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Environment Conference

SUSTAINABILITY

TOWARDS >>>
2071
SHAPING THE
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UNIVERSITY OF TECHNOLOGY
IN THE EUROPEAN CAPITAL OF CULTURE
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Environment Conference

INDUSTRY 4.0 – CHALLENGES AND CHANCES FOR SMART CITIES

Prof. Dr. Dr. h. c. Wolfram Hardt

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SUSTAINABILITY

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

IBS
Foundation

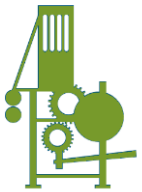
Introduction

Chemnitz University of Technology, Germany

Agenda

- How do you define Industry 4.0 ?
- What is the technological basis ?
- Challenges / Chances ?

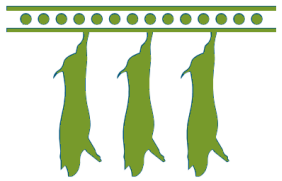
Industrial Revolution - History



Mechanical Production

1784

1.0



Mass Production based on Electricity

1870

2.0

IT based Automation of Production

1969

3.0

01001101101

Digitalization of Production and Processes

2010

4.0

Industry 4.0

- **Revolution**
  - Do the same thing as before in a **completely new way**
  - Much more **productivity**
  - New **products**

- **Digitalization of Production and Processes**
  - Digital Network
    - connects in Real-Time (online)
    - Machines, Objects,
    - Humans, Processes

Industry 4.0 is increasing Productivity

- **Global networks introduce decentralized optimization**
  - ➢Load balance between production locations
  - ➢Intelligent coordination of production phases
  - ➢Management of supply chain

- **Global networks introduce integrated processes**
  - ➢Handling of orders
  - ➢Handling of payments
  - ➢Customer communications

Agenda

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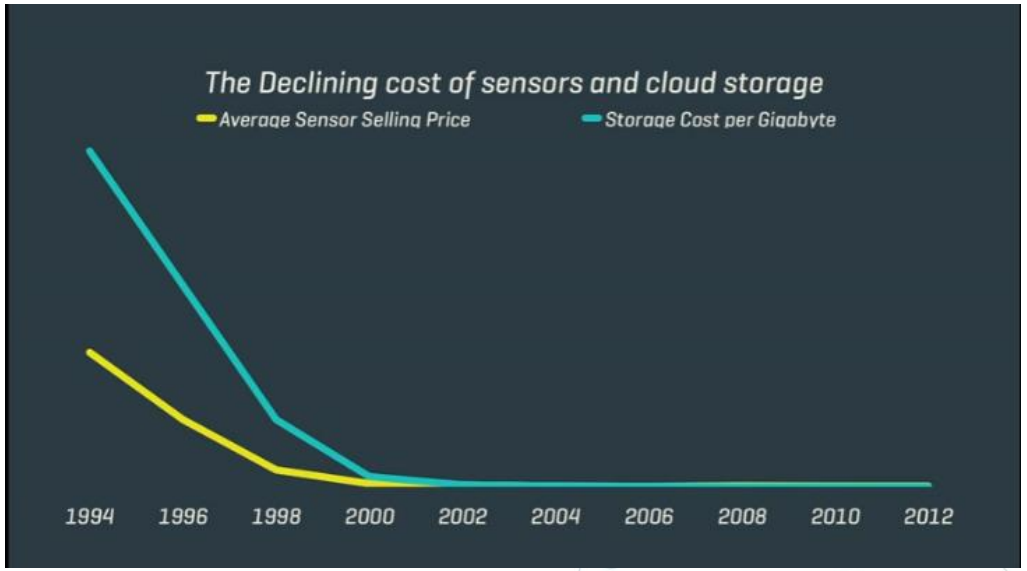
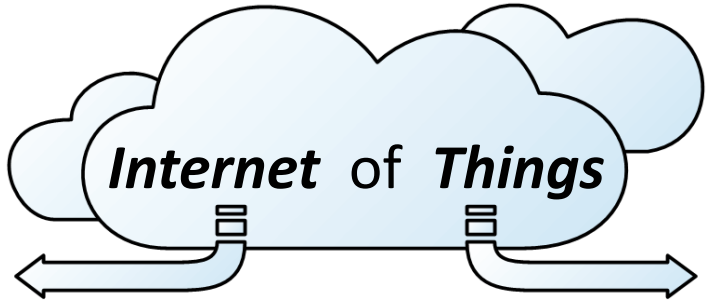
Technological Basis: Sensory

