

The MSD-first operation in the online arithmetic is accomplished by utilizing a redundant number system [?], in which each digit is represented with a redundant digit set  $\{-a, \dots, -1, 0, 1, \dots, a\}$ , where  $a \in [r/2, r-1]$ . Due to the redundancy, the MSDs of the result can be estimated only based on partial information of the inputs and then the value of the number can be revised by the following digits.