Karlsruher Institut für Technologie

AISS CV Final Presentation

Pandemic Package Team

Agenda

- **Project**
  - Use Case
  - Timeline

- Implementation
  - Training Data Collection
  - Data Augmentation
  - System Architecture
  - Object Detection Models

- Evaluation
  - Results
  - Documentation
  - Lessons Learned
  - Outlook

Our Team

- **Alexey Rosenberg**
- Industrial Engineering (1st M.Sc.)
- Application Engineer

- **Luca Deck**
- Industrial Engineering (4th M.Sc.)
- Project Manager

- **Bolatito Zäch**
- Industrial Engineering (3rd M.Sc.)
- ML Engineer

- **Joel Oswald**
- Information Systems (2nd M.Sc.)
- Infrastructure

- **Manuel Sauter**
- Information Systems (2nd M.Sc.)
- Data Scientist

- **Johannes Jestram**
- Information Systems (2nd M.Sc.)
- ML Engineer

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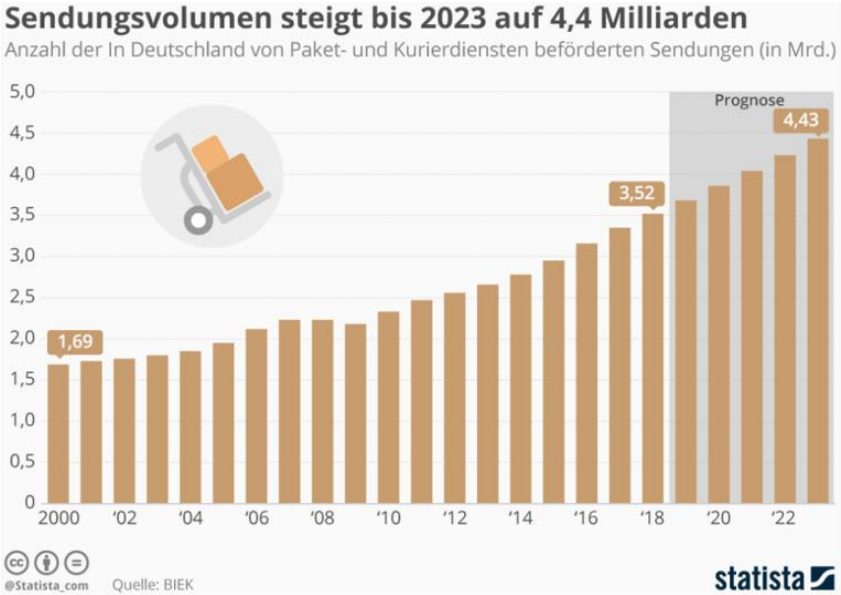
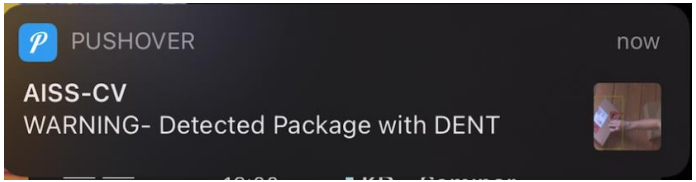
Use Case


Sendungsvolumen steigt bis 2023 auf 4,4 Milliarden
Anzahl der In Deutschland von Paket- und Kurierdiensten beförderten Sendungen (in Mrd.)
5,0
4,5
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0
1,69
3,52
Prognose
4,43
2000
'02
'04
'06
'08
'10
'12
'14
'16
'18
'20
'22
@Statista_com
Quelle: BIEK
statista


PUSHOVER
now
AISS-CV
WARNING- Detected Package with DENT


Hole - 0.99
Dent - 0.99

Project Timeline

April

Team creation
Use case brainstorming

May

Use case definition
Training data collection
Begin data augmentation
Begin model prototyping

June

Finish data augmentation
Implementation YOLO and SSD model
Cloud training in Azure
Test deployment on Jetson Nano

July

Evaluation of models
Further collection of training data
Final training and evaluation
Implement user notification

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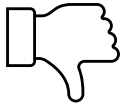
Training Data Collection (1/2)

- First Collection in May (~440)
- Every team member labeled approx. the same number of pictures
- Careful box/damage ratio
  ➡ reduce overfitting

