary Number System

E. Octal Number System

Octal stands for 8, so the number system with radix 8 is known as the octal number system. This system uses eight symbols or digits, 0, 1, 2, 3, 4, 5, 6 and 7 to represent the number. Hence any octal number cannot have any digit greater than 7. Its number has two parts the Integral part or integers and fractional part or fractions. [2], [5]. For example: $(250.70)_8$. The digits of this number system are shown in figure: 2.

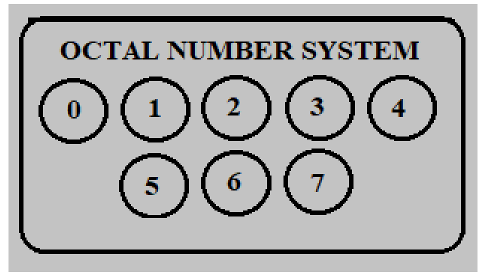

Figure: 2. Digits in Octal Number System

F. Decimal Number System

The decimal number system is known as international number system. It is also called base10 or denary number system. It uses 10 as its base. It is most widely used by modern civilization. And the digits or symbols used in this number system are 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. Its number has two parts the Integral part or integers and fractional part or fractions. [2], [5]. For example: $(850.70)_{10}$. The digits of this number system are shown in figure: 3.

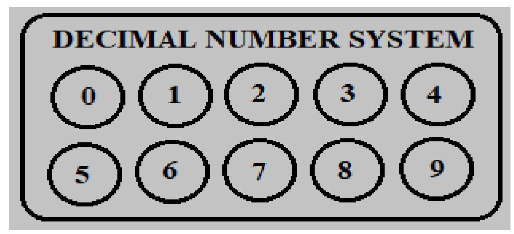

Figure: 3. Digits in Decimal Number System

G. Hexadecimal Number System

Hexadecimal number system is popular in computer uses. The base or radix for hexadecimal number system is 16 which requires 16 symbols or digits to represent the number. It's also known as alphanumeric number system. We use both alphabets and numeric to represent a hexadecimal number. Hexadecimal number system uses 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F. Its number has two parts the Integral part or integers and fractional part or fractions. [2], [5]. For example: $(E50.A0)_{16}$. The digits of this number system are shown in figure: 4.

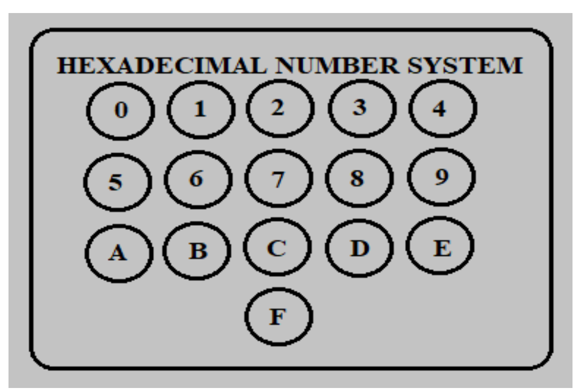

Figure: 4. Digits in Hexadecimal Number System

III. RELATED WORK

Shahid Latif, Juniad Qayyum, Muhammed Lal and Faheem Khan [2] have defined the number system and their conversions. You can see that in this paper you have to remember so many things. They told three different methods in a tabular form. In first, they told a method for decimal to other and other to decimal conversions and you have to require to solve factional part separately there. In second, they told again some conversions in a different approach, whereas we already have read their conversions, in first method. And In third, they told octal to hexadecimal and hexadecimal to octal conversion. As it is difficult to learn all these methods because all are differ from each other. Also in Data Communication and Networking [4] and Digital Computer Design Fundamentals [5], you read number system conversion, in two part i.e., integer and fractional. And in my method "multiples number system conversion", you have not to require separately solve fractional number and also you have not to learn different method to deal with different-different number system conversions. It is quite easy to learn because the methodology is same in all conversions.

IV. METHODOLOGY

The most common number systems are the binary, octal, decimal and hexadecimal, as I have discussed in earlier section. Now we have to check that how any number can be converted from one to another number system.

A given number in any of the above number systems may consist of two parts that is the integer part and the fraction part. But in my methodology you have not worry about all because my method can be used to solve your complete section (integer + fraction). If your number contains only integer part then you do not need to write multiples for the part of the fraction. Write the multiples only for the integer part.

I am describing here conversion in two concepts.

First, convert any number to decimal number.

