Elephant Herd Tracking IoT Application: Design Decisions and Tradeoff Analysis

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ABSTRACT

This report presents the design considerations, energy modeling, structural components, and implementation feasibility of an IoT-based elephant herd tracking application. The system aims to monitor elephant migration patterns in Southern India (where the author is originally from), using a network of infrared-equipped sensor nodes. Inspired by other short range sensors like the ones used in Ring doorbells, the nodes will detect and localize elephants based on heat signatures. The report then concludes the two best wireless technologies for this application, NB-IoT and LoRa, based on a tradeoff analysis of power consumption, data throughput, and cost efficiency. The final design is both cost-effective and energy-efficient, promising a robust solution for real-world wildlife monitoring.

1 INTRODUCTION & APPLICATION MOTIVATION

I am originally from Southern India, (in particular a city called Chennai), but when I go to visit my relatives who live in more remote parts of South India, I often hear stories about elephants wandering into villages and causing damage. I am also an Elephant enthusiast and have always been fascinated by these Elephants. This project is a way for me to combine my passion for elephants with real-world design considerations.

1.1 Background

Elephants are a keystone species in the Indian subcontinent, playing a crucial role in forest ecosystems. However, human-elephant conflicts are a significant issue in regions where human settlements overlap with elephant habitats. Monitoring elephant migration patterns is essential for wildlife conservation and to mitigate human-elephant conflicts, as well as to preserve the Quality of Life for both humans and elephants. I localize my study to strictly Southern India to serve as a *pilot* for a larger scale project that could be implemented in other parts of India and the world.

Figure 1 shows the current elephant migration patterns, especially concentrated in South India, which bolster the
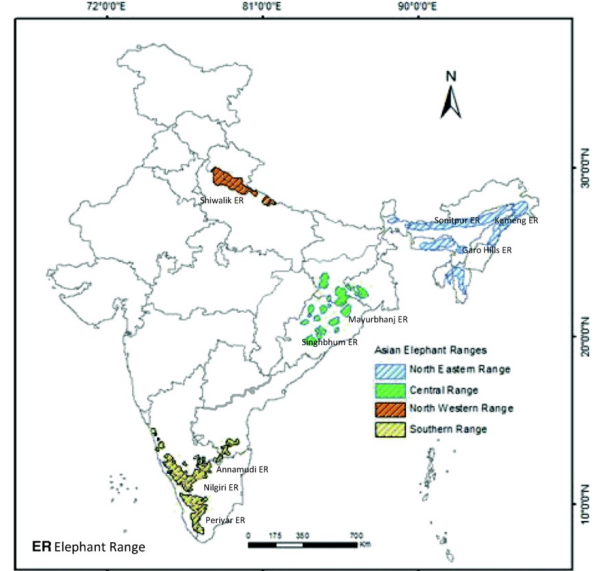

Figure 1: Map of Current Elephant Migration Patterns and concentrated Habitats in India. Notice the concentration of elephants in the *Annamadi*, *Nilgiri*, and *Periyar* Regions.

need for a system to monitor these elephants. The *Annamadi*, *Nilgiri*, and *Periyar* while located in remote areas, are proximal to many important cities like **Bangalore**, **Coimbatore**, and **Madurai**, aggregating to a total population of over 20 million people[1]. The need for a system to monitor these elephants is evident, and the system must be low-cost, low-power, and scalable to cover a large area.

Also another important design consideration is the fact that the elephants habitat are spread in a variety of terrains, usually in high elevation, dense forests, and remote areas. This provides some road blocks in terms of connectivity and power, and also makes it difficult for large scale infrastructure to be built (i.e. cell phone towers, power lines, etc.). So relative to each sensor node, the system must be self-sufficient in terms of power for our pilot study, and must be able to communicate over long distances.
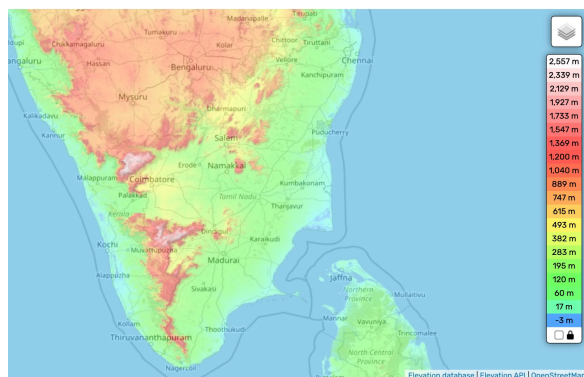
Figure 2: Ground Topology of the Elephant Habitat Area.

2 CONCLUSION

This paper has detailed the design considerations, energy modeling, and tradeoff analysis for an IoT-based elephant migration tracking system. By evaluating multiple wireless technologies, NB-IoT and LoRa emerge as the most viable solutions given our requirements. The final design is both cost-effective and energy-efficient, promising a robust solution for real-world wildlife monitoring.

REFERENCES

[1] Hitendra Padalia, Surajit Ghosh, Sudhakar Reddy Chintala, Subrata Nandy, Sarnam Singh, and Senthil Kumar. 2020. Assessment of historical forest cover loss and fragmentation in Asian elephant ranges in India. *Environmental Monitoring and Assessment* 191 (01 2020). https://doi.org/10.1007/s10661-019-7696-5