DIGITAL FUTURE CHALLENGE #6

Elevator Pitch for Aconium GmbH: **DINO** (**D**igital **I**nfrastructure **N**otation **O**perator)

Germany suffers €500 million in annual infrastructure damage due to poor documentation. How do we move beyond paper and passive response?
Our DINO uses an AI-driven, two-tier system (MOM for overview, KIDS for detail) to ensure complete, precise subsurface data in a single mission. We link efficiency with ethics, guaranteeing data privacy and cutting the project's carbon footprint. Privacy-by-design and EU hosting ensure trust from day one.

DINO utilize AI-fusion and a cost-saving retrofit design to achieve systematic subsurface mapping, ensuring data integrity and high public acceptance while minimizing the project's carbon footprint.

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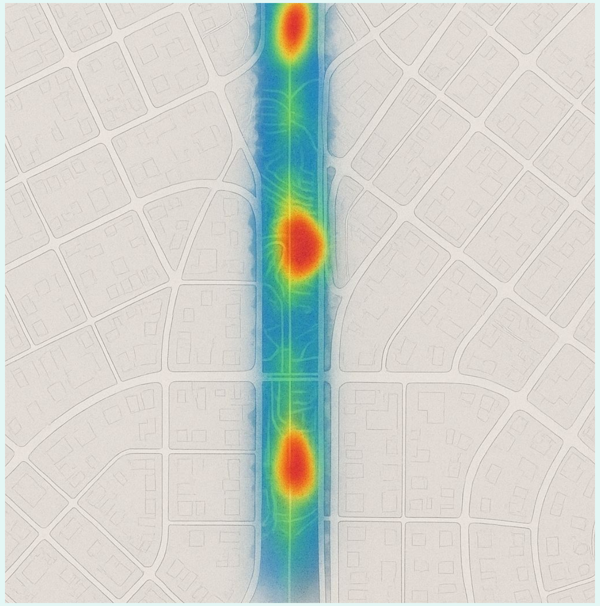
From the idea to the big picture – your vision as a convincing visualization

300,000,000 m^3 water lost annually in Germany due to aged Pipes.

What if we predict every leak with a **DIGITAL TWIN** Eliminating the loss **BEFORE** the pipes even crack?

The system will systematically map **where** infrastructure exactly is and in **which state** it is in.

Robots mapping **autonomously** with the **acceptance** of the local community.



Digital Twin Simulation: **Potential Damages** in the next years are visible before they happen.

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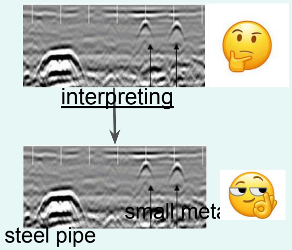
The challenges – and what makes our solution unique

Challenge

- Manual surveying is highly inefficient and costly, often leading to errors and demanding expensive re-surveys.
- Sensor data requires expert interpretation and manual translation, creating a processing bottleneck that prevents real-time feedback for optimizing subsequent scanning missions.



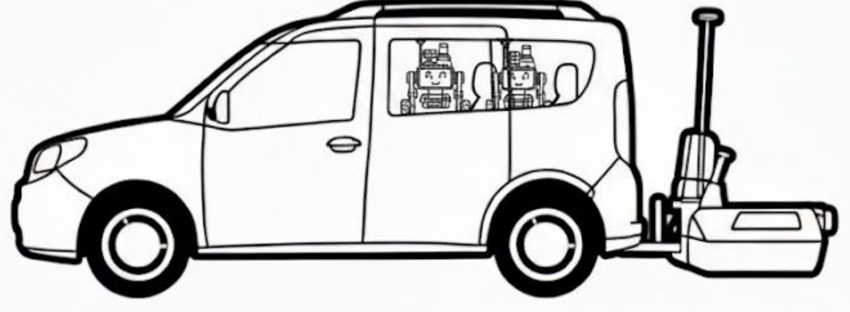
- The data collection operates in public areas. How do we mitigate potential public Surveillance Concerns and worries regarding data privacy?
- How to maximize technical compatibility with existing municipal resources to minimize adaptation barriers, curb unnecessary equipment manufacturing, and thereby reduce the project's overall carbon footprint?

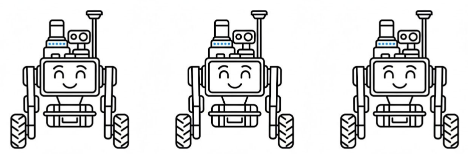
Our solution

- Our two-tier system uses Reinforcement Learning AI to guide a first rapid scan which offers an area overview. AI then performs **real-time data interpretation** to dynamically plan a detailed, adaptive second scan, which is executed by **autonomous robots**. This ensures complete data capture in a single mission, eliminating costly re-surveys and human bottlenecks.
- Appropriate Human-Robot Interaction and transparency are crucial to addressing this point. Applying **automatic anonymization to sensor data** (e.g., obscuring faces and vehicle plates) run by Edge Computing AI, reduces privacy concerns and prevents robots from functioning as surveillance tools.
- The first-tier scanner is a retrofit kit designed for municipal vehicles. This leverages snowplows or cleaning trucks belong to **existing system** to gather initial data, avoiding the high cost and carbon footprint of manufacturing new vehicles and minimizing adaptation barriers.

