Bessere Entscheidungen treffen – mit KI

Hoch-automatisierte Erkennung von Müll auf Meeren und Flüssen

7. Gemeinsame Tagung Fernerkundung DGfG & DGPF
Heidelberg, 5.10.2018

Ralph D. Humberg

eCognition®

Trimble®
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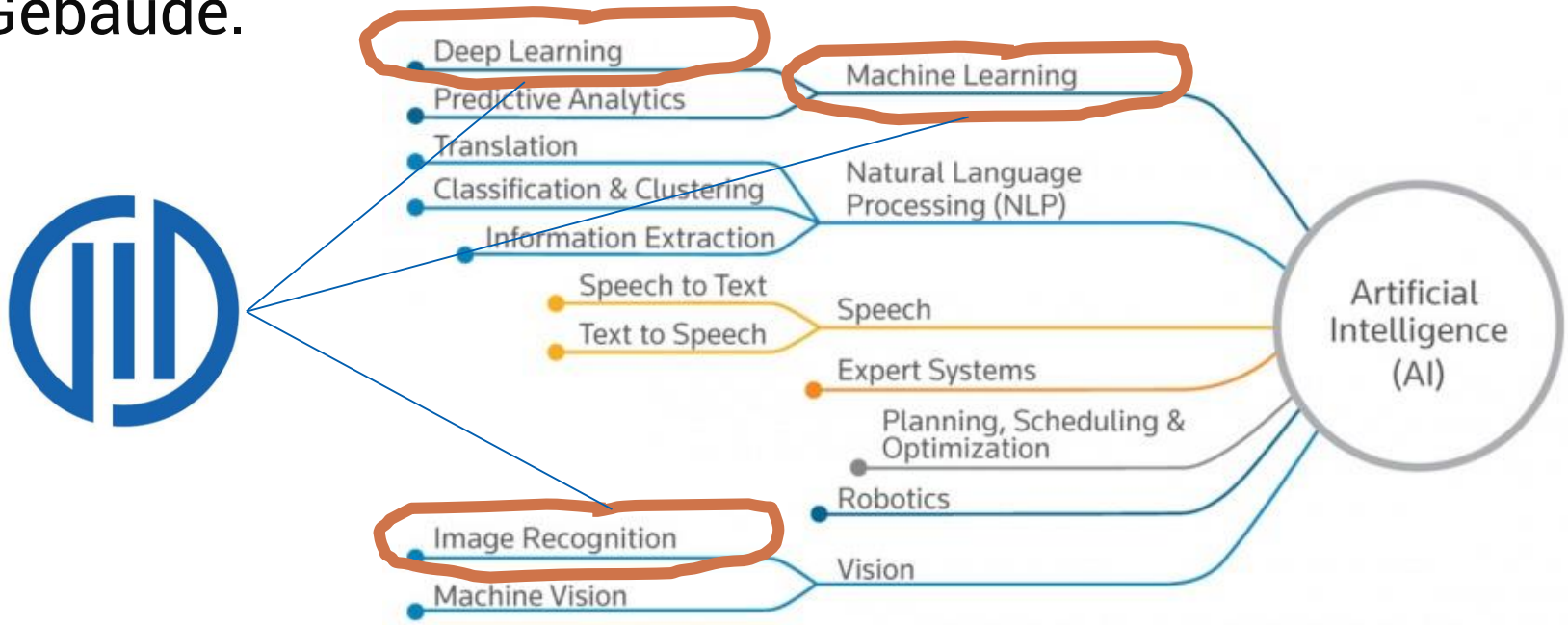
TAMA GROUP

Die technische Welt wird „smarter“

vor allem durch künstliche Intelligenz, im Web, im Auto, im smart phone, in der Sensorik, in der Software, im Gebäude.



Wir betrachten KI vor allem für B-B und B-G Anwendungen von langlebigen Wirtschaftsgütern. Das ist Technik, die Fachleuten hilft, ***bessere Entscheidungen*** *zu treffen. Unsere technologische Basis kommt aus der Fernerkundung und den Lebenswissenschaften*

Wenn Verantwortliche von langlebigen Wirtschaftsgütern immer aktuelle Zustandsinformationen haben…