Second, convert decimal number to any number.

A. Convert Any Number to Decimal Number

The steps for converting any number to decimal number are:

Step 1:- Start with 1 on the left side of the decimal, write multiples of base below of each digit of decimal number. And on the right side of 1, write multiples of 1/base below of each digit.

Step 2:- Do multiply of multiples, with each digit (which are above of multiples).

Step 3:- Then add all the obtained numbers.

Example 1: $[1010.10]_2$ (Binary to Decimal)

	1	0	1	0	.	1	0
Step 1:	8	4	2	1	.	.5	.25
Step 2:	8	0	2	0	.	.5	0

Step 3: $[10.5]_{10}$

For Hint: (Base = 2 & 1/Base = 0.5)

For Hint: (8*1) + (4*0) + (2*1) + (1*0) = 10

& (0.5*1) + (0.25*0) = 0.5

& (10 + 0.5) = 10.5

Example 2: $[567.60]_8$ (Octal to Decimal)

	5	6	7	.	6	0
Step 1:	64	8	1	.	.125	.15625
Step 2:	320	48	7	.	.75	0

Step 3: $[375.75]_{10}$

For Hint: (Base = 8 & 1/Base = 0.125)

For Hint: (64*5) + (8*6) + (1*7) = 375

& (0.125*6) + (0.15625*0) = 0.75

& (375 + 0.75) = 375.75

Example 3: $[7CE.A0]_{16}$ (Hexadecimal to Decimal)

	7	C(12)	E(14)	.	A(10)	0
Step 1:	256	16	1	.	.0625	.00390625
Step 2:	1792	192	14	.	.625	0

Step 3: $[1998.625]_{10}$

For Hint: (Base = 16 & 1/Base = 0.0625)

For Hint: (256*7) + (16*12) + (1*14) = 1998

& (0.0625*10) + (0.00390625*0) = 0.625

& (1998 + 0.625) = 1998.625

B. Convert Decimal Number to Any Number

The steps for converting decimal number to any number are:

Step 1:- Start with 1 on the left side of the decimal, write multiples of base. And on the right side of 1, write multiples of 1/base. And write down these multiples, until you find larger number than the decimal number on both sides.

For Example: If your number is 41.75, then for the integer part type the multiples of the base more than 41. And write the multiples of the number obtained from 1 / base (do not consider the decimal when calculate 1/base, consider only the number), up to more than 75.

Step 2:- Make your decimal number, by adding the multiply of maximum possible multiplier with maximum possible digit of the base.
Step 3:- Write the numbers in a sequence, which was multiplied by multiples. And write 0 below of those multiples which you are not using to make your decimal number.

Example 1: $[41.75]_{10}$ (Decimal to Binary)

Step 1: 64 32 16 8 4 2 1 . 0.5 0.25 0.125

Step 2: *1 *1 *1 . *1 *1

Step 3: $[0101001.110]_2$

For Hint: (Base = 2 & 1/Base = 0.5)

For Hint: (32*1) + (8*1) + (1*1) = 41

& (0.5*1) + (0.25*1) = 0.75

Example 2: $[375.75]_{10}$ (Decimal to Octal)

Step 1: 512 64 8 1 . 0.125

Step 2: *5 *6 *7 . *6

Step 3: $[567.6]_8$

For Hint: (Base = 8 & 1/Base = 0.125)

For Hint: (64*5) + (8*6) + (1*7) = 375

& (0.125*6) = 0.75

Example 3: $[1998.625]_{10}$ (Decimal to Hexadecimal)

Step 1: 4096 256 16 1 . 0.0625 0.00390625

Step 2: *7 *12 *14 . *10

Step 3: $[7CE.A]_{16}$

For Hint: (Base = 16 & 1/Base = 0.0625)

For Hint: (256*7) + (16*12) + (1*14) = 1998

& (0.0625*10) = 0.625

Note: A = 10; B = 11; C = 12; D = 13; E = 14; F = 15.

V. CONCLUSION AND FUTURE SCOPE

In this paper, I propose a different approach (A Multiples Method) for inter conversion of various number systems in digital world, especially for computer technology. These are not only the four number systems used in the digital world but also very common and often used systems in most digital technologies and devices. And here, six types of conversions have been shown in this method are also able to perform other base to decimal and decimal to other base conversions very easily by using the multiples of base and 1/base with given three steps. This study will be very helpful for researchers to easy understanding of all number systems conversions in the field of computer science and technology.

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