
INNOVATION
INTEGRATION
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URGO

Kollisionsvermeidungssystem Für Wasserfahrzeuge

Objekterkennung & Stereovision

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Kantonsschule Zofingen 2022

Inhalt

- Ziel der Arbeit
- Was ist ein Kollisionsvermeidungssystem?
- Stereovision – OAK-D
- Objekterkennung – Yolov5
- Programmstruktur
- Eignet sich das CAS für die Praxis?
- Demo

ZIEL DER ARBEIT

Entwicklung eines Kollisionsvermeidungssystems für Wasserfahrzeuge

Objekterkennung

Um welchen Objekttyp handelt es sich und wo befindet er sich im Bild?

Positionsbestimmung

Mit Stereovision wird die relative Position des Objekts zur Kamera geschätzt

Darstellung der Objektpositionen

Ein Pathfinding-Algorithmus zeigt die Fähigkeit der Software mehrere Prozesse auszuführen

Automatisierung in Echtzeit

mit dem Ziel einen Prototyp einer Software zu kreieren, der in der Praxis angewendet werden könnte

Kollisionsvermeidungssystem (CAS)

Definition:

- Aufgabe die Schwere einer Kollision zu verringern oder zu verhindern
- Der Fahrzeugführer wird über die Gefahr Informiert und kann dann tätig werden
- Für Objekte, die eine unmittelbare Gefahr darstellen (in geringer Distanz)
- Soll den Fahrer unterstützen, wenn dieser versagt die Gefahr zu erkennen.

KOLLISIONS VERMEIDUNG

EU-Verordnung 2024

Warum Kollisionsvermeidung

In der privaten (Segel-)Schifffahrt auf dem See?

97,532

Segel- und Motorboote in der Schweiz registriert (Stand 2020)

Warum der Private Schifffartssektor

privat

kommerziell

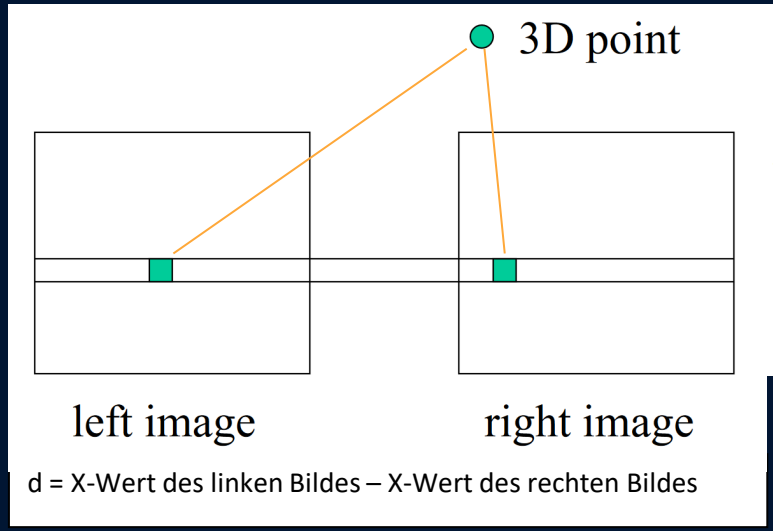
- Erhöhte Sicherheit
- geringes Budget
- Chaotischer Kurs
- Erkennen von unmittelbaren Gefahren

- Höchstmögliche Sicherheit
- Einsparung von Kosten (Crew)
- Hohes Budget
- Geplante Route

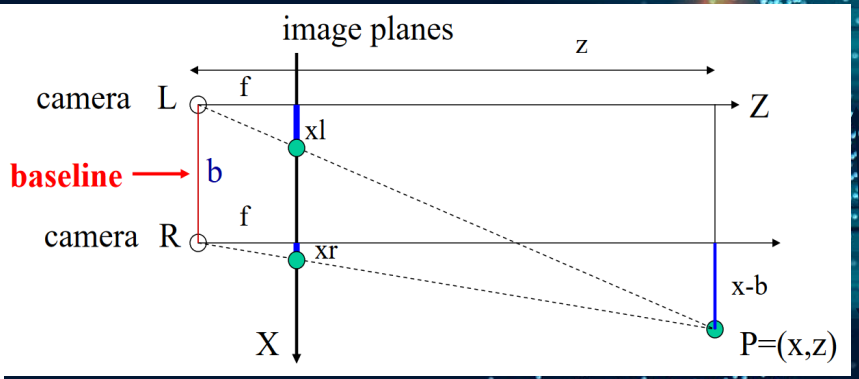
Stereovision

Positionsbestimmung mit der OAK-D
Stereokamera von Luxonis

Was ist Stereovision?



d = X-Wert des linken Bildes – X-Wert des rechten Bildes



$$\frac{z}{f} = \frac{x}{xl} \qquad \frac{z}{f} = \frac{x-b}{xr} \qquad \frac{z}{f} = \frac{y}{yl} = \frac{y}{yr}$$

(from similar triangles)

Depth $z = f*b / (xl - xr) = f*b/d$

$x = xl*z/f$ or $b + xr*z/f$

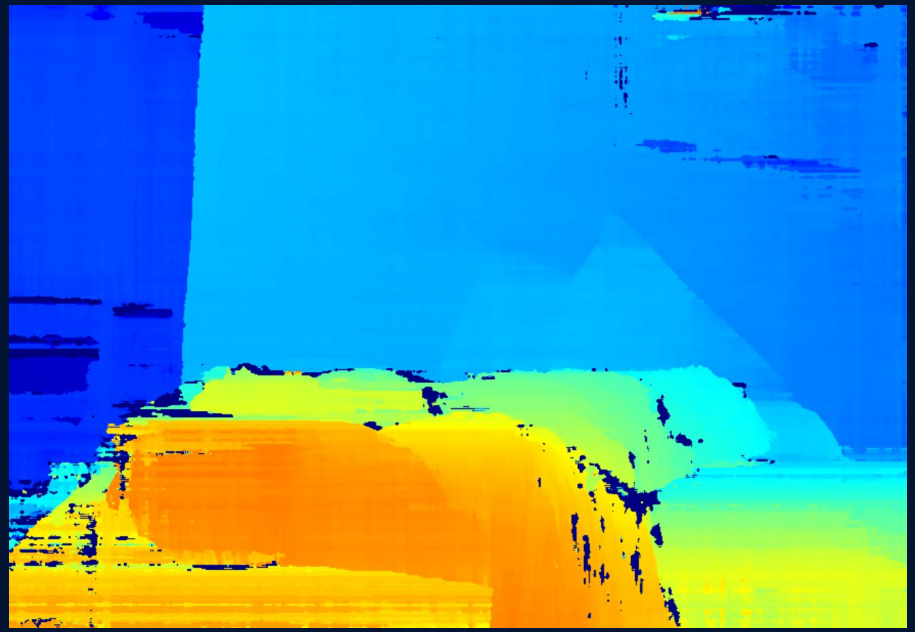
$y = yl*z/f$ or $yr*z/f$

OAK-D Stereokamera

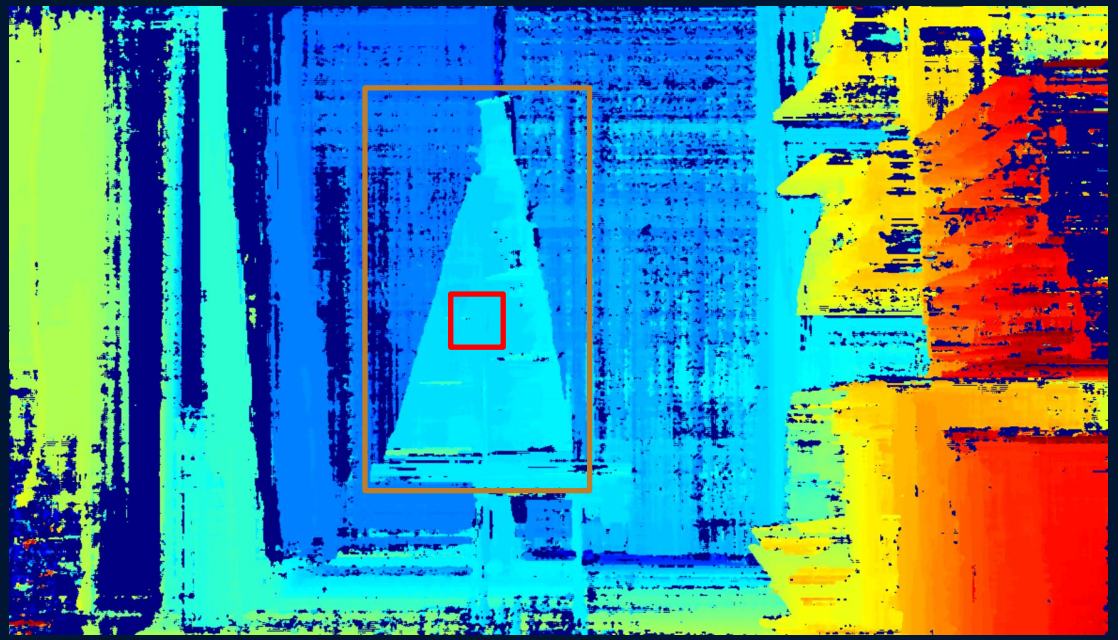
Camera Specs	Color camera	Stereo pair
Sensor	IMX378	OV9282
DFOV / HFOV / VFOV	81° / 69° / 55°	82° / 72° / 50°
Resolution	12MP (4032x3040)	1MP (1280x800)
Focus	Auto-Focus: 8cm - ∞	Fixed-Focus: 19.6cm - ∞
Max Framerate	60 FPS	120 FPS

- Mittlerer Sensor für Objekterkennung
- Äussere Sensoren für Stereovision
- Interne Recheneinheit
- Preis von 200-300 CHF

Depth-Map (Tiefen Karte)



Zentrums- und Gesamtmethode

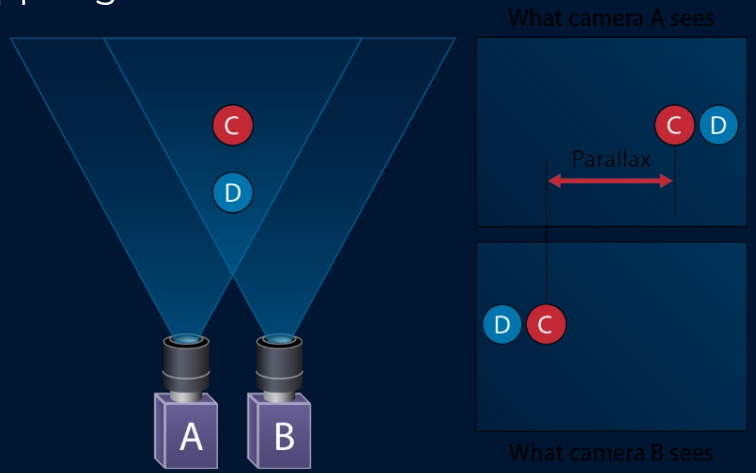


Wichtig zu beachten ist:

- Die benötigte Rechenleistung steigt, wird die Auflösung der Kameras vergrössert

→ Denn es muss für mehr Pixel die Disparity bzw. Depth berechnet werden

- Grössere Baseline (b) → grössere Reichweite, **Aber** Überlappungsbereich der beiden Kameras wird kleiner



OAK-D Stereokamera
2 in 1 Lösung

Stereokamera

Lidar, Radar

Was für ein Typ von Objekt ist es?

