

LAUSANNE, 2022 //

Autonomous Robots for Industrial Inspection



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2022 **I**ntelligent
Maintenance
Conference

anybotics

Today's industrial operations
still rely on human presence, despite...



MISSING WORKFORCE

1.5 million plant operators
missing until 2030 in the EU alone



LIMITED PRODUCTIVITY

Undetected issues lead to downtime
costs of \$50 billion each year



HUMAN ERROR

Is the leading cause of
most industrial accidents

But things are changing.




We are on the verge of the next robotic revolution

AI-powered, agile robots enable the transition from human-centric operations to the autonomous industry.

AUTOMATED MANUFACTURING

Enabled by 3 million industrial robots in operation






-  Workforce shortage
-  Repetitive motions
-  Structured tasks

SMART WAREHOUSING

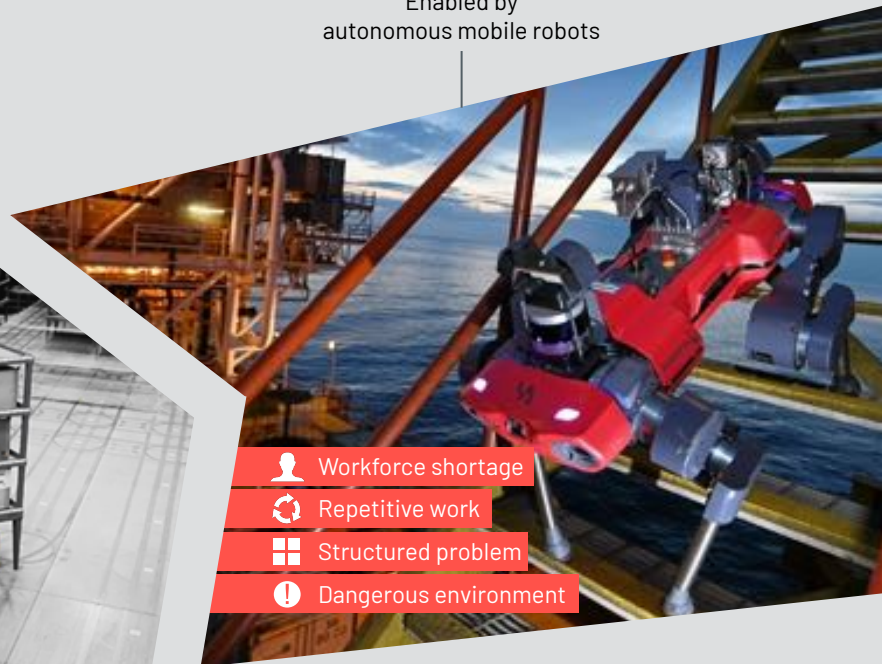
Enabled by 600'000 warehouse robots in operation







-  Workforce shortage
-  Repetitive tasks
-  Structured environment

AUTONOMOUS INDUSTRY

Enabled by autonomous mobile robots



-  Workforce shortage
-  Repetitive work
-  Structured problem
-  Dangerous environment

