### 3.5.2 Check Sums

Simple parity cannot detect two errors within the same word. One way of overcoming this difficulty is to use a sort of two-dimensional parity. As each word is transmitted, it is added to the sum of the previously transmitted words, and the sum retained at the transmitter end. At the end of transmission, the sum (called the *check sum*) up to that time is sent to the receiver. The receiver can check its sum with the transmitted sum. If the two sums are the same, then no errors were detected at the receiver end. If there is an error, the receiving location can ask for retransmission of the entire data. This is the type of transmission used in teleprocessing systems.

### 3.5.3 Block Parity

When several binary words are transmitted or stored in succession, the resulting collection of bits can be regarded as a block of data, having rows and columns. Parity bits can then be assigned to

both rows and columns. This scheme makes it possible to *correct* any single error occurring in a data word and to *detect* any two errors in a word. The parity row is often called a parity word. Such a block parity technique, also called word parity, is widely used for data stored on magnetic tapes.

For example, six 8-bit words in succession can be formed into a $6 \times 8$ block for transmission. Parity bits are added so that odd parity is maintained both row-wise and column-wise and the block is transmitted as a $7 \times 9$ block as shown in Table A. At the receiving end, parity is checked both row-wise and column-wise and suppose errors are detected as shown in Table B. These single-bit errors detected can be corrected by complementing the error bit. In Table B, parity errors in the 3rd row and 5th column mean that the 5th bit in the 3rd row is in error. It can be corrected by complementing it.

Two errors as shown in Table C can only be detected but not corrected. In Table C, parity errors are observed in both columns 2 and 4. It indicates that in one row there are two errors.

**Table A**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |
| | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 |
| | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| Parity row → | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |

↑ Parity column

**Table A**

0 1 0 1 1 0 1 1 0
1 0 0 1 0 1 0 1 1
0 1 1 0 1 1 1 0 0
1 1 0 1 0 0 1 1 0
1 0 0 0 1 1 0 1 1
0 1 1 1 0 1 1 1 1
Parity row → 0 1 1 1 0 1 1 0 0
↑ Parity column

**Table B**

0 1 0 1 1 0 1 1 0
1 0 0 1 0 1 0 1 1
0 1 1 0 0 1 1 0 0 ← Parity error in 3rd row
1 1 0 1 0 0 1 1 0
1 0 0 0 1 1 0 1 1
0 1 1 1 0 1 1 1 1
0 1 1 1 0 1 1 0 0
↑ Parity error in 5th column

**Table C**

0 1 0 1 1 0 1 1 0
1 0 0 1 0 1 0 1 1
0 1 1 0 1 1 1 0 0
1 0 0 0 0 0 1 1 0
1 0 0 0 1 1 0 1 1
0 1 1 1 0 1 1 1 1
0 1 1 1 0 1 1 0 0
↑ ↑
Parity errors in 2nd and 4th columns