The approximation methods for Voronoi Diagram and Convex Hull have their limitation while selecting next hop neighbors and delivering messages to probable destinations. Approximation methods depend on the number of points selected on the circle boundary. Selecting smaller number of points may leave some potential neighbors for routing undiscovered. Selecting more number of points may account for additional neighbors for routing. This may increase flooding ratio. Any approximation method may also leave some probable destination position inside the circle. Therefore, computing the results of actual Voronoi diagram (VD) and Convex hull (CH) algorithms is unavoidable to prove the superiority of VD and CH over the existing algorithms.

This chapter compares the performance of algorithms of Voronoi diagram and convex hull with existing algorithms DREAM and LAR. We have used plane intersect method to implement Voronoi diagram and Jarvis's March method to implement convex hull. These algorithms have already been explained in chapter 3. Performance is evaluated in both static as well as mobile network.

9.1 Static network

Algorithms for Voronoi diagram and convex hull are implemented for routing in static environment for single destination with circle (expected zone) drawn around the destination. Destination is assumed to be the center of the circle. The routing process of marking nodes continues until destination is found. We are referring the Voronoi diagram and convex hull algorithms as VD and CH respectively. The concept of dominating sets is also applied to reduce the flooding ratio.
Percentage of Successful Deliveries: The results obtained for success rate before and after applying dominating sets for \(P=20\%\) are given in the following figures 9.1 and 9.2 respectively. From the figures it is observed that success rate for all algorithms is approximately same except DREAM for all values of \(K\). However VD and CH have marginally higher than other algorithms. Same trend is prevailing after applying the dominating sets.

Figure 9.1: Percentage of Successful Deliveries before using dominating sets

Figure 9.2: Percentage of Successful Deliveries after using dominating sets

Average Minimum Hop Counts: The results of average minimum hop counts before and after applying dominating sets for \(P=20\%\) are given figures 9.3 and 9.4 respectively (shown below). Significant observation is that all algorithms have closer hop counts to each other before and after applying dominating sets. However, there is
a slight reduction of 1-2 hop counts at K=5 after using dominating sets since success rate is low at K=5. As the value of K increases hop counts also increase marginally after using dominating sets.

![Average Minimum Hop Counts for Successful Deliveries](image)

Figure 9.3: Average Minimum Hop Counts before using dominating sets

![Average Minimum Hop Counts for Successful Deliveries](image)

Figure 9.4: Average Minimum Hop Counts after using dominating sets

**Flooding Ratio:** Flooding ratio before and after applying dominating sets is shown in the following figures 9.5 and 9.6 respectively for P=20%. The results in figures 9.5 show the flooding ratio for VD is lowest among all algorithms except DREAM and SP. CH gives marginally higher flooding ratio than R-DIR but lower than LAR. There is reduction of almost 40-60% in flooding ratio after using dominating sets. VD yields lowest flooding ratio even after using dominating sets.
Chapter 9

Delivery Rate in Geocasting: The actual VD and CH were also implemented for geocasting. The results obtained before and after applying dominating sets are given in following figures 9.7 and 9.8 respectively for P=20%. The delivery rate for all algorithms is closer to each other except for DREAM for all values of K. After applying the dominating sets (figure 9.8) the delivery rate of DREAM and LARI has reduced.
Chapter 9

We observed that YD, CH and R-DIR have performed better than DREAM and LAR. Significant observation is that VD is very effective in controlling flooding ratio in comparison to other algorithms. The use of dominating sets has again proved its effectiveness in reducing flooding ratio.

**Figure 9.7:** Delivery rate before using dominating sets

**Figure 9.8:** Delivery rate after using dominating sets

**Conclusion**

We observed that VD, CH and R-DIR have performed better than DREAM and LAR. Significant observation is that VD is very effective in controlling flooding ratio in comparison to other algorithms. The use of dominating sets has again proved its effectiveness in reducing flooding ratio.
9.2 Mobile Network

The Voronoi diagram and convex hull algorithms are implemented with proactive and reactive routing approaches using different location update schemes. This section discusses the results obtained for proactive approach with location update scheme based on time interval. We have also used the concept of dominating sets in VD and CH algorithms. All algorithms give approximately same results in proactive approach based on link formations and breakages, and reactive approach. The results obtained with these approaches are given in appendix C.

Percentage of Successful Deliveries: The results obtained for success rate before and after applying dominating sets are given in following figures 9.9 and 9.10 respectively. From figure 9.9, it is observed that success rate for all algorithms is approximately same except DREAM and LAR-P. The success rate for LAR1-P and DREAM has significantly reduced after using the dominating sets. However, success rate for VD, CH, R-DIR has not been affected after using dominating sets.

![Percentage of Successful Deliveries](image)

Figure 9.9: Percentage of successful deliveries before using dominating sets
Average Minimum Hop Counts: Results of average minimum hop counts before and after applying dominating sets given following figures 9.11 and 9.12 respectively. Significant observation is that all algorithms have closer hop counts to each other before and after applying dominating sets. However, hop counts after applying dominating sets are slightly higher.

Figure 9.10: Percentage of successful deliveries after using dominating sets

Figure 9.11: Average minimum hop counts before using dominating sets
Flooding Ratio: Flooding ratio before and after applying dominating sets is shown in following figures 9.13 and 9.14 respectively. The results in figure 9.13 show that flooding ratio for LAR2-P is exceptionally higher in comparison to all other algorithms. VD has lowest flooding ratio except DREAM. There is reduction of almost 40-60% in flooding ratio for all algorithms after using dominating sets. However the reduction in flooding ratio for LAR2-P is very significant (i.e. 80-85%). VD yields lowest flooding ratio even after using dominating sets.
Conclusion

The results in mobile environment show that success rate for VD and CH is higher than DREAM and LAR. The flooding ratio is low for VD. It signifies that implementation of VD can be useful in reducing load on a network. However, CH has higher flooding ratio but after applying dominating sets its flooding ratio is reduced by two third (approximately). Therefore, dominating sets are important to control flooding in a network.

Finally, we conclude that VD and CH are better than existing highly publicized algorithms DREAM and LAR on all parameters of performance evaluation considered in this work.

![Flooding Ratio Graph](image)

Figure 9.14: Flooding ratio after using dominating sets