- Sensory
  - To see
  - To listen
  - To feel



- Technological basis for new system's perspective
  - Systems become reactive
  - Systems become forward-thinking
  - Systems become social

Technological Basis: Network Technology



Interaction

- Communication
  - RFID, NFC
  - Bluetooth (Low Energy), Zigbee
  - Internet / WLAN / Cloud
- Smart devices
  - Data handling
  - Additional functions

Application

- Automation of buildings
- Wearables
- Automated service processes
- …

Network Technology: RFID / NFC

- RFID: Radio Frequency Identification
  - ➢Wireless identification / localization
  - ➢Transponder with readable data

Frequency	Typical distance	Data rate
LF 30-500 kHz	< 1 m (passive)	low
HF 3-30 MHz	< 1 m (passive)	middle
UHF 433, 850-950 MHz	3-6 m (passive)	high
SHF 2.4 – 2.5, 5.8 GHz)	~ 10 m (active)	high

- NFC: direct data transmission based on RFID

Network Technology: Bluetooth (Low Energy)

- Technique:
  - Frequence: 2.4 GHz
  - Bitrate: 1.0 Mb/s
  - Max. power: 10 mW

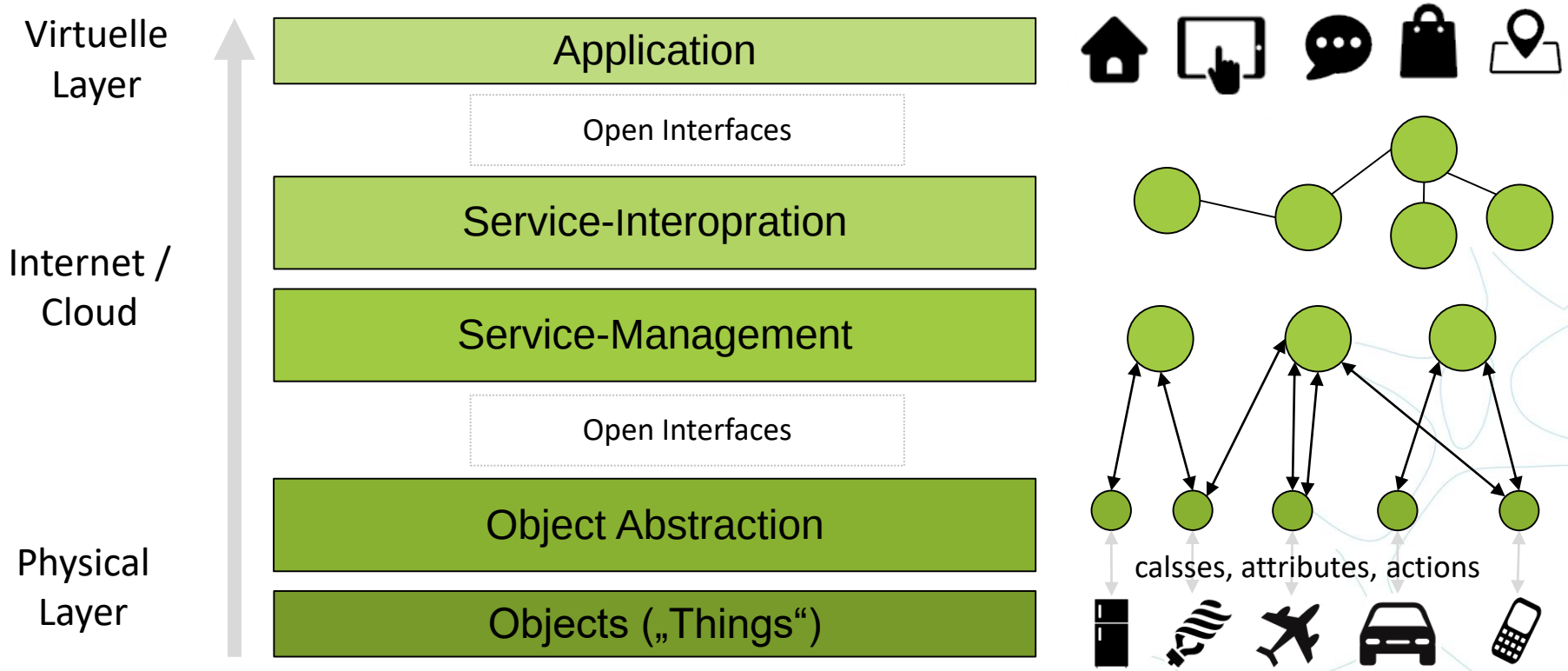
Bluetooth® SMART

- Interconnection / communication by configured profiles

- Benefits:
  - Highly energy efficient
  - Ideal suited for communication in WSN: wireless sensor network