- Different cameras
- Different backgrounds
- Different resolutions



Training data harder than usecase

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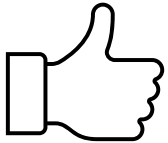
Training Data Collection (2/2)

- Second collection in July (~270)
- Negative examples
- Static background
- Captured with Jetson camera



Training data closer to the usecase

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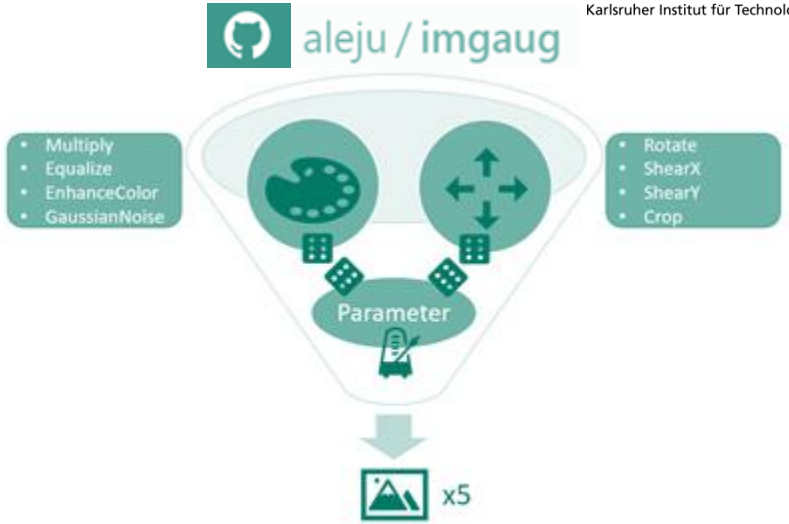
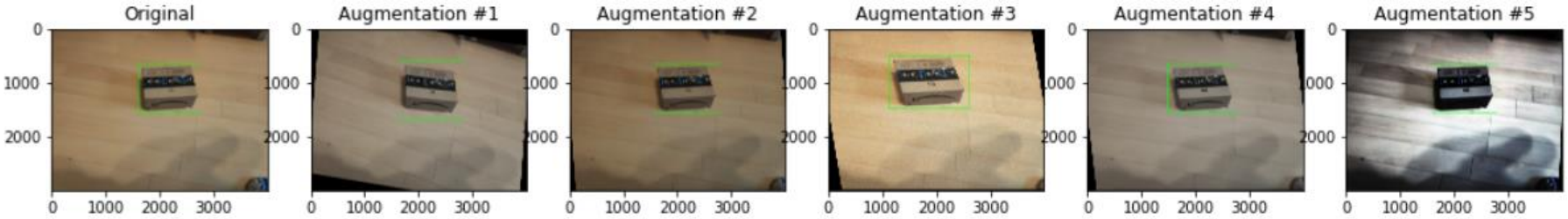
Data Augmentation

- Inspired from bbaug paper [1]
- Multi-stage randomization
- Implemented offline
- Diversity of augmentations





