

Technical Meeting EVT2304391

Integrating Artificial Intelligence, Data Science & Related Computer Tools with Non-Destructive Testing for Disaster Management

International Atomic Energy Agency (IAEA)

24 February - 2 March 2024, VIC, Vienna, Austria

NDT activities in & from Argentina + An AI update

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NDT activities in & from Argentina

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An AI update

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Local Activities in NDT for Civil Engineering (CE)

NDT Day in Concrete

Talk organized by AAENDE with a company that represents ScreenEagle (Proceq) around AI and AR 2D and 3D in concrete, in Buenos Aires, with practical exercises.

Contract between AAENDE and NA-S.A.

2 years contract for advisory and services signed between the Non-Destructive Testing Committee applied to CE and Historial Heritage and Nucleoeléctrica Argentina S.A. (NA-S.A., operator of the 3 nuclear power plants in Argentina)



Local Activities in NDT for Civil Engineering (CE)

Workshop on NDT-CE during XI CORENDE

(Regional Congress on Non Destructive Testing,
Argentina)

- Update in Ultrasound based method – Level 1
- NDT in civil engineering (Sebastián Laprida)



Argentina in the ICNDT (International Committee for NDT)

Specialist International Group (SIG) in NDT

created at ICMDT during the European Conference on NDT (Portugal, July 2023).

AAENDE as chair of the ICMDT SIG

Chaired two virtual meetings of this group in September 20th and December 21th.

Subgroups created during December meeting

- NDT CE Standardization
- NDT CE Applications
- NDT CE Emerging Technologies



SIG in NDT

NDT CE Standardization

Working towards standards for each known method, new technologies, etc.

Working towards standards for training Professionals as Level 1, 2, or 3, for every method.

Working towards standardizing the documentation related with training for each method

Don't reinvent but harmonize what exists



SIG in NDT

NDT CE Applications

New constructions

How can we use NDT as a support tool when making new constructions?

Investigation & maintenance of structures

How can we use NDT to better investigate the structural integrity of structures, e.g. to assess damage, for heritage conservations and preservation, etc.

NDT as a support tool in different applications



SIG in NDT

NDT CE Emerging Technologies

Developing new technologies or landing of NDTs
for other areas for CE (including AI)

Too broad and too narrow, still looking for
definitions



Argentina in the ICNDT (International Committee for NDT)

**Proposal of actions for
pre & post disasters structural monitoring**

Objective

Use **satellite SAR interferometry** to determine **magnitude of surface displacements** with millimiter precision & comparison with measurements made with topographic techniques of fixed points existing in the structures.



Proposal of actions for pre & post disasters structural monitoring

Initial scope:

- Pilot test with different countries using information from our satellites SAOCOM 1A & 1B.
- Use SAR interferometry technology for evaluating infrastructure damage, to detect, map, identify, and characterize areas with displacements.
- Monitor these areas through time to model the underlying processes



Proposal of actions for pre & post disasters structural monitoring

Long term goals:

- Characterize displacement processes using multimodal data (e.g. surveys, time series of rainfall, temperaturas, piezometric levels).
- Establish and quantify relationships with conditioning and triggering factors for better management, correction and planning of the risks associated.
- Enable preliminary evaluations of service limit states (e.g. Angular distortions and settlements) to identify parts of the infrastructure in which these have been exceded.
- Define fragility curves to create damage probability maps for territorial planning for damage reduction using multimodal data.



Speaking of which...

... how is AI doing now?

New AI solutions (Multimodal) Foundation Models

- Characterization of images and text simultaneously
- Generative (+ discriminative) capabilities.
- Few-shot learners.
- Expensive and data hungry for training, not so much for fine-tuning (upstream vs. downstream tasks)
- GPT-4 (Vision), Gemini Pro (accessible through commercial APIs.)