Anhand von Bildern kann Objekterkennung angewendet werden

Wo befindet sich ein Objekt

Position des Objekts mit Stereovision abschätzen

Vorteile von Stereovision

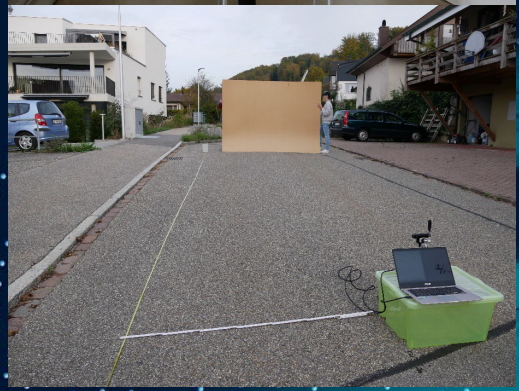
- Hohe Flexibilität in der Datennachbearbeitung
- Kameratechnologie ist erschwinglich
- Hohe Bildwiederholungsrate (30+ bei 12MP, 60 bei 1MP OAK-D)
- Keine beweglichen Teile

Versuchserkenntnisse

Zentrumsmethode ist bei Objekten, die nicht der Box entsprechen genauer

Erhöhte Ungenauigkeit bei:

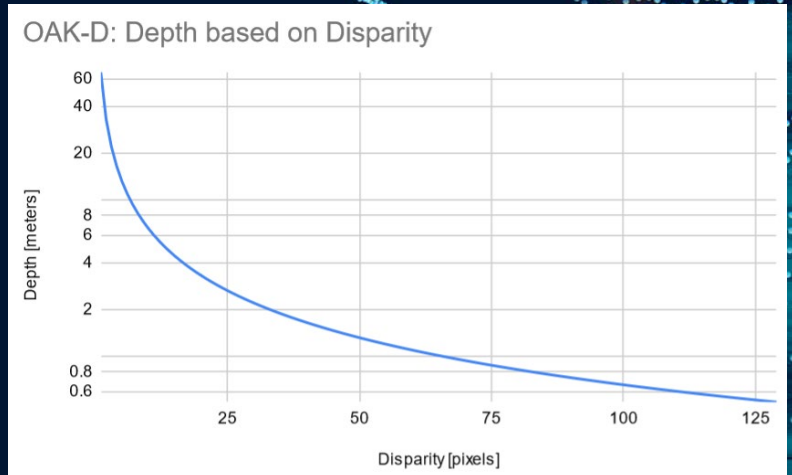
- wiederholender Struktur/Textur
- Schlechten Lichtverhältnissen

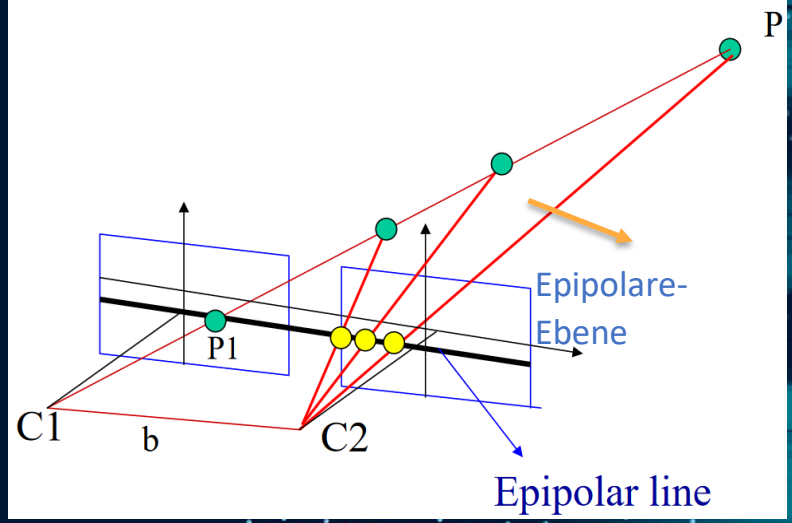


Reichweite

Daten von Hersteller:
- Theoretische Reichweite ca. 35m
- Praktische Reichweite ca. 15m

Eigene Ergebnisse
- Praktische Reichweite bis ca. 25m (hohe Ungenauigkeit)
- Praktische Reichweite bis ca. 15m



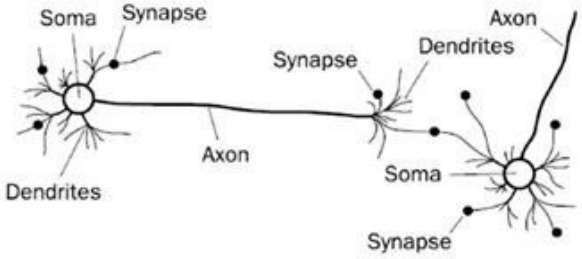


Objekterkennung

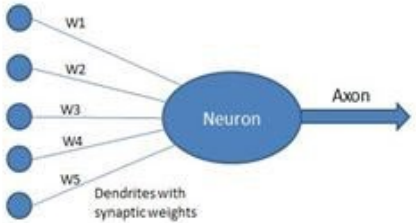
Mit Hilfe des Yolov5-Algorithmus

Yolov5 – Artificial Neural Network (ANN)

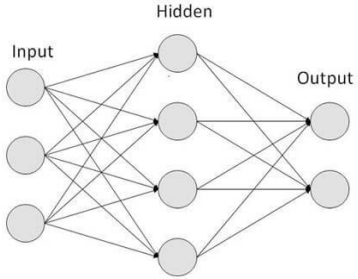
- ANN ist wie ein Neuronales Netz aufgebaut (Gehirn)
- Convolutional Neural Network (CNN), ein ANN das auf Bilderkennung spezialisiert ist



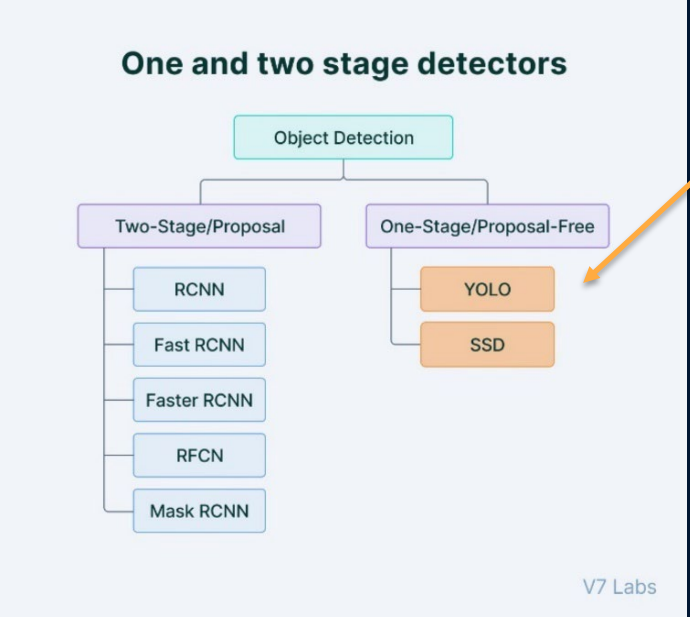
(a) Biological Neural Network



(b) Artificial Neural Network



You Only Look Once (Yolov5)

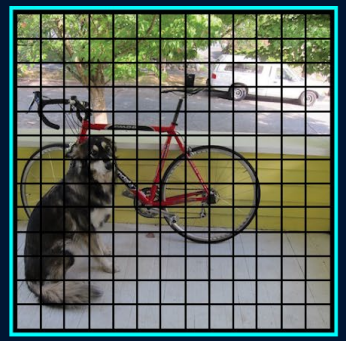


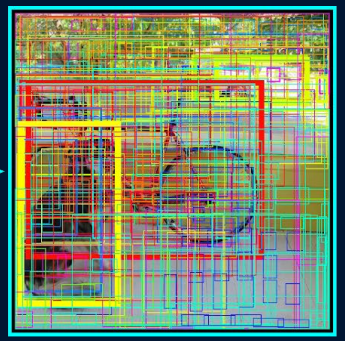
Yolov5 ist ein One-Stage-Detektor

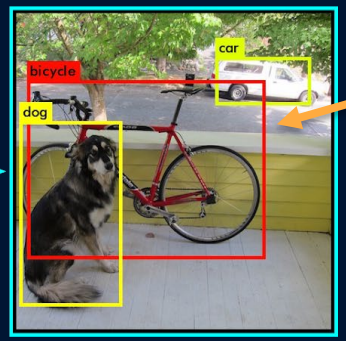
- Schnelle Inferenzzeit
- Höhere Erkennungrate

→ Besser Performance

Wie funktioniert Yolov5?







