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OPTICAL SOLUTIONS FOR THE UNBOUNDED SUBSET-SUM PROBLEM

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Abstract. *A special computational device which uses light rays in order to decide whether there is a solution for the unbounded subset-sum problem is described in this paper. The device has a multigraph-like representation and the light traverses it following the routes given by the connections between the nodes. The graph has* 3 *nodes: the first one is where the light enters in the device; the second one is used for computing the solution (the computational node) and the third one is used for collecting the solution (the destination node). The computational node has a number of loops equal to the cardinal of the given set. To each loop (arc) we assign a number from the given set. The nodes are connected by an arc having been assigned a constant value. When the light passes through an arc it is delayed by the amount of time indicated by the number assigned to that arc. At the destination node we will check if there is a ray whose total delay is equal to the target value of the subset sum problem. In this way we have provided a solution to the YES/NO decision problem.*
Keywords: Unconventional computing, Optical computing, NP-complete, Unbounded subset-sum problem

1. **Introduction.** Optical computing refers to the use of light (instead of electricity) for manipulating, storing and transmitting data. It is hoped that in the near future optical computers will perform better than standard electronic computers.

Here we show how to solve a NP-complete problem (the unbounded subset-sum) by using an optical device. The problem is concerned with finding whether a given positive number B can be decomposed into a sum, having been given only the elements from a given set A. Each element of A is allowed to have any number of occurrences in the considered sum. Actually, we have to find if there is such a thing as a multiset composed of elements from A and having the sum B. The multiset is a variation of a set, but it accepts repeated values. Formally, a multiset maps unique elements to positive integers, indicating the multiplicity of that element.

The proposed device, which is very simple, has a multigraph-like structure. A multigraph or pseudograph is a graph which is allowed to have multiple edges, (i.e. edges that have the same end nodes). In other words, two nodes may be connected by more than one edge [18]. A multigraph also allows the usage of loops (i.e. edges with both ends on the same node).

The nodes are connected in such a way that all the possible multisets with elements from A can be generated. The multigraph has 3 nodes: one for initiating the signal (the start node), one for computing the solution (the computational node) and the third one is used for collecting the solution (the destination node). The computational node has