…fehlende Markierungen…

…Risse im Beton…

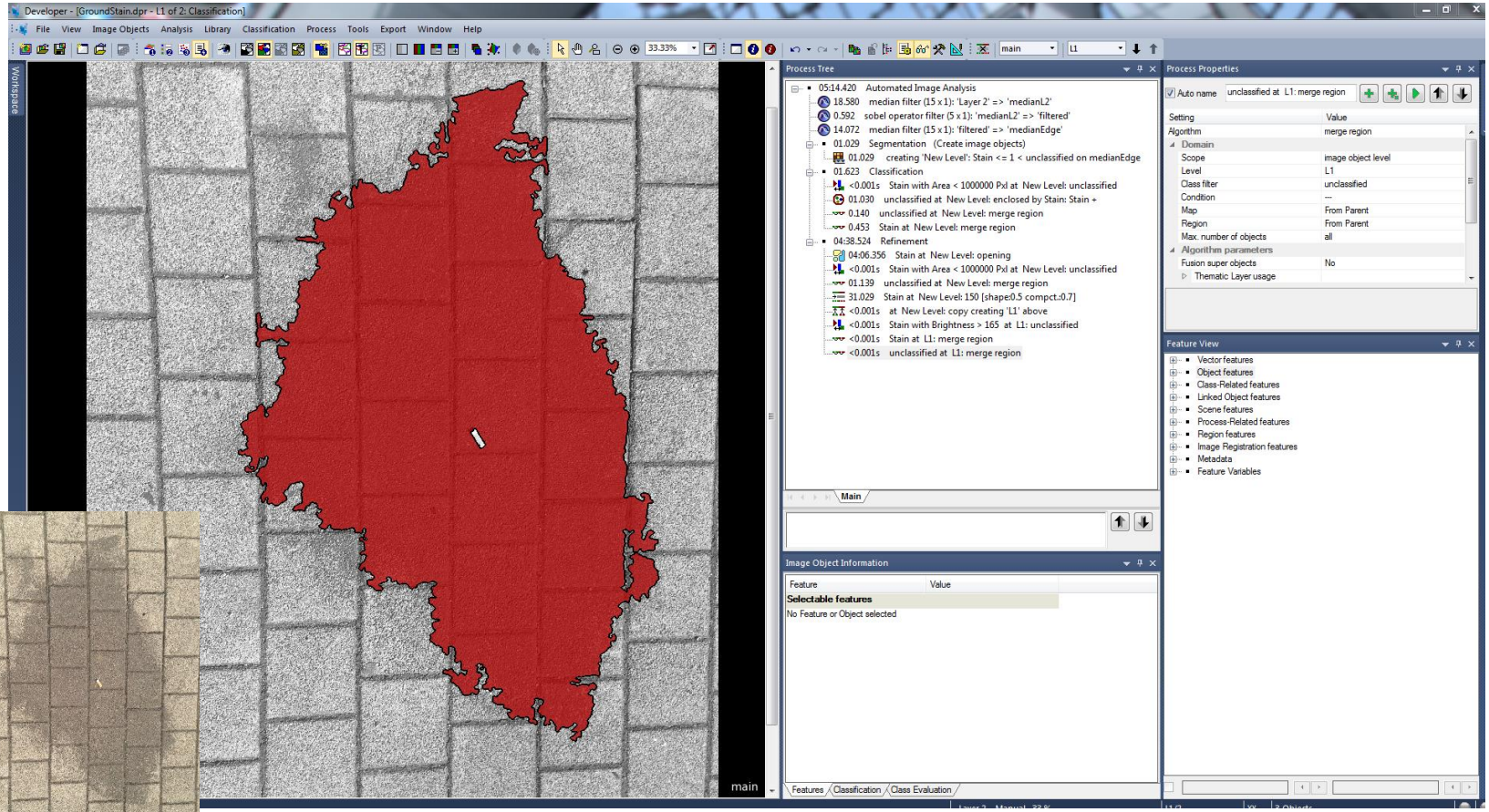
…schlecht schließende Fenster…

…Borkenkäfer…

…große Wasserpfützen…

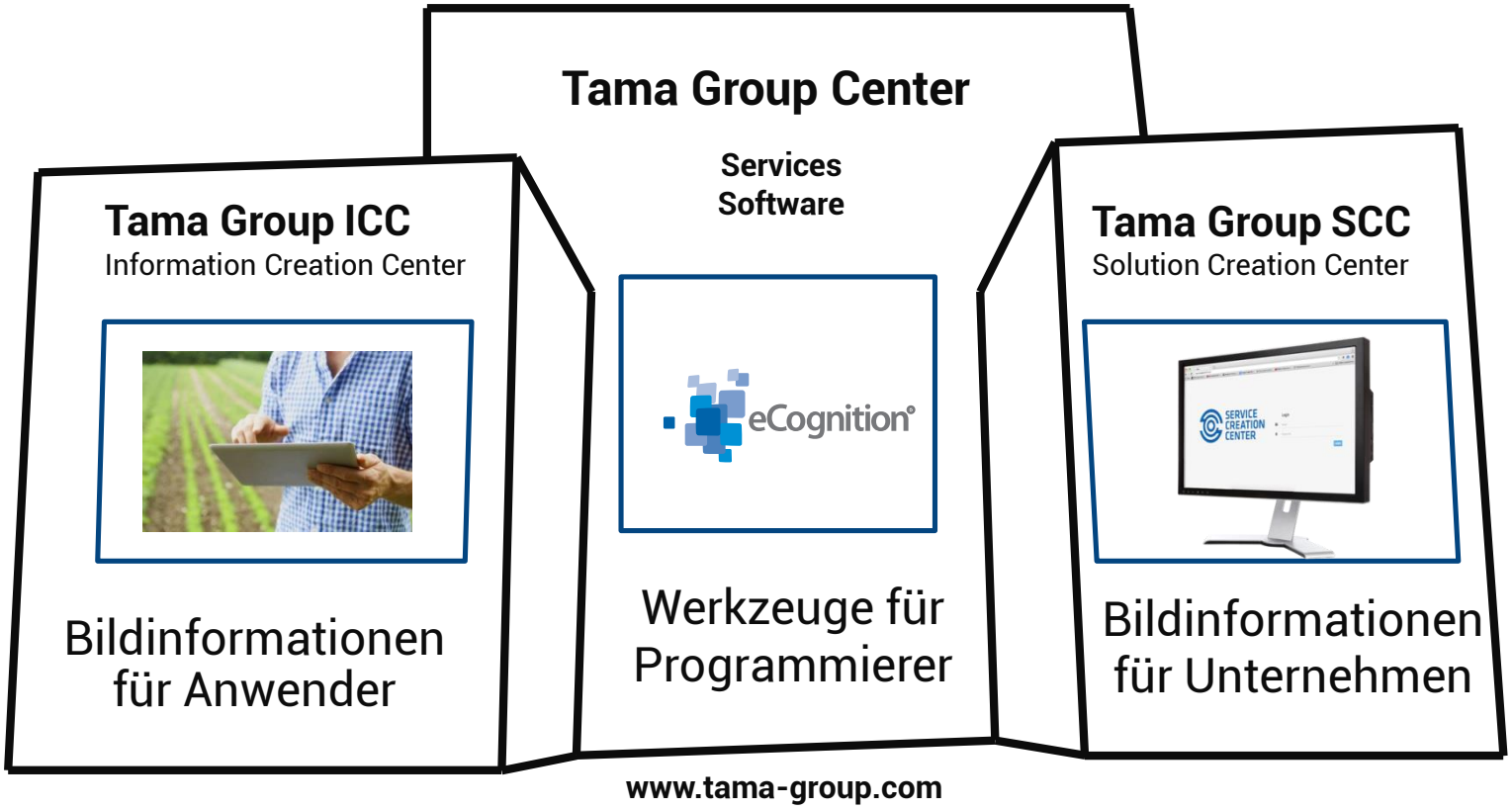
- ..dann sind diese weit kostengünstiger und effizienter zu betreiben, insbesondere durch
  - **Prädiktive Wartung,** statt teurer reaktiver Wartung,
  - **Präzises Eingreifen:** nur dann und dort wo nötig (z.B. Chemikalien nur dort wo Unkraut wächst, und nicht überall)
  - **Design für reale Nutzung:** wenn man die reale Nutzung permanent analysieren kann, kann man sich auch sparen, überall Extrareserven vorzuhalten, die mehr stören als helfen