[1] https://arxiv.org/abs/1906.11172

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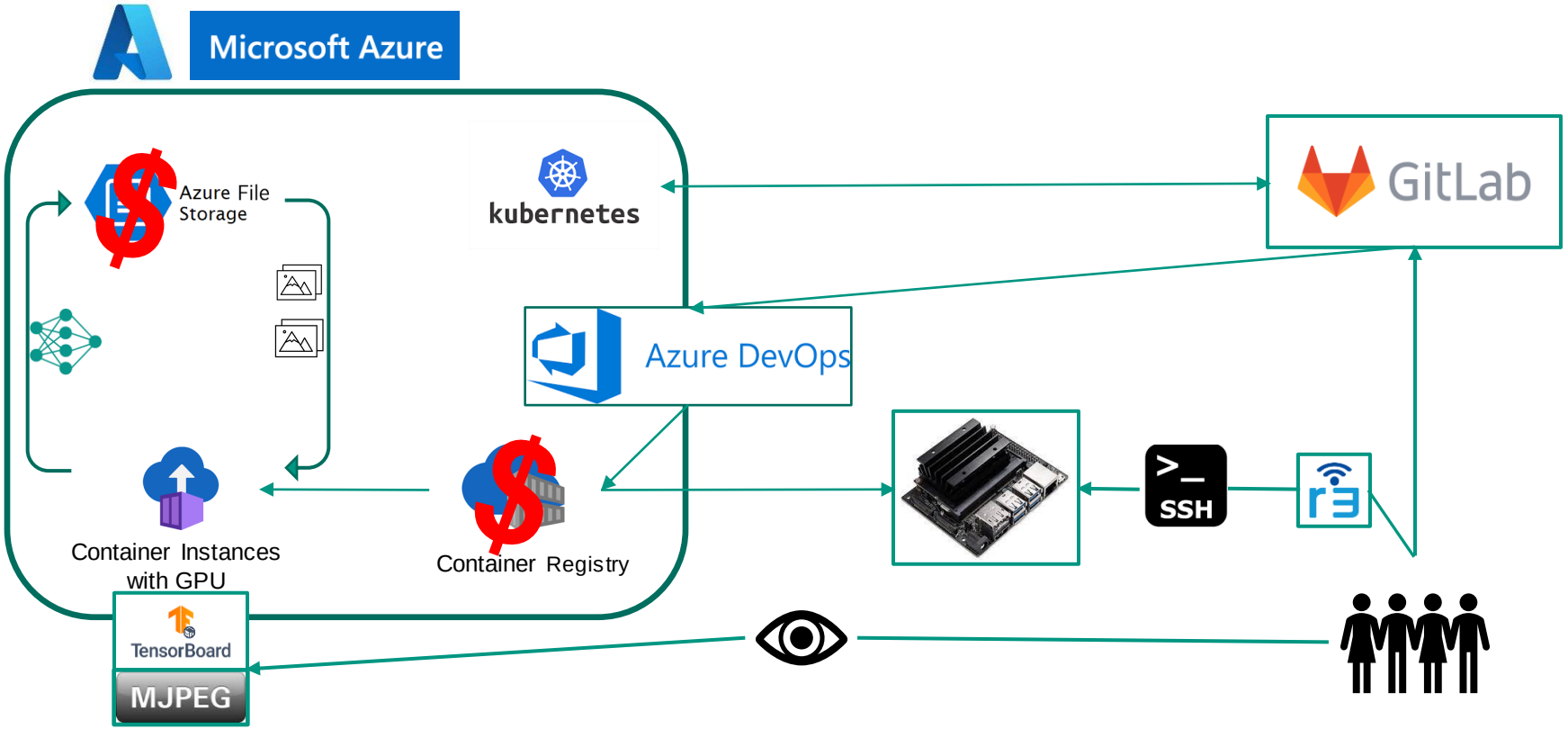
System Architecture



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Object Detection Models

- Multiple common frameworks
- Unsure which is best/feasable
  - ➡ Both

- Darknet:
  - Fast, plain C
  - State of the Art: YOLO
  - Training abstracted from code
  - One Stage
  - Conversion to TensorRT

- TF2 OD API:
  - Variety of models
  - One interface for many architectures
  - SSD
    - One Stage
    - MobileNet/ResNet feature extractor
  - Training abstracted from code

Evaluation

LIVE NOW

(or backup video)

