OCR Number System

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Abstract— There is a problem in standard number system, which is not representation in this system when the radixes are not equal. This study reveals that OCR (Object Class and Radix) number system can remove this obstacle of non-representation of unequal radixes in standard number system.

Key words: OCR, Object, Class, Radix

I. INTRODUCTION

OCR is an abbreviated form of the words "Object Class and Radix". Before describing the OCR number system, let us study the Decimal number system through an example.

Decimal number system contains digits from 0 to 9. Other number is combination of these digits. For example, 73 is combination of digit 7 and 3. But 7 and 3 are belonging to different classes. 7 are belonging to class ten and 3 are belonging to class one as show in Table 1.

Class	Objects	Base or Radix
One	0 1 2 3 4 5 6 7 8 9	10
Ten	0 1 2 3 4 5 6 7 8 9	10

Table 1: OCR Table

As it is evident from Table-I the Radix of the Decimal number is 10. So we can easily calculate and represent that in any number system (Binary, Octal, Hexadecimal number system). But in our daily life we encounter such problems where the radix is unequal. These problems cannot be representation mathematical term i.e. number system. For example: Radix problem in digital clock. Show in Table-2.

Hour	Minute	Second	→ Class
00	00	00	Objects
01	01	01	
02	02	02	
03	03	03	
⋮	⋮	⋮	
22	58	58	
23	59	59	
24	60	60	→ Base or Radix

Table 2: Digital clock OCR table

As it evident from Table-2 second and minute class's radix is equal i.e. 60 at the same time. Hour's class has different radix i.e. 24. Now this problem cannot be represent in the standard number system.

II. FORMULATION OF PROBLEMS

A. OCR Table

OCR table is a table that classifies objects in different classes. For example, 0,3,5,a,i,,o,1,2,e,4,,u,.

vowel	number	→ Class
	0	Objects
a	1	
e	2	
i	3	
o	4	
u	5	
5	6	→ Base or Radix

Table 3: OCR Table

As it evident from the OCR Table, 6 is the base of number class and 5 is base of vowel class.

Class(n)		Class(n-1)			Class(2)		Class(1)	
Number	Represent Objects	Number	Represent Objects		Number	Represent Objects	Number	Represent Objects
0	$K_n(0)$	0	$K_{n-1}(0)$	⋯	0	$K_2(0)$	0	$K_1(0)$
1	$K_n(1)$	1	$K_{n-1}(1)$	⋯	1	$K_2(1)$	1	$K_1(1)$
2	$K_n(2)$	2	$K_{n-1}(2)$	⋯	2	$K_2(2)$	2	$K_1(2)$
3	$K_n(3)$	3	$K_{n-1}(3)$	⋯	3	$K_2(3)$	3	$K_1(3)$
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
O_n-3	$K_n(O_n-3)$	$O_{(n-1)}-3$	$K_{n-1}(O_{(n-1)}-3)$	⋯	O_2-3	$K_2(O_2-3)$	O_1-3	$K_1(O_2-3)$
O_n-2	$K_n(O_n-2)$	$O_{(n-1)}-2$	$K_{n-1}(O_{(n-1)}-2)$	⋯	O_2-2	$K_2(O_2-2)$	O_1-2	$K_1(O_2-2)$
O_n-1	$K_n(O_n-1)$	$O_{(n-1)}-1$	$K_{n-1}(O_{(n-1)}-1)$	⋯	O_2-1	$K_2(O_2-1)$	O_1-1	$K_1(O_2-1)$
O_n		$O_{(n-1)}$		⋯	O_2		O_1	

Fig. 1: OCR General Table

$O_1, O_2, O_3 \cdots O_{(n-2)}, O_{(n-1)}, O_n$ are denoting to the base. $K_1, K_2, K_3 \cdots K_{(n-2)}, K_{(n-1)}, K_n$ is denoting to objects.

B. Decimal to OCR Conversion

The given decimal number (Decimal number is ≥ 0 and < Possible combination, Possible combination = $O_n \times O_{(n-1)} \times O_{(n-2)} \times \cdots \times O_3 \times O_2 \times O_1$) can be converted into equivalent OCR number, dividing it by O_1. The subsequent quotient are further divided by O_2 till, we get the divisor is O_n, quotient is zero and a remainder. Make remainder to equal digit by adding prefix 0. Because there is impossible assign a symbol to all number. For example,

Remainders	Number of digits	Equal number of digits remainders
50	2	050
3	1	003
7	1	007
973	3	973
54	2	054
1	1	001

Table 4: Equal Number of Digit Table

Greatest number of digit(s) (GND) in table 4 is 3. So make all remainders are GND by adding Prefix 0.Then by writing the remainders from bottom to top, we get the OCR equivalent number of a given decimal number. For example: 050003007973054001is OCR equivalent number

(General form of Decimal to OCR Conversion)

O_1	Dec. number	R_1	Remainders ↑
O_2	Q_1	R_2	
O_3	Q_2	R_3	
O_4	Q_3	R_4	
⋮ $O_{(n-2)}$	Q_4 ⋮	⋮ $R_{(n-2)}$	
$O_{(n-1)}$	$Q_{(n-2)}$	$R_{(n-1)}$	
O_n	$Q_{(n-1)}$	$R_{(n)}$	
	$Q_{(n)}$		

$O_1, O_2, O_3, \cdots O_{(n-1)}, O_{(n)}$ are base, $Q_1, Q_2, Q_3, \cdots Q_{(n-1)}$, $Q_{(n)}$ are quotient and $R_1, R_2, R_3, \cdots R_{(n-1)}$, $R_{(n)}$ are remainders.

