UNIVERSITY OF TECHNOLOGY
IN THE EUROPEAN CAPITAL OF CULTURE
CHEMNITZ

مؤتمر عجمان الدولي السادس للبيئة
Ajman 6th International Environment Conference

Deep Learning & Machine Learning in Computer Vision

SHADI SALEH

TOWARDS >>> 2071 SHAPING THE FUTURE FOR ENVIORMENTAL SUSTAINABILITY

Informatik
Professorship of Computer Engineering
Prof. Dr. Dr. h. c. Wolfram Hardt

IBS
Stiftung Internationales Informatik- und Begegnungszentrum Sachsen

Agenda

- About Me
- Introduction
- Computer Vision is everywhere
- Classical CV vs Deep Learning (CNNs)
- Challenges of Deep learning
- Edge Computing
- Active Learning vs Passive) Deep Learning
- CE Projects & Research Activities

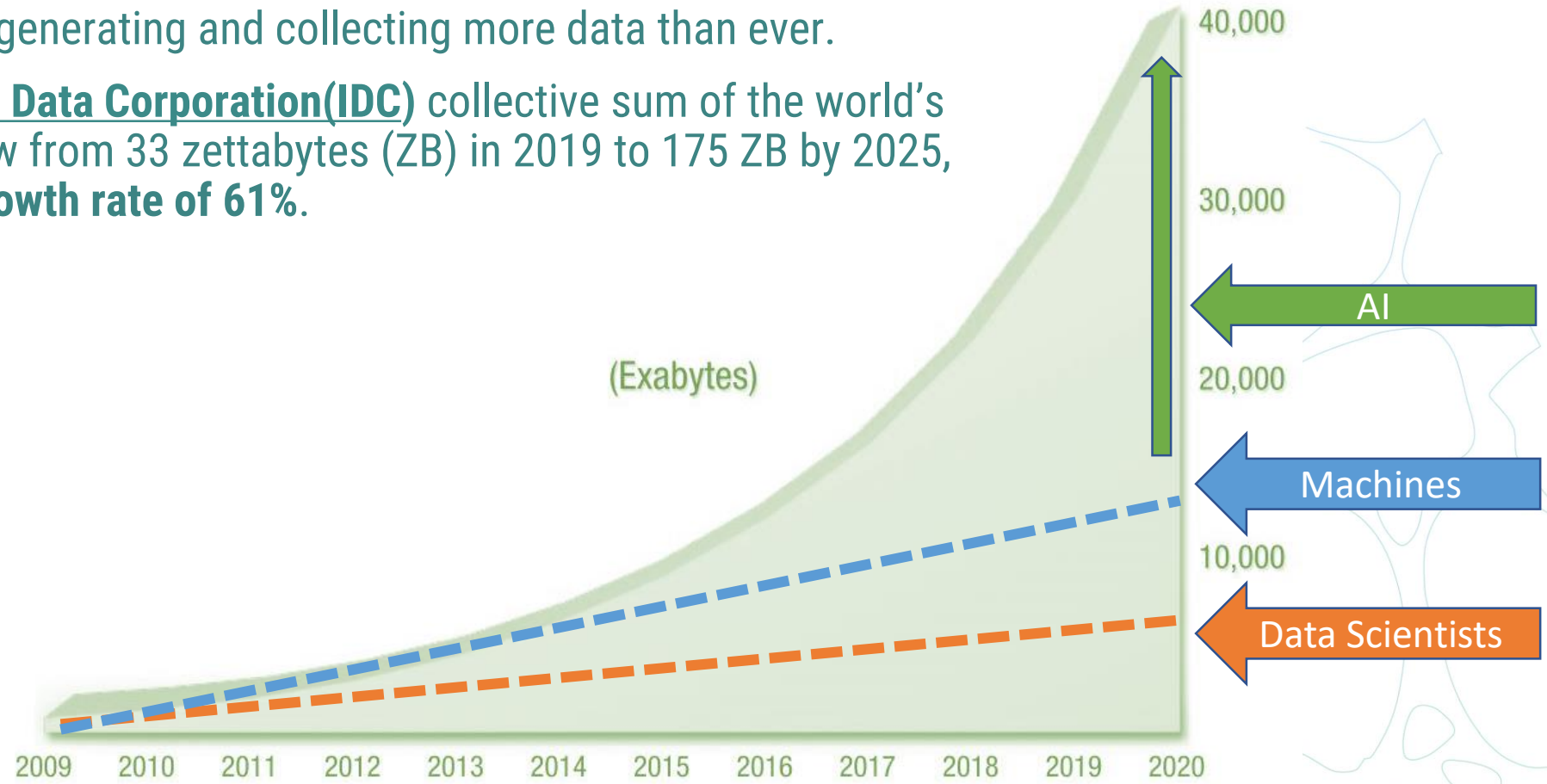
About Me, [Shadi Saleh]

- **Associate Researcher** (Computer Engineering Chair) , Chemnitz University (Germany)
  - Research contributions regarding Deep Learning/ Machine learning in Computer Vision.
  - 24 Research items.
- **Ph.D. Student** (Computer Engineering Chair) , Under supervision of Prof.Wolfram Hardt
  - Working Research Title: **Depth Estimation from Monocular Camera based on Adaptive Learning.**
- Associate Researcher (Software Engineering Chair) , Chemnitz University (Germany)
  - Research contributions regarding Eye Tracking/ Facial and Emotion Recognition & Software Engineering
- M. Sc. Automotive Software Engineering , Chemnitz University (Germany)