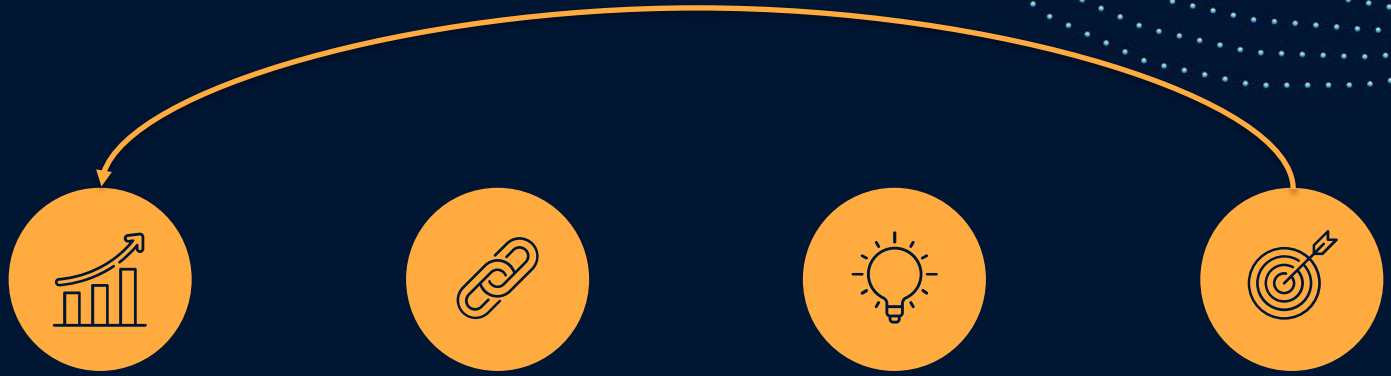
Bounding Box

1.
Aufteilung des Bildes

2.
Objekterkennung pro Zelle

3.
Fusionierung der einzelnen Zellen

Yolov5 mit eigenem Datenset



Datenerhebung

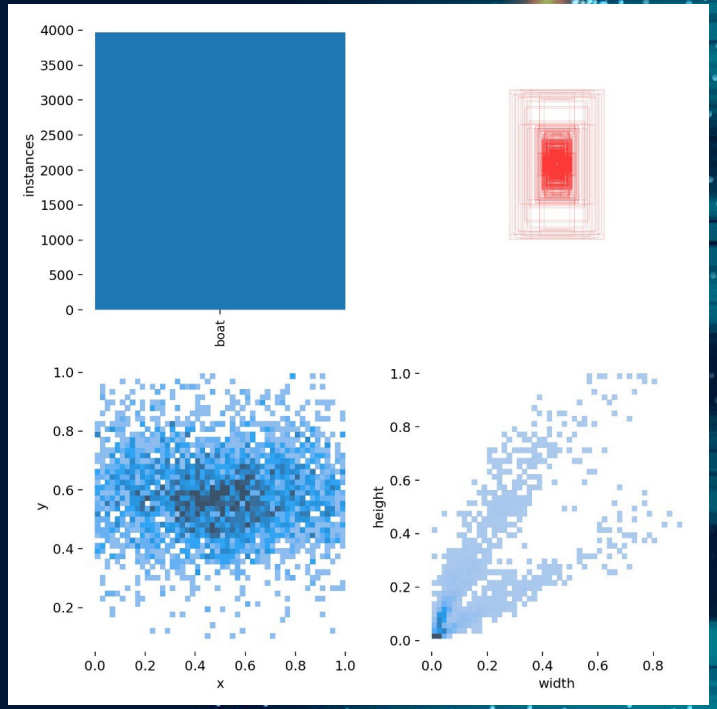
Datenaufbereitung

Training

Anpassen

Datenset

- 1446 Trainingsbilder
- 137 Validierungsbilder
- 4000 Instanzen



Training

Epoche

Wird X-Mal wiederhold (Batchsize)

Prediction → Überprüfung → Anpassung der Verknüpfungen

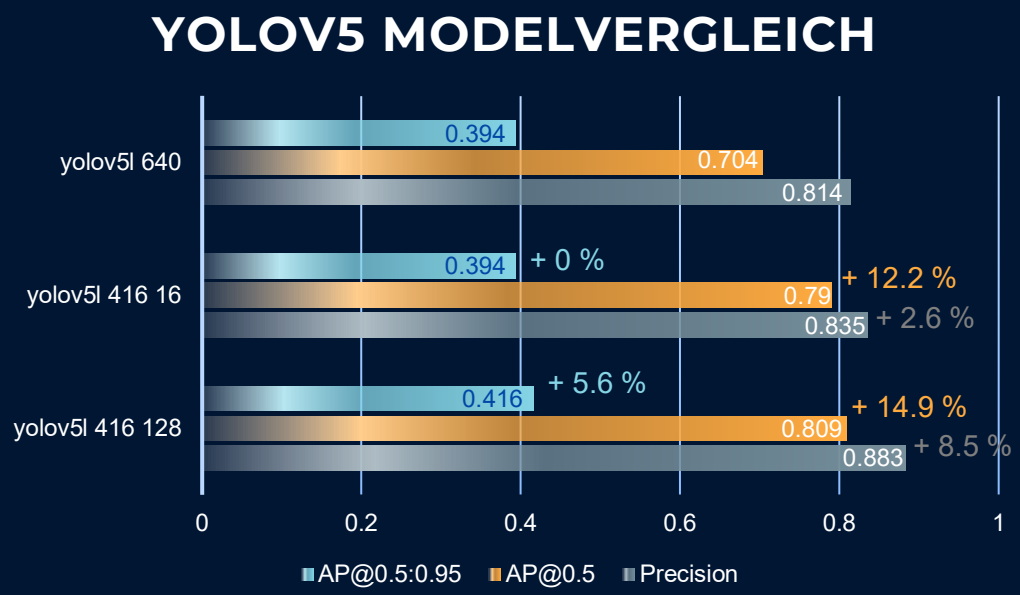
8+ verschiedene Versionen mit Unterscheidung in:

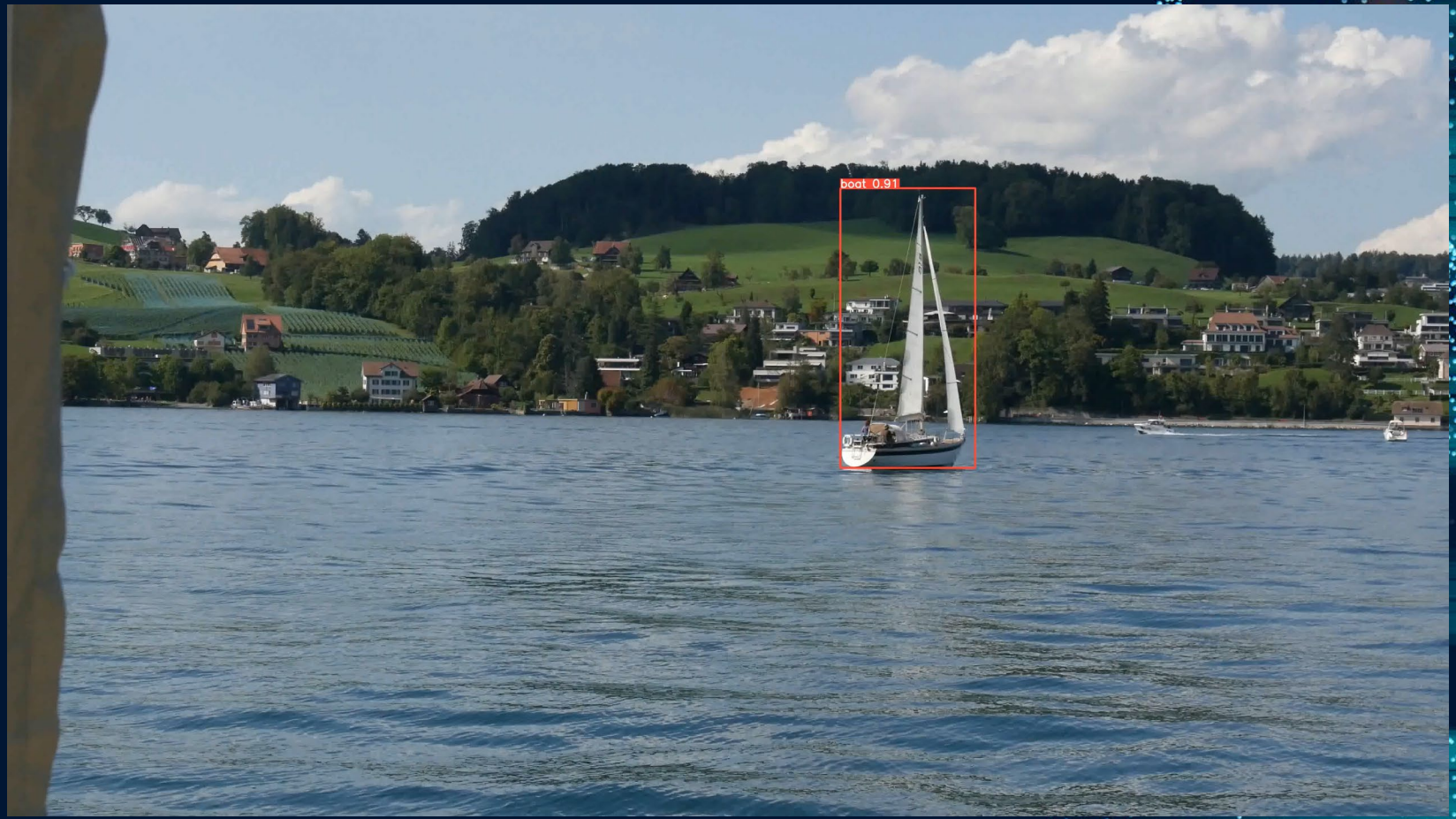
- Auflösung der Trainingsbilder (416x416, 928x928)
- Batchsize
- Modelltyp {n, s, m, l, l6}

Trainingsdauer:

- 200 Epochen
- bis zu 8h

Erkennungsrate



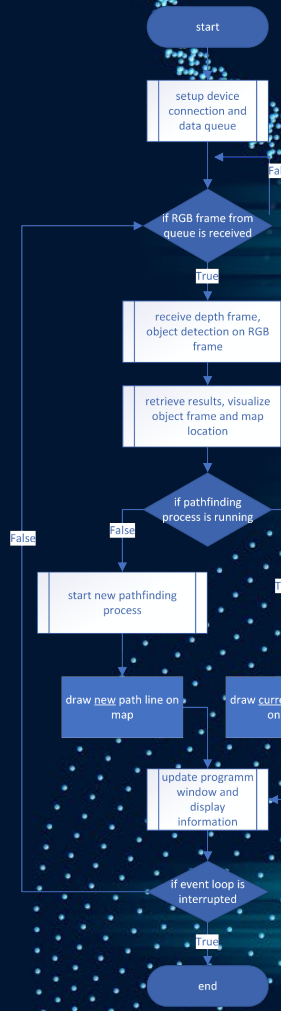

boat 0.91

Programmstruktur

Automatierungs der Aufgaben

Programm-Loop

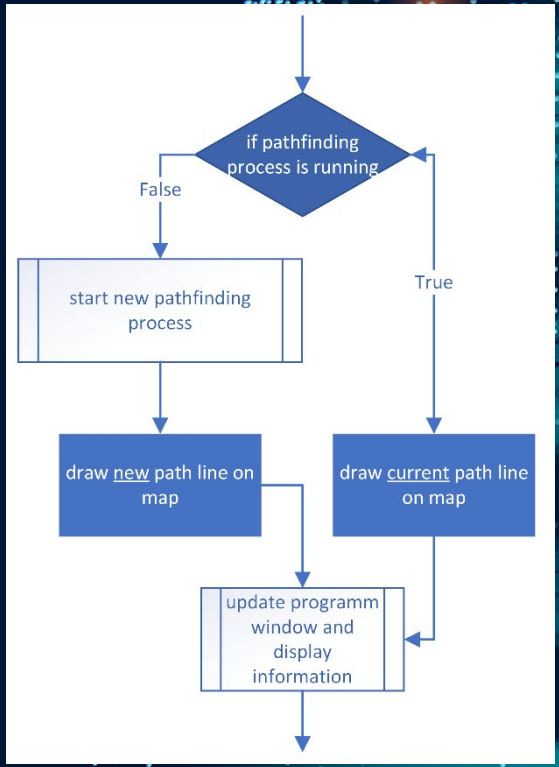
- Depthmap wird auf OAK-D erstellt
- Depthmap und Farbbild wird an PC gesendet
- Objekterkennung wird durchgeführt
- Bounding Box des erkannten Objekts wird auf Depthmap übertragen
- Position des Objekts wird berechnet
- Pathfinding-Algorithmus wird auf Karte ausgeführt



Multiprocessing

Wird verwendet um mehrere Prozesses gleichzeitig auszuführen

→ Bessere Performance



Eignet sich das CAS für die Praxis?