ANYbotics creates a workforce of autonomous robots

ALL-PURPOSE MOBILITY PLATFORM

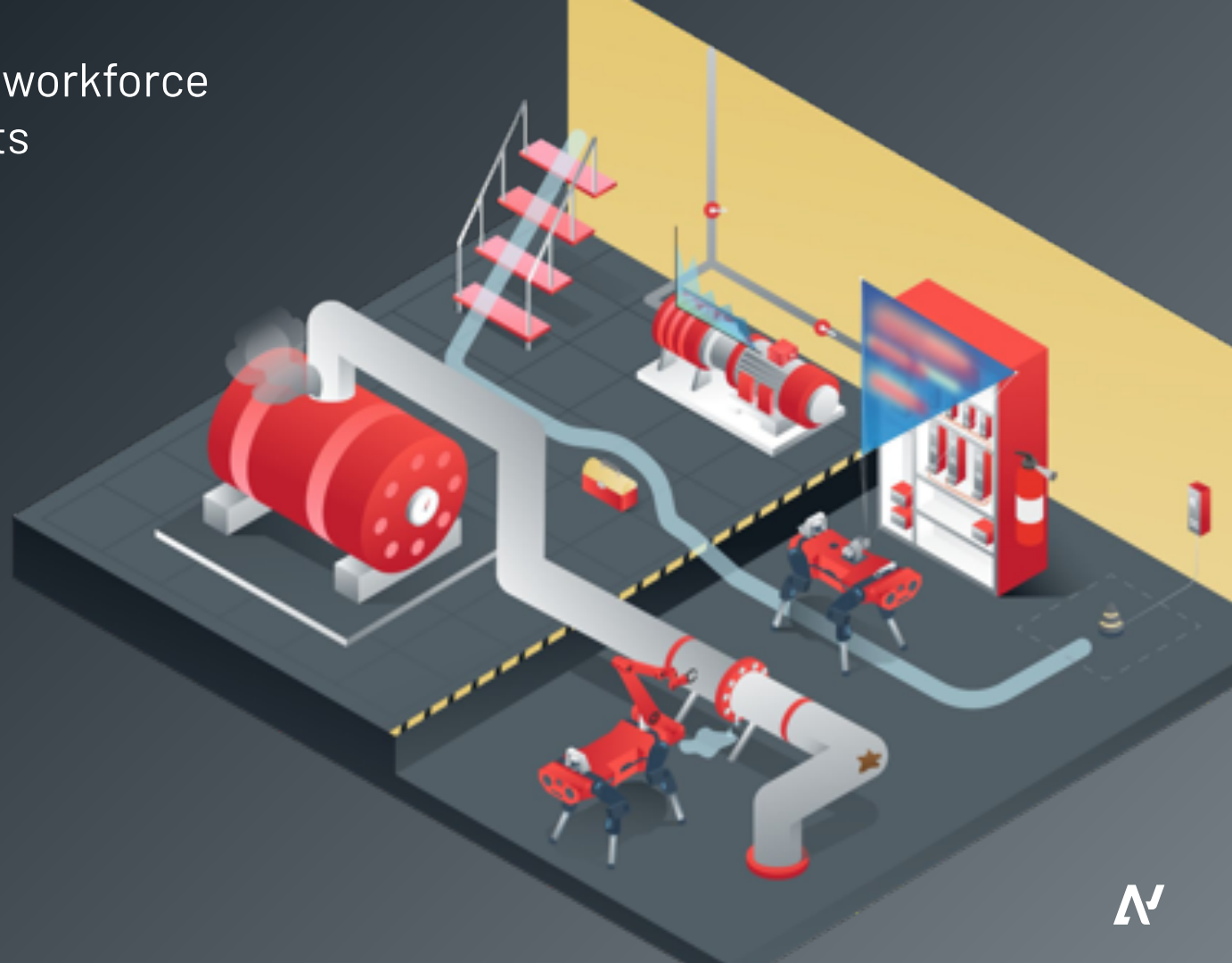
Access to hard to reach places in any type of facility