Email:	**shadi.saleh@informatik.tu-chemnitz.de**
• Phone	+49 371 531-34036
• Fax	+49 371 531-834036
• ORCID • Website • Researchgate	https://orcid.org/0000-0001-5783-790X https://www.tu-chemnitz.de/informatik/ce/professur/staff.php.en https://www.researchgate.net/profile/Shadi-Saleh-3
• Address:	Chemnitz University of Technology Faculty of Computer Science Chair of Computer Engineering Straße der Nationen 62 | R. 1/019 D-09111 Chemnitz

Introduction

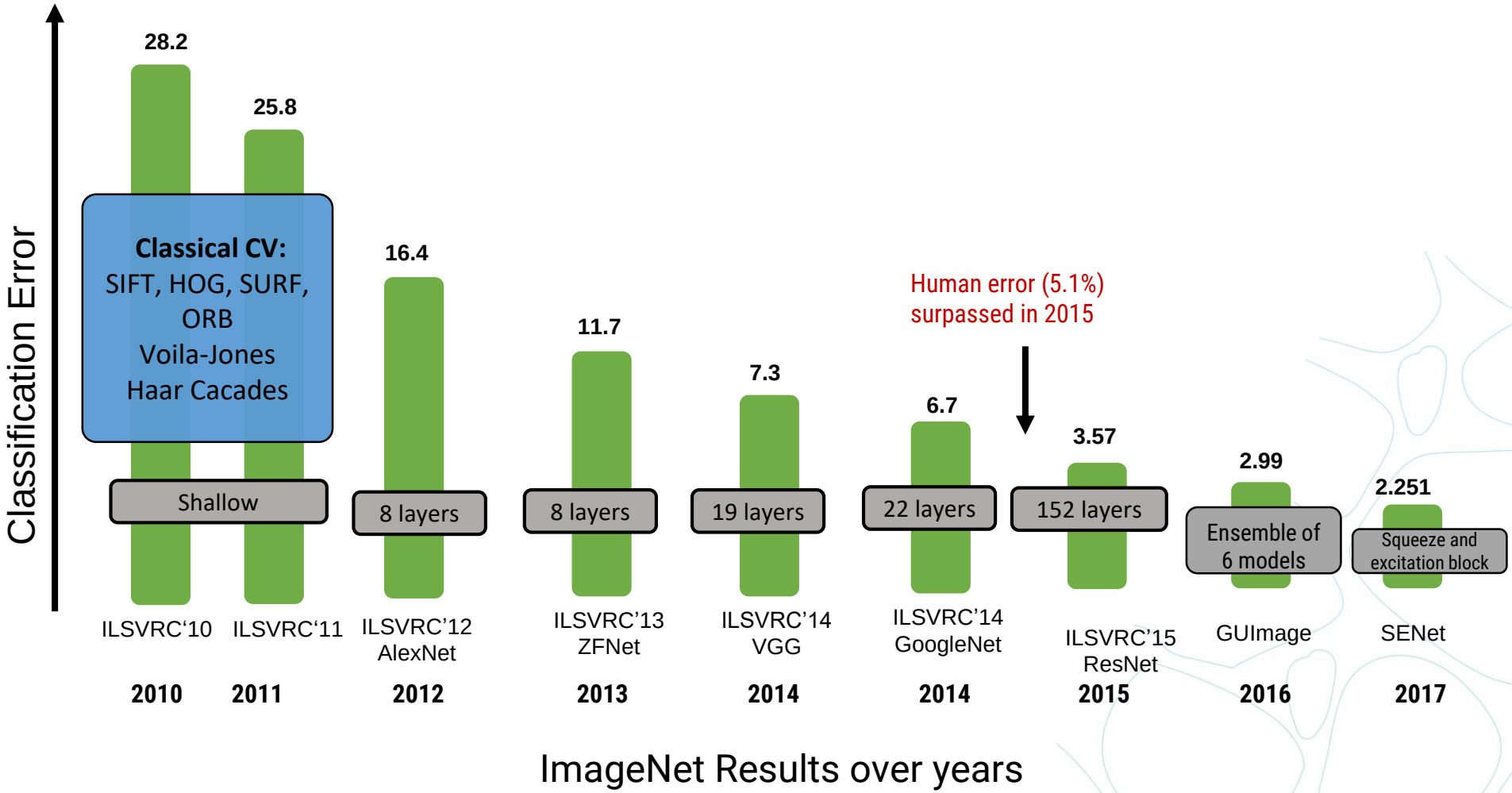
- Humans are generating and collecting more data than ever.
- **International Data Corporation(IDC)** collective sum of the world's data will grow from 33 zettabytes (ZB) in 2019 to 175 ZB by 2025, an **annual growth rate of 61%**.



