Summer Internship Report

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1 INTRODUCTION

The summer internship began on 8th of May 2015 and ended on July 15th 2015 in TU Braunschweig, Lower Saxony, Germany, under Professor Sandor Fekete. I was selected for the internship based on a personal interview by Professor Fekete on Skype after my resume was short listed for the interview. This report talks about the work done during summers as a research scholar.

2 INITIAL PERIOD

In the very initial month, we read research papers of the 2 triangulation problems:

- *Minimum Relay Triangulation problem* (MRTP): The objective of this problem is to triangulate a given area with as little robots as possible. The robots have a limited communication range. The ultimate aim is to explore the area by the robots with the help of the dual graph. We studied both the offline and the online versions of this problem.
- *Maximum Area Triangulation problem* (MATP): The objective of this problem is to capture as much area as possible with a fixed number of robots of limited communication range. We studied the offline as well as the online versions of this problem as well.

3 CONTINUING

We were further introduced the *problem of tilt*. This is a fairly interesting problem. We are given a fixed set of stationary obstacles. We also are given an initial configuration of mobile particles which can move maximally along the direction of applied field. We showed that it is NP hard to decide if a given initial configuration can lead to some desired final configuration. We proved this by a reduction from the 3SAT problem.

We also discussed the *graph exploration problem*. In this problem, we are given a graph (tree), and a fixed number of robots which can communicate only when they are at a certain vertex or, they can leave marks on vertices to indicate it as visited. We read about an algorithm to explore the graph in as little time as possible. The standard algorithm is to divide into (almost) have sized clusters as soon as an unvisited branch is seen. The algorithm was shown to have a competitive ratio of $\frac{p + \log p}{1 + \log p}$ where p is the initial number of robots and the logarithm is to the base of 2

4 THE MONTH OF JUNE

In this month, the primary focus was on the problem called as *universal art gallery problem.* In this problem, we are given a set of fixed points in a plane. We are supposed to find out a subset of those points which will guard each and every proper polygon that can be constructed from the given set of points. We were successfully able to prove that the points on the convex hull are not needed in the desired subset. We tried to find an upper bound for the maximum number of points needed. A suggested algorithm was to take no point on the convex hull and to take alternate points on the second convex hull. But a counter example for this algorithm was given and then, further progress on the study of this problem was quite slow because most of the algorithms suggested ended up being flawed by this counter example.

5 THE MONTH OF JULY

In this month, we studied a few algorithms for *finding the convex hull* of a given set of points. We studied *Jarvis March algorithm* (gift wrapping algorithm), *Graham's scan algorithm* and further, we also studied how *Chan's algorithm* uses both of them to create an output sensitive fast algorithm to find the convex hull.

We also studied about the concept of a lower envelop of a monotone polygonal chain and studied how Chan's algorithm could be applied to the problem to get a better complexity.

6 CONCLUSION

The internship was indeed a great experience. We learnt a lot in the internship. We got an idea of how research occurs in a prime institution. We also experienced a completely new place, new culture and new atmosphere. The professor and his colleagues were kind enough to assist us with all our needs. We had a great time in summers and we indeed learnt a lot of new problems and techniques. I hope that I will contribute more to the research field in future. We thank Professor Fekete and his colleagues for giving us this opportunity.