

SCHOOL OF COMPUTATION,
INFORMATION AND TECHNOLOGY —
INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Master's Thesis in Data Engineering & Analytics

Thesis Proposal

**Enhancing Photovoltaic Detection Using
Generative AI for Super-Resolution Satellite
Imagery**

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Abstract

The expansion of photovoltaic (PV) installations calls for efficient systems to monitor and evaluate their distribution and performance. High-resolution aerial imaging provides precise detection but is highly inaccessible in terms of availability and expense. In contrast, low-resolution satellite imagery is abundant but insufficient for accurate PV detection due to its low geographic resolution. This thesis suggests using generative artificial intelligence (AI) models to produce synthetic super-resolution (SR) images from low-resolution satellite data. The goal is to improve PV detection accuracy while lowering the costs associated with collecting high-resolution imagery. Geographically, the study will focus on select areas of Germany with high-resolution aerial and low-resolution satellite photographs available to confirm the proposed method's effectiveness.

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1 Introduction

1.1 Background

Photovoltaic (PV) detection through remote sensing is significant due to its potential for efficient monitoring and assessment of solar installations. High-resolution aerial imagery, such as 40 cm resolution images, provides precise detection results; however, this type of imagery is often limited in availability and expensive, making it impractical for widespread use across various regions. Conversely, satellite imagery, available abundantly and at a lower cost, typically suffers from lower resolution (e.g., 10 m resolution), which poses challenges for accurate PV detection.

Recent advancements in generative AI, particularly in super-resolution techniques like Generative Adversarial Networks (GANs), ResNet, and Super-Resolution Convolutional Neural Networks (SRCNN), offer promising solutions. These models can enhance the resolution of images, potentially bridging the gap between low-resolution satellite data and the requirements for accurate PV detection.

1.2 Problem Statement

The main challenge addressed in this thesis is the limitation posed by low-resolution satellite imagery for accurate PV detection. There is a need for a cost-effective method to enhance the resolution of readily available satellite images to match the detection capabilities of high-resolution aerial imagery.

1.3 Objective

The primary goal is to demonstrate the feasibility and effectiveness of using generative AI to produce high-quality super-resolution images from low-resolution satellite imagery, focusing on different regions in Germany where both high-resolution aerial and low-resolution satellite images are available.

2 Methodology

The project will start with acquiring and preparing 40cm resolution aerial pictures and 10m resolution satellite images for specific German locations. Advanced generative AI techniques will be used to create synthetic SR images from low-resolution satellite data. These generated SR pictures will then be assessed using standard image quality metrics. PV segmentation will be applied to both the original low-resolution and synthetic SR pictures. By comparing these segmentation results, the study aims to validate the cost-effectiveness of synthetic SR images as a practical, cost-effective, and accessible alternative to high-resolution aerial imagery for PV detection. This highlights the potential of generative AI in improving remote sensing applications for renewable energy monitoring.

3 Timeline

This timeline constitutes a tentative outlook for this thesis. The tasks are subject to change based on the research progress and requirements.

Table 3.1: An overview of the planned thesis timeline.

Task	Duration
Literature Review	Month 1
Data Acquisition and Preparation	Month 2-3
Experimental Design and Execution from Literature	Month 4-5
Analysis, Reports, and Overall Results	Month 6

4 Conclusion

This thesis seeks to address a noticeable gap in the field of remote sensing for renewable energy applications. By enhancing low-resolution satellite imagery using generative AI, the research has the potential to drive great impact towards PV detection processes, making them more accessible and cost-effective.