**Exploiting few shot capabilities for co-pilot of NDT.
NDT-specific (multimodal) foundation models.
New applications with less data requirements.**

Model: GPT-4 with vision ALPHA

The screenshot shows a GPT-4 interface with the following components:

- Star Data Table:**

Star	Absolute Magnitude	Apparent Magnitude	Temperature (in degrees K)	Distance (in Light Years)
Sun	+5	+1	6,000	...
Spica	-3	+1	20,000	220
Alpha Centauri A	+1.2	+1	7,200	4.4
Aldebaran	-0.7	+0.9	4,500	68
Betelgeuse	-5.5	+0.8	3,300	650
Proxima Centauri	+15	+11	3,000	4.2
- Hertzsprung-Russell Diagram:** A scatter plot showing the relationship between Temperature (K) on the y-axis (log scale from 3,000 to 25,000) and Absolute Magnitude on the x-axis (log scale from 10⁻⁴ to 10⁴). The plot is divided into regions: Supergiants, Giants, Main Sequence, and White Dwarfs.
- Text Input:** "Transcribe the information from the 'Star Data Table' into a table and then explain how the diagram is helpful for astronomers."
- Text Response:** "Here's the information from the 'Star Data Table' transcribed into a more readable table format:

Star	Absolute Magnitude	Apparent Magnitude	Temperature (K)	Distance (Light Years)
Sun	+5	+1	6,000	...

"
- Message Bar:** "+ Send a message" and "...".
- ChatGPT may produce inaccurate information about people, places, or facts. ChatGPT July 20 Version

An AI update

New AI solutions (Multimodal) Focus

- Characterization of images and text
- Generative (+ discriminative) capabilities
- Few-shot learners.
- Expensive and data hungry for training, but efficient for fine-tuning (upstream vs. downstream)
- GPT-4 (Vision), Gemini Pro (access)

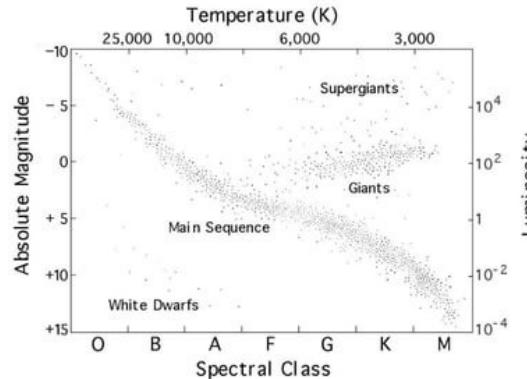
Exploiting few shot capabilities for NDT-specific (multimodal) foundry applications with less data

Model: GPT-4 with vision ALPHA



Star Data Table

Star	Absolute Magnitude	Apparent Magnitude	Temperature (in degrees K)	Distance (in Light Years)
Sun	+5	-26.5	6,000	--
Spica	-3	+1	20,000	220
Sirius B	+12	+8	7,000	8.6
Aldebaran	-0.7	+0.9	4,500	68
Betelgeuse	-5.5	+0.8	3,300	650
Proxima Centauri	+15	+11	3,000	4.2



Transcribe the information from the 'Star Data Table' into a table and then explain how the diagram is helpful for astronomers.

T

Here's the information from the 'Star Data Table' transcribed into a more readable table format:

Star	Absolute Magnitude	Apparent Magnitude	Temperature (K)	Distance (Light Years)
Sun	+5	-26.5	6,000	--

Send a message

...