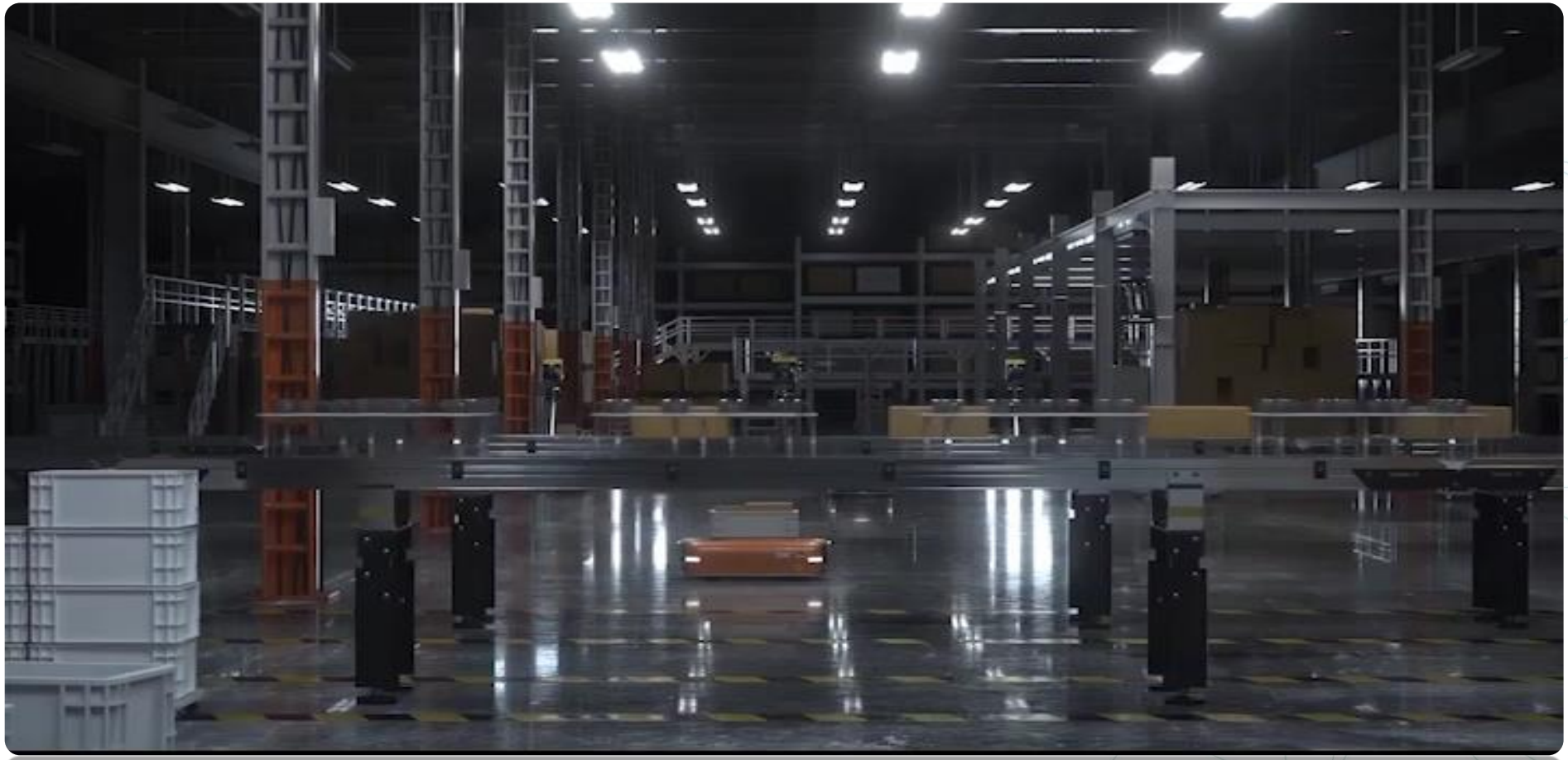
Source: IDC's Digital Universe Study, sponsored by EMC, December 2012

Computer Vision is everywhere…

Classical CV vs Deep Learning (CNNs)



Deep Learning Revolution



- CognexTV, How is deep learning different than machine vision?
- Dell EMC, Dell EMC PowerScale for Autonomous Driving Vehicle Development.
- The Next 30, The Rapid Advancement Of Computer Vision and Its Future Implications

Challenges of Deep learning

- Pros
  - Enables for feature learning rather than hand feature tuning
  - Represent Nonlinear Complex Features with Outstanding Performance Gains:
    - Computer Vision
    - Speech Recognition
    - Natural Language Processing
  - Scalable and massively parallel computations for large data volumes
- Cons
  - Deep learning requires a huge amount of data
  - Deep learning is opaque
  - Extremely expensive to train due to complex data models
  - Computer vision can be difficult due to hardware limitations
  - Complexity of Scaling Computer Vision Systems

Challenges of Deep learning

- Pros
  - Enables for feature learning rather than hand feature tuning
  - Represent Nonlinear Complex Features with Outstanding Performance
    - Computer Vision
    - Speech Recognition
    - Natural Language Processing
  - Scalable and massively parallel computations for large data volumes
- Cons
  - Deep learning requires a huge amount of data
  - Deep learning is opaque
  - Extremely expensive to train
  - Computer vision can be difficult due to hardware limitations
  - Complexity of Scaling Computer Vision Systems

Edge Computing is Essential for Mission-Critical Computer Vision Use Cases.

What is Edge Computing?

- Edge computing consists of delegating data processing tasks as close as possible to the data sources.
  - This enables real-time data processing at a very high speed.
  - Reduces energy consumption.
  - Increases security.
  - Improves data privacy.

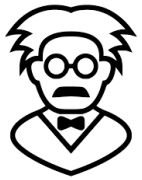
- The downside of doing it **locally** is that the **hardware** is not as powerful as a super computer in the cloud, and we cannot compromise on **accuracy** or **speed**.

Research Questions and Objectives

- The solution to this is either **stronger**, **more efficient hardware**, or **less complex deep neural networks**.
  - To obtain the best results, a balance of the two is essential.