Diskussion

Objekterkennungsgenauigkeit

80%

Aller Segel- und Motorboote

> 90%

Aller Segel- und Motorboote innerhalb 30m

Messungsgenauigkeit

- Ab 10m eine Ungenauigkeit von ca. 10%
- Ab 15m eine Ungenauigkeit von bis zu ca. 20%
- Reichweite von bis zu 25m
- Die Zentrumsmethode ermöglicht genauere Positionsbestimmung

→ Eine Kollisionsvermeidung ist möglich

Stereokamera für weiterer Reichweite wird empfohlen

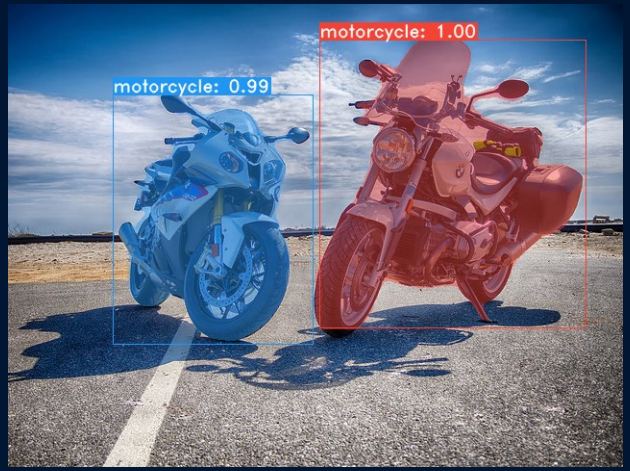
Software Performance

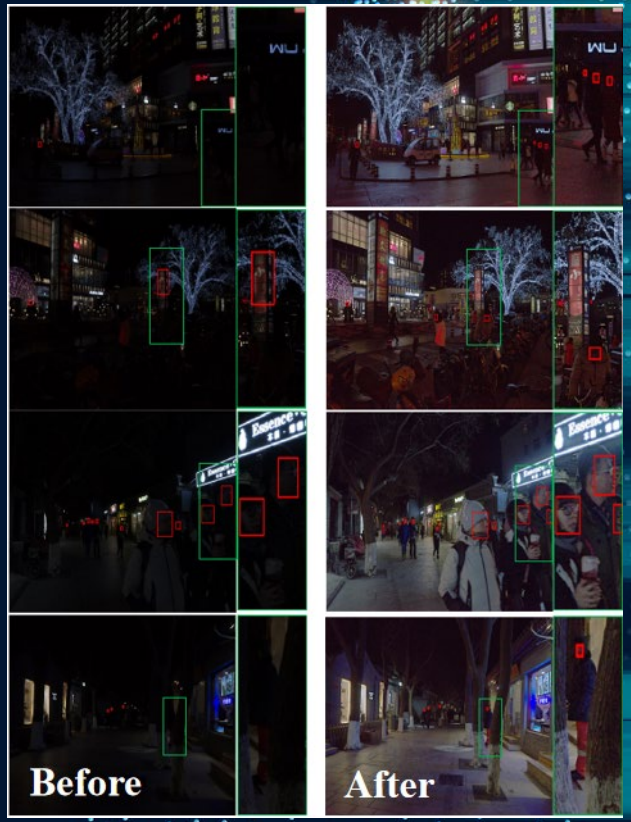
- Mindestens 3 FPS auf Laptop (CPU)
- ca. 20 FPS auf PC (mit Pathfinding)
- ca. 40+ FPS auf PC (ohne Pathfinding)

Eignet sich für die Anwendung in der Praxis

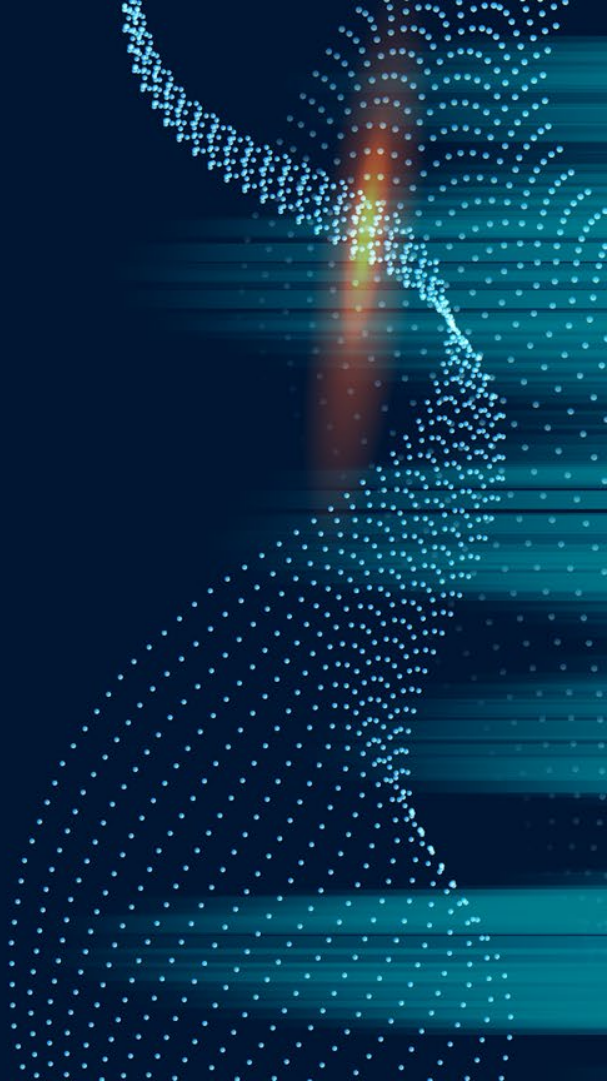
Ausblick

- Optimierung der Depthmap mit ANN
- Low-Light-Enhancement mit ANN für Image-Preprocessing
- Objektsegmentation mit Yolact
- Statistische Auswertung der gespeicherten Daten



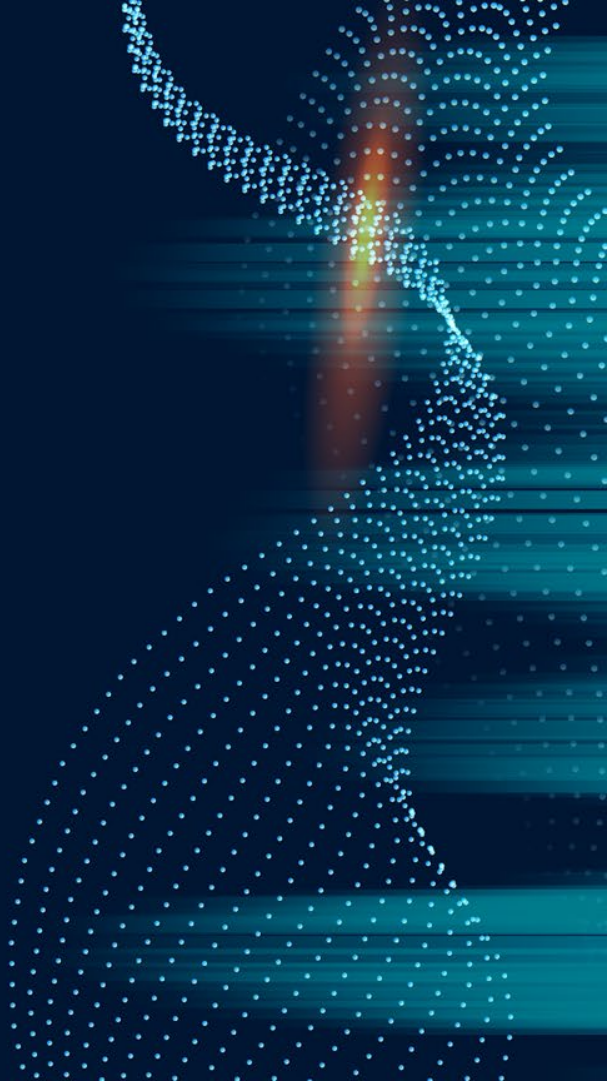


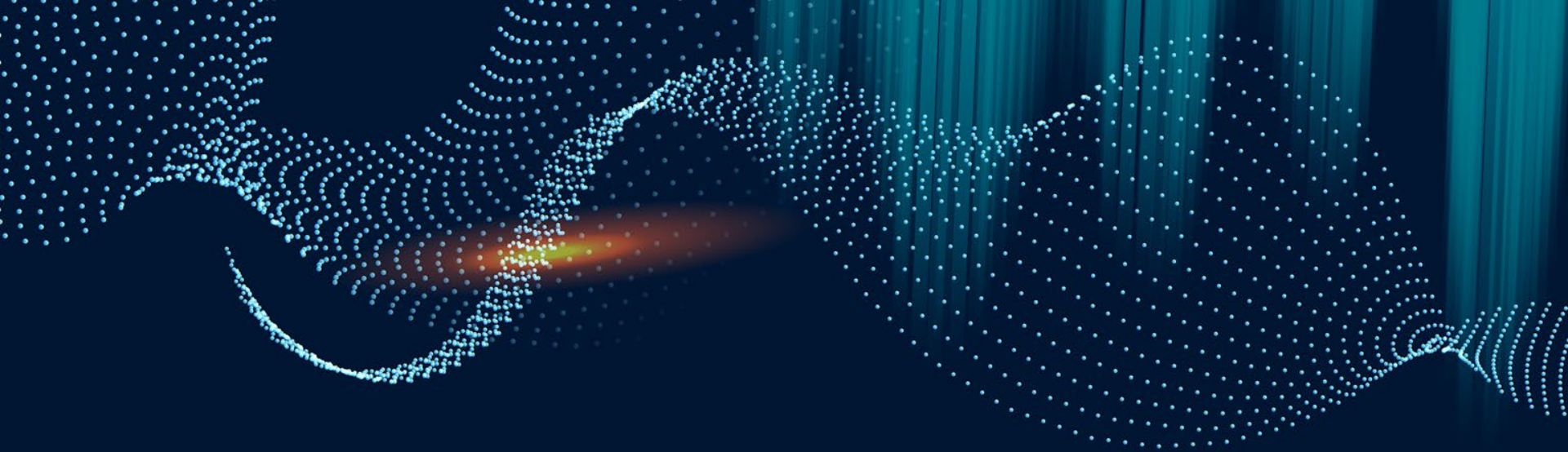
Reflexion



Demo - Features

- Warntext, bzw Ton
- Anzeige verschiedener Video Streams (viel Auswahl)
- Skalierbarkeit der Karte
- Pathfinding-Algorithmus





