Michael McDermott

REFLECTION ON RESEARCH IN ENERGETIC SUSTAINABILITY OF HETEROGENOUS WIRELESS AD-HOC NETWORKS

This creative research was conducted during the summer of 2019 as part of the CSUSM Summer Scholars Program. During this time, I studied energy efficiency of adaptive clustering protocols in heterogenous wireless ad-hoc networks (HANETs). The goal was to evaluate current adaptive clustering protocols and to create a new protocol that solves the shortcomings of those that are currently known.

To begin the research, I started my search for protocols in energy efficient adaptive clustering and HANETs. I used tools like Google Scholar and the online OneSearch tool on the CSUSM University Library website. Once I acquired the relevant resources, I compiled the literature and started reviewing the material. In adaptive clustering, there are multiple nodes capturing data such as temperature, motion, seismic, or some other data. All of the nodes are running on a finite amount of energy. In an effort to conserve energy, the nodes will group into clusters and each group will elect a cluster head that will aggregate the data for its given group, and then transmit the aggregated data to the base station. These protocols differ in a number of ways, such as the amount of energy the nodes have or creating different categories of nodes that have different probabilities of becoming cluster heads, but they all had a similar shortcoming. Nodes further away from the base station would run out of energy sooner, and there were no direct solutions. I found one protocol that took an interesting approach that was different from the rest, and that was to evaluate each node's residual energy and give it an individual weight each round that would affect its probability of becoming a cluster head. This meant that nodes with less energy would have a smaller chance of becoming a cluster head. I compared this protocol with the others and found that it performed well in the effort to keep the whole network alive the longest, however, when tracking others I found that this protocol sacrificed throughput of data.

In order to compare these existing protocols against our own, I had to program a simulation of the protocols and use data visualization methods to analyze the results. This

consisted of finding code implementation by network researchers and reimplementing it in my own simulation. I used the scripting language MATLAB, which is very common in network research. I was new to using this scripting language, and collaboration with other Summer Scholars students gave me insight on how I could improve the efficiency of the simulation. My simulation started with taking about 40 minutes to run, and after refactoring and optimization, was able to run in just a few minutes. Having a faster simulation meant being able to run more scenarios and analyze results faster. I could annotate these results and send them to my faculty mentor and discuss solutions to make a more energy efficient adaptive clustering protocol. Through analysis of the other protocols, we determined that by enforcing an optimal number of cluster heads along with an individual weighted probability, the throughput of data could be maximized while still maintaining a long network lifespan. We found a couple unexpected scenarios where our protocol did not appear to perform as well as expected. We analyzed these scenarios and calculated that it would be impossible to get better results.

Creating a new energy sustainable adaptive clustering protocol named ESAC over the span of 10 weeks was a huge accomplishment for me and my experience was a very positive one. I improved my communication and presentation skills. I also strengthened my ability to derive insights from ambiguous situations and come up with creative solutions that drive positive results. We wrote a research paper and it was accepted by IEEE and I presented it at a highly regarded networking conference in Las Vegas. The paper will be published in the conference proceedings. Overall, this research contributes to a rapidly growing field of internet-of-things (IoT) devices that is in need of innovations such as ours. The library subscriptions to scientific journals aided me in the acquisition of articles and research on this topic as well as gave me access to the software needed to implement the simulations. Without this, the research would been costly and may have taken longer to conduct, as the code would have needed to be converted to a different programming language.