- As a consequence, we address the following research questions:
  1. Which edge hardware and what type of network should we bring together in order to **maximize the accuracy** and **speed of deep learning algorithms**?
  2. Can machines be trained with **less labeled data** and **less human supervision?**

Conventional(Passive) Deep Learning Workflow



expert

unlabelled raw data

human labelling

labelled data

Deep Learning Approach

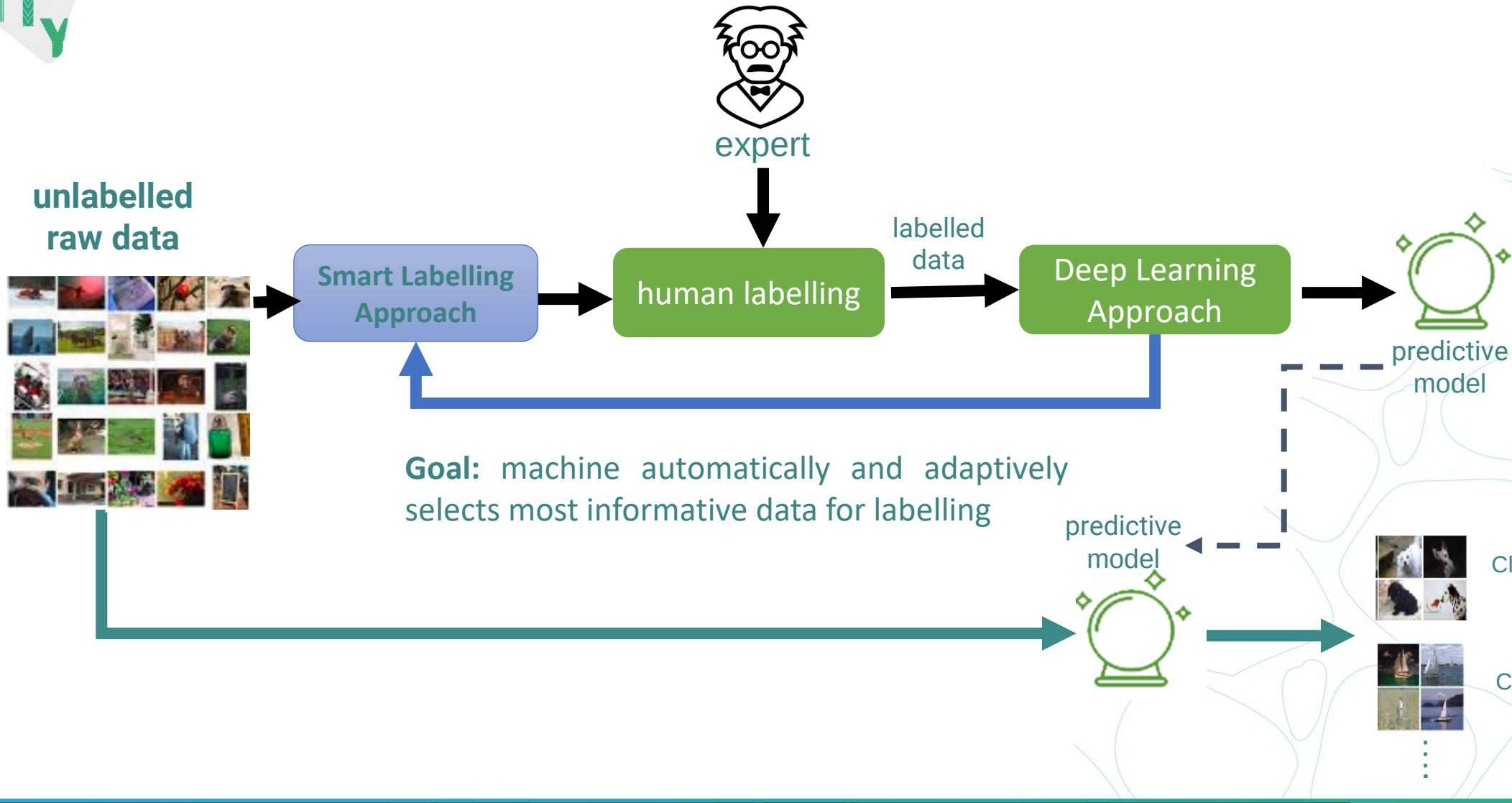
predictive model

predictive model

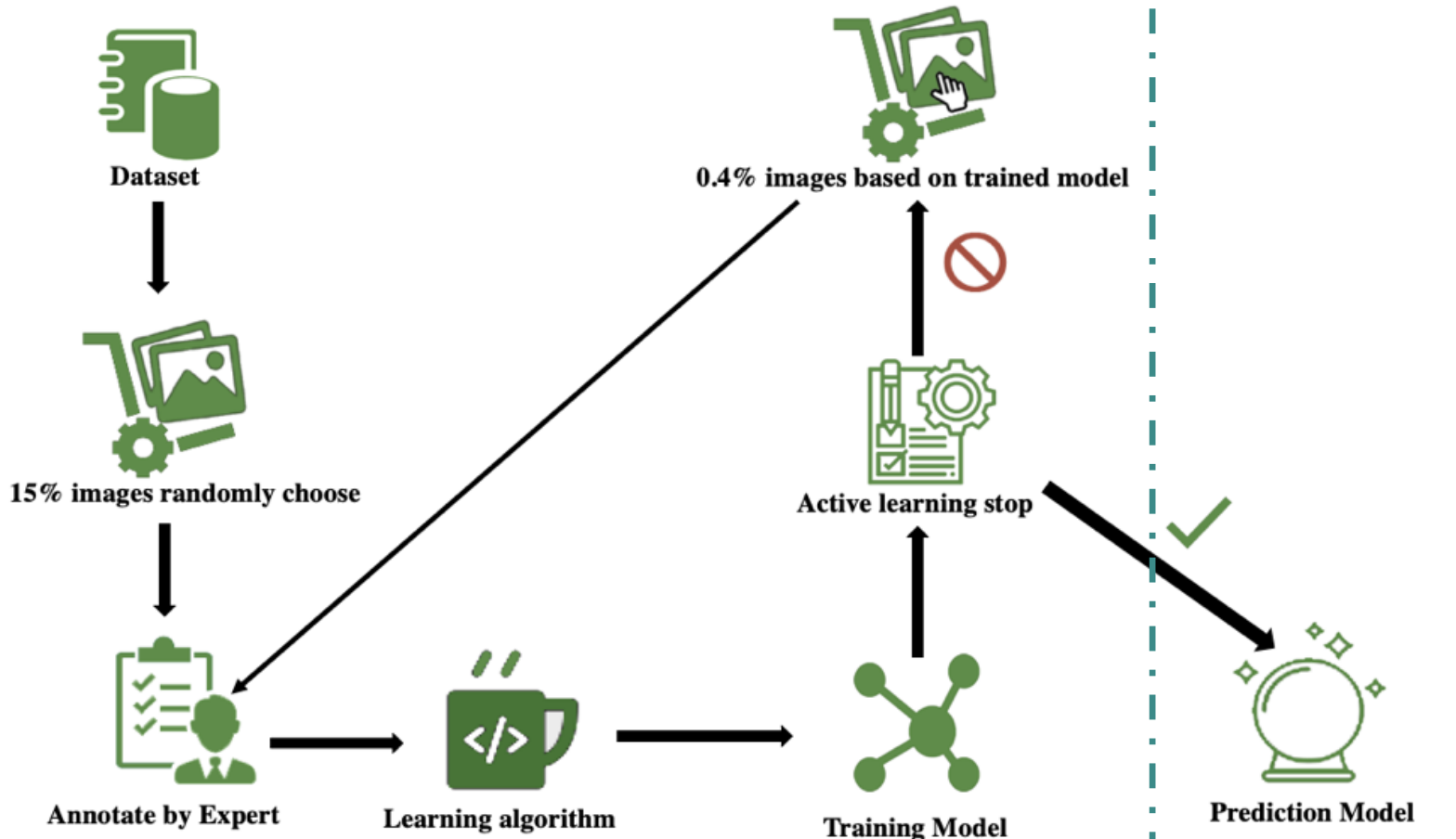
Class1

Class2

Active Deep Learning Workflow



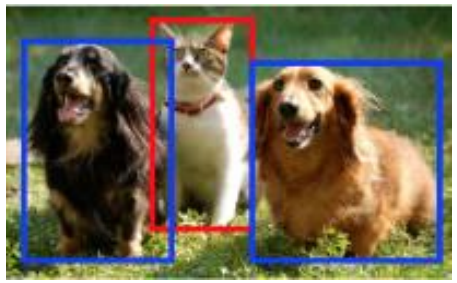
Active learning Framework