VIELEN DANK

Für eure Aufmerksamkeit

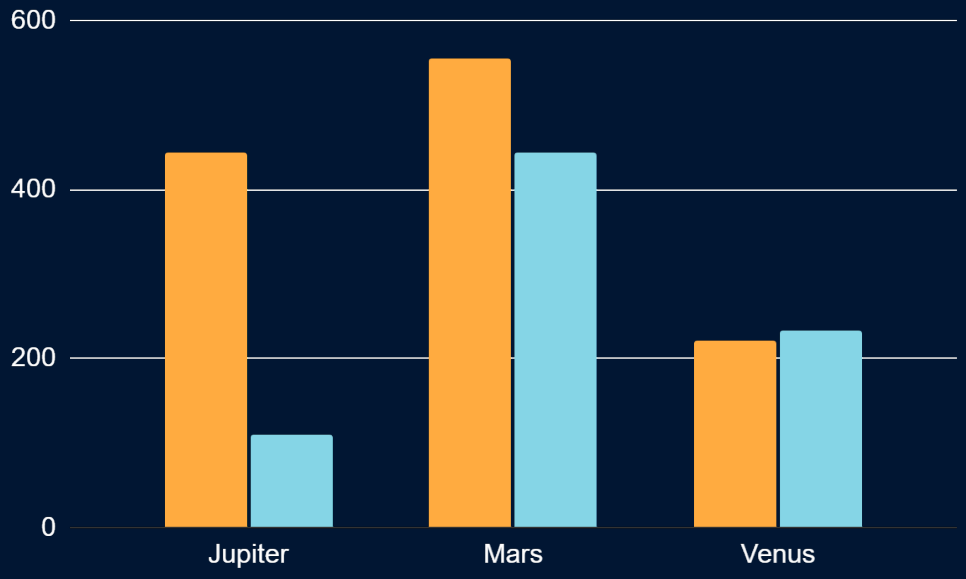
THE SLIDE TITLE GOES HERE!

Do you know what helps to make your point clear? Lists like this: one

- They’re simple
- You can organize your ideas clearly
- You’ll never forget to buy milk!

And the most important thing: the audience won’t miss the point of your presentation

DO YOU PREFER THIS GRAPH?

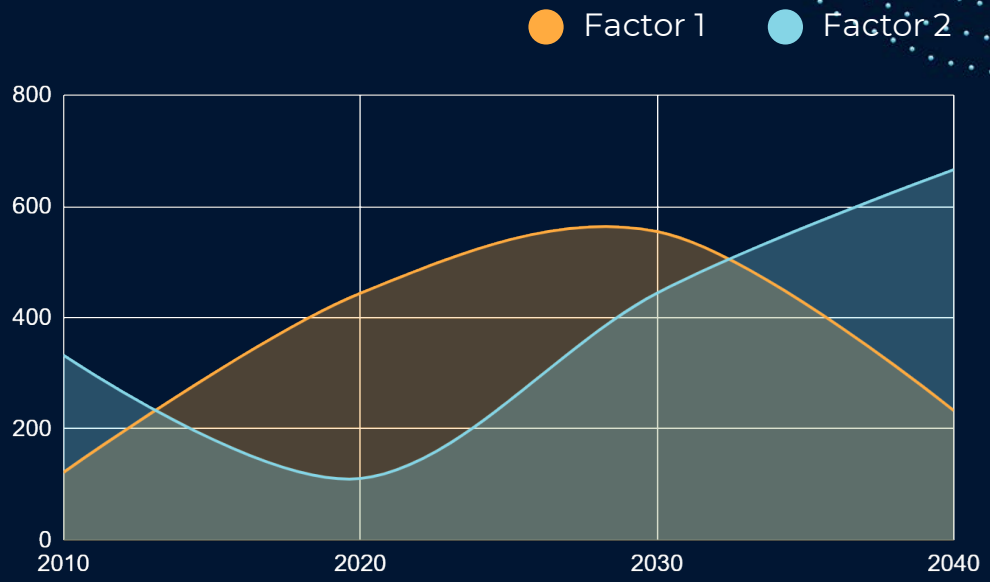


Factor 1

Factor 2

To modify this graph, click on it, follow the link, change the data and replace it

THIS IS A GRAPH!



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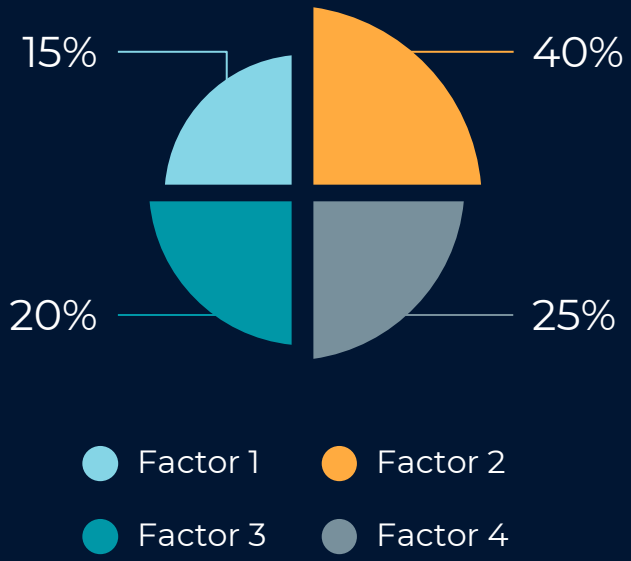
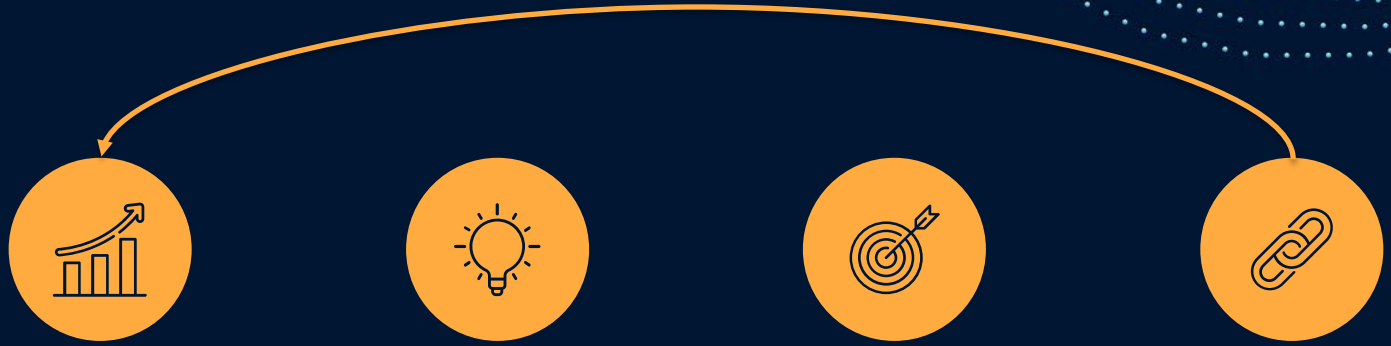
INFOGRAPHICS MAKE YOUR IDEA UNDERSTANDABLE...



... AND THE SAME GOES FOR TABLES

	MASS	DIAMETER	GRAVITY
MERCURY	0.06	0.38	0.38
MARS	0.11	0.53	0.38
SATURN	95.2	9.4	1.16

Yolov5 für Wasserfahrzeuge



Datenerhebung

Despite being red, Mars is a cold place

Datenlablei ng

Mercury is the closest planet to the Sun

Training

It is the biggest planet in the Solar System

Tuning

Venus has a beautiful name, but it’s hot

THIS IS A MAP!

Arbeitsprozess

Problem

Auswahl der Technologien

OAK-D Stereokamera

Jupiter is the biggest planet

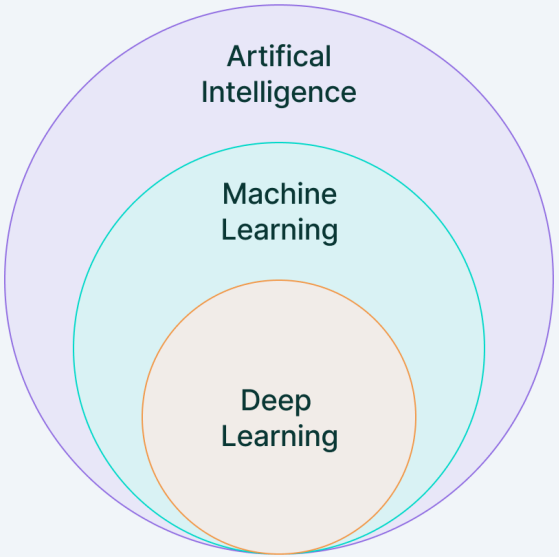
Implementierung von Stereovision

Training und Implementierung von Objekterkennung

Mars is a cold place

Venus has a nice name

Performance verstellung



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2. An assortment of illustrations and pictures that are suitable for use in the presentation can be found in the **alternative resources slide**.
3. A **thanks slide**, which you must keep so that proper credits for our design are given.
4. A **resources slide**, where you'll find links to all the elements used in the template.
5. **Instructions for use**.
6. Final slides with:
    - The **fonts and colors used** in the template.
    - More **infographic resources**, whose size and color can be edited.
    - **Sets of customizable icons** of the following themes: general, business, avatar, creative process, education, help & support, medical, nature, performing arts, SEO & marketing, and teamwork.

