



# Vidyavardhini's College of Engineering and Technology

## Department of Artificial Intelligence & Data Science

|   |
|---|
| Experiment No. 7                                |
| Implement Booth's algorithm using c-programming |
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| Date of Submission:                             |

**Aim:** To implement Booth's algorithm using c-programming.

### Objective -

- To understand the working of Booths algorithm.
- To understand how to implement Booth's algorithm using c-programming.

### Theory:

Booth's algorithm is a multiplication algorithm that multiplies two signed binary numbers in 2's complement notation. Booth used desk calculators that were faster at shifting than adding and created the algorithm to increase their speed.

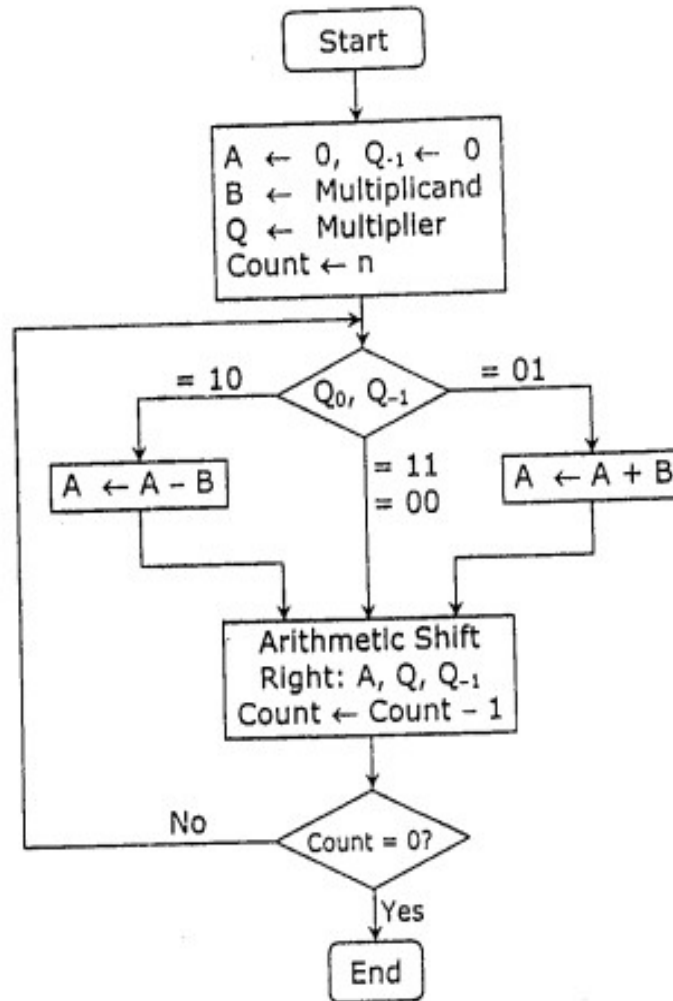


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The algorithm works as per the following conditions :

1. If  $Q_n$  and  $Q_{-1}$  are same i.e. 00 or 11 perform arithmetic shift by 1 bit.
2. If  $Q_n Q_{-1} = 10$  do  $A = A - B$  and perform arithmetic shift by 1 bit.
3. If  $Q_n Q_{-1} = 01$  do  $A = A + B$  and perform arithmetic shift by 1 bit.



| Multiplicand (B) ← 0 1 0 1 (5), Multiplier (Q) ← 0 1 0 0 (4) |                       |         |                 |             |
|--|-----------------------|---------|-----------------|-------------|
| Steps  | A                     | Q       | Q <sub>-1</sub> | Operation   |
|  | 0 0 0 0               | 0 1 0 0 | 0               | Initial     |
| Step 1 :   | 0 0 0 0               | 0 0 1 0 | 0               | Shift right |
| Step 2 :   | 0 0 0 0               | 0 0 0 1 | 0               | Shift right |
| Step 3 :   | 1 0 1 1               | 0 0 0 1 | 0               | A ← A - B   |
|  | 1 1 0 1               | 1 0 0 0 | 1               | Shift right |
| Step 4 :   | 0 0 1 0               | 1 0 0 0 | 1               | A ← A + B   |
|  | 0 0 0 1               | 0 1 0 0 | 0               | Shift right |
| Result   | 0 0 0 1 0 1 0 0 = +20 |         |                 |             |



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### Program:

```
#include <math.h>
```

```
int a = 0, b = 0, c = 0, a1 = 0, b1 = 0, com[5] = { 1, 0, 0, 0, 0};
```

```
int anum[5] = {0}, anumcp[5] = {0}, bnum[5] = {0};
```

```
int acomp[5] = {0}, bcomp[5] = {0}, pro[5] = {0}, res[5] = {0};
```

```
void binary(){
```

```
    a1 = fabs(a);
```

```
    b1 = fabs(b);
```

```
    int r, r2, i, temp;
```

```
    for (i = 0; i < 5; i++){
```

```
        r = a1 % 2;
```

```
        a1 = a1 / 2;
```

```
        r2 = b1 % 2;
```

```
        b1 = b1 / 2;
```

```
        anum[i] = r;
```

```
        anumcp[i] = r;
```

```
        bnum[i] = r2;
```

```
        if(r2 == 0){
```

```
            bcomp[i] = 1;
```

```
        }
```

```
        if(r == 0){
```

```
            acomp[i] = 1;
```

```
        }
```

```
    }
```

```
    c = 0;
```

```
    for ( i = 0; i < 5; i++){
```

```
        res[i] = com[i] + bcomp[i] + c;
```

```
        if(res[i] >= 2){
```

```
            c = 1;
```

```
        }
```

```
        else
```

```
            c = 0;
```

```
        res[i] = res[i] % 2;
```

```
    }
```