Deep Learning : Vision Tasks

Classification

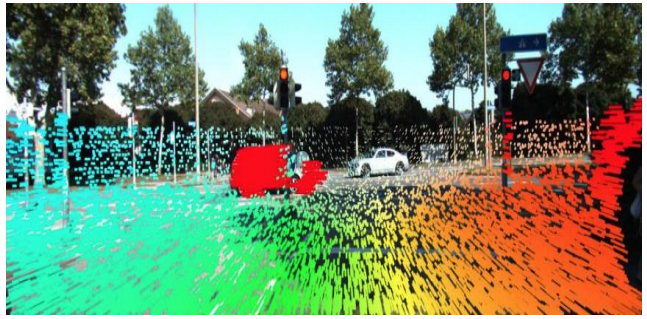
Classification + Localization



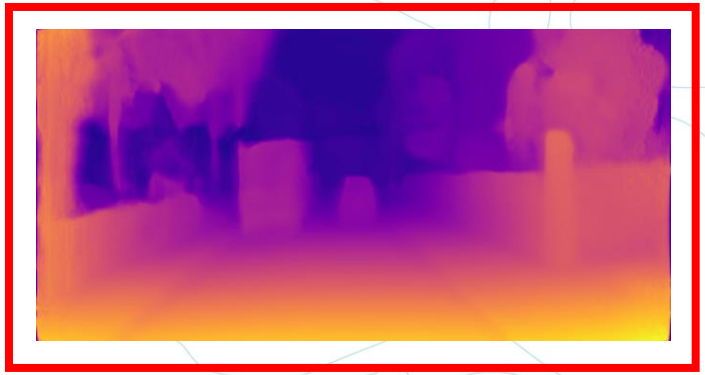
Object Detection

Instance Segmentation

Super-Resolution

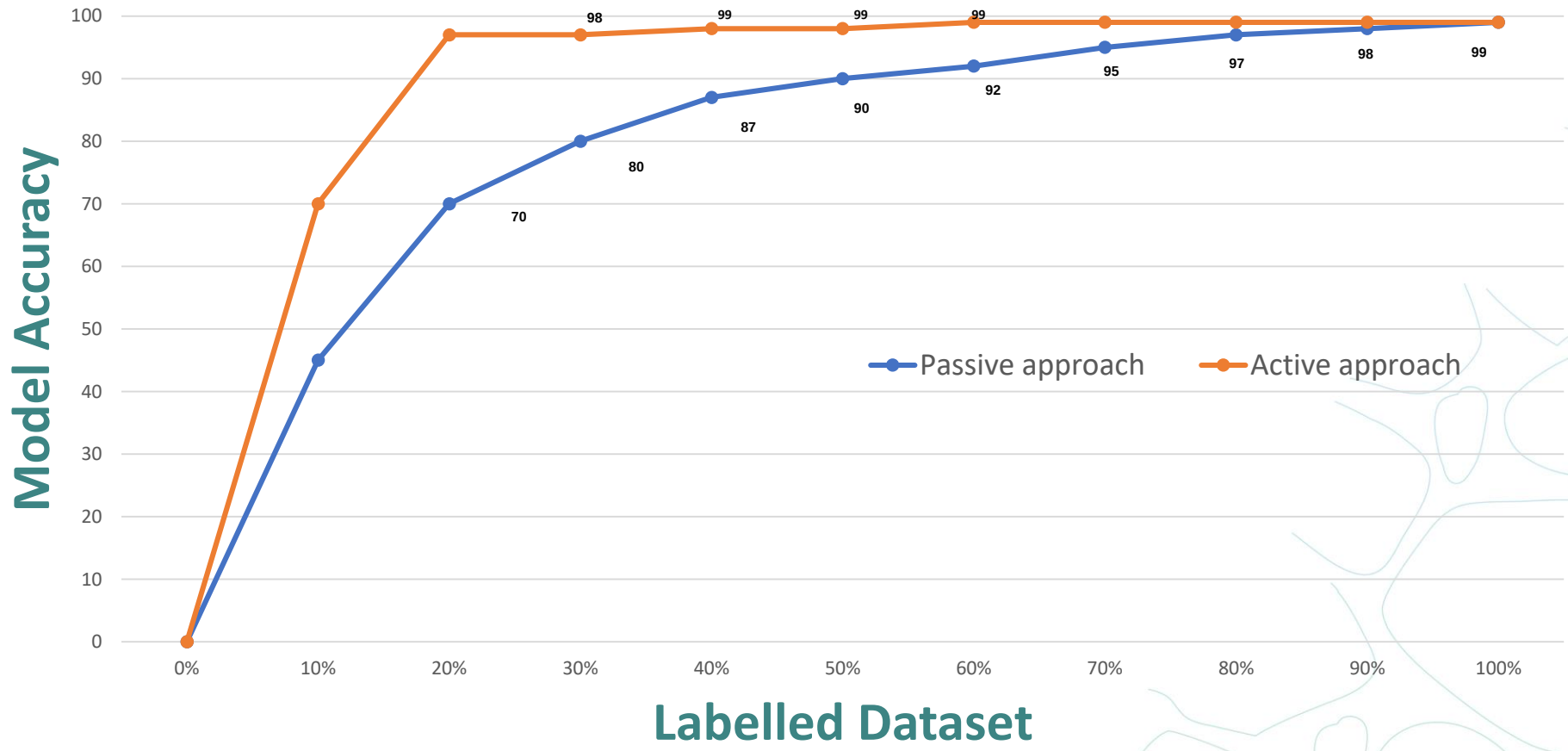


Optical Flow



Depth Map

Active Learning vs Passive Learning



Deep Learning Workflow

unlabelled raw data

Labelled Data

Training Dataset

Validation Dataset

Learn Deep Neural Network

Validate

Tuning & Adjusting Hyperparameters, Network Architecture ….

مـؤتـمـر عـجـمـان
الـدولي السادس للبيئة
Ajman 6th International
Environment Conference

AIEC2022
Ajman 6th International Environment Conference on