Network Technology:
Interoperability of Heterogeneous Networks

Technological Basis: Software Layer Model



Agenda

- How do you define Industry 4.0 ?
- What is the technological basis ?
- Challenges / Chances ?

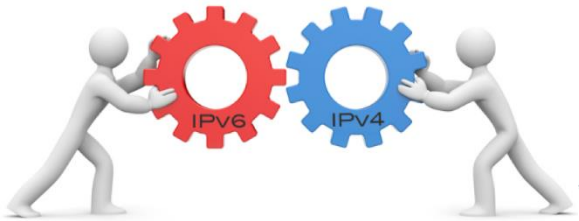
Challenge I

- **New, feasible solutions needed for:**
  - ➢Guarantee of data privacy
  - ➢Guarantee of data security

- **Examples:**
  - ➢Who gets to know were I am going?
  - ➢Who gets to know, if my product had a failure before?
  - ➢Hacking attacks?

Challenge II

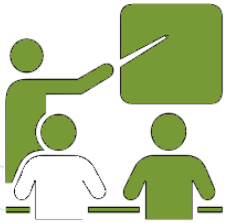
- **Adaptation of production processes:**
  - ➢Interconnection of machines
  - ➢Management of decentralized data
- **Adaptation of network technology:**
  - ➢IPV4 → IPV6
- **Adaptation of working process:**
  - ➢Where do I get information?
  - ➢When have I to present for work?
  - ➢Hacking attacs?



Challenge III

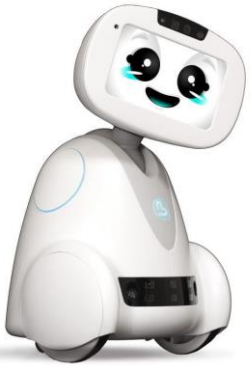
- **Qualification of ITK staff**
  - ➢Implementation of network, server, cloud
  - ➢Implementation of services, applications

- **Qualification of production and administration staff**
  - ➢Data organization
  - ➢Data management
  - ➢Software services and application



Chances:
Industry 4.0 is introducing new Products

- **Products due to Industry 4.0**
  - ➢Mobile devices
  - ➢Network Technology
  - ➢Internet of Things – Technology
  - ➢**Mobile applications**: mobile Robots, mobile assistant system

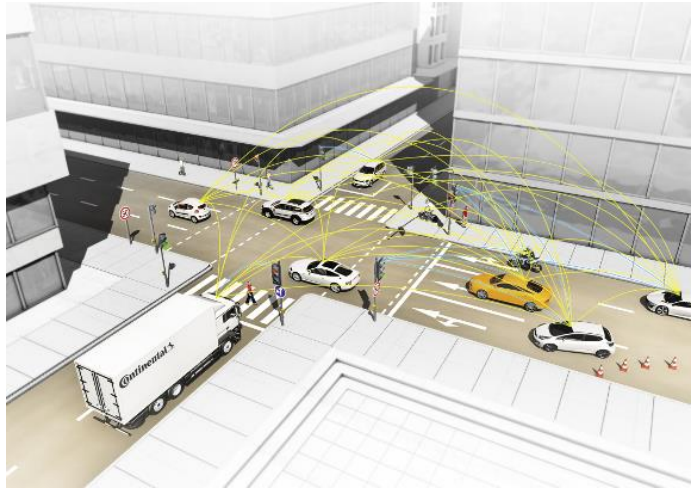


- **Services needed to handle Industry 4.0**
  - ➢Education for workers and leaders
  - ➢Process implementation
  - ➢ITK maintenance

