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# IMPLEMENTATION OF $k$-SHORTEST PATHS COMPUTATION ON A MOLECULAR COMPUTER VIA HYBRIDIZATION-LIGATION AND PARALLEL OVERLAP ASSEMBLY

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Abstract. *In this paper, an in vitro implementation of DNA computing for finding k-shortest paths of a weighted graph is reported. After the initial solution is subjected to amplification by polymerase chain reaction, k-shortest paths are visualized by polyacrylamide gel electrophoresis and the selection can be done. For initial pool generation, hybridization-ligation and parallel overlap assembly are employed and compared. The experimental results show the effectiveness of the proposed in vitro computation, where both initial pool generation methods are able to generate the initial pool candidates for the k-shortest paths computation on a DNA computer. However, parallel overlap assembly is more preferable than that of hybridization-ligation in terms of population size and generation time.*

**Keywords:** Molecular computing, Initial pool generation, Hybridization-ligation, Parallel overlap assembly, $k$-shortest paths computation

## 1. **Introduction.**

Until now, it is well-known that some properties of DNA could be used as indicators for solving weighted graph problems. As such, Yamamoto *et al.* carried out concentration-controlled DNA computing (CC-DNAC) for accomplishing a local search for solving shortest path problem [1] by avoiding the generation of hopeless solutions. On the other hand, Lee *et al.* [2] have proposed an approach based on DNA melting temperature called temperature gradient based DNA computing (TG-DNAC) for solving traveling salesman problem (TSP) problem. According to CC-DNAC and TG-DNAC, a shortcoming of these approaches is that only the optimal solution is visualized after the computation. However, in this paper, it is found that the previously proposed direct-proportional length-based DNA computing (DPLB-DNAC) for the shortest path problem [3] is able to generate and visualize multiple optimal solutions, and thus, suitable for solving the $k$-shortest paths problem.

The $k$-shortest paths problem is to list $k$ paths in a graph with minimum total length, for a given $k$ and a source-destination pair in a graph [4-5]. Initially, consider a directed