OCR equivalent number = $(R_{(n)}\ R_{(n-1)}\ R_{(n-2)} \cdots R_3\ R_2\ R_1)_{(GND,\ Q1,\ Q2,\ Q3,\ \cdots\ Q(n-1),\ Q(n))}$

OCR equivalent object(s) = $K_n(R_n)\ K_{n-1}(R_{n-1})\ K_{n-2}(R_{n-2}) \cdots K_3(R_3)\ K_2(R_2)\ K_1(R_1)$

C. *OCR to Decimal Number Conversion*

The conversion of OCR into decimal equivalent is done by the following way.

Decimal number= $[R_{(n)} \{(O_n)^0 \times (O_{n-1})^1 \times (O_{n-2})^1 \cdots \times (O_3)^1 \times (O_2)^1 \times (O_1)^1\} + R_{(n-1)} \{(O_n)^0 \times (O_{n-1})^0 \times (O_{n-2})^1 \times \cdots \times (O_3)^1 \times (O_2)^1 \times (O_1)^1\} + R_{(n-2)} \{(O_n)^0 \times (O_{n-1})^0 \times (O_{n-2})^0 \times \cdots \times (O_3)^1 \times (O_2)^1 \times (O_1)^1\} + \cdots + R_{(3)} \{(O_n)^0 \times (O_{n-1})^0 \times (O_{n-2})^0 \times \cdots \times (O_3)^0 \times (O_2)^1 \times (O_1)^1\} + R_{(2)} \{(O_n)^0 \times (O_{n-1})^0 \times (O_{n-2})^0 \times \cdots \times (O_3)^0 \times (O_2)^0 \times (O_1)^1\} + R_{(1)} \{(O_n)^0 \times (O_{n-1})^0 \times (O_{n-2})^0 \times \cdots \times (O_3)^0 \times (O_2)^0 \times (O_1)^0\}]$

III. EXAMPLES

Q.1 Solve the digital clock's problems by OCR number system.

A. *Digital Clock's OCR Table.*

Hour		Colon		Minute		Colon		Second	
number	Represent object	number	Represent object	number	Represent object	number	Represent object	number	Represent object
0	00	0	:	0	00	0	:	0	00
1	01			1	01			1	01
2	02			2	02			2	02
3	03			3	03			3	03
⋮	⋮			⋮	⋮			⋮	⋮
21	21			57	57			57	57
22	22			58	58			58	58
23	23			59	59			59	59
24		1		60		1		60	

Fig. 2: Digital Clock OCR Table

Possible combination = 24 × 1 × 60 × 1 × 60
= 86400

Decimal number is ≥ 0 and < 86400.

Digital Clock's Decimal to OCR Conversion

Let decimal number = 86040

60	86040	0	Remainders ↑
1	1434	0	
60	1434	54	
1	23	0	
24	23	23	
	0		

GND is 2, so remainders are 00, 00, 54, 00 and 23.

OCR equivalent number = $(2300540000)_{(2,\ 24,\ 1,\ 60,\ 1,\ 60)}$

OCR equivalent objects = 23: 54: 00

B. *Digital Clock's OCR to decimal number*

Let OCR number = $(2300540000)_{(2,\ 24,\ 1,\ 60,\ 1,\ 60)}$

GND = 2

So make two digit pair.

23 00 54 00 00

$R_5 = 23$ $O_5 = 24$
$R_4 = 00$ $O_4 = 1$
$R_3 = 54$ $O_3 = 60$
$R_2 = 00$ $O_2 = 1$
$R_1 = 00$ $O_1 = 60$

Decimal number = $[23\{24^0 \times 1^1 \times 60^1 \times 1^1 \times 60^1\} + 0\{24^0 \times 1^0 \times 60^1 \times 1^1 \times 60^1\} + 54\{24^0 \times 1^0 \times 60^0 \times 1^1 \times 60^1\} + 0\{24^0 \times 1^0 \times 60^0 \times 1^0 \times 60^1\} + 0\{24^0 \times 1^0 \times 60^0 \times 1^0 \times 60^0\}]$ = (23 × 3600) + (0 × 3600) + (54 × 60) + (0 × 60) + (0 × 1)
= 82800 + 0 + 3240 + 0 + 0
= 86040

Q.2 Music (vocal/ harmonium/ key board notation)

C. *Music's OCR Table*

Music is belonging to number system. Suppose Music's OCR table is Fig. 3.

