Optical multiplexing-demultiplexing with non-linear material based switches

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Multiplexing and de-multiplexing of data are an essential part of digital optical computation as well as communication. A new approach to organize optical multiplexing and de-multiplexing with spatially coded triggering data is proposed. Output optical beam will be guided by its respective input value triggered by some different spatially coded data. Some spatial characters of non-linear materials are used here.

1 Introduction

Optical non-linear material (OPNLM) can be used sometimes very successfully as optical switching devices. The non-linear materials were seen to be used as the switching system in different ways. Among these one particular approach may be identified which may be exploited very nicely to conduct the multiplexing scheme. This type of switching operation conducted by OPNLM will be triggered here by spatially encoded digital data represented by proper light beam. The switching character of such non-linear material is described in the present paper.

2 Switching of a Non-linear Material: a Specific Type

This type of switching was earlier used by many scientists in the field of optical parallel computation. In Fig. 1 this type of OPNLM is shown. Three beams are used here. Two of them are readed beam and one is probe beam. Two read beams are allowed

Fig. 1 — Function of an optical non-linear material (OPNLM)
to fall on the non-linear material from two opposite sides of the materials, where the probe beam falls on it in the point of interaction of the two above beams. Now the non-linear material forms a real time hologram if proper beams are suggested. Here the probe beam reflected from the OPNLM bears the output. The reflected probe output will appear only if both the read beams present as above, otherwise (if one read beam is present or both the beams are absent) reflected probe beam does not appear at-all.

3 Spatially Encoded Read Beams

If two read beams from two opposite sides of the OPNLM are given in a spatially encoded form and the two forms of the beams are superimposed completely on the OPNLM from two opposite sides, then the probe beam will be reflected back only from that position of OPNLM where two beams are present. If one beam is absent or both are absent, the reflected probe beam will be dropped totally by the OPNLM and we get no reflected beam at that time.

In Fig. 2 four positions (0,1,2,3) of the OPNLM are shown which are excited by the superimposed spatially coded beams of inputs A and B from two opposite sides. A and B are two binary inputs following respective encoding guidelines. In this process, the inputs become encoded by the combination of presence and absence of light in spatial mode. Here inputs A and B, each having two rectangular halves, are spatially coded as shown in

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Fig. 2 — Optical selective multiplexing–demultiplexing scheme

Fig. 3. Input A takes 1 when light is present in the lower half and no light in the upper half. Similarly input B takes 1 when light is in right half of the square and no light in the left half. The lower states of A and B are designated in reverse forms of their higher states as shown in Fig. 3. We have used beam-splitters (BS), mirrors, etc., for addition of two beams in this scheme as shown in Fig. 2. Now parallel beam of light comes from coded input A and B combination according to the values of inputs and falls on the OPNLM from two opposite sides.

Fig. 3 — Coding of the two binary variables
4 Multiplexing and De-multiplexing by Spatially Coded Read Beams

When A and B, both are ‘0’ (i.e., A=0, B=0), the position marked by ‘0’ of the OPNL in Fig. 2 will receive light from both sides and the probe beam marked by 0 will come to the output after reflection from the position of the OPNL marked by ‘0’ whereas other probe beams (i.e., 1,2,3) falling on the OPNL will be totally dropped as shown in Fig. 2.

When A is low and B is high (i.e., A=0, B=1), the position of the OPNL marked by ‘1’ will receive light from both sides and the probe beam marked by ‘1’ falling on the OPNL at the position marked ‘1’ by the partial reflection by the respective beam-splitter (BS) will again be reflected by the OPNL and finally comes the output. Other probe beams are dropped here by the OPNL.

When A is high and B is low (i.e., A=1, B=0), the probe beam marked by ‘2’ will come to the output after the reflection from the position of the OPNL marked by ‘2’ whereas other probe beams falling on the OPNL will be dropped. Similarly, we shall get the probe beam marked ‘3’ at the output when A=1 and B=1 as the position on the OPNL marked ‘3’ will receive light from both sides. Here the other probe beams are dropped.

Thus for a particular set of values of A and B, we may get a particular probe beam at the output. Four different sets of values of A and B [i.e., (A=0, B=0), (A=0, B=1), (A=1, B=0) and (A=1, B=1)] allow four different probe beams at the output (one particular probe beam for a particular set of (A,B)). Thus the Fig. 2. may be considered to be a multiplexer as we can drive any probe beam to the output by utilising A and B driving inputs properly.

So, this scheme may be treated as a multiplexing scheme.

The architecture of Fig. 2. may be treated for implementing the function of a demultiplexer also. For a demultiplexer, the same scheme (infrastructure) in Fig. 2 may be used if the output (reflected probe) beam (in reverse direction) is considered as input probe beam and the input beams in reverse directions are considered as 4 output beams, where triggering inputs AB remain intact.

5 Conclusion

These types of optical multiplexing and de-multiplexing circuits are advantageous because of the real time parallel operation is expected here. 4x1 multiplexing and 1x9 de-multiplexing are also possible here if A and B are coded separately. For 2x1 multiplexing case we can use 9 inputs states. The case given above is the example of 4x1 multiplexing and 1x4 de-multiplexing.

References