**Batch: B-1 Roll No.: 16010122104**

**Experiment / assignment / tutorial No. 2**

TITLE: To study and implement Booth’s Multiplication Algorithm.

AIM: Booth’s Algorithm for Multiplication

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Expected OUTCOME of Experiment: (Mention CO/CO’s attained here)

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1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, TataMcGraw-Hill.
2. William Stallings, “Computer Organization and Architecture: Designing for Performance”, Eighth Edition, Pearson.
3. Dr. M. Usha, T. S. Srikanth, “Computer System Architecture and Organization”, First Edition, Wiley-India.

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It is a powerful algorithm for signed number multiplication which generates a 2n bit product and treats both positive and negative numbers uniformly. Also the efficiency of the algorithm is good due to the fact that, block of 1’s and 0’s are skipped over and subtraction/addition is only done if pair contains 10 or 01

Flowchart:

A diagram of a multiplier count

Description automatically generated

Design Steps:

1. Start
2. Get the multiplicand (M) and Multiplier (Q) from the user
3. Initialize A= Q-1 =0
4. Convert M and Q into binary
5. Compare Q0 andQ-1 and perform the respective operation.

|  |  |
| --- | --- |
| Q0 Q-1 | Operation |
| 00/11 | Arithmetic right shift |
| 01 | A+M and Arithmetic right shift |
| 10 | A-M and Arithmetic right shift |

1. Repeat steps 5 till all bits are compared
2. Convert the result to decimal form and display
3. End

Example: (Handwritten solved problem needs to be uploaded)

A piece of paper with writing on it

Description automatically generated

Conclusion:

We learned multiplication through Booth’s Algorithm.

Post Lab Descriptive Questions

1. Explain advantages and disadvantages of Booth’s algorithm.

**Ans:**

**Advantages:**

1. **Faster Multiplication:** Booth's algorithm reduces the number of partial products that need to be added, leading to faster multiplication compared to traditional methods.
2. **Reduced Number of Steps:** The algorithm skips unnecessary addition steps when consecutive 1s or 0s occur in the multiplier, leading to fewer steps in the multiplication process.
3. **Less Hardware Complexity:** Booth's algorithm requires fewer hardware resources compared to traditional methods, making it suitable for hardware implementations.
4. **Improved Efficiency:** Especially for large binary numbers, Booth's algorithm offers a more efficient multiplication process by minimizing the number of arithmetic operations.
5. **Suitable for Multipliers:** It's particularly effective when implemented in hardware multipliers, as it takes advantage of the regularity in the multiplication process.

**Disadvantages:**

1. **Complexity for Negative Multipliers:** The algorithm introduces complexity when dealing with negative multipliers, as it requires converting them to their two's complement form.
2. **Overhead for Smaller Numbers:** For smaller binary numbers, the overhead introduced by Booth's algorithm, including the extra operations to detect consecutive 1s and 0s, might not be justified.
3. **Not Optimal for All Sizes:** The effectiveness of Booth's algorithm depends on the size of the operands. For very small operands, the overhead of detecting patterns may outweigh the benefits.
4. **Non-Power-of-2 Multipliers:** When the multiplier is not a power of 2, the algorithm becomes less efficient and might involve additional complexity in handling these cases.
5. **Limited Application:** Booth's algorithm is most suitable for hardware implementations like digital circuits. In software implementations, its complexity might not always outweigh the advantages.
6. Is Booth’s recoding better than Booth’s algorithm? Justify

**Ans:**

Booth's algorithm is aimed at improving multiplication speed by reducing the number of steps, while Booth's recoding focuses on optimizing hardware resources by reducing the required number of adders or subtractors. Which one is "better" depends on the specific goals and constraints of the implementation. If speed is the main concern and the multiplication process can benefit from reduced steps, Booth's algorithm might be preferred. If optimizing hardware resources is the priority, then Booth's recoding might be a better choice.

**Date: 16/08/2023**