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Lifecycle

MARS

Despite being red, Mars is actually a cold place

JUPITER

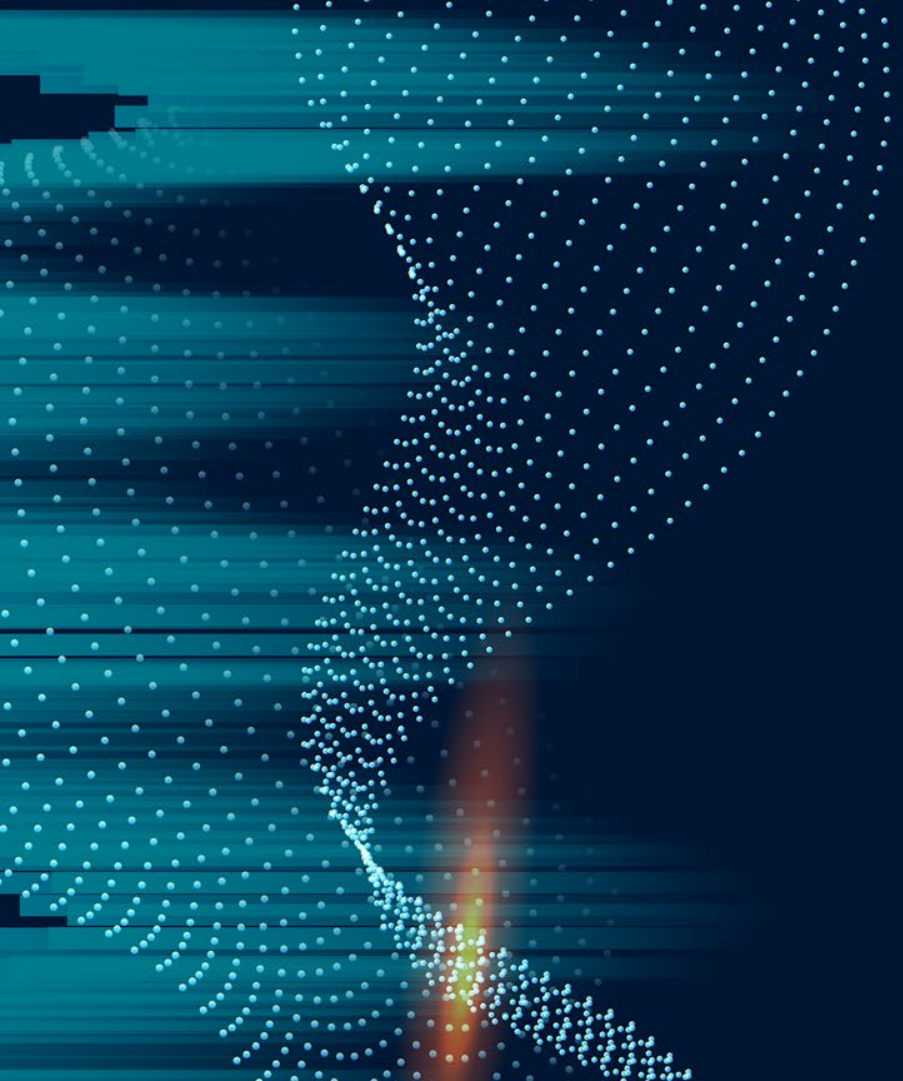
It’s a gas giant and the biggest planet in the Solar System

VENUS

Venus has a very poisonous atmosphere

97,532

Segel- und Motorboote in der Schweiz registriert (Stand 2020)



333,000

Mercury is the smallest planet

245,00

Jupiter is the biggest planet

386,000

Despite being red, Mars is cold

Die Zahlen

34%

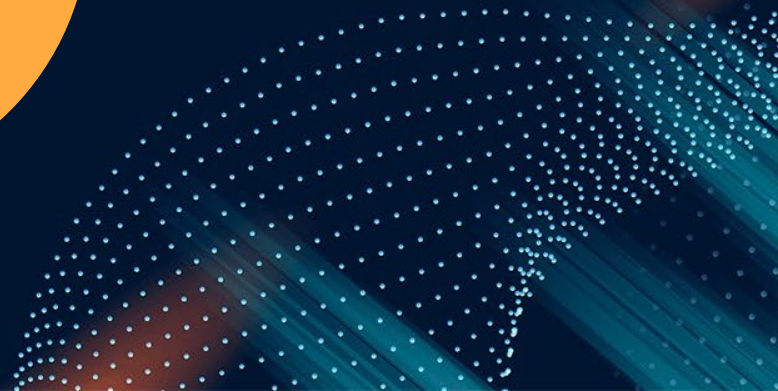
Mars is a cold place

94%

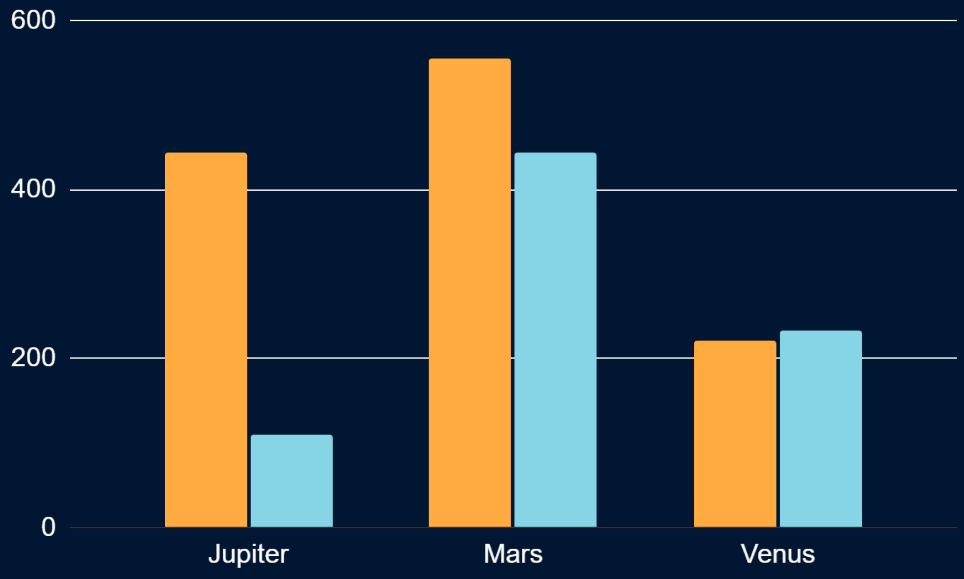
Genauigkeit in Versuchen

18%

Jupiter is the biggest one



Performance



Factor 1

Factor 2

To modify this graph, click on it, follow the link, change the data and replace it

REVIEWING CONCEPTS IS A GOOD IDEA

MERCURY

Mercury is the smallest planet

VENUS

Venus has a beautiful name

MARS

Mars is actually a cold place

JUPITER

It’s a gas giant and the biggest one

SATURN

Saturn is the ringed one and a gas giant

NEPTUNE

It’s the farthest planet from the Sun

Trainingsprozess

You can use bullet points to talk about the concepts. It is much more visual than a large text

- You can write about a concept here and talk about it a little
- You can write about a concept here and talk about it a little
- You can write about a concept here and talk about it a little
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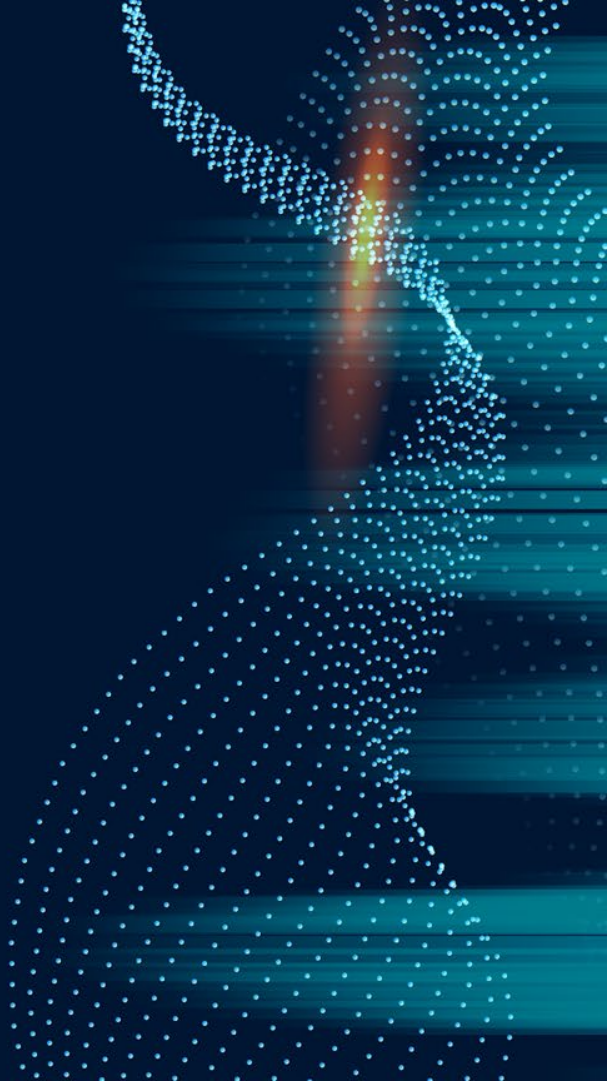
- You can write about a concept here and talk about it a little
- You can write about a concept here and talk about it a little
- You can write about a concept here and talk about it a little

Vierwaldstättersee als Beispiel

Am besten geeignet im vergleich zu andere Technologien, weil:

- They’re simple
- You can organize your ideas clearly
- You’ll never forget to buy milk!