Tama‘s Informationsextraktion mit eCognition findet, was Sie sonst nur mit dem Auge sehen, und zählt, misst, erfasst



Die Tama Group

Informationsextraktion, vor allem aus Bildern, für bessere Entscheidungen bei Wartung und Nutzung langlebiger Wirtschaftsgüter



Highly Automated Beach Litter Detection
Maritime case study

BEACH LITTER

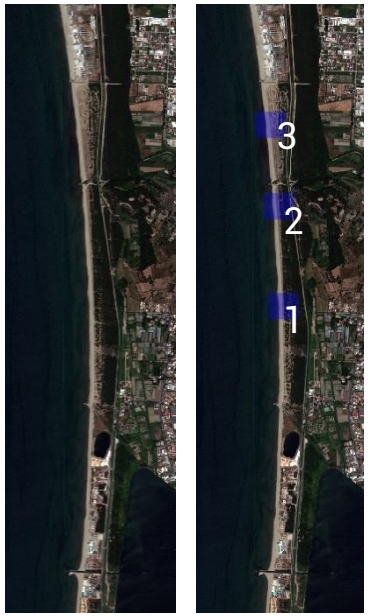
River Litter
Sea Litter
Modules

TAMA library

TAMA GROUP

Highly Automated Beach Litter Detection

Worldview-III scene
2017-05-31



Target regions

EUSI Images

Pansharp

Export of results
(.shp/.jpg/.tiff)

Aggregation within
spatial entities
(Litter per entity)

Feature extraction
(Litter-candidates)