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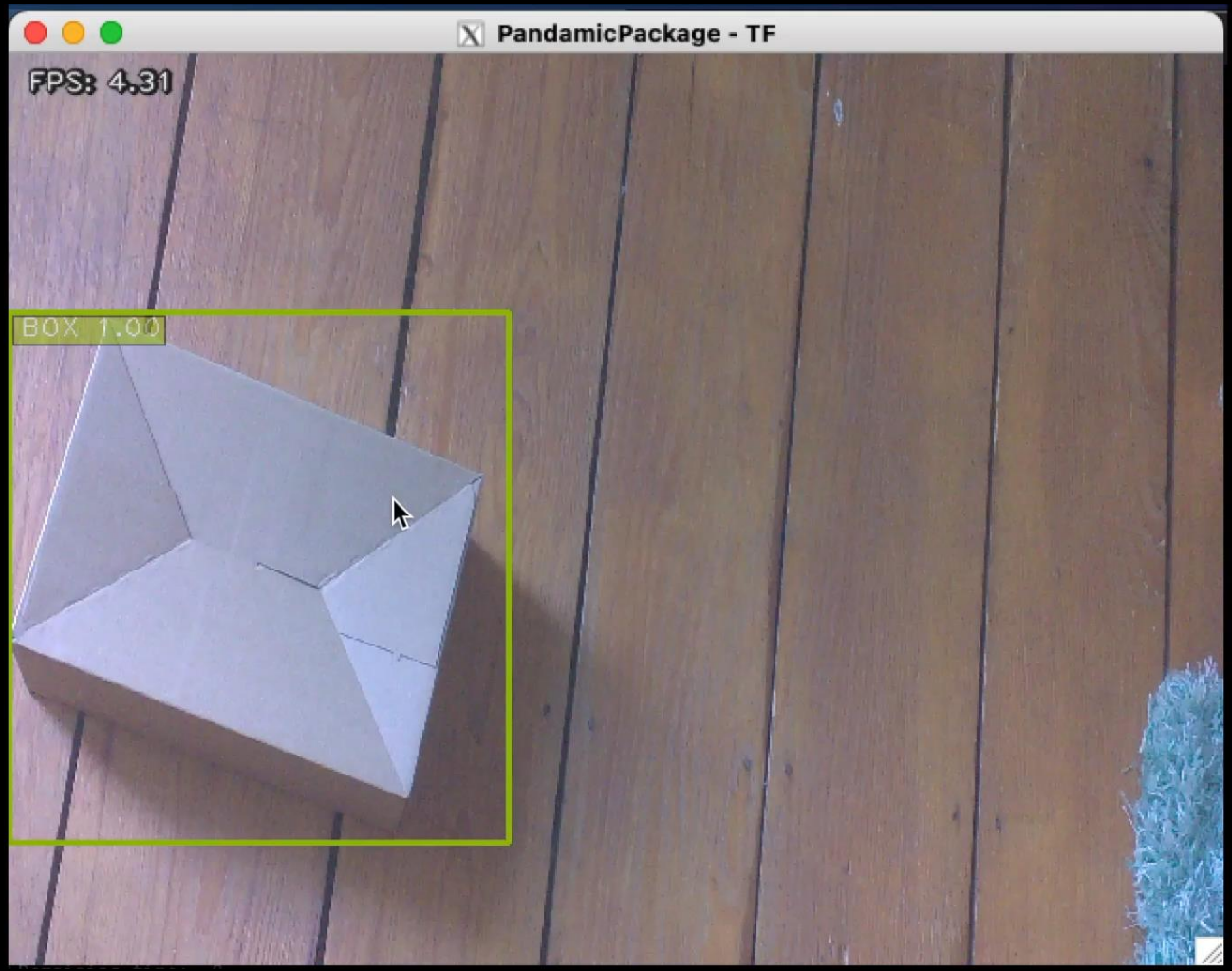
PandamicPackage - TF
FPS: 4.31
BOX 1.00

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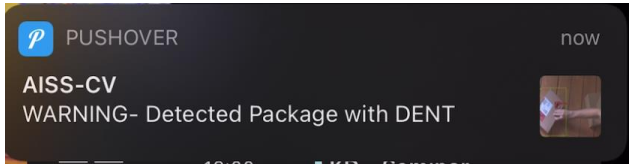
Evaluation