And the most important thing: the audience won’t miss the point of your presentation



Anforderungen

Erkennung von Objekten)

“Jupiter is the biggest planet of them all”

—HELENA PATTERSON, 22

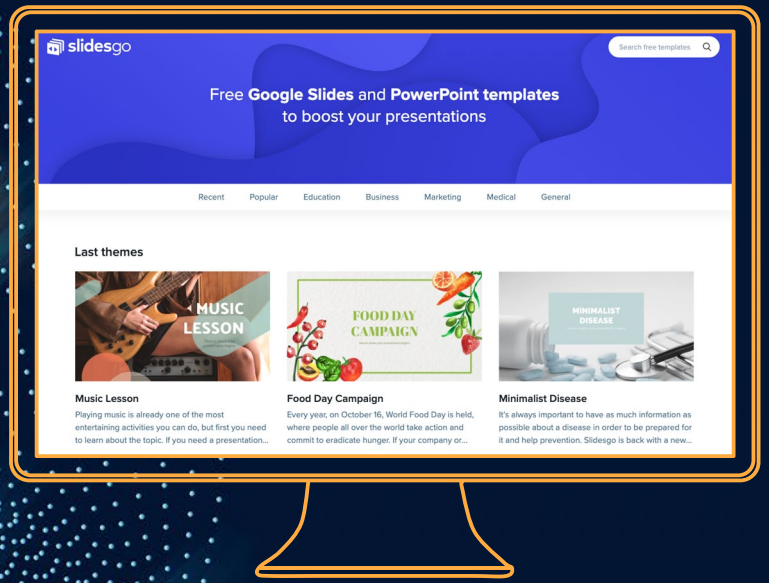
“Despite being red, Mars is actually a cold place”

—JOHN DOE, 31

“Venus has a beautiful name, but it’s hot”

—WILL WHITMAN

DESKTOP SOFTWARE



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TABLET APP

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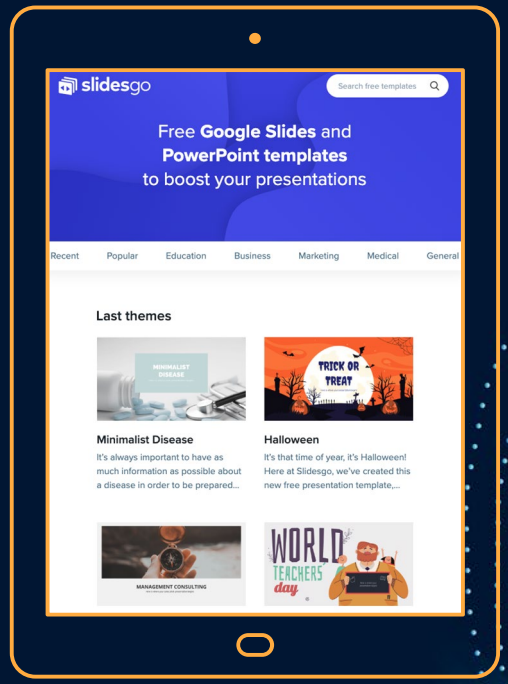

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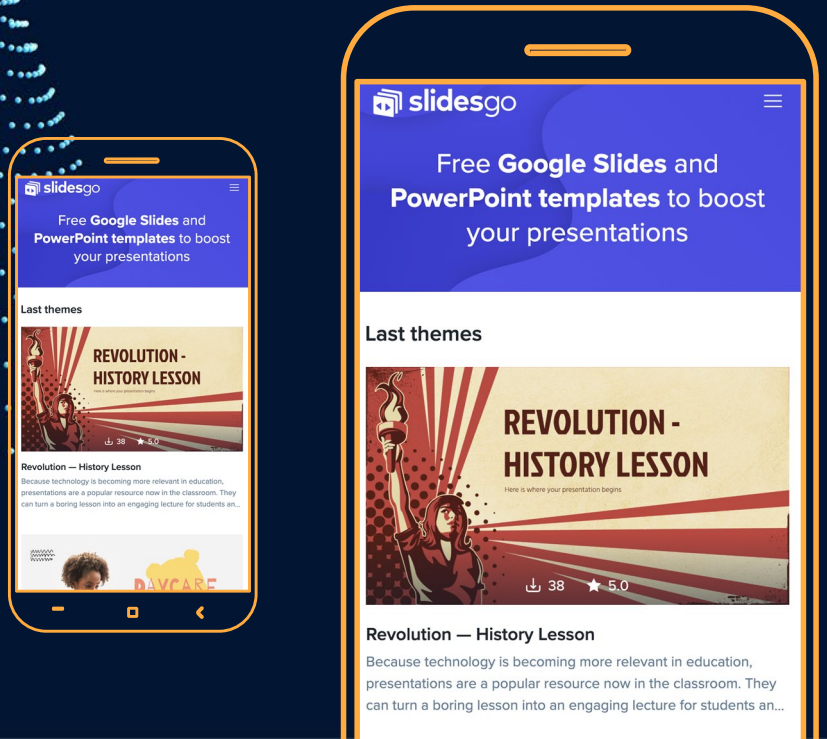

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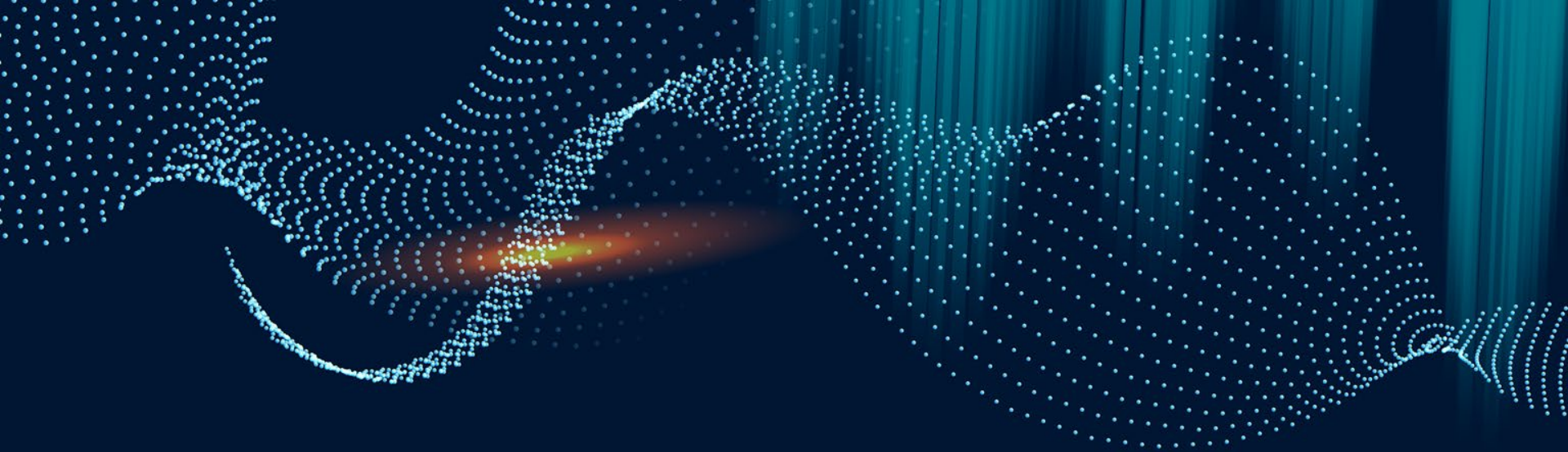

VIELEN DANK

Für eure Aufmerksamkeit

THANKS!

Do you have any questions?
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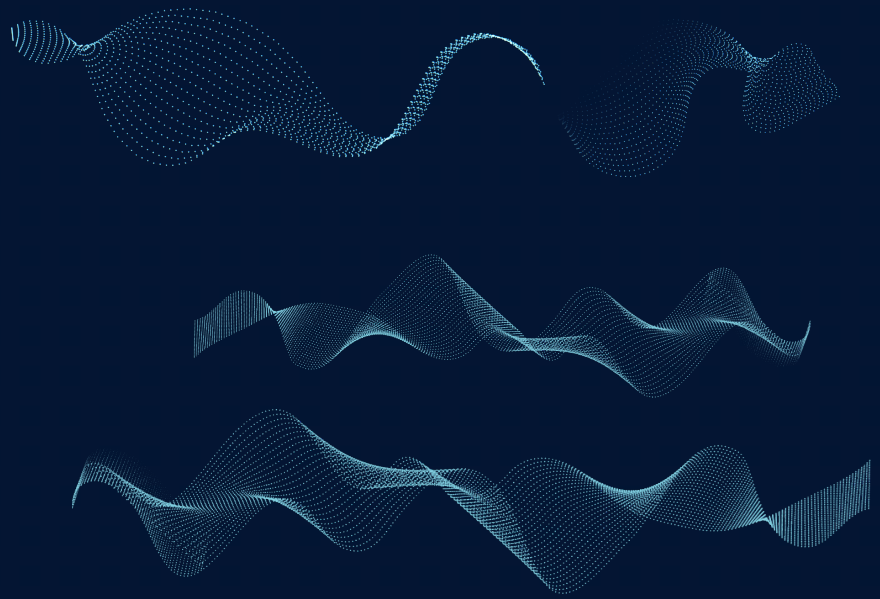

PHOTOS:

- Low angle man with virtual reality simulator
- Young man working on an ethernet switch medium shot
- Motherboard with optical fiber cables
- High speed optical fiber with blue light

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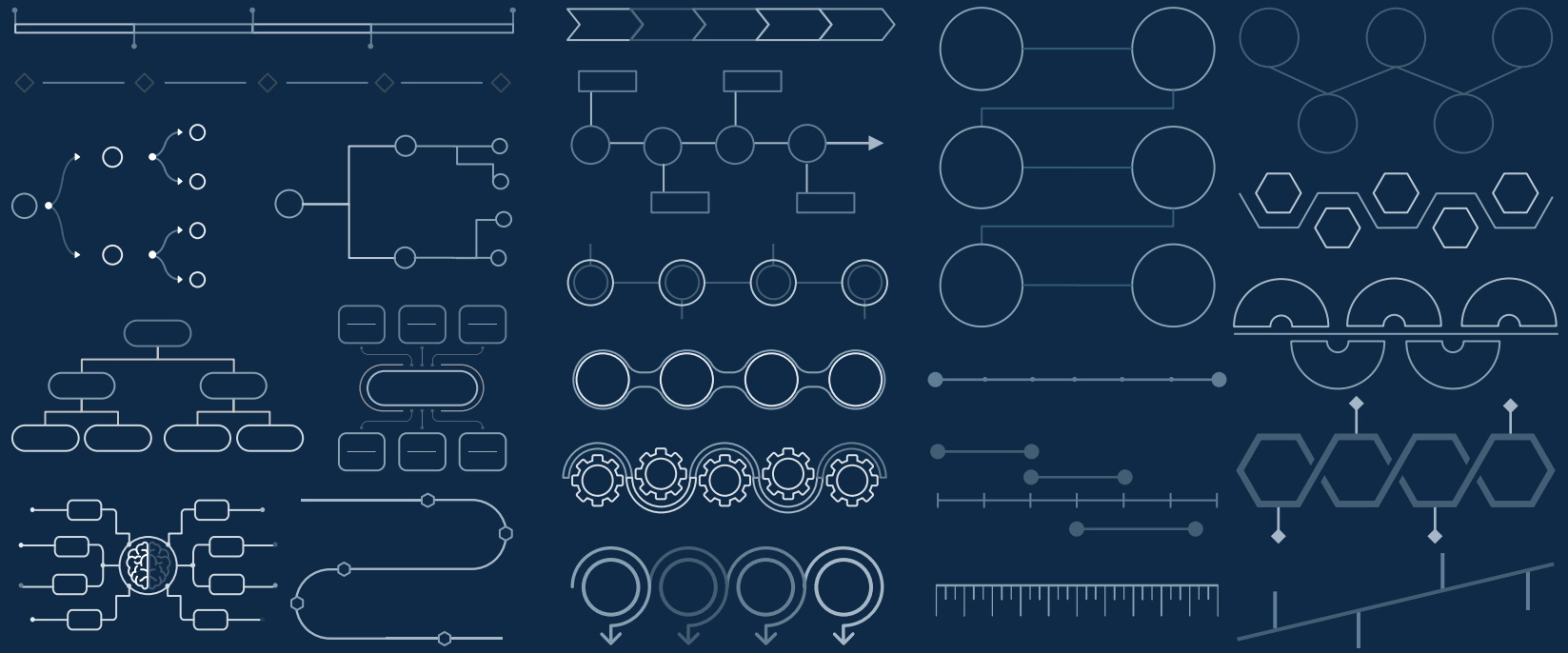