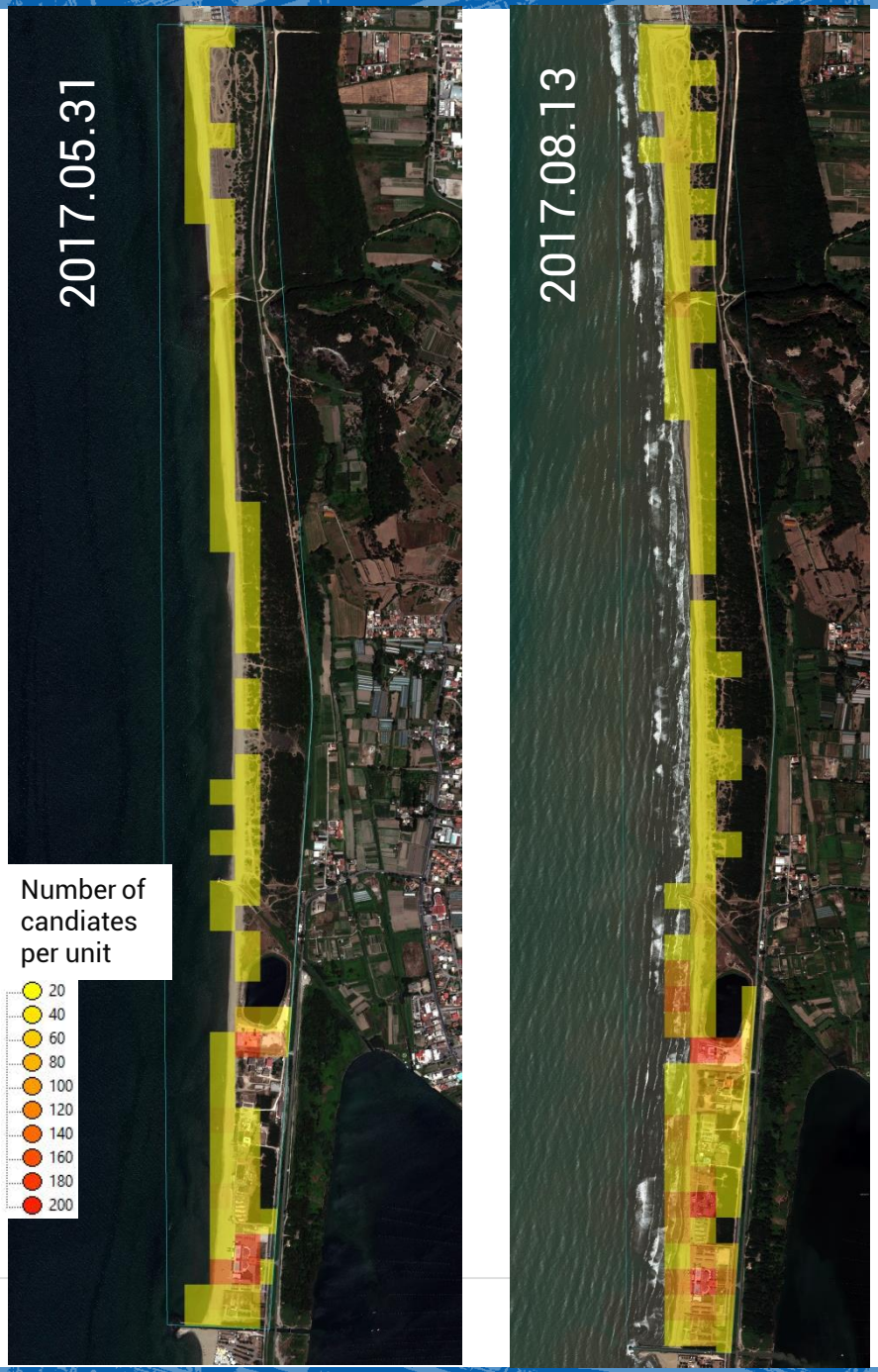
eCognition

Density
map for
indication

Results: Worldview-III scene August 13, 2017 – Region 1

Beach Litter Analysis

- Case built by comparison of May to August 2017
- Since the target objects‘ size is in the same order of magnitude as GSD, we are analysing by a candidate density approach
- In situ knowledge will drive service quality further up
- Candidate density mapping can be done fully automatically



imagery from EUSI, Munich

Automatische Mülldetektion auf Flüssen

Imagery from JRC, Ispra

European Commission

JRC LITTERCAM for monitoring of riverine floating macro litter

Georg Hanke[1], Daniel Gonzalez [2], Fritjof Luethje[3]
[1]European Commission Joint Research Centre, Ispra, Italy, [2]University of Cadiz, Cadiz, Spain, [3]TAMA group, Munich, Germany

The European Commission Joint Research Centre JRC is providing support to the implementation of the Marine Strategy Framework Directive and is therefore also studying methods for the quantification of riverine litter flows to the seas (TG Marine Litter 2017). Quantification of macro litter flows in riverine systems is of importance for management purposes and prioritization of policy actions, as the proportion of litter reaching the sea from inland through waterways are not known.

Within the RIMMEL (RIverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading) project, an observation network by human observers on 52 rivers was set-up and operated for 1 year (Gonzalez, 2017). While this has provided an overview about surface floating macro litter in riverine systems, a continuous observation method is needed for the observation of short term variability and peak events. Therefore a camera system with automated image analysis was set-up, as a further development of the JRC SEALITTERCAM (Hanke, 2014).

The JRC LITTERCAM system:
- High resolution (5120 x 5120 pixel) digital industrial camera (SVS-VISTEK) installed in a watertight housing
- Industrial computer with 1 TB SSD and power supplies for periphery are installed in a splashproof box
- Sensor array system (Thies Clima) and GPS sensor provide weather condition, light and geographic coordinates.
- Manual focus 50 mm Zeiss lens at aperture 1.8. The camera is pointed perpendicular downward to the water surface
- Images are aquired at a frequency of 1/second, resulting in 3600 images/hour and are stored as jpg files for later off-line analysis.

Littercam deployment

Following first tests on the Ticino and Magra River, the camera was deployed on a bridge across the River Po in northern Italy, close to Piacenza from 10.11.2017 to 15.11.2017. The camera was installed under the bridge on a gangway, at a height of 14 m above the water, resulting in a coverage of 6.5 x 6.5 m water surface and a resolution of ca. 8 pixel/cm.

The system was continuously operational, image aquisition was triggered by a light sensor, resulting in image data from ca. 7:00 – 8:00 to 15:00 – 17:00 on different days, for a total of 49 hours during the deployment period.
The resulting ca. 170000 images have been transferred with an external HDD to a dedicated work station for image analysis and automated detection of floating objects. Each image file is accompanied by a metadata file with information on image aquisition, light conditions, and geographical coordinates.

Image analysis

Object based image recognition using ECOGNITION software (TRIMBLE) was employed in order to identify floating objects on the water surface and to verify their occurence in a multiple step approach. A INTEL XEON CPU E5-2650 v4 12 core, 64 GB RAM workstation (FUJITSU) provided the computing power for the image analysis.

The specifically developed ruleset (TAMA GROUP) identifies potential objects by comparison of a stacked image set with individual images. For each potential object candidate then the following two images are analysed for the occurence of that object in a distance, in river flow direction, that matches the river flow speed, previously calculated by the software. Once an object has been confirmed in two steps it is flagged as a final object candidate and provided with the two following images as output for a final manual check.

Stacking of 10 images Comparison with single image Confirmation in sequence

Screenshot of ECOGNITION software interface during analysis

Computing time averaged 30 hours for 1 hour of images i.e. 3600 images. Further optimisation of the ruleset parameters is ongoing. Encoding of the final ruleset in a dedicated application will reduce computing time drastically.

Outcome

Image aquisition by the LITTERCAM system proved operational and robust for long term deployment.
Image quality and resolution allows detection of objects down to few cm.
Environmental conditions require scrutining of image datasets.
Further work is required to optimize the Ecognition ruleset.
Long term deployment is planned for testing under various conditions.

Acknowledgements:
The authors thank Fausto Bonavitacola (PHOENIX) for engineering support in preparing the Littercam system. We thank Ralph Humberg (TAMA GROUP), and Christian Weise (TRIMBLE) for supporting the ECOGNITION ruleset preparation. We thank the Italian Road Authority ANAS (Caterina Mietner and colleagues) for the opportunity to install the Littercam on the Po river. Support by the JRC D2 IT Team, Carlo Landi and Alessandro Crespi is gratefully acknowledged as well as the help from Michela Ghiani and Irmi Henzel.

