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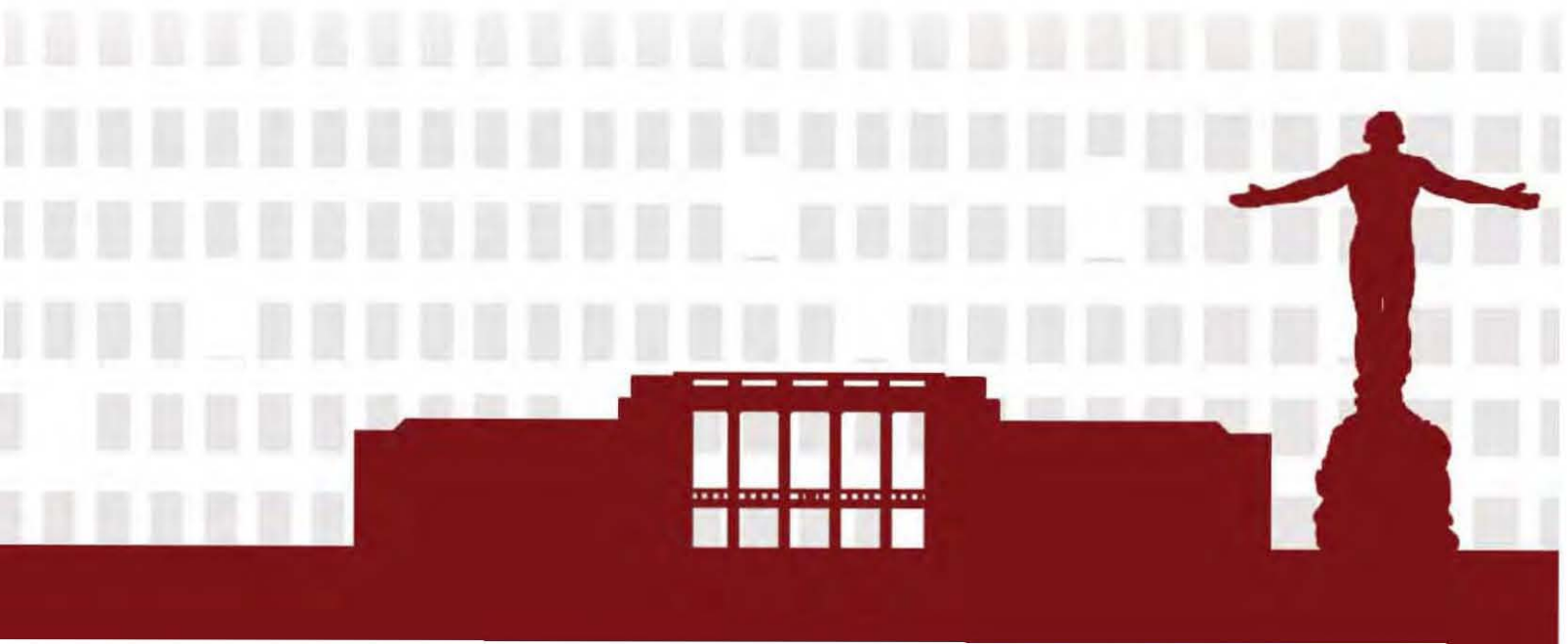
Metro Manila, Philippines



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PERFORMANCE EVALUATION OF CLUSTERING TECHNIQUES

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ABSTRACT

Huge networks (i.e. Distributed Wireless Sensor Networks) are sometimes divided into multiple groups of nodes called clusters for easier network coordination. Clustering is a hierarchical routing technique where a structure is imposed on the network to improve energy-efficiency, stability and scalability. This work investigates the behaviour and characteristics of five clustering algorithms: LEACH, LEACH-C, LEACH-F, MH-LEACH and CDC. The results of this study would be used to develop a new objective function to enable loop correction for the Routing Protocol for Low-Power and Lossy Networks (RPL), an IETF Standard for routing over Low-Rate Wireless Personal Area Networks.

Each of the aforementioned protocols were developed in MatLab by using an available LEACH code. The protocols' behaviours were cross-referenced to their respective original sources (referenced papers) to ensure that these implementations behave correctly. In order to properly characterize the clustering algorithms for this study, the most crucial aspect is determining the proper energy equations and network parameters. Most clustering studies used the network parameters and variables found in [2] in order to characterize an algorithms behaviour. Given this case, this work would also base its simulations and analysis using these parameters. However, a variation with respect to the initial energy was done (2J to 0.02J) to improve the simulation time. Looking at initial analyses this does not affect the overall behaviour of the simulation. Variables of interest include communication overhead (setup and data), energy efficiency (i.e. network lifetime, average energy per round) and network load distribution (i.e. fairness, cluster size). The clustering techniques were evaluated using five (5) different randomly generated sensor networks. For each network, each of the developed protocols was tested fifty (50) times with each individual simulation terminating if 80% of the number of nodes have died. Data for each of the variables mentioned above have been gathered for each test conducted. The respective averages and standard deviations with a 95% confidence interval have been also computed.

From the results, LEACH-F outperforms all protocols when it comes to energy efficiency which translates to a longer network lifetime. But upon inspecting the simulations, LEACH-F reports the earliest node death and consequently, its cluster. This may be the result of inefficient optimization. However, this premature cluster death only occurs at single cluster with the others performing significantly well. Looking at communication overhead, LEACH-C offers the least N-CH (node-to-cluster head) due to the results of the optimization algorithm. This however translates to more clusters which results in higher number of CH-BS packets. Due to fixed clusters, LEACH-F has the least setup overhead among the other protocols. LEACH only outperforms the other protocols in terms of the time a first unique node death occurs due to the fairness of its load distribution.

Keywords: Clustering, LEACH, RPL

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