An AI update

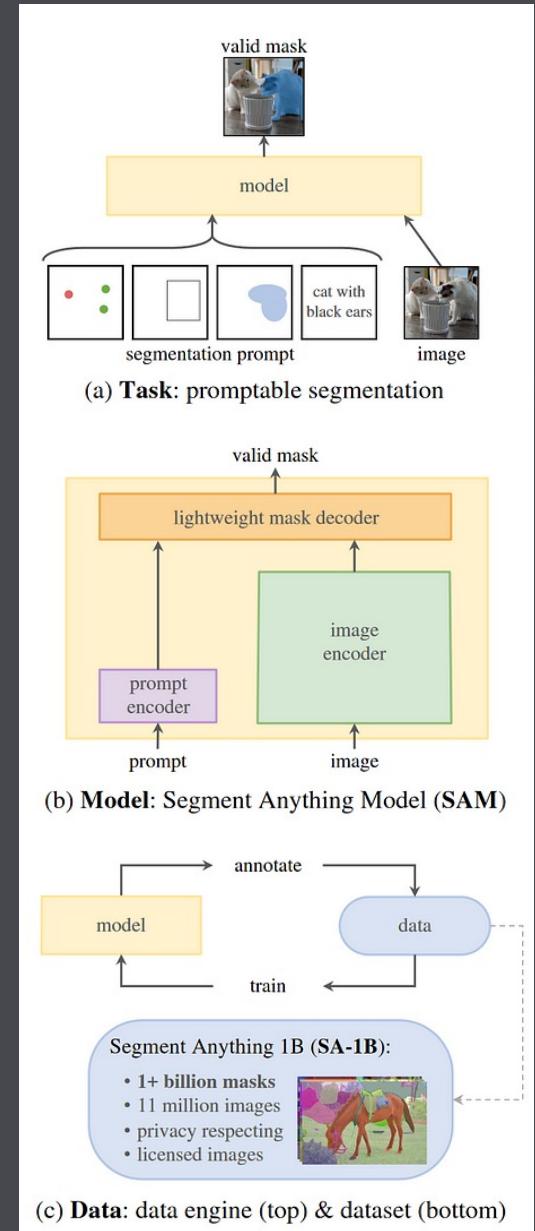
New AI solutions

Segment Anything Model (SAM)

- Foundation model for image segmentation (computer vision).
- Allows to segment (e.g. Magic wand in Photoshop) any object on an image from prompts (foreground/background points, bounding boxes, initial ROI, text).
- Easy to use and integrate.