G		F		E		D		C		B		A	
no.	nt	no.	nt	no.	nt	no.	nt	no.	nt	no.	nt	no.	nt
0	SA	0	SA	0	RE	0	SA	0	DHA	0	RE	0	SA
1	RE	1	RE	1	GA	1	RE	1	GA	1	DHA	1	RE
2	GA	2	GA	2	MA	2	GA			2	NI	2	GA
3	MA	3	MA	3	PA	3	MA					3	MA
4	PA	4	PA									4	PA
5	DHA	5	DHA										
6	NI												
7		6		4		4		2		3		5	

Fig. 3: Music OCR Table

A, B, C, D, E, F and G are classes.

No. is denote to number.

nt is denote to notation.

Possible combination = 7 × 6 × 4 × 4 × 2 × 3 × 5
= 20160

Decimal number is ≥ 0 and < 20160.

D. *Music's Decimal to OCR Conversion*

Let decimal number =20145

5	20145	0	Remainders ↑
3	4029	0	
2	1343	1	
4	671	3	
4	167	3	
6	41	5	
7	6	6	
	0		

GND is 1, so remainders are same.

OCR equivalent number = $(6533100)_{(1,\ 7,\ 6,\ 4,\ 4,\ 2,\ 3,\ 5)}$

OCR equivalent notations = NI DHA PA MA GA RE SA

E. *Music's OCR to decimal number*

Let OCR number = $(6533100)_{(1,\ 7,\ 6,\ 4,\ 4,\ 2,\ 3,\ 5)}$

GND = 1

So make one digit pair.

6 5 3 3 1 0 0

$R_7 = 6$ $O_7 = 7$
$R_6 = 5$ $O_6 = 6$

$R_5 = 3$ $O_5 = 4$
$R_4 = 3$ $O_4 = 4$
$R_3 = 1$ $O_3 = 2$
$R_2 = 0$ $O_2 = 3$
$R_1 = 0$ $O_1 = 5$

Decimal number = $[6\{7^0 \times 6^1 \times 4^1 \times 4^1 \times 2^1 \times 3^1 \times 5^1\} + 5\{7^0 \times 6^0 \times 4^1 \times 4^1 \times 2^1 \times 3^1 \times 5^1\} + 3\{7^0 \times 6^0 \times 4^0 \times 4^1 \times 2^1 \times 3^1 \times 5^1\} + 3\{7^0 \times 6^0 \times 4^0 \times 4^0 \times 2^1 \times 3^1 \times 5^1\} + 1\{7^0 \times 6^0 \times 4^0 \times 4^0 \times 2^0 \times 3^1 \times 5^1\} + 0\{7^0 \times 6^0 \times 4^0 \times 4^0 \times 2^0 \times 3^0 \times 5^1\} + 0\{7^0 \times 6^0 \times 4^0 \times 4^0 \times 2^0 \times 3^0 \times 5^0\}]$
$= (6 \times 2880) + (5 \times 480) + (3 \times 120) + (3 \times 30) + (1 \times 15) + (0 \times 5) + (0 \times 1)$
$= 17280 + 2400 + 360 + 90 + 15 + 0 + 0$
$= 20145$

Q.3 Cloth wearing.

F. Cloth wearing OCR Table

Suppose we have seven shirts, five sweaters, three pants and three shoes. Then our OCR table is

Shirt		Sweater		Pant		Shoe	
0	white	0	yellow	0	black	0	red
1	black	1	black	1	blue	1	white
2	yellow	2	blue	2	grey	2	black
3	blue	3	white			3	blue
4	cyan	4	grey				
5	pink						
6	purple						
7		5		3		4	

Table 5: Cloth wearing OCR table

Possible combination = $7 \times 5 \times 3 \times 4$
$= 420$
Decimal number is ≥ 0 and < 420
Cloth wearing Decimal to OCR Conversion
Let decimal number= 205

4	205	1
3	51	0
5	17	2
7	3	3
	0	

Remainders ↑

OCR equivalent number = $(3201)_{(1, 7, 5, 3, 4)}$
OCR equivalent objects =Blue shirt, blue sweater, black pant, white shoe

G. Cloth wearing OCR to Decimal Number

Let OCR number = $(3201)_{(1, 7, 5, 3, 4)}$
GND=1
So make one digit pair.
3 2 0 1

$R_4 = 3$ $O_4 = 7$
$R_3 = 2$ $O_3 = 5$
$R_2 = 0$ $O_2 = 3$
$R_1 = 1$ $O_1 = 4$

Decimal number = $[3\{7^0 \times 5^1 \times 3^1 \times 4^1\} + 2\{7^0 \times 5^0 \times 3^1 \times 4^1\} + 0\{\{7^0 \times 5^0 \times 3^0 \times 4^1\} + 1\{7^0 \times 5^0 \times 3^0 \times 4^0\}]$
$= (3 \times 60) + (2 \times 12) + (0 \times 4) + (1 \times 1)$
$= 180+24+1$
$= 205$

IV. CONCLUSIONS

1) This method is applied in our daily life, like cloth wearing, cooking and etc.
2) Two or more loop is executed in single loop.
3) Standard number system (binary, octal, decimal and etc.) method is solving when base or radix is equal. But this method solve base is equal or not.

REFERENCE

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