Evaluation of Neural Object Detection Models for Human Detection in Infrared Images

PROJECT REPORT T1000

from the course of studies Computer Science - Artificial Intelligence

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Ravensburg Campus Friedrichshafen

by

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Declaration of Authorship

In accordance with clause 1.1.13 of Annex 1 to §§ 3, 4 and 5 of the Dual Hochschule Baden-Württemberg's Study and Examination Regulations for Bachelor's degree programs in the field of Technology, dated 29.09.2017. I hereby declare that I have written my thesis on the topic:

Evaluation of Neural Object Detection Models for Human Detection in Infrared Images

independently and have used no other sources or aids than those specified. I further declare that all submitted versions are identical.

Taufkirchen 29.07.2025

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Lukas Florian Richter

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Abstract

test

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List of Acronyms

API   Application Programming Interface

HTTP   Hypertext Transfer Protocol

REST   Representational State Transfer

Glossary

Exploit   An exploit is a method or piece of code that takes advantage of vulnerabilities in software, applications, networks, operating systems, or hardware, typically for malicious purposes.

Patch   A patch is data that is intended to be used to modify an existing software resource such as a program or a file, often to fix bugs and security vulnerabilities.

Vulnerability   A Vulnerability is a flaw in a computer system that weakens the overall security of the system.

1 Introduction

Introduces the problem of human detection in thermal images and the importance of infrared surveillance systems for security applications. Outlines the thesis objectives and structure.

2 Literature Review and Theoretical Background

Reviews existing object detection methods, focusing on SSD architectures, and examines previous work on thermal image processing and human detection in infrared imagery.

2.1 Object Detection Fundamentals

Covers basic principles of computer vision and object detection, including traditional methods and deep learning approaches.

2.2 Single Shot MultiBox Detector (SSD) Architecture

Detailed explanation of SSD model architecture, inclusing backbone networks (VGG, ResNet) and detection mechanisms.

2.3 Thermal Image Processing

Discusses characteristics of thermal images, preprocessing techniques (inversion, edge enhancement), and challenges specific to infrared imagery.

3 Methodology

Describes the experimental setup, datasets used, model configuraitons, and evaluation metrics employed in the study.

3.1 Dataset Description

Details the thermal image datasets (FLIR ADAS v2, AAU-PD-T, OSU-T, M3FD, KAIST-CVPR15) and their characteristics.

3.2 Model Implementation

Explains the implementation of SSD models with different backbones and preprocessing configurations.

3.3 Experimental Design

Outlines the systematic approach to comparing model variants and the evaluation framework.

4 Results and Analysis

Presents comprehensive results from model training and evaluation, including performance comparisons across different configurations.

4.1 Training Performance

Reports training loss curves, converegence behavior, and computational requirements for different mdoel variants.

4.2 Detection Accuracy Analysis

Provides detailed mAP scores and detection performance metrics for each model configuraiton and preprocessing technique.

4.3 Preprocessing Impact Evaluation

Analzyes the effects of image inversion and edge enhancement on detection performance.

5 Discussion

Interprets the results, discusses the practical implications for surveillance systems, adn addresses limitations of the current approach.

5.1 Model Performance Comparison

Compares SSD-VGG and SSD-ResNer performance and discusses trade-offs between accuracy and computational efficiency.

5.2 Practical Deployment Considerations

Discuesses real-world application scenarios and system requirements for thermal surveillance.

6 Conclusion and Future Work

Summarizes key findings, contributions to the field, and suggestst directions for future research in thermal image human detection.

7 Examples

Just a couple of examples to demonstrate proper use of the typst template and its functions.

7.1 Acronyms

Use the `acr` function to insert acronyms, which looks like this Hypertext Transfer Protocol (HTTP).

Application Programming Interfaces are used to define the interaction between different software systems.

REST is an architectural style for networked applications.

7.2 Glossary

Use the `gls` function to insert glossary terms, which looks like this:

A Vulnerability is a weakness in a system that can be exploited.

7.3 Lists

Create bullet lists or numbered lists.

- This
- is a
- bullet list

1. It also
2. works with
3. numbered lists!

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7.4 Figures and Tables

Create figures or tables like this:

7.4.1 Figures

Figure 1 — Image Example

7.4.2 Tables

	Area	**Parameters**
cylinder.svg	$\pi h \dfrac{D^2 - d^2}{4}$ (1)	h: height D: outer radius d: inner radius
tetrahedron.svg	$\dfrac{\sqrt{2}}{12} a^3$ (2)	a: edge length

Table 1 — Table Example

7.5 Code Snippets

Insert code snippets like this:

```
1  const ReactComponent = () => {
2    return (
3      <div>
4        <h1>Hello World</h1>
5      </div>
6    );
7  };
8
9  export default ReactComponent;
```

Listing 1 — Codeblock Example

7.6 References

Cite like this International Organization for Standardization [1]. Or like this [1].

You can also reference by adding `<ref>` with the desired name after figures or headings.

For example this Table 1 references the table on the previous page.

8 Conclusion

References

[1] International Organization for Standardization, "ISO/IEC 18004: Information technology – Automatic identification and data capture techniques – QR code bar code symbology specification," in *ISO/IEC 18004:2015*, 2015.