TOWARDS 2071 SHAPING THE FUTURE FOR ENVIRONMENTAL SUSTAINABILITY

Research Activities & Projects

Professorship of Computer Engineering
Faculty of Computer Science
Chemnitz University of Technology

International Computer Science
and Meeting Center Saxony
Stiftung Internationales Informatik- und
Begegnungszentrum Sachsen (IBS)

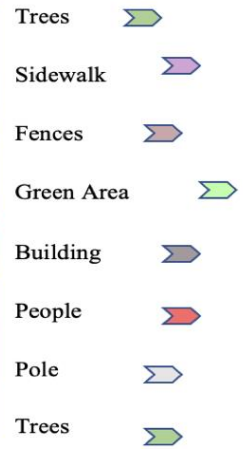
CE-Research Activities

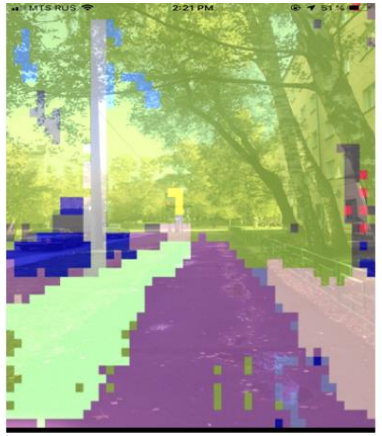
Collision Warning Based on Multi-Object Detection and Distance Estimation. ISCSET [October 2020], Mongolia.

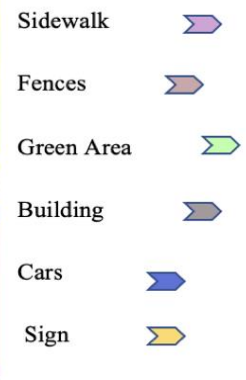
Traffic Signs Recognition and Distance Estimation using a Monocular Camera, IEEE [November 2019], Moscow.

