Fig. 6: Residual energy average in the Routing Protocols
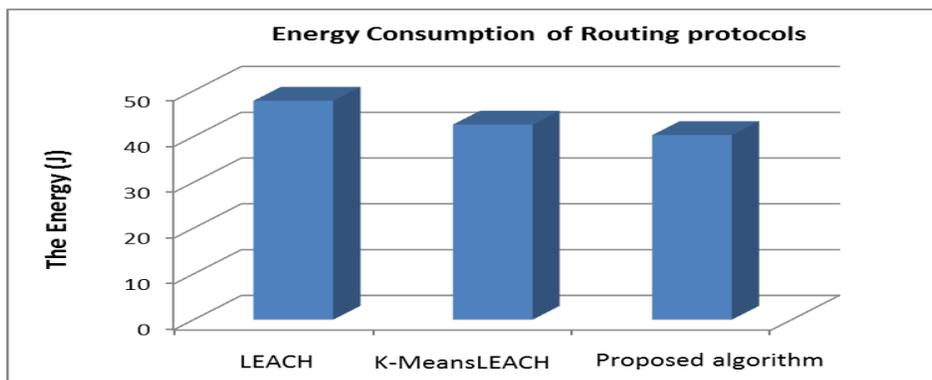

Fig. 7: Energy Consumption in Routing Protocols

5. Conclusion

In this paper, clustering routing protocols using the K-Means model was enhanced by the EM algorithm in the WSN. The EM performed better than the K-Means in some cases such as convergence speed, data set size, accuracy, etc. Thus, we introduced the EM-based clustering algorithm showing better results than the aforementioned protocols. In other words, the proposed algorithm can improve significant factors such as network lifetime, the total residual energy of nodes, the energy average of the network, etc. In further search, our algorithm extension can continue with Distributed Expectation Maximization (DEM), Genetic Algorithm-Expectation Maximization (GA-EM) and Particle Swarm Optimization-Expectation Maximization (PSO-EM) methods for lower energy consumption and higher lifetime in the network.

6. References

[1] H.Shokrzadeh, and M. Moghadaszadeh "A STUDY AND COMPARISON OF GSTEB METHODS WITH THE GOAL TO DATA GATHERING FROM HIERARCHICAL SENSORS," in *Proc. 2016 CSME Conf.*, 2016, pp. 1-5.

[2] M. Pc, S. Meenu, and L. R. P, "Fault Prediction using Quad Tree and Expectation Maximization Algorithm," vol. 2, no. 4, pp. 36–40, 2012.

[3] A. F. S. D. Muruganthan, D. C. F. Ma, B. Rollyi, "A centralized energy-efficient routing protocol for wireless sensor networks,"," *IEEE Radio Commun.*, vol. 43, pp. 8–13, 2005.

[4] P. Bholowalia, and A.Kumar "EBK-Means : A Clustering Technique based on Elbow Method and K-Means in WSN," vol. 105, no. 9, pp. 17–24, 2014.

[5] D. Mechta, S. Harous, I. Alem, and D. Khebbab, "LEACH-CKM: Low Energy Adaptive Clustering Hierarchy protocol with K-means and MTE," *2014 10th Int. Conf. Innov. Inf. Technol. IIT 2014*, pp. 99–103, 2014.

[6] J. Kaur and A. Kumar. (Jun-Dec 2015). GA Based Balanced Clustering Approach for Energy Efficiency in WSN. 9(1). pp. 24-31. Available: http://www.csjournalss.com

[7] E. Rabiaa, B. Noura, and C. Adnene, "Improvements in LEACH based on K-means and Gauss algorithms," *Procedia Comput. Sci.*, vol. 73, no. Awict, pp. 460–467, 2015.