**Fast automated assessment of cracks.
Automation of structural damage quantification.**

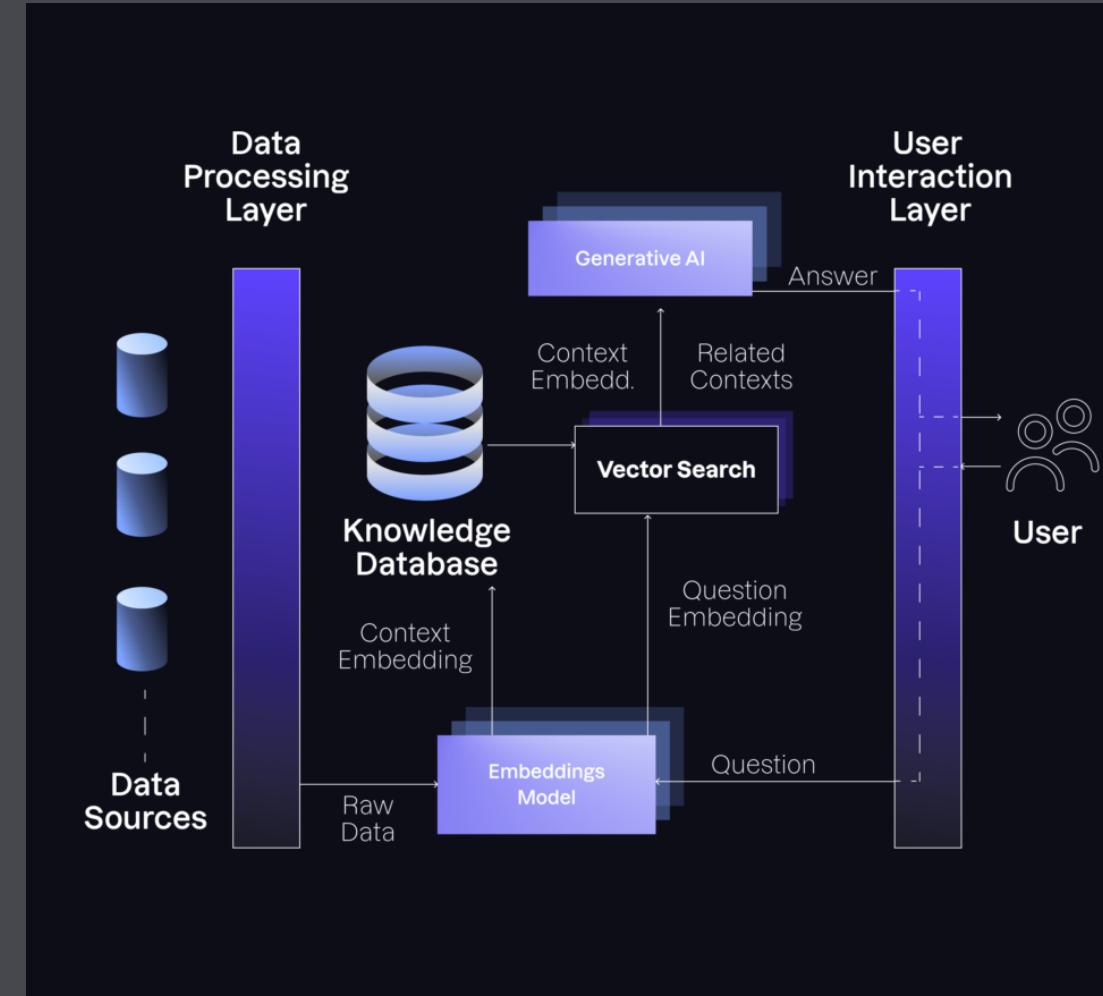
<https://arxiv.org/pdf/2311.10245.pdf>



An AI update

New AI solutions RAG

- Retrieval Augmented Generation
- Ask questions about a dataset without requiring to train or fine tune an LLM.
- Knowledge database of contexts = pieces of text (or any other content) mapped into embeddings.
- Every given question is mapped to an embedding.
- K-nearest neighbors (contexts) are identified.
- GenAI takes the contexts to produce answers.