References:
- TG Marine Litter: Riverine Litter Monitoring – Options and Recommendations 2016, EUR 28307 EN
- Daniel Gonzalez, Georg Hanke, Towards a Harmonized Approach for Monitoring of Riverine Floating Macro Litter Inputs to the Marine Environment, Front. Mar. Sci., 28 March 2017
- Georg Hanke, Daniel Gonzalez, JRC Sealittercam, PERSEUS scientific workshop, 3.12.2014, Marrakech, Morocco.

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Joint Research Centre

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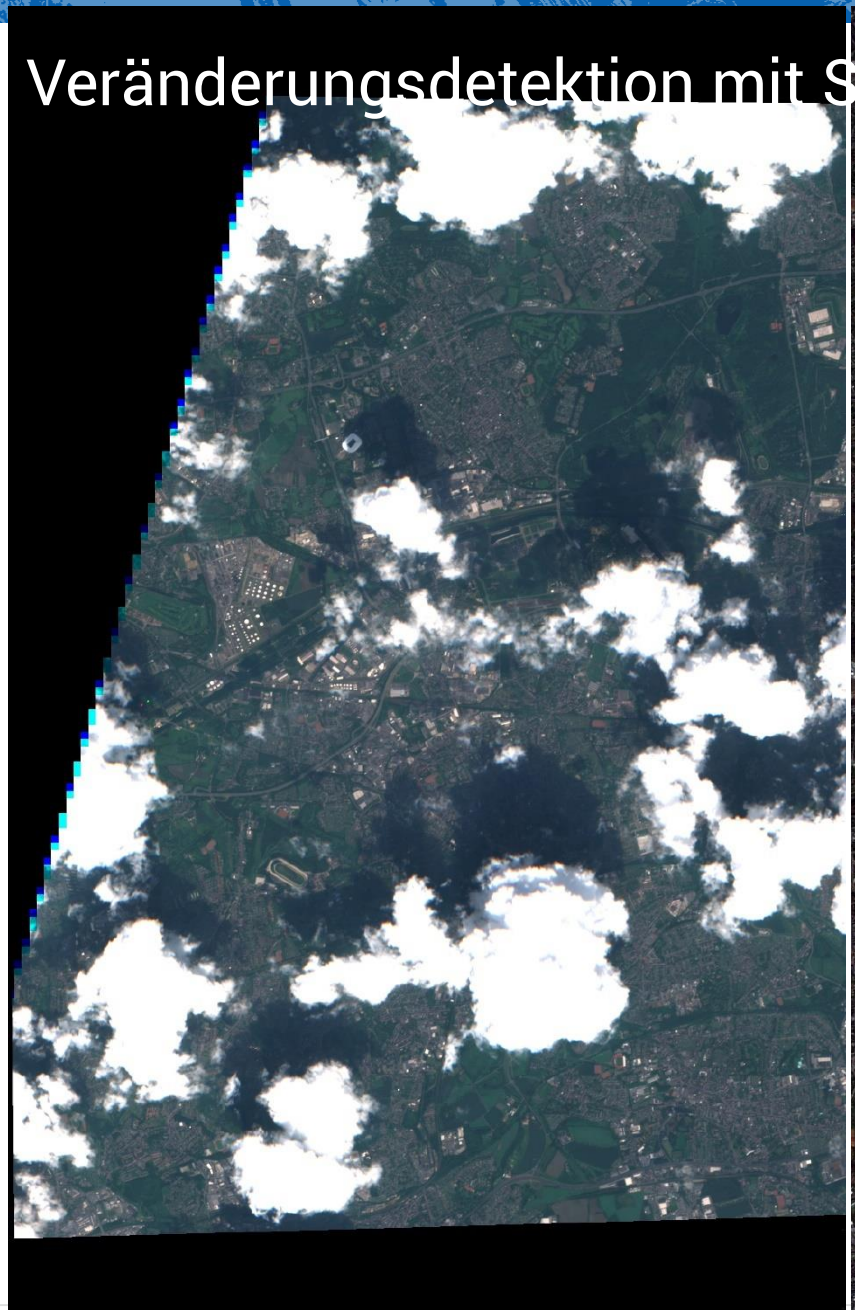
TAMA GROUP

