CHAPTER 7

CONCLUSION AND FUTURE DIRECTION

7.1 CONCLUSION

The proposed research work comprises the following four methodologies:

- Fuzzy Based Energy Efficient Clustering (FBEEC) for electing effective cluster head from the available sensor nodes using fuzzy rule set.
- Hybrid scheduling mechanism contains TDMA Scheduling and Fuzzy Based Energy Efficient Clustering (FBEEC) Technique. The hybrid scheduling implemented TDMA on FBEEC.
- Energy efficient Two Cluster Head WSN, which provides two cluster head and assign task for both cluster heads.
- Path Load Factor Traffic Free Routing, which improves existing routing and increases the data transfer rate and avoids data loss in the WSN.

The four proposed works are combined and termed as Energy Efficient Traffic Free Routing in Two Cluster Head WSN (EE-TFR-TCH). The results of the each proposed works and overall performances are discussed in earlier chapters.
The performance of the proposed EE-TFR-TCH and existing Power Aware Routing (PAR), Sequential Assignment Routing (SAR) and Geographical Position Routing (GPR) has been compared in the chapter 6. The performance in terms of delay, packet delivery ratio and throughput are computed on various numbers of sensor nodes and various packet sizes. The number of nodes is varied from very small WSN (few tens) to typical WSN (few thousands). The packet size also varied from 20 to 100 bits.

In the proposed work, after every 100 rounds, the algorithm is implemented to form clusters and CHs there is an increment in delay but the delay is less than the existing methods. Therefore the proposed work is a reliable algorithm for surface water applications.

The scope of the proposed work (TCHEE-WSN) is on the higher side even when the network area increases. It is designed by keeping the time taken for a message to travel between the node and the BS as a major factor. Even though the clustering mechanism is an older one, the usage of second CH (SMN) increases the reliability of data communication and reduces the packet loss by a considerable amount.

The reliability of the network with SMN was above the threshold value of 90% whereas reliability of network without SMN was below the threshold most of the times. The reliability increases when the SMN is included in the network. If there were PMN alone there is a possibility of packet loss. The reason is when messages were sent by nodes to PMN, there is a chance that PMN is engaged in communicating with the BS. In TCHEE-WSN algorithm the SMN is dedicated to communicate only with the BS. Because of the two cluster heads the reliability in WSN increases and the packet loss decreases considerably. The packet loss was below the threshold (5%) for a network with SMN.
The packet delivery ratio of the proposed routing methodology (TFR-PLF) is maintained above 95% comparing the well-known and recent existing methods. The packet delivery ratios of the existing systems are 60% - 90% according to the number of nodes. Whereas in this proposed work the low traffic paths are selected for data transmission so that the congestion is avoided. This proves the proposed method is more optimal than the existing methods. The packet delivery ratio of the proposed work is improved from minimum of 4% to a maximum of 28%. The stability of this proposed work on packet delivery ratio is verified by error bars and exponential trend line and identified that the scalability of proposed work is in considerable level.

The throughput increases when the packet delivery ratio increases. The throughput of this proposed system (TFR-PLF) is improved from a minimum of 10% to a maximum of 28% than the existing methods. The stability of the proposed work on throughput calculation is proved by error bars and exponential trend line.

From the results, it is identified that the delay in the proposed work (TFR-PLF) is reduced to a minimum of 5% to a maximum of 23% than the existing works. The stability of the proposed work on delay calculation is proved by error bars and exponential trend line. Routing decision is taken based on the Load Factor (LF) which includes the Link Capacity (LC) and node’s Target Utility (TU). Since the low traffic path is selected based on the link capacity, the delay get reduced.

The energy required for communicating the data between sensor nodes to the BS is a major part compare to the energy required for other activities of the sensor nodes like sensing and aggregation.
The following parameters improve the energy efficiency of the WSN:

- Increased packet delivery ratio
- Increased throughput
- Reduction in delay

Since the retransmission of data required is very less in this proposed work, the average energy saving of the proposed work EE-TFR-TCH WSN was around 36% which is more than the existing methods. Therefore this proposed system will satisfy the objective of achieving energy efficiency in the WSN. Hence it is concluded that the proposed work proves that it is more optimal than the well-known existing methods such as SAR, PAR and GPR.

7.2 FUTURE DIRECTION

Energy saving in WSN is a complex problem comprising of a large number of challenging issues. Regarding the aspects addressed in this thesis, there are still many possible research areas that the future work may take. The energy efficient clustering method and proper route selection over static WSN was addressed in this work, however further improvements for dynamic WSN may be envisioned.

By identifying new routing approaches and clustering techniques to improve the percentage of energy savings, throughput and packet delivery ratio may be implemented. The Proposed methods of this thesis can further extend to multipurpose applications.