

Abstract

Wireless sensor networks (WSNs) are critical in a wide range of applications, including environmental monitoring, industrial automation, and other areas. However, their effectiveness is frequently restricted due to sensor nodes' low energy resources. The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is commonly used to improve energy efficiency in WSNs. Despite its benefits, LEACH has substantial downsides, such as uneven energy distribution and poor cluster head selection, which results in a shorter network lifetime. To address these limitations, we presented the Extended Low Energy Adaptive Clustering Hierarchy (X-LEACH) protocol, which includes enhanced cluster head selection methods and balanced energy utilization. This paper presents a comparative analysis of XLEACH performance using extensive simulation experiments. The primary aim of this study is to carry a comparative analysis to evaluate X-LEACH's performance across various network scenarios, including sparsely and densely populated nodes, increased number of rounds, and increasing the initial energy of nodes. Critical performance metrics such as the number of dead nodes per round, number of live nodes per round, total remaining energy per round, packet delivery ratio per round throughput per round, and the number of cluster heads formed per round were used. The study analysed the performance of X-LEACH with the traditional LEACH and SEP as the benchmark protocols protocol. Simulation results indicate that X-LEACH significantly improves energy efficiency and network lifespan compared to LEACH and SEP protocols in all the scenarios.