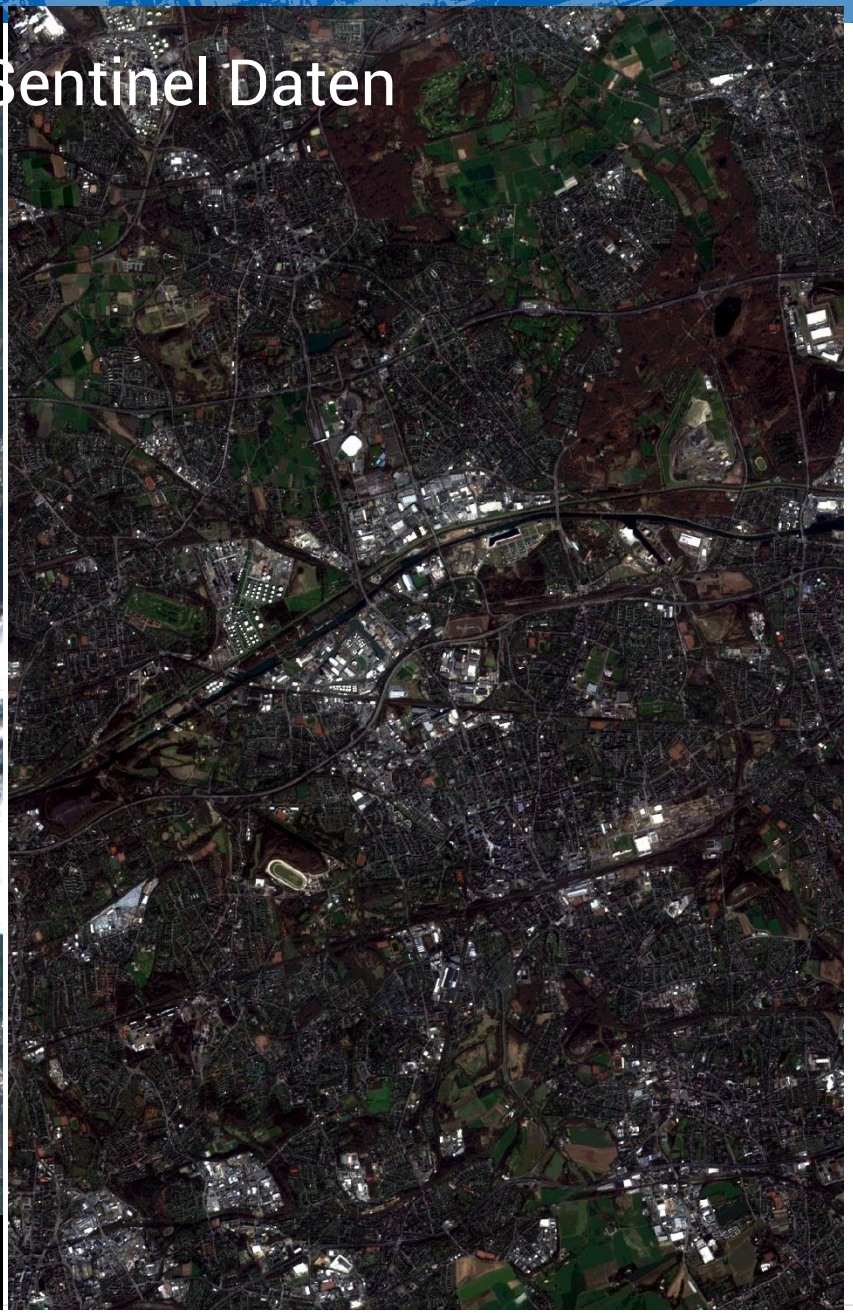
Anwenderdomänen und Sensorauswahl

Die Tama Group ist überall dort aktiv, wo Bilder im Einsatz sind

	Nutzungsbeispiele	Bau-ingenieur	Geo-Experte	Umwelt-Experte	Forst-Experte	Agronom Landwirt	Weitere Domänen
	Satelliten	Planung	Fern-erkundung	Kartierung	Kartierung	Erfassung	Verteidigung
	Luftbilder und Scans	Planung	Vermessung	Kartierung	Kartierung	Subventions-kontrolle	Portale
	Drohnen	Monitoring	Vermessung	Erfassung	Schaden-Erfassung	Schaden-Erfassen	Verteidigung
	Mobile Messsysteme	Erfassung	Vermessung	Erfassung	Forstwege	Höhen-modelle	Eisenbahn
	Bodenradar	Strassen	Vermessung	Minensuche	Boden-analyse	Erden-Analysen	Archäologie
	Digitalcameras	Erfassung	Doku-mentation	Erfassung	Erfassung	Schaden-erfassung	Polizei
	Präzisionsmessysteme	Bilder zur Dokument.	Bilder zur Erfassung	Ver-änderungen	Gelände-modelle	Grundstücks-grenzen	Tektonik
	Smartphone	Ergänzung	Ergänzung	Erfassung	Erfassung	Erfassung	3D-Modellierung
	Bildgebende Spezial-Sensoren	Ultraschall, Infrarot	Alles mögliche	Sensor-Netze	Hyper-spektral	Multi-spektral	Wissen-schaft