CE-Research Activities

- Outdoor Navigation for Visually Impaired based on Deep Learning
  - Detect and segment important objects & obstacles with high accuracy in real-time with
  - Estimate the obstacles distance
  - Provide voice awareness



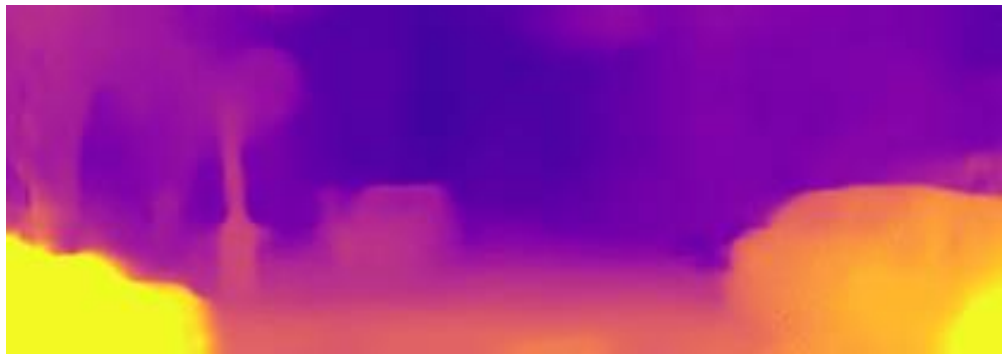




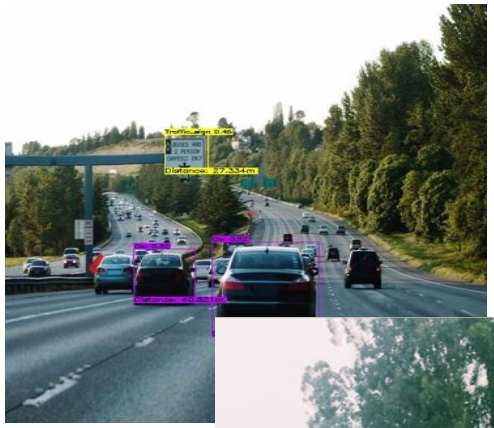
Outdoor Navigation for Visually Impaired based on Deep Learning , IEEE [November 2019], Moscow.

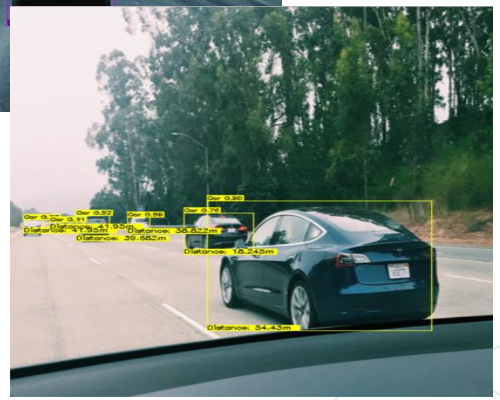
CE-Research Activities

- Develop an accurate, light model, and cost-effective approach to avoid the collision with real-time capabilities.



Towards Robust Perception Depth Information For Collision Avoidance, IEEE [December 2020], ARGENCON.



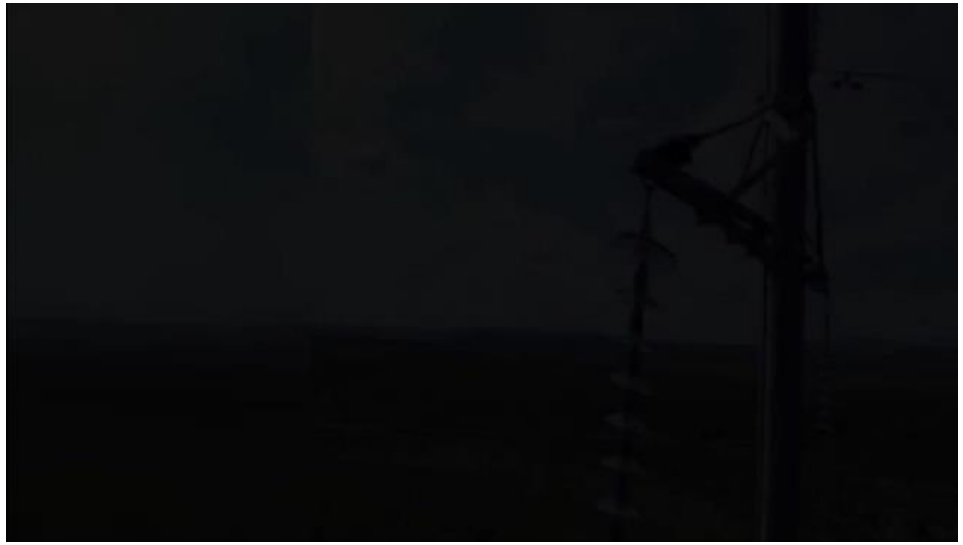


Robust Collision Warning System based on Multi Objects Distance Estimation, IEEE [April 2021], San Diego, CA, USA.

