Optimising Antenna Positioning for Maximum Coverage

The case study of cattle tracking in Austrian Alps using Long Range (LoRa) based Monitoring System

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1 Introduction

Due to the rapid growth in population and expansion of urban areas, Livestock farming has become one of the fastest growing sectors of agriculture globally. With 8,000 alpine pastures alpine farming is an important aspect of agriculture in the Austrian mountain regions. It not only contributes to an attractive cultural landscape but is also vital in securing the biodiversity. As the movement and forage intake of the livestock affects and is affected by the ecosystem monitoring it can provide vital information's to the farmers. This requires the extensive coverage of the area of interest with a sufficient number of antennas.

- Can the problem of optimal antenna positions for monitoring cattle movement in alpine regions be modeled with spatial optimization techniques?
- Which constraints determine the antenna candidate positions?
- Which algorithmic techniques can be used to improve the optimization process?

Fig. 1: The components of the ViehFinder-System, Antenna (left) and Collar (top right).

2 The ViehFinder-System

The system for monitoring the cattle consists of a solar powered collar, that is mounted around the neck of the cattle, a solar powered antenna, that routes the data to the server and the server itself.

3 Antenna Coverage Location Problem

The ACLP is a Maximum Coverage Location Problem. Thus, it is a NP-hard problem and depending on the problem size might only be solvable using heuristics. At this state it just tries to maximize the coverage, while minimizing the number of antennas.

4 Requirements and Challenges

Candidate Positions require easy access for installation and maintenance as well as a mobile network reception. Demand points are restricted by the area of the alps in the area of interest. The high degree of freedom in the placement of the antennas leads to a challenging computational burden. Achieving a solution in a reasonable amount of time with exact algorithms might not be possible.

5 Proposed Solution

First the demand points and candidate positions are generated by applying the constraints to the datasets. For each candidate position a viewshed is computed. This set of viewsheds is then handed to the optimization process together with the demand points. Fig. 3 visualizes the result. The algorithm returns the optimal viewsheds with their total covered demand.

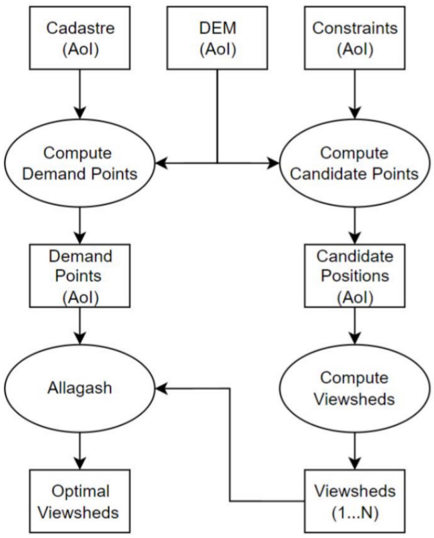

Fig. 2: Spatial Optimization approach depicting the relevant inputs and processes.

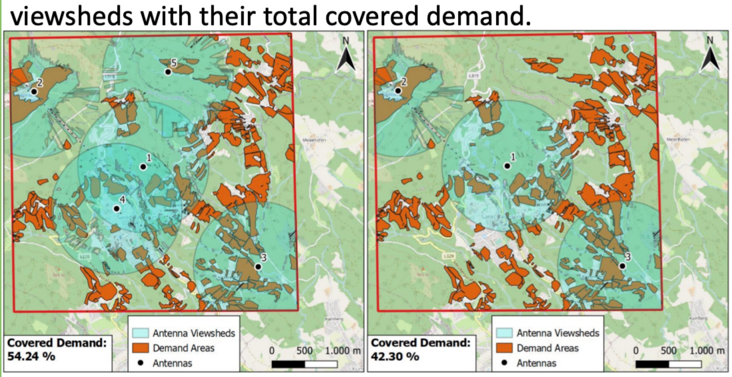

Fig. 3: Example for the application of the ACLP with a budget of 3 antennas on a small subset of the study area Schöckelland

6 Future Work

Future work will explore the boundaries and computational burden of the proposed spatial optimization modelling approach. Further the constraints will be evaluated for their usefulness. Algorithmic techniques for reducing the problem size such as resampling will be considered as well. The model will be extended to include backup coverage and the Line-of-Sight approach will be replaced by using Radio-Frequency-Modelling.

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