Veränderungsdetektion mit Sentinel Daten





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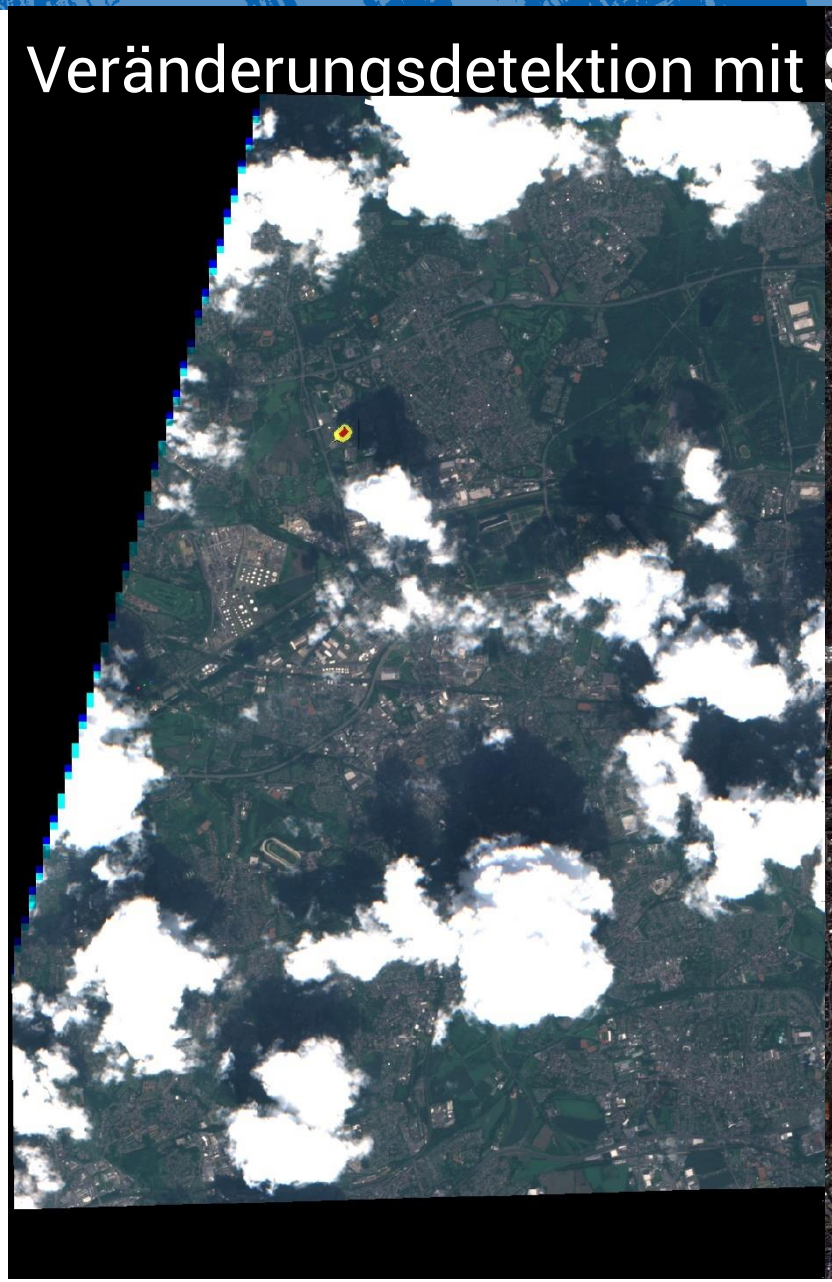
Veränderungsdetektion mit Sentinel Daten



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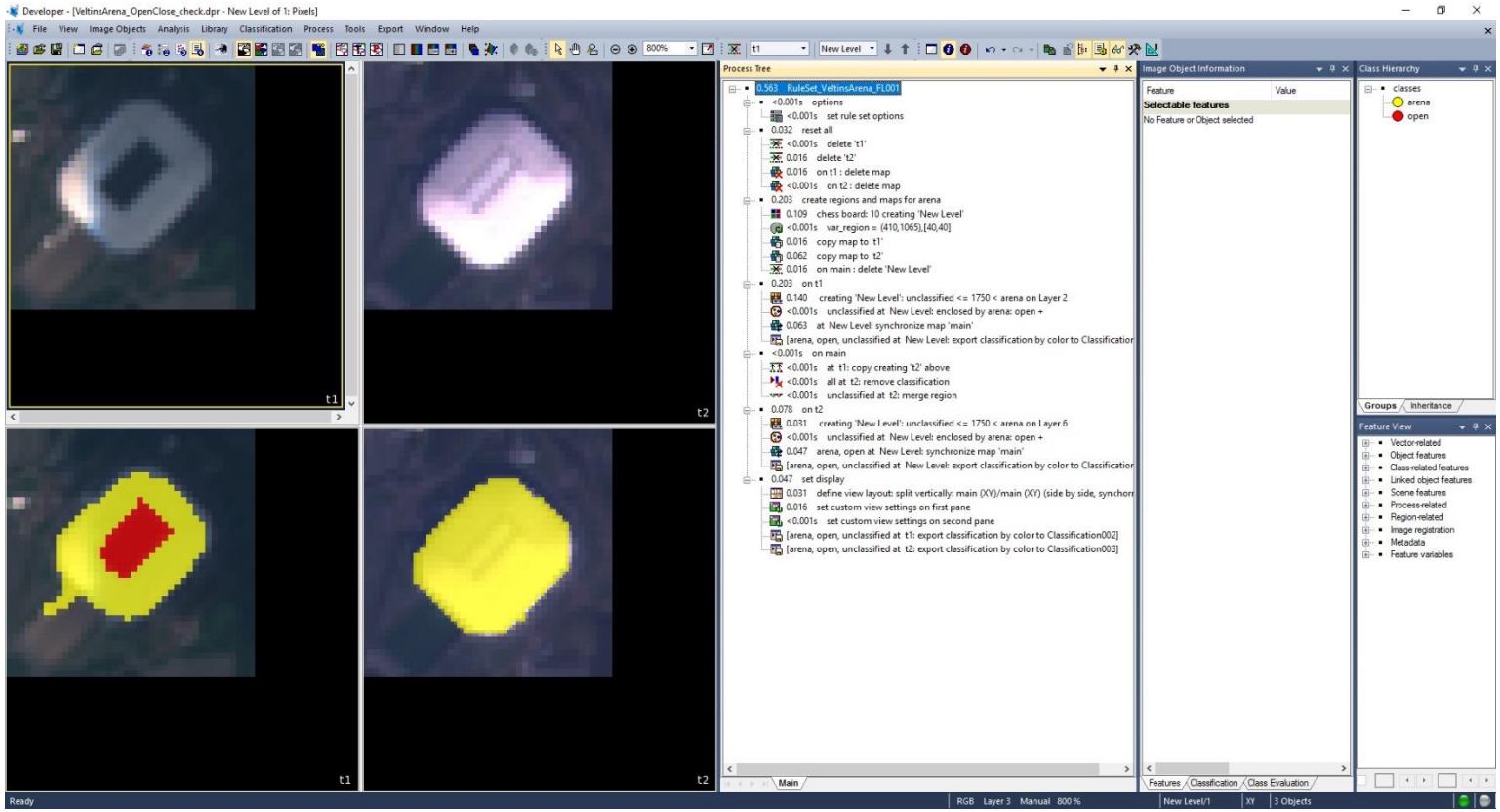
Veränderungsdetektion mit Sentinel Daten