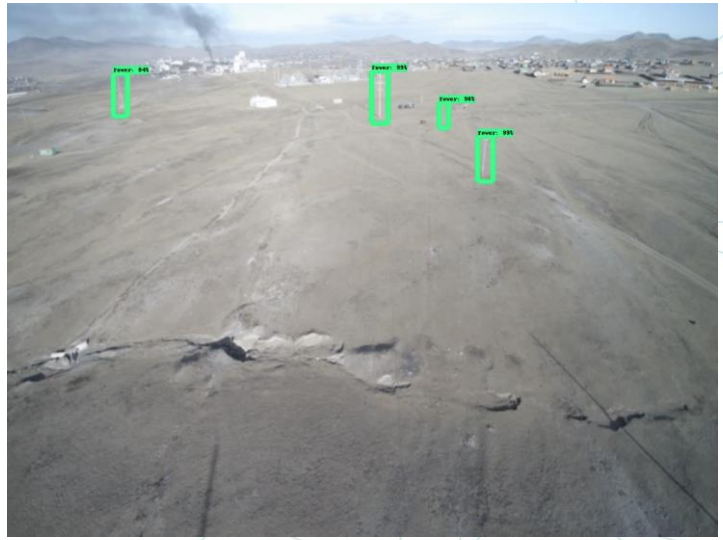
Vehicle Speed Estimation Based on Optical Flow. 2022, International Journal of Intelligent Transportation Systems Research

CE-Research Activities

- AI Algorithms for Industrial Flying Robot Inspections
- Automatic Detection of high voltage powerline insulators using a mounted camera on MAV



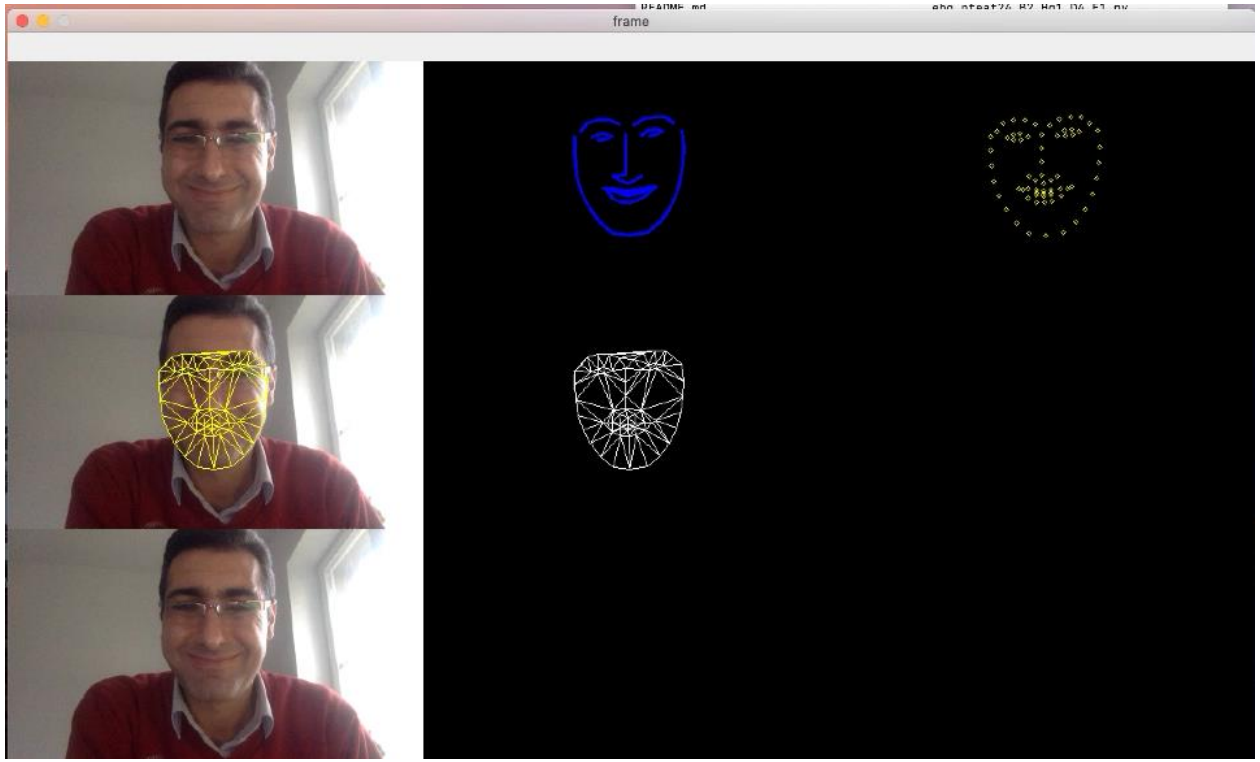
Insulator Recognition



Power-line Detection

CE-Research Activities

- Integration Eye Tracking with Facial Emotion Recognition



Conclusion

- Computer vision is a field of AI which aims to give computers a visual understanding of the world around them by image processing techniques.
- Machine vision is widely used in industry to analyze and inspect predictable or known events automatically.
- Deep learning techniques used in computer vision require a significant amount of computational power and massive data processing.
- Reduce the cost and time-consuming process of labeling training datasets and reduce the redundancy in training data,
- Improve the model training by better generalization

THANK YOU
FOR YOUR ATTENTION

M. Sc. Shadi Saleh

Email shadi.saleh@informatik.tu-chemnitz.de
ORCID https://orcid.org/0000-0001-5783-790X
Phone +49 371 531-34036
Fax +49 371 531-834036
Chair Website https://www.tu-chemnitz.de/informatik/ce/professur/professor.php.en
Researchgate https://www.ibs-laubusch.de/en/
Address Chemnitz University of Technology
Faculty of Computer Science
Chair of Computer Engineering
Straße der Nationen 62 | R. 1/019
D-09111 Chemnitz