LARGE-SCALE AUTONOMY

Automate tasks while leaving the environment untouched

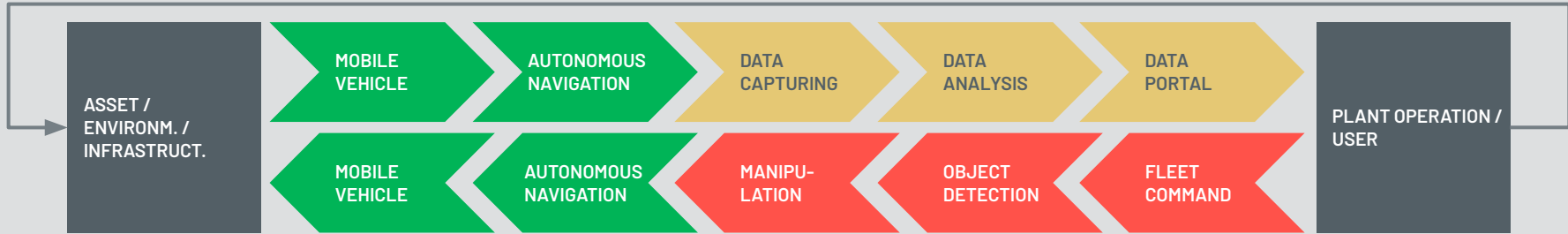
AI FOR THE REAL WORLD

Uncover invisible risks with superhuman sensing and real-time AI analysis



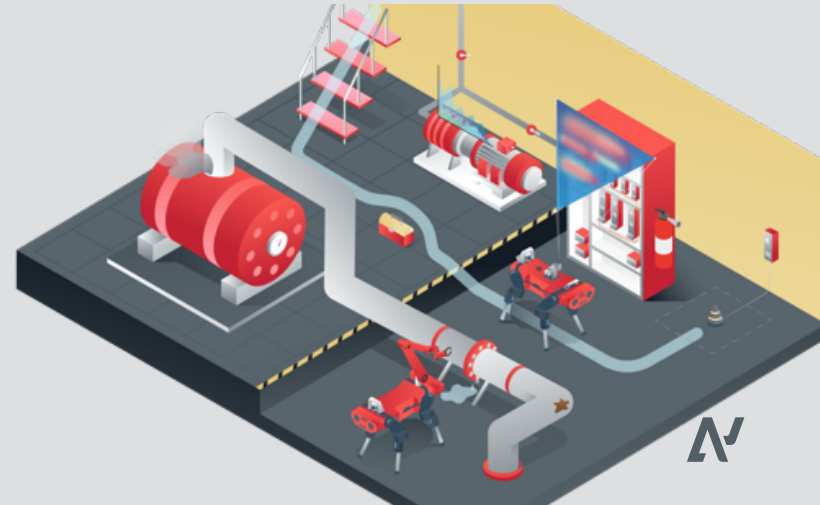
End-to-end solution for plant operator

Corrective measures, adjustments, repairs, from multiple times a day to once a year



Tasks of the robot

- Industrial inspection & surveillance
 - Reading instruments
 - Checking health of equipment
 - Detecting events
- 3D reality capture
 - 3D scanning & photogrammetry
- Safety & security
 - Patrolling
 - Anomaly detection
 - Situational awareness



Substantial cost savings through robotic inspection

5×

More insights

10×

Faster reporting

3×

Monitoring frequency

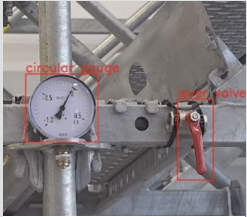
100%

Personel safety

100%

Accuracy & consistency

CUSTOMER CASES



Unplanned downtime

\$200-500k
cost per incident



Inspection during operation

\$200-300k
revenue loss p. hour



Asset damage prevention

\$0.5-1.5m
cost per incident



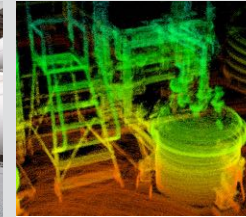
Remote operation

\$30-50k
cost per trip



Gas leakage detection

\$5-10k
cost per day



3D asset scanning

\$100-150k
cost per year



Frequent sampling

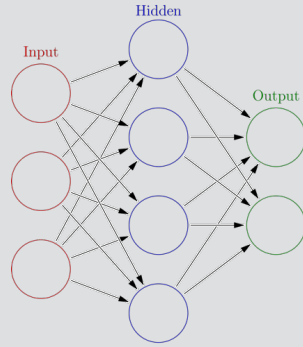
\$200-300k
cost per year

How does ANYmal learn to move?

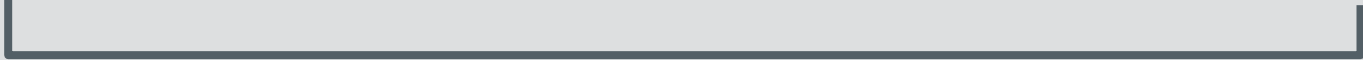
Velocity commands



Observations



Motor commands



Internal measurements

How do we train a neural network?