Mit 10m Sentinel-Daten lässt sich problemlos und mit eCognition vollautomatisch feststellen, ob das Dach der Arena geschlossen ist. Wenn man mit 1cm Drohnendaten fliegt, kann man problemlos und mit eCognition vollautomatisch feststellen, ob ein Brandschutzfenster geschlossen ist.

eCognition

der Goldstandard der objektbasierten Bildanalyse

- eCognition Developer
- eCognition Server
- eCognition Architect

2D
3D
4D

Tama Group Entwicklungs-Basisprozess eCognition

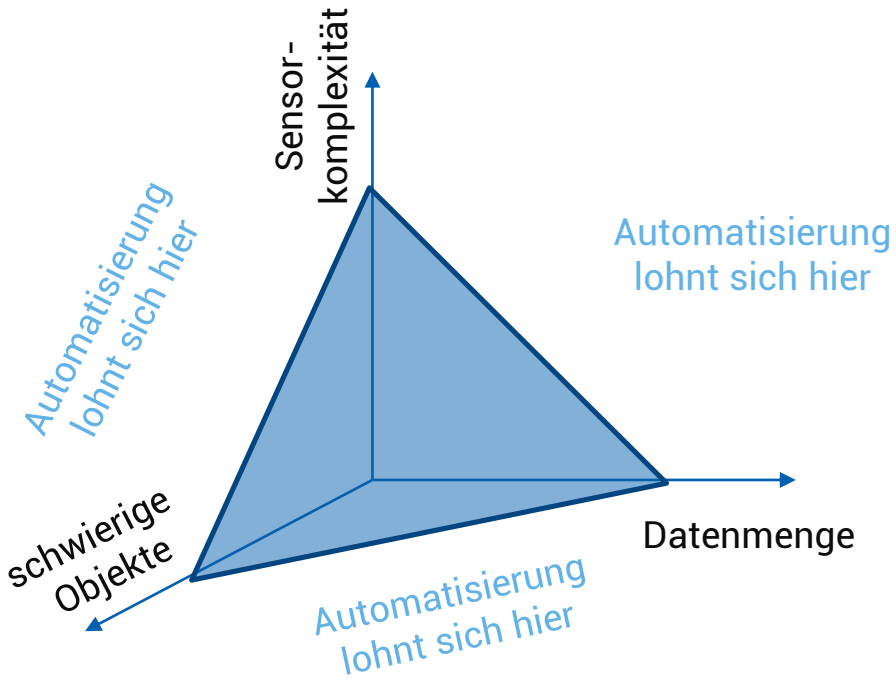
Sensorunabhängigkeit
Qualitätsabhängigkeit

- Satellitenbilder
  - Sentinel, DigitalGlobe, …
- Luftbildsensoren,
  - Trimble, Riegl, …
- RPAS-Sensoren,
  - Copter, Fixed wing, …
- Fahrzeugmontierte Sensoren
  - Pkw, Messfahrzeuge, Schienenfahrzeug, ..
- Mikroskope, eingebaute Kameras
  - Mineralogie, smartphones, …
- Viele weitere Sensoren möglich

- Geometrische Verhältnisse
- Schattenwürfe
- Varianz
- Optische Qualität
- Metadaten
- Komprimierungsmethoden
- Vorverarbeitung
- Einiges mehr

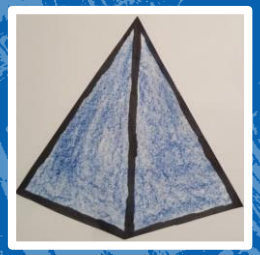
Automatisierung lohnt sich …

- bei einer Vielzahl von Bildern
- bei schleichenden Veränderungen und schwer zu erkennenden Objekten,
- bei komplexer Sensorik, die das Auge kaum korrelieren kann



Tama‘s AI Avengers

Experten-
wissen



deep
learning

maschinelles
Lernen

Fusionsplattform
eCognition

Warum sollte man überhaupt zwischen kodifiziertem Expertenwissen, maschinellem Lernen und Deep Learning wählen? Solange man eine passende Fusionsplattform zur Verfügung hat kann man alle drei Methoden für sich arbeiten lassen – jede gemäß ihren Vorteilen.

Ralph D. Humberg

TAMA GROUP

Access to expert knowledge
= art & science

Autonomous systems

Code turning data into actionable information

CNN

Ground truethed samples

ML

system design

problem assessment

system redesign

subject matter expert code

Manual part

automated part

Information as a service

Manual systems

Personalized knowledge

We don‘t see a reason to opt out any of the big three *„hammer, screw-driver and pincers – you need them all“*

	Coded expert knowledge	Machine learning	Deep learning
USP	For complex situations still the gold-standard; works with sparse training data; desktop computing	Finds best code in the code	Directly from samples to code; „if you see it within 50ms, you have it – 24/7“
Key challenges	Need to translate cognitive capabilities into code	Needs code to get started	Needs lots of samples; yet to prove capabilities for complex structures
Typical implementation	Code written by programmers (Python, C++), ruleware written by experts (OBIA)	Support vector machines, random forest, KNN, Bayes	CNN, derivatives; TensorFlow, other
Typical output	Shape files, attributes	Classifications	Bounding boxes, center points
Tama‘s AI Avengers	**For structural knowledge**	**For „in the middle of the road“ tasks**	**For mass objects (cars, tree crowns,..)**

Wir freuen uns auf Sie

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TAMA GROUP