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```
for (i = 4; i >= 0; i--){
    bcomp[i] = res[i];
}

if (a < 0){
    c = 0;
    for (i = 4; i >= 0; i--){
        res[i] = 0;
    }
    for ( i = 0; i < 5; i++){
        res[i] = com[i] + acomp[i] + c;
        if (res[i] >= 2){
            c = 1;
        }
        else
            c = 0;
        res[i] = res[i]%2;
    }
    for (i = 4; i >= 0; i--){
        anum[i] = res[i];
        anumcp[i] = res[i];
    }
}

if(b < 0){
    for (i = 0; i < 5; i++){
        temp = bnum[i];
        bnum[i] = bcomp[i];
        bcomp[i] = temp;
    }
}

void add(int num[]){
    int i;
    c = 0;
    for ( i = 0; i < 5; i++){
        res[i] = pro[i] + num[i] + c;
        if (res[i] >= 2){
```



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```
        c = 1;
    }
    else{
        c = 0;
    }
    res[i] = res[i]%2;
}
for (i = 4; i >= 0; i--){
    pro[i] = res[i];
    printf("%d",pro[i]);
}
printf(":");
for (i = 4; i >= 0; i--){
    printf("%d", anumcp[i]);
}
}

void arshift(){
    int temp = pro[4], temp2 = pro[0], i;
    for (i = 1; i < 5 ; i++){
        pro[i-1] = pro[i];
    }
    pro[4] = temp;
    for (i = 1; i < 5 ; i++){
        anumcp[i-1] = anumcp[i];
    }
    anumcp[4] = temp2;
    printf("\nAR-SHIFT: ");
    for (i = 4; i >= 0; i--){
        printf("%d",pro[i]);
    }
    printf(":");
    for(i = 4; i >= 0; i--){
        printf("%d", anumcp[i]);
    }
}

void main(){
    int i, q = 0;
```



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```
printf("\t\tBOOTH'S MULTIPLICATION ALGORITHM");
```

```
printf("\nEnter two numbers to multiply: ");
```

```
printf("\nBoth must be less than 16");
```

```
//simulating for two numbers each below 16
```

```
do{
```

```
    printf("\nEnter A: ");
```

```
    scanf("%d",&a);
```

```
    printf("Enter B: ");
```

```
    scanf("%d", &b);
```

```
}while(a >=16 || b >=16);
```

```
printf("\nExpected product = %d", a * b);
```

```
binary();
```

```
printf("\n\nBinary Equivalents are: ");
```

```
printf("\nA = ");
```

```
for (i = 4; i >= 0; i--){
```

```
    printf("%d", anum[i]);
```

```
}
```

```
printf("\nB = ");
```

```
for (i = 4; i >= 0; i--){
```

```
    printf("%d", bnum[i]);
```

```
}
```

```
printf("\nB'+ 1 = ");
```

```
for (i = 4; i >= 0; i--){
```

```
    printf("%d", bcomp[i]);
```

```
}
```

```
printf("\n\n");
```

```
for (i = 0; i < 5; i++){
```

```
    if (anum[i] == q){
```

```
        printf("\n-->");
```

```
        arshift();
```

```
        q = anum[i];
```

```
    }
```

```
    else if(anum[i] == 1 && q == 0){
```

```
        printf("\n-->");
```

```
        printf("\nSUB B: ");
```

```
        add(bcomp);
```

```
        arshift();
```



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```
        q = anum[i];
    }
    else{
        printf("\n-->");
        printf("\nADD B: ");
        add(bnum);
        arshift();
        q = anum[i];
    }
}

printf("\nProduct is = ");
for (i = 4; i >= 0; i--){
    printf("%d", pro[i]);
}
for (i = 4; i >= 0; i--){
    printf("%d", anumcp[i]);
}
}
```

### Output:

#### OUTPUT:-

#### BOOTH'S MULTIPLICATION ALGORITHM

Enter two numbers to multiply:

Both must be less than 16

Enter A: 10

Enter B: 2

Expected product = 20

Binary Equivalents are:

A = 01010

B = 00010

B'+ 1 = 11110

-->

AR-SHIFT: 00000:00101

-->

SUB B: 11110:00101



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**AR-SHIFT: 11111:00010**

**-->**

**ADD B: 00001:00010**

**AR-SHIFT: 00000:10001**

**-->**

**SUB B: 11110:10001**

**AR-SHIFT: 11111:01000**

**-->**

**ADD B: 00001:01000**

**AR-SHIFT: 00000:10100**

**Product is = 0000010100**

### Conclusion -

This experiment involving Booth's algorithm has underscored its importance in enhancing binary multiplication efficiency. Booth's algorithm effectively reduces the quantity of partial products and minimizes the overall operations needed for multiplication. This not only accelerates computational speed but also trims down hardware intricacy. Booth's algorithm stands as a potent instrument for streamlining multiplication procedures and constitutes a vital concept within digital arithmetic. Our experiment has effectively showcased its real-world applicability in computer system architecture and the design of digital circuits.