Training Process

Create random neural network



Run neural network in Simulation



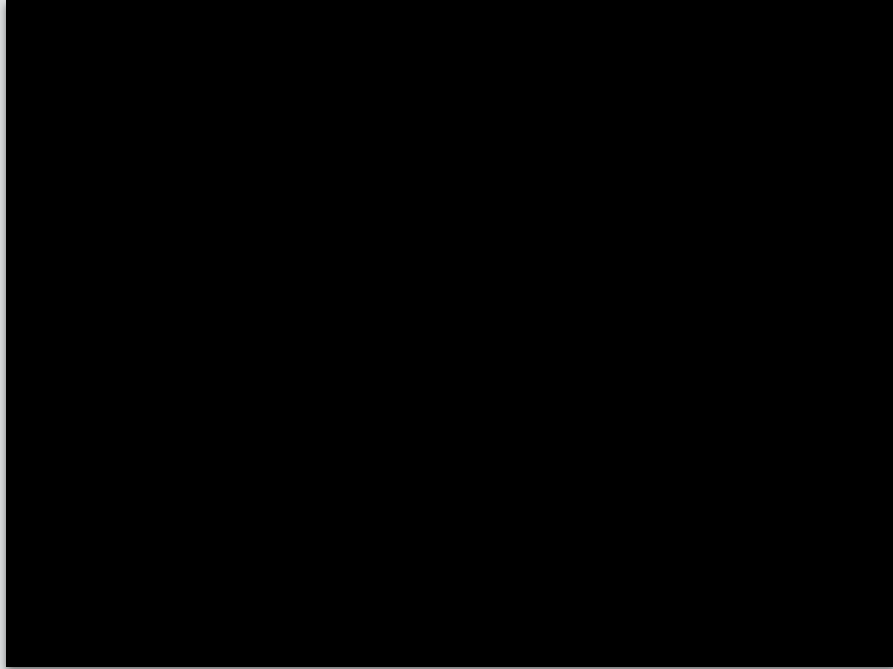
Collect observations and rewards



Learn which actions give better reward



Change the neural network to do more good actions!





Source: Robotic Systems Lab, ETH Zürich

Applying AI: Extreme mobility in all situations



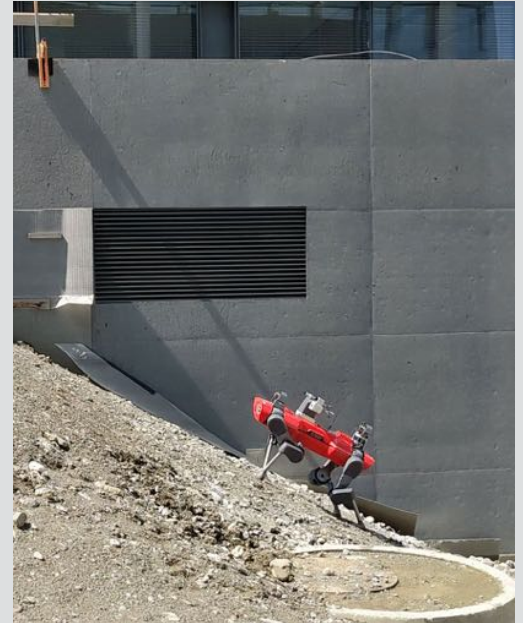
Smartly walk over disturbances

Easily overcomes debris, unforeseen objects in path



Slippery industrial terrain

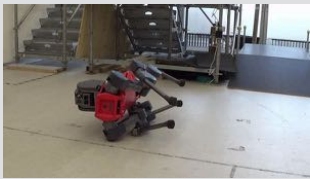
Passes extreme on-site industrial slippage tests (e.g., oil)