Application Domain: Smart City

- Sensor network,
  e.g. for maintenance
- Building control
- Car2X

Quelle: Siemens AG



Quelle: Continental AG

Quelle: ProDomus; http://www.prudomus.de/hausautomation/


10%
Of flight delays
$8 Billion
In additional costs


7 Million
passengers at their destinations on-time


5 cents
per KWH

Industry 4.0 for Smart City in Germany

- **Future Trend**
  - ➢Research, analysis, suggestions by BITKOM, Fraunhofer, et.al.
  - ➢Building up central competence centers

- **Increase of Productivity (aggregate value added)**
  - ➢6 areas of business have been analyzed
    - Increase of 78 Bil. Euro until 2025
    - Increase of 1.7% until 2025
  - ➢Mechanical and plant engineering:
    - Increase of 23 Bil. Euro until 2025
    - Increase of 2.2% until 2025

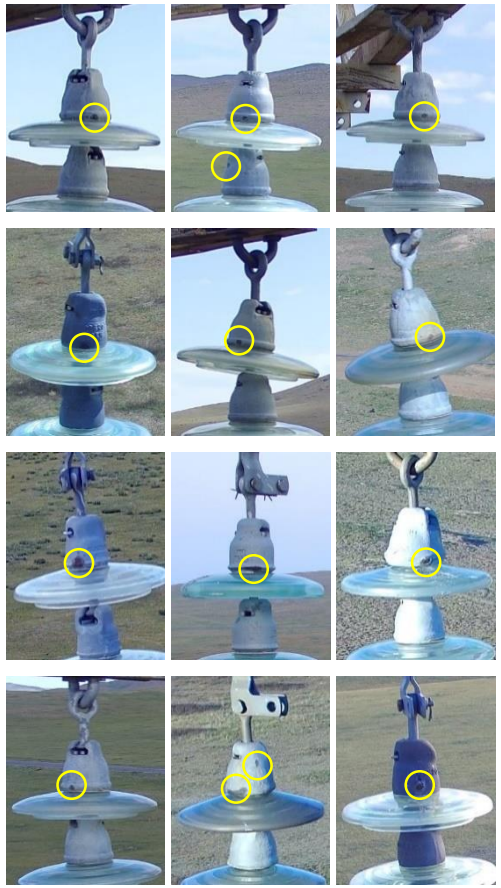
TUC Projects for Smart City Applications

- Automated Micro Air Vehicle Inspection (APOLI)
  - Vision-based drone mission
  - Automated inspection
    - Electric power transmission systems
    - Buildings and facilities
    - Trains and wagons
  - Digital data
    - Transfer to Cloud system
    - AI-based analysis

TUC Project: APOLI

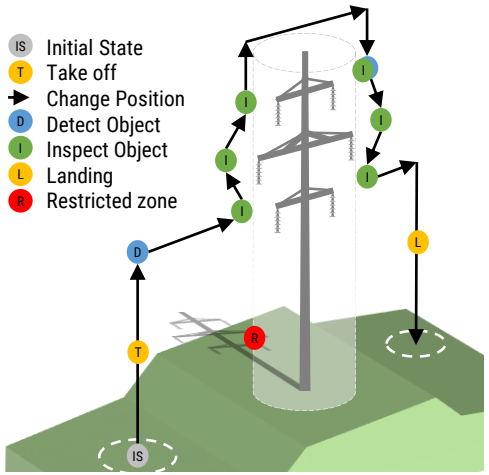
Motivation:

Damaged Insulators

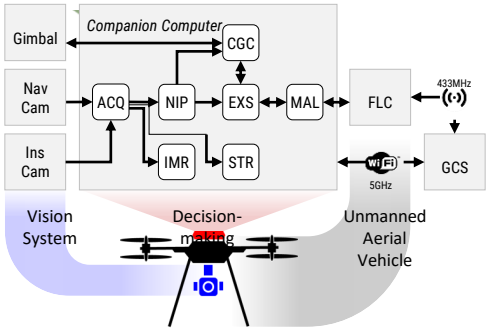


Concept:

Autonomous Mission

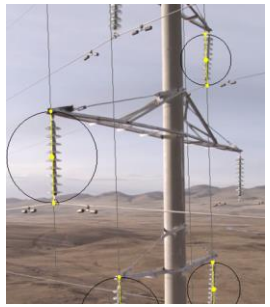


UAV Architecture

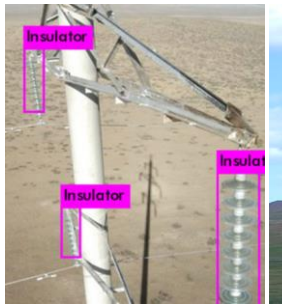


Ongoing Results:

Image Processing



Classical IP based Insulator Detector



AI based Insulator Detector

AI based Burn-mark Detector

Autonomous UAV

Research Field:

1. *Image Processing*
2. *Decision-making*
3. *Unmanned System*
4. *Autonomous Flight*

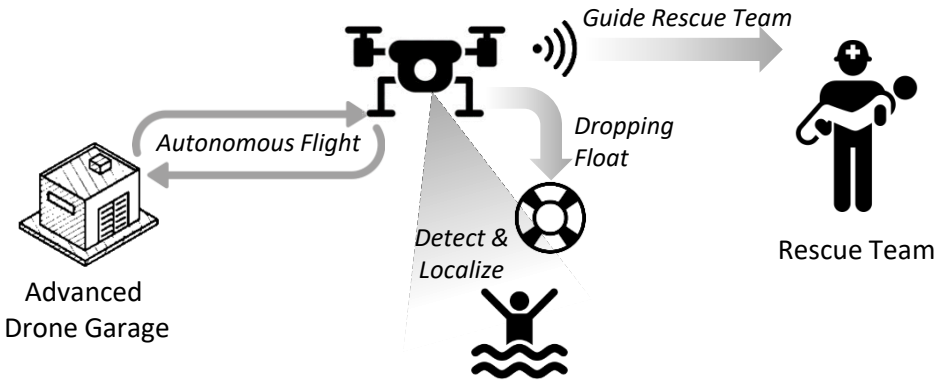
Partners:

- *TU Chemnitz (Germany)*
- *National Power Transmission Grid Ltd (Mongolia)*
- *Mongolian University of Science and Technology*

RescueFLY

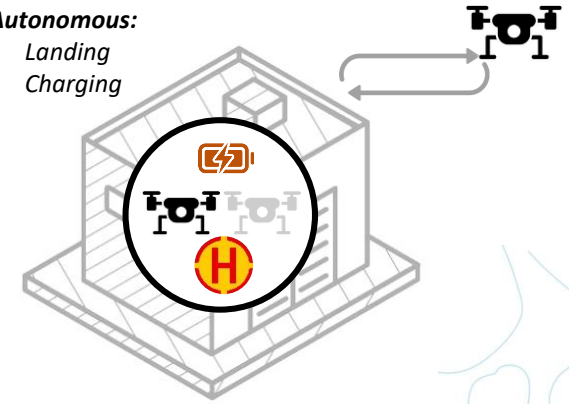
Cross-county / cross-state prevention and rescue using drones in Lusatia

Planned Rescue Process



Advanced Drone Garage

Autonomous:
- *Landing*
- *Charging*



- *Shorten the time for water rescue*
- *Dropping floats early*
- *Navigating rescue forces to the casualty*

- *Retractable landing platform*
- *Multiple docking stations*
- *Automated drone monitoring and loading*

Partners:
- Björn Steiger Stiftung (BSS)
- Brandenburgisches Institut für Gesellschaft und Sicherheit (BIGS)
- Brandenburgische Technische Universität Cottbus-Senftenberg (BTU)
- Technische Universität Dresden (TUD)
- Technische Universität Chemnitz (TUC)
- THOLEG Civil Protection Systems
- DRONIQ

Research Field:
1. *Unmanned System*
2. *AI based Image Processing*
3. *Decision-making*
4. *Autonomous Landing*
5. *Robotics*

TUC Research

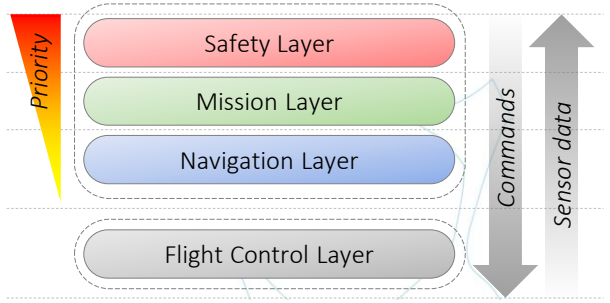
Adaptive Research Multicopter Platform (AREIOM)

Research activities:

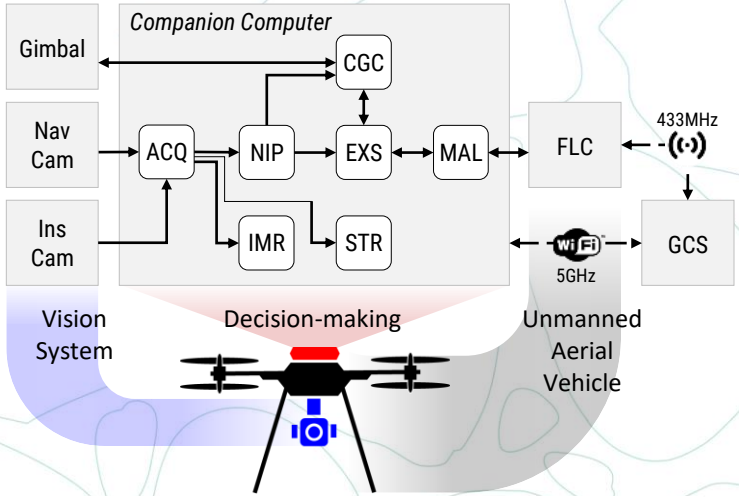
- On-board real-time data exploitation of high-resolution mission sensor systems
- Decision making and active perception for navigation and automated mission execution
- Hardware-software-co-design for reliable flight control and multi-sensor signal processing
- Mission safety supervision to guarantee anytime safe autonomous mission execution

Application:

- Vision-based inspection of wind turbines, photovoltaic systems, and power transmission lines
- Aerial photogrammetry (2D/3D building/object reconstruction, area documentation)
- Exploration and surveillance of large-size areas or regions with hard accessibility
- Disaster and emergency relief (e.g., flooding, forest fire)
- Transportation of lightweight goods and payload (e.g., small parcels, medicine)



AREIOM Layered Architecture

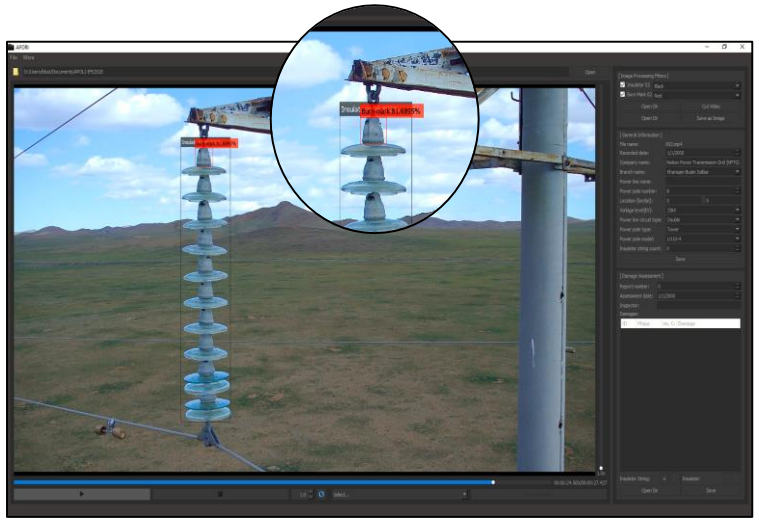


Software and Hardware Architecture

TUC Research

Intelligent Frame Extractor (IFE)

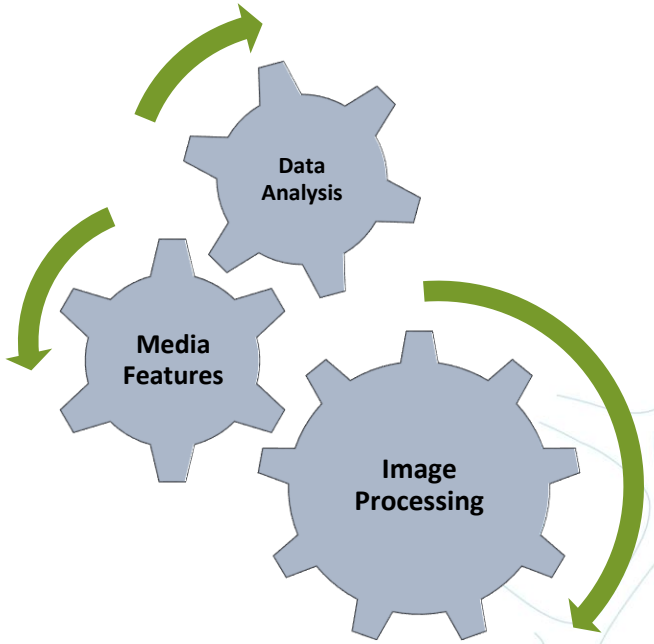
On going results:



Motivation:

- Post-processing support for different projects
- Visualisation of video datasets
- Support visualization of different computer vision methods

Concept:



Data Analysis:

- Serialization of Detection Results
- Data Visualisation
- Generation of inspection reports

Media Features:

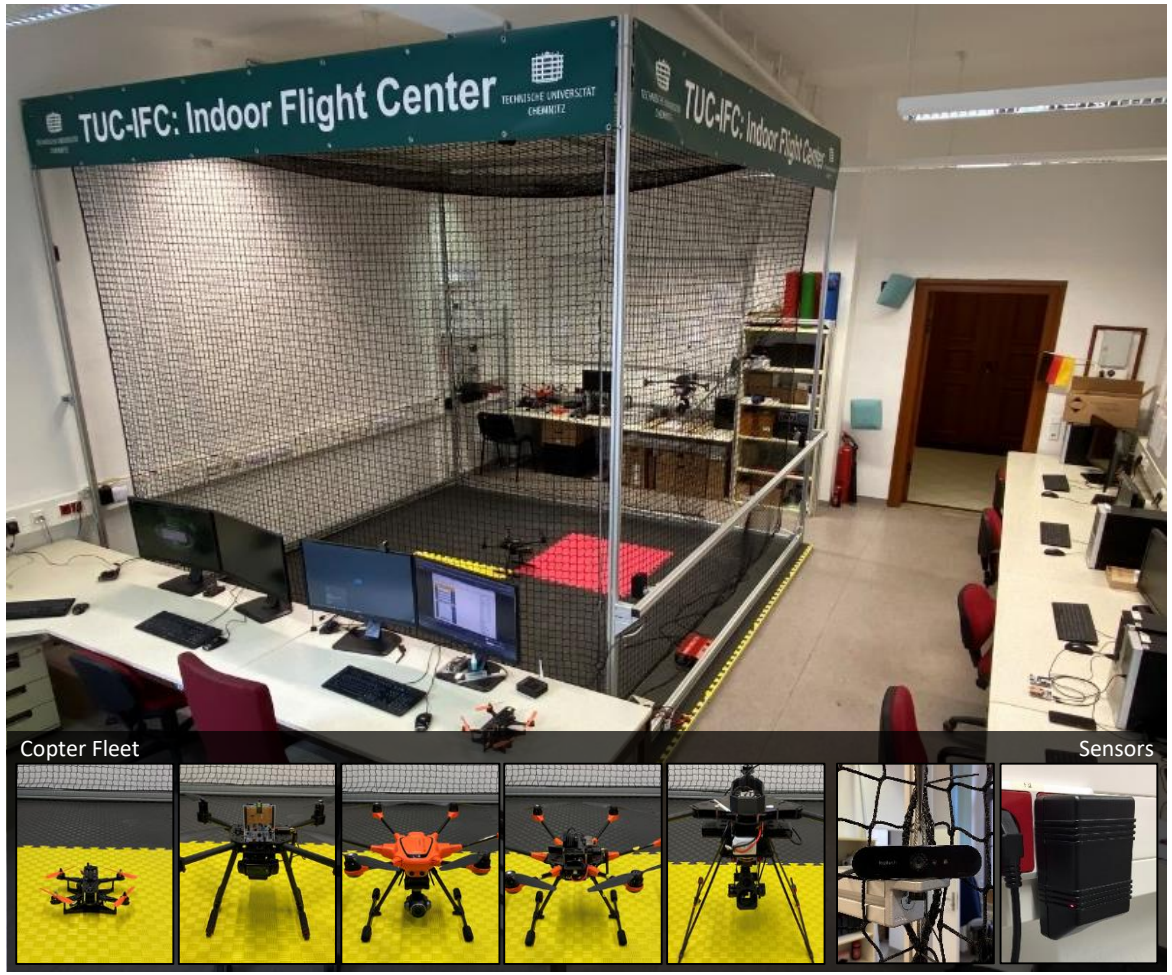
- Playback
- Zoom feature

Image Processing:

- Supported Methods:
  - Conventional methods
  - AI-based methods
- C++/Python support

Indoor Flight Center (IFC)

Semi & interactive real-world environment



Goal:

- Developing unmanned system
- Developing autonomous missions
- Safe indoor flights
- Investigate and explore multiple AI-based methods

Flight Cage:

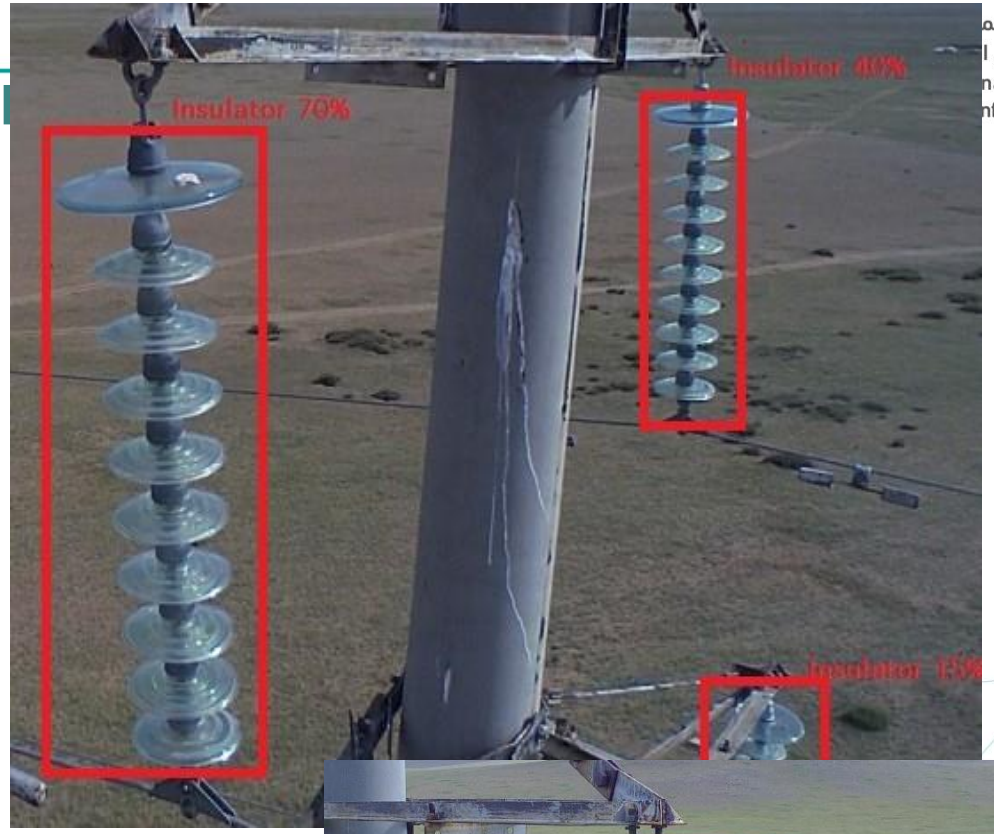
- Flight area: 4.0 x 4.0 x 3.8 m
- Equipped with:
  - 4K cameras (x3)
  - Indoor Real-time Location System (UWB based)
  - Protection net
  - Soft landing mat
- Copter fleet: 5 different copters

TUC Project

Intelligent Frame Extr

AI based Image Processing

- Manual inspection led to these drawbacks:
  - Time Consuming
  - Life Threatening
  - Large Capital needed
- Artificial intelligence and algorithms bring MAVs inspection breakthrough
- AI Visual defect inspection based on machine learning and computer vision techniques is employed for the defect and mismatch assessment.
  - Automatic Detection of high voltage powerline insulators using a mounted camera on MAV



Professorship

- Head of Computer Engineering Chair
- Director of Foundation International Computer Science- and Meeting Center Saxony (IBS)
- Successfully completed Ph.D. and habilitation:
- Experience:
  - 20 years of experience in research, teaching, doctoral education
  - supervisor Ph.D. & postdoc candidates
  - 15 years as director of the University Computing Center
  - 12 years as dean of the Faculty of Computer Science at the Chemnitz University of Technology

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THANK YOU
FOR YOUR ATTENTION

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