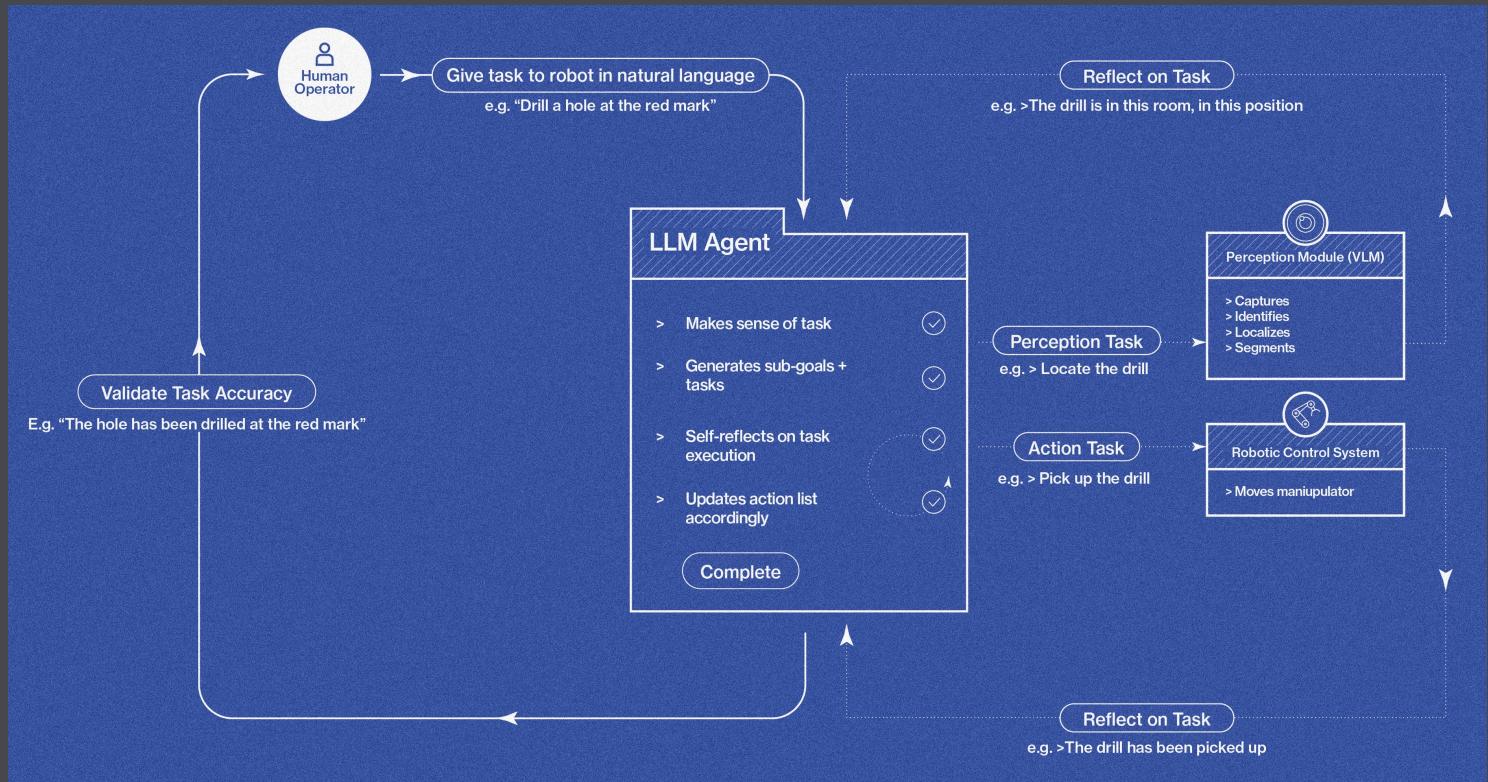
Question answering systems to digest guidelines for NDT. Quick retrieval when fast decisions are needed.