Unstoppable on rough terrain

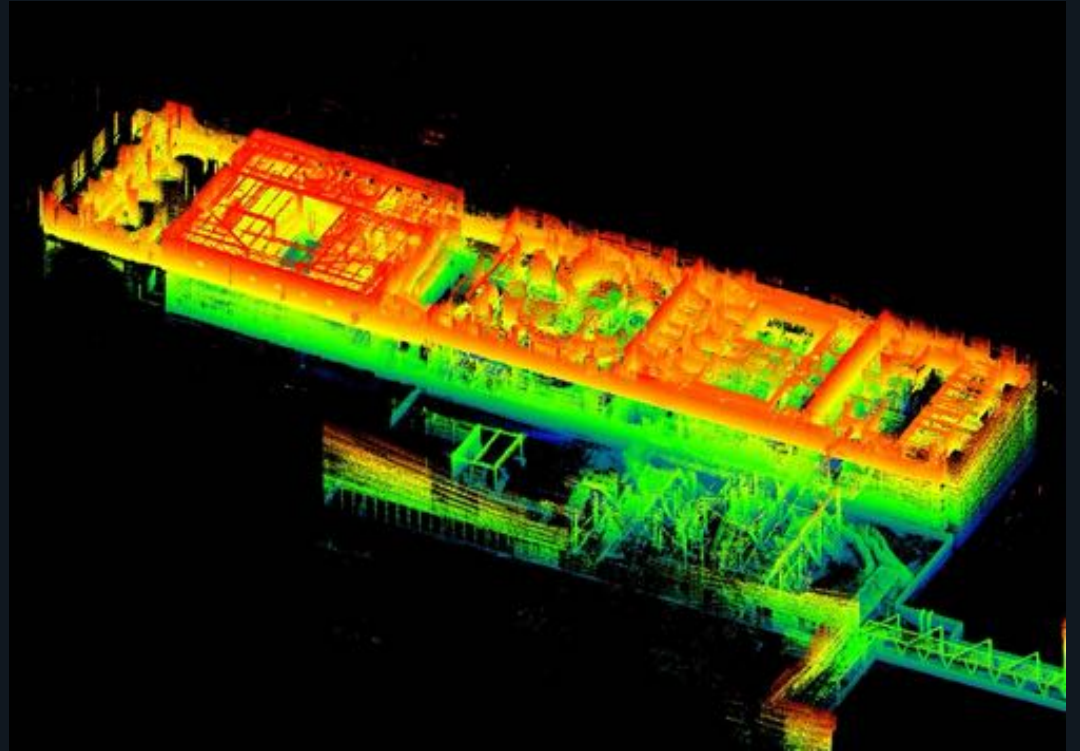
Walks up a $>30^\circ$ slope with loose dirt and stones



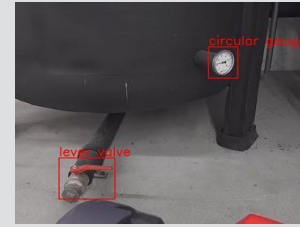
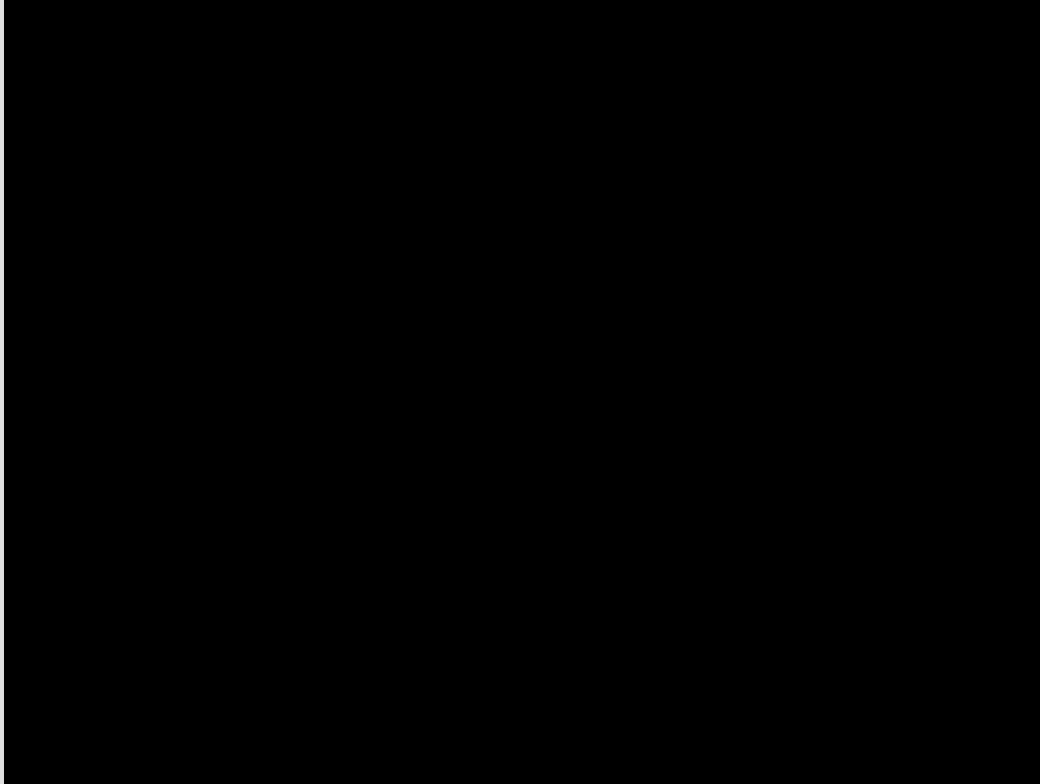