Key Performance Indicators

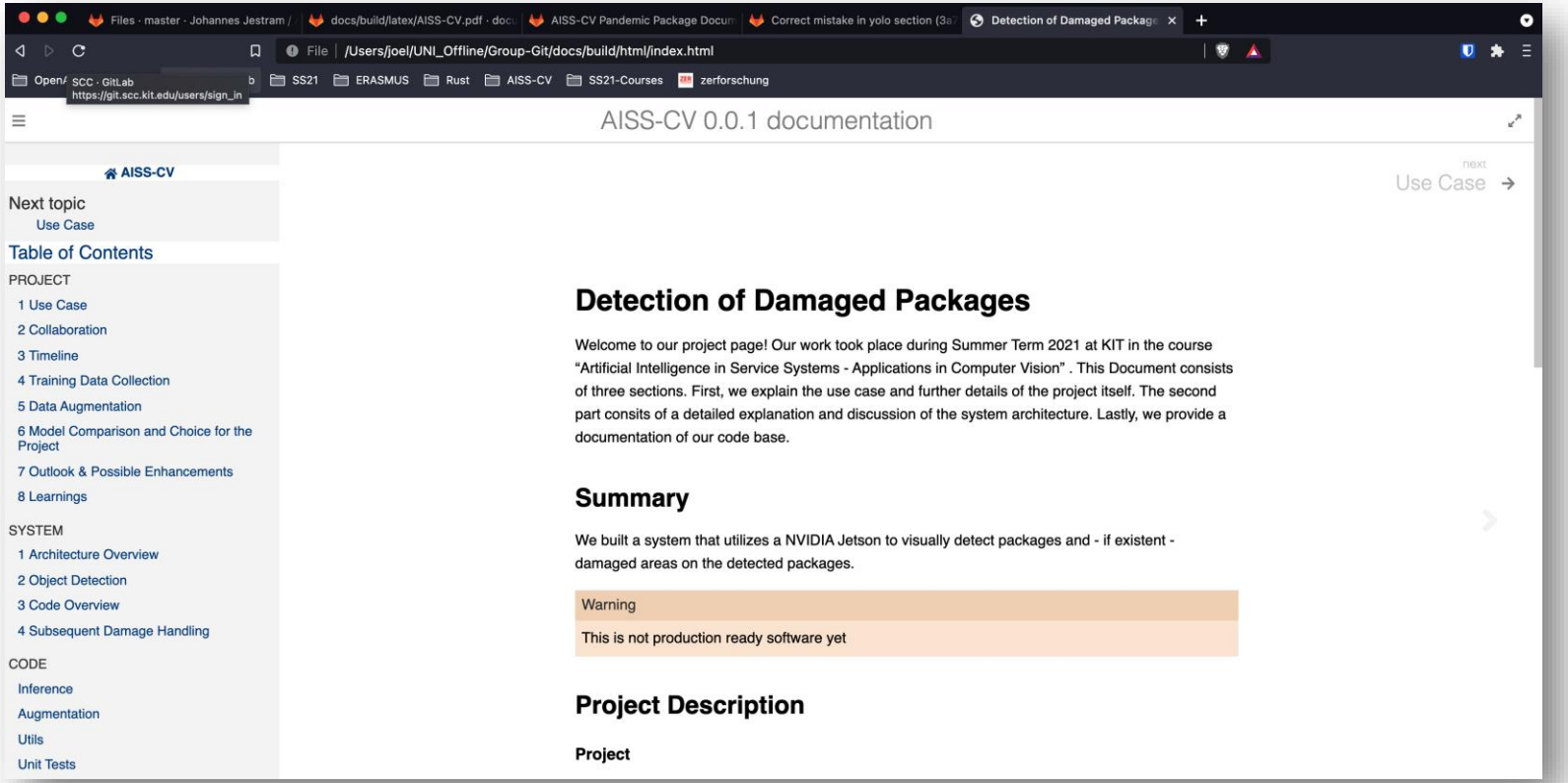
KPI \ Model	YOLOv4	YOLOv4-tiny	SSD with MobileNet
FPS on Jetson	5±3	22±8	4±2
mAP@0.5 IoU (validation)	(0.84)	0.54	0.79
Training time	(12h)	9h	6-30h

Application

- System detects damages and labels image
- Control Loop: model agnostic (TensorRT - TF)
- User notified about damage with Pushover API
  - Push notification with labeled image
  - SMS message also possible



Documentation



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Lessons Learned

Selection of appropriate Framework

- SotA vs effort to use

Training Data Collection

- Overcomplex environment
- Too much labeling effort
- Production camera

Co-Working & Communtication

- Read ReadMes
- Get used to Git flow

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Outlook

Real-Life Insights and Fine-Tuning for the Working Environment

- Define relevant critical properties based on domain knowledge
- Specify the interpretation and handling of critical properties

Two-Stage Model Architecture

- One model detects the boxes and a second model detects the damages
- Compare performance to our one-stage model

Implementation of Polygon Labels and Instance Segmentation

- Leverage polygons with a segmentation
- Compare improvements in KPIs to increase in complexity

Deployment: Integration into a Warehouse Management System (WMS)

- Create an interface for common WMS to facilitate seamless integration

Thank you for your attention!

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BACKUP