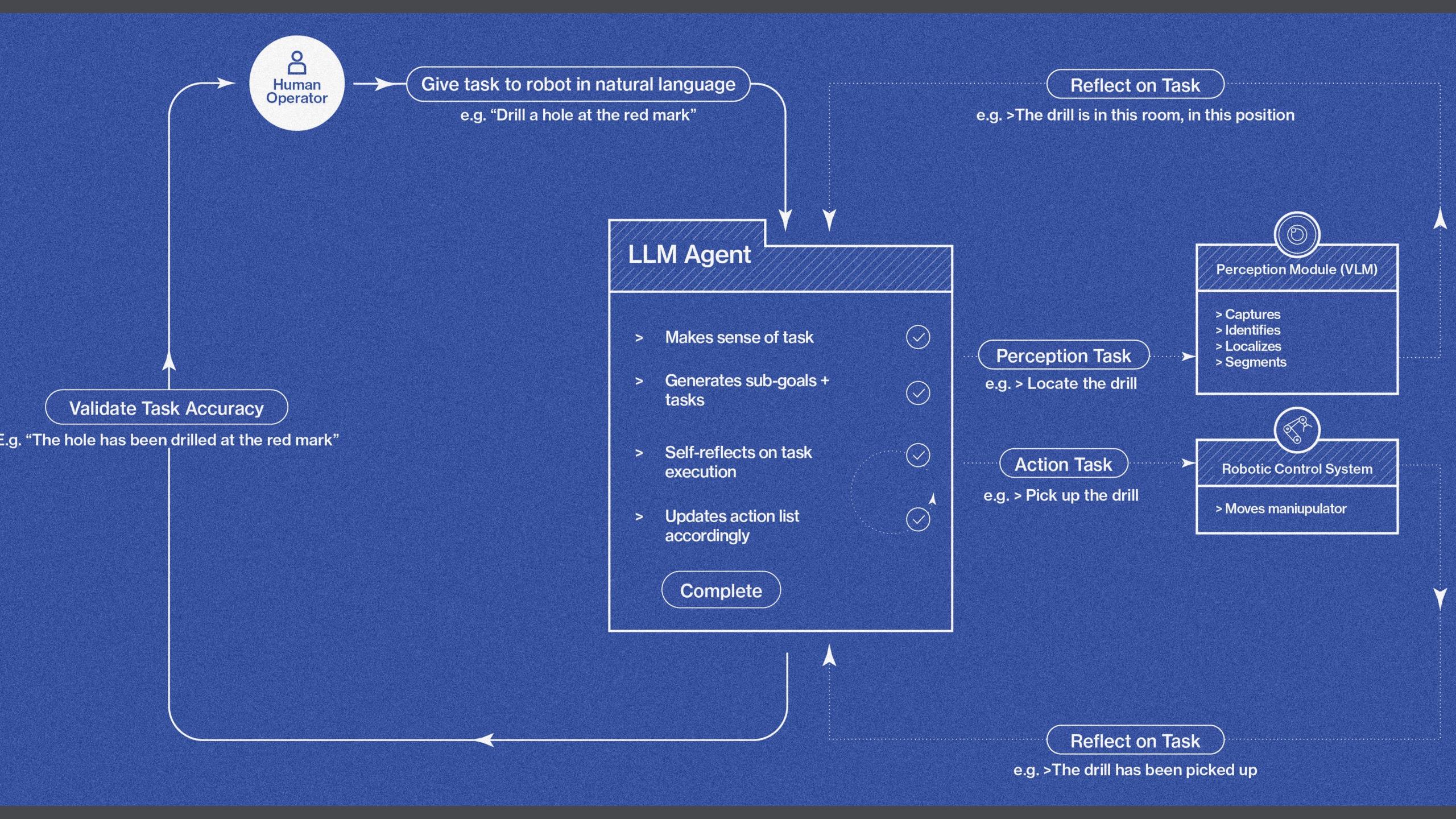
An AI update

New AI solutions LLMs as agents

- Language as a proxy for reasoning.
- Using LLMs to decompose instructions into a series of actions, based on contextual information.
- Automation of tasks, including robotics.

LLM-guided tools for NDT. NDT automation.





An AI update

New AI solutions **3D Gaussian Splatting**

- Render 3D scenes in real-time from only a few 2D pictures.
- Capture all the complexities of a 3D scenario with enough realism and minimum artifacts from just a couple of photographs.

Rapid virtual damage assessment from remote imagery (cracks, deformations, etc.)
Immersive collaborative environments for discussions and training.





F
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▼ Metrics
57.56 (17.37 ms)
VSync On

► 3D Gaussians

► Camera Point view

Menu Views Capture

► 3D Gaussians

► Camera Point view

 Die Aufnahme wurde
begonnen

F
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▼ Metrics

78.72 (12.70 ms)



To conclude, a reflection on
how we should think about AI today

A paradigm shift in AI

Automation vs. Augmentation

- **Automation** increases efficiency, reduce errors (?), and cut costs
- Usually data hungry. Prohibitive in some scenarios.
- No standards in data formatting in NDT yet.
- Negative and positive impacts (job displacement, deskilling vs. enhanced efficiency, time for other tasks)
- **Augmentation** aims to enhance human capabilities e.g. improve results or decision making, enhance skills and creativity.
- Human in the loop systems.
- AI as an assistant to achieve better results.

Automation for augmentation!



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Thanks for your attention!

Do you have any question?

Looking forward for a fruitful meeting!

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