Digital twin

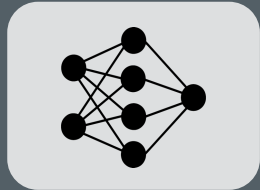
- Mapping large, multi-floor environments
- Precise SLAM
- Integrates with BIMs



Inspection intelligence



Platform for preventive maintenance



Detector

(Detects Object)



Interpreter

(Extracts digital data)



READING INSTRUMENTS

Gauges, valves, counters, LCD displays



CHECKING HEALTH OF EQUIPMENT

Thermography, vibrations, missing parts



DETECTING EVENTS

Hotspots, leakages, acoustic anomalies



GAS DETECTION

LEL: CH₄, C₂H₄, C₃H₈

PPM: O₂, CO, H₂S, Cl, SO₂, NO₂, NH₃

Payload partners

Specialized applications through modular third-party payloads (up to 15 kg).

Leica
Geosystems

Ω Metrohm

⊙ Polytec

FLUKE

INFICON



Inspection report











Access **PDF** and **XML** inspection reports with actionable information.

✓ Time & Geo-referenced inspection insights

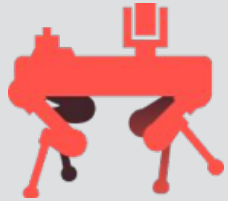
✓ Access to raw inspection data for further analysis