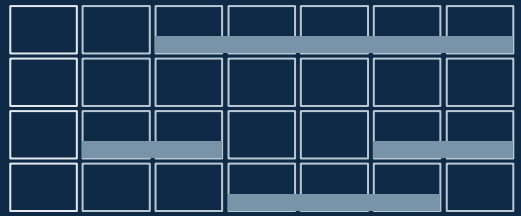

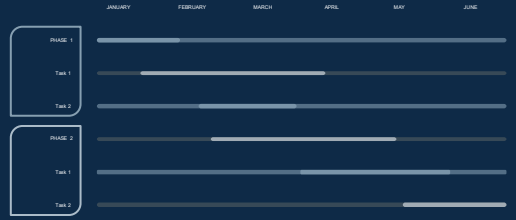
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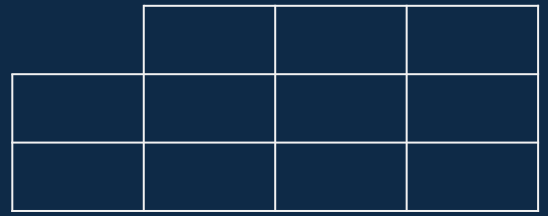

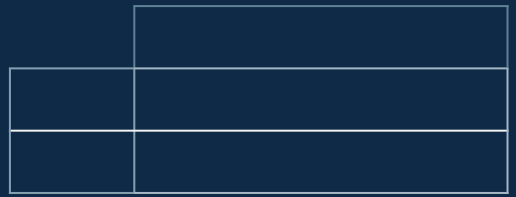

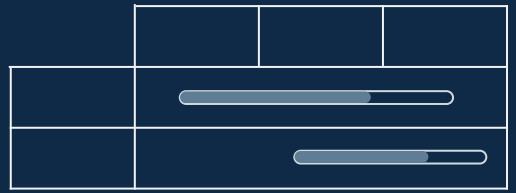

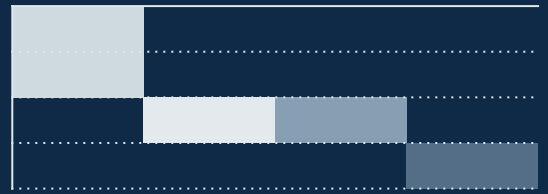

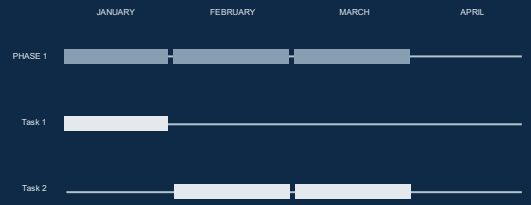
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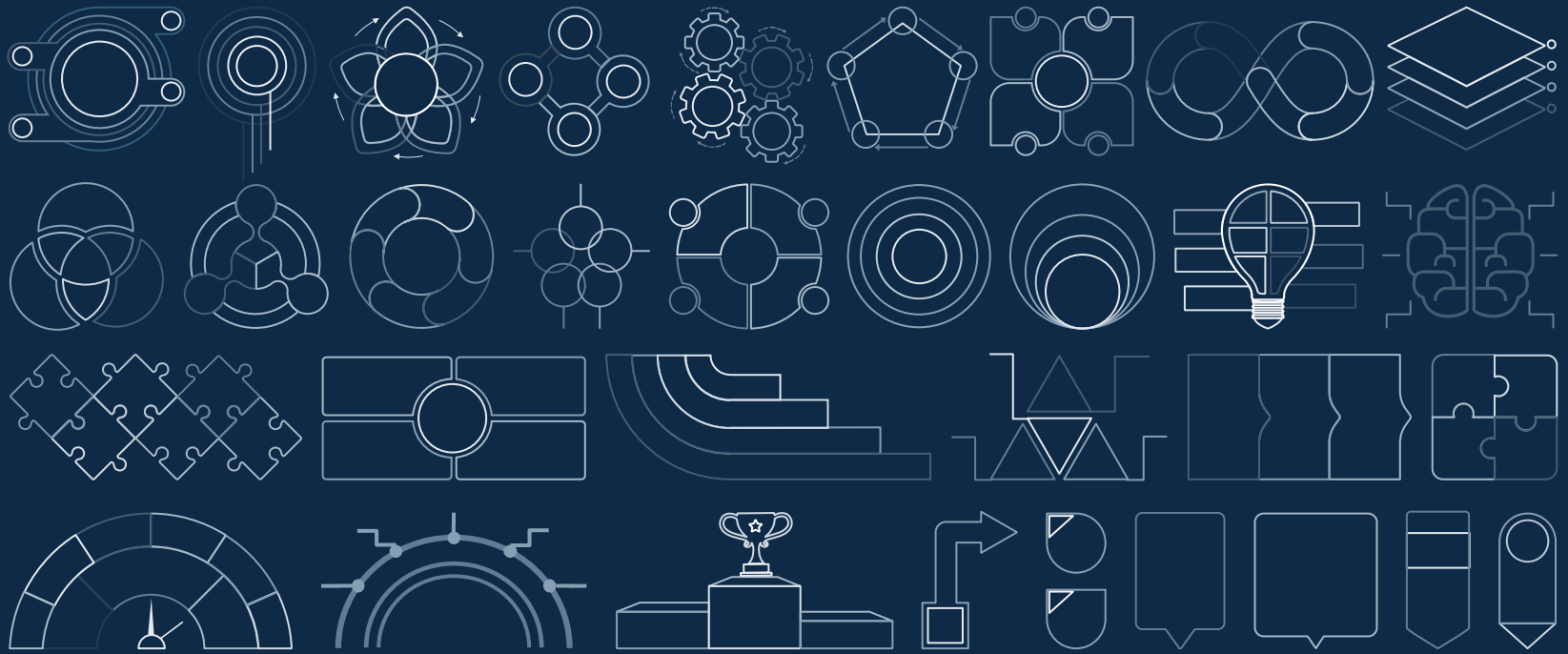

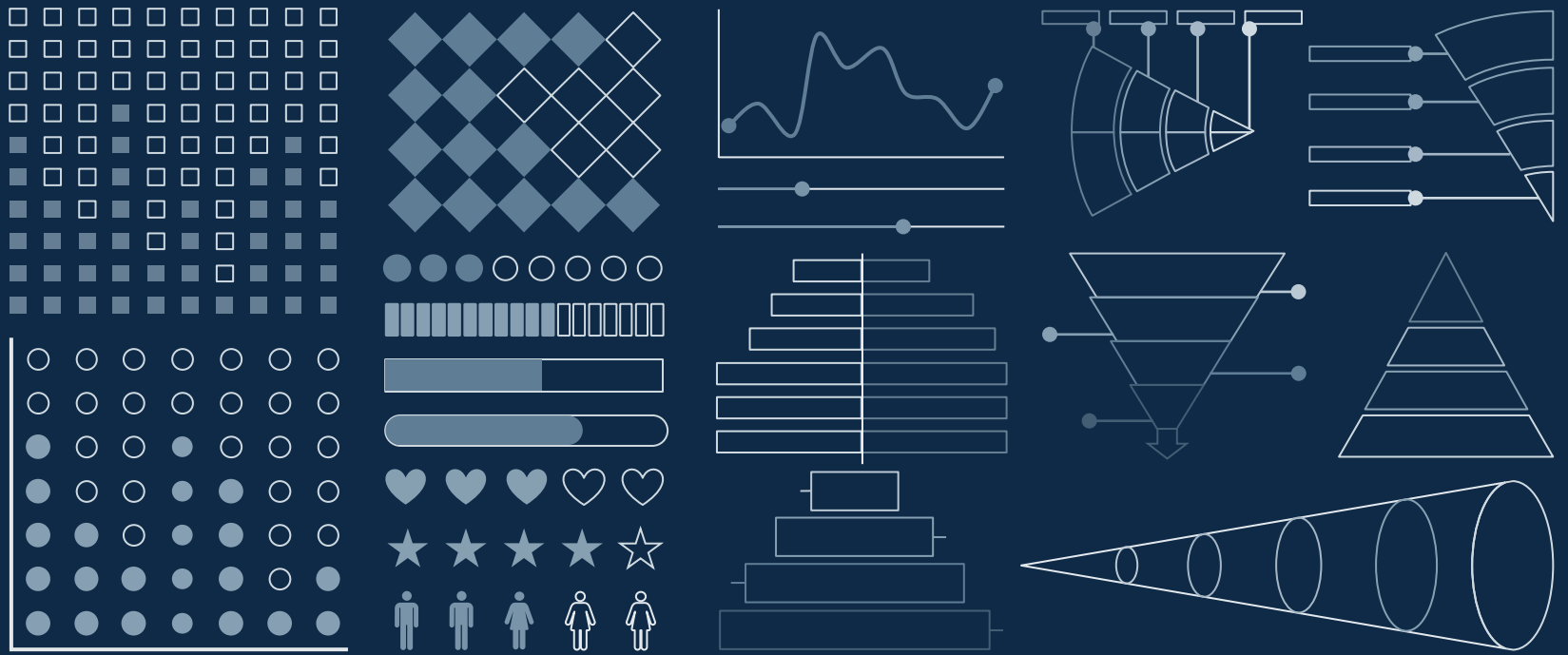

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