✓ Track patterns and historical issues

✓ Built on standard formats: *JPG, WAV, MP4, E57, PLY, CAE*

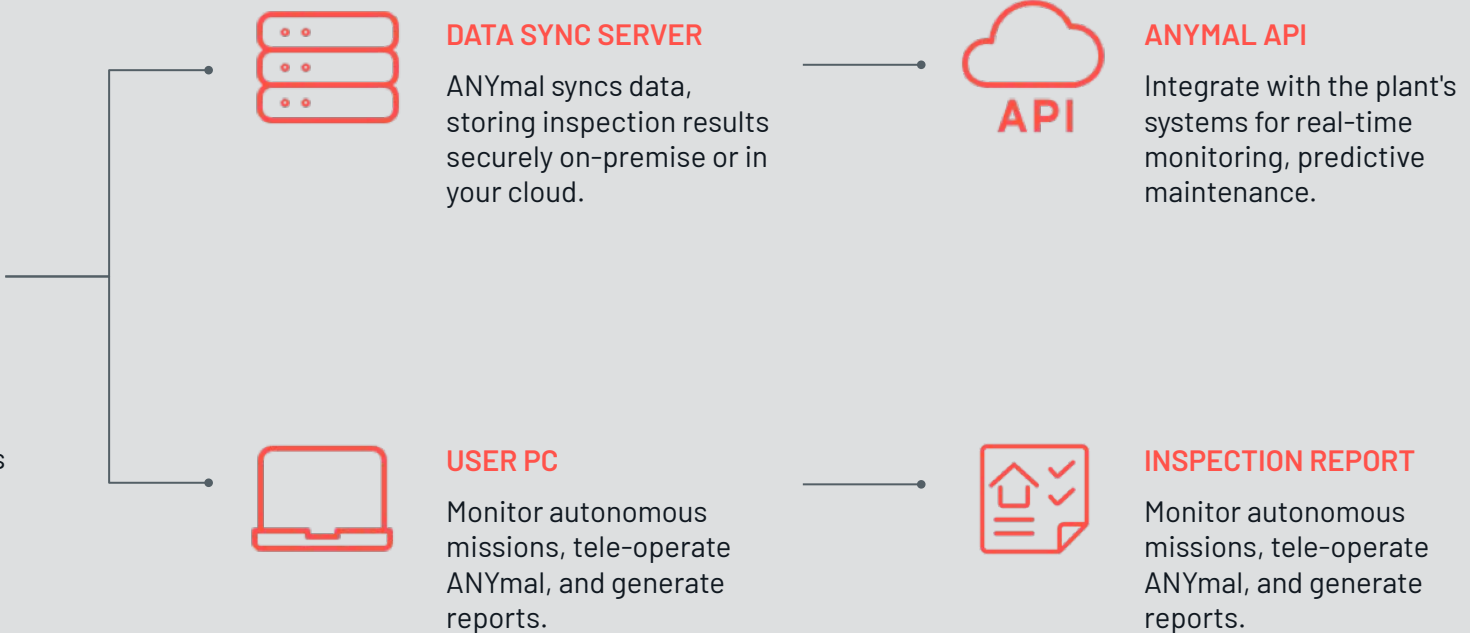
MISSION REPORT						MWBotics	
Location: Hagenholz							
Date: 2021/09/16							
Robot: ANYmal Dragon							
Time (hh:mm:ss)	Level	Event	Value	Status	File		
07:54:22	INFO	Starting mission 'Routine Inspection' ...	--	--	--		
07:55:38	INFO	Successfully recorded audio sample of 'Compressor 3 Sound'.	--	--	--		
07:56:17	INFO	Successfully read data of 'Manometer Dial 1'. Certainty is sufficient: 0.97 >= 0.80. Reading is within expected operating range (2.00, 2.50).	2.38 bar	Normal			
07:57:30	WARN	Successfully analyzed temperature of 'Flange 1'. Certainty is sufficient: 1.00 >= 0.80. Reading is not within expected operating range (50.00, 90.00).	60.40 °C	Anomaly			
07:58:32	INFO	Successfully read the beam 'Valve 1'. Certainty is sufficient: 1.00 >= 0.80.	1	Normal			
08:01:27	INFO	Successfully analyzed temperature of 'Motor 1'. Certainty is sufficient: 1.00 >= 0.80. Reading is within expected operating range (20.00, 90.00).	76.01 °C	Normal			
08:02:48	INFO	Successfully read data of 'Manometer Dial 2'. Certainty is sufficient: 0.98 >= 0.80. Reading is within expected operating range (4.50, 5.00).	4.91 bar	Normal			
08:03:58	INFO	Successfully read the beam 'Digital Display 1'. Certainty is sufficient: 1.00 >= 0.80.	11.44.5	Normal			
08:09:36	INFO	Successfully read the beam 'Fire Extinguisher 1'. Certainty is sufficient: 0.85 >= 0.80.	1	Normal			
08:09:58	INFO	Successfully read the beam 'Fire Extinguisher 2'. Certainty is sufficient: 0.84 >= 0.80.	1	Normal			
08:10:40	INFO	Successfully read the beam 'Square Gauge 2'. Certainty is sufficient: 0.97 >= 0.80. Reading is within expected operating range (2.00, 10.00).	1.38 A	Normal			
08:18:55	INFO	Successfully executed mission 'Routine Inspection'.	--	--	--		

Software integration



ANYMAL

Autonomously collects inspection data in and around your site



DATA SYNC SERVER

ANYmal syncs data, storing inspection results securely on-premise or in your cloud.



USER PC

Monitor autonomous missions, tele-operate ANYmal, and generate reports.



ANYMAL API

Integrate with the plant's systems for real-time monitoring, predictive maintenance.



INSPECTION REPORT

Monitor autonomous missions, tele-operate ANYmal, and generate reports.

Working with leaders across industries

OIL & GAS



CHEMICALS



POWER



MINING



CONSTRUCTION



ANYmal X



Conformity as of 08.2022

IECEX CONFORM

Ex ib eb db op is pxb sb IIB T4 Gb



ATEX CONFORM

Ex II 2G IIB T4 Zone



Building the Autonomous Industry

Autonomous mobile robots bridge the skill gap required to operate plants without human presence.

AUTONOMOUS INDUSTRY

ASSISTED OPERATION

AUTONOMOUS INSPECTION

ASSISTED EXAMINATION

Measure

Full-coverage plant insights for data analytics and equipment health monitoring



Act

Real-time remote plant management and automated routine maintenance tasks

AUTONOMOUS MAINTENANCE

ASSISTED INTERACTION







Thank you!

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