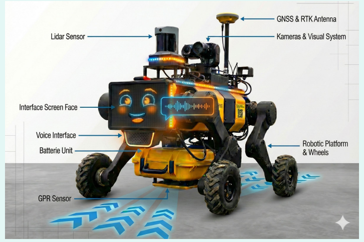
How our solution works

Name	MOM	KIDS
Type	**Vehicle** equipped with a rapid scanning sensor and surveying coordinate system;	Autonomous Scanning **Robot**
Scanning	Initial area **overview at low resolution**	**High resolution detailed** scanning
How they work	Reach and scan any paved road quickly; **Long-range, high efficiency**.	Limited operating time. Specialized for complex subsurface features.
Mom & Kids	Offering **backup battery to KIDS** ; **Deliver and pick up KIDS**	





Our two-tier solution uses a “MOM and KIDS” strategy to ensure the data integrity. The MOM is a rapid-scanning vehicle, capable for high-speed coverage of paved roads, and capture the initial urban overview efficiently. The KIDS are autonomous robots specialized in complex terrain and detailed subsurface scans. A very similar approach, that integrating high-precision Radar and LiDAR with the mobile platforms, has been developed by Vinci Energies. Back to the DINO project, we use the MOM as a logistic hub to deliver and power the KIDS. The maximized mission efficiency, focusing the 90-minute battery life on the most intricate gaps to create a complete environmental data service.



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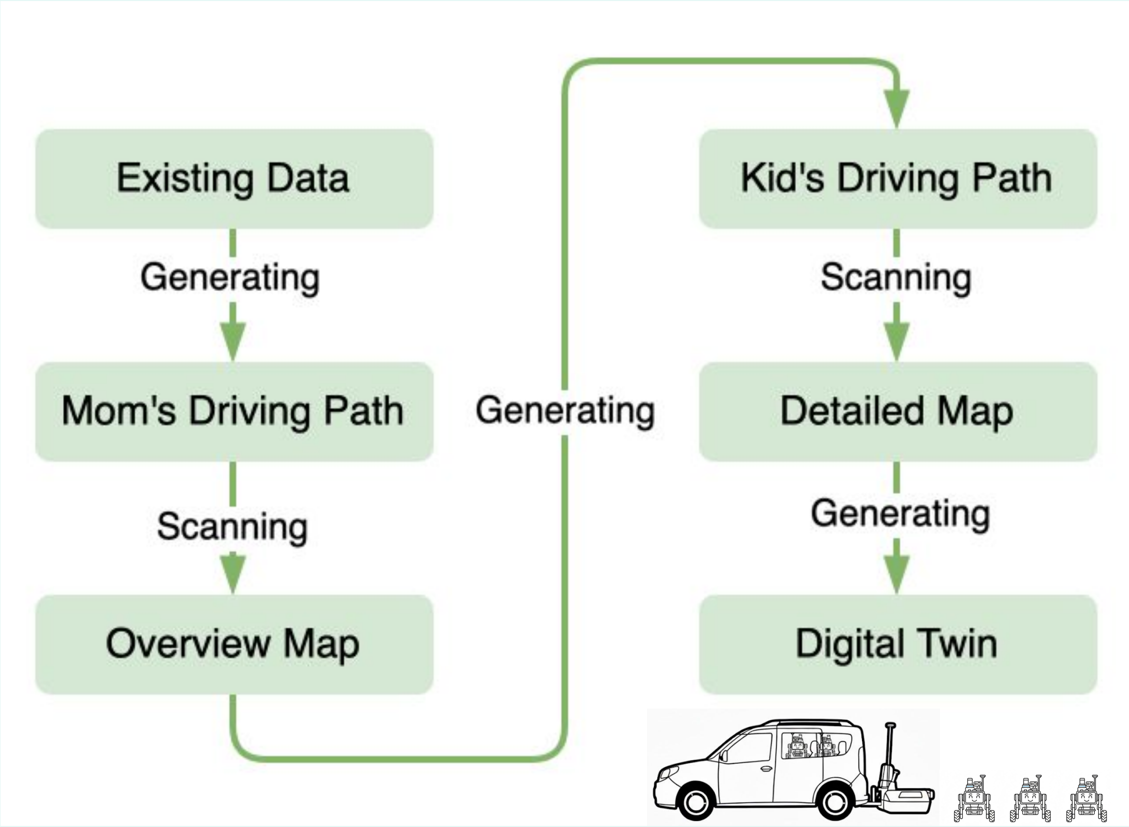
Extra page: How it works



Existing Data for initial planning
To get a headstart existing data from municipalities is collected and used to create an initial plan using Reinforcement Learning AI.

Vehicles (MOM) scan the city
Regularly circulating vehicles collect wide-area, low-resolution data, anonymized directly on the device. Sensors can be mounted to existing infrastructure (street cleaning cars etc.) for evaluation.

Overview map generation
The scans are processed in an EU-based backend to create a live, city-wide overview map of infrastructure and potential gaps.

Gap detection & Robots mission planning
The system identifies areas needing more detail and automatically generates targeted missions for robots.

Robots (KIDS) perform high-resolution scans
robots go on-site, navigate using the overview map and capture precise sensor data of critical otherwise unreachable points.

Fusion into a Digital Twin
Overview data and detail scans are merged into a scalable, continuously updated Digital Twin.

Stakeholder integration
Cities and utilities access the Digital Twin via APIs to support planning, maintenance and Smart City applications.

How our solution works – and next steps

Leveraging Existing Assets for Continuous Mapping

Our strategy maximizes both sustainability and data accuracy. The Digital Twin demands constant, accurate updates, a need we meet by integrating the MOM (Mobile Overview Mapper) kit into existing municipal routines (like snow removal and street sweeping). This approach leverages current resources to ensure continual data collection at minimal operational cost, simultaneously eliminating the high cost and carbon footprint of manufacturing new vehicles, thereby solving the 'update problem' while minimizing adaptation barriers.

Various Type of MOM

Snow Plowing Vehicle

Street Cleaning Vehicle

Tractor

etc.

Concrete steps for implementation are...

- ✔ Building a physical prototype of the robot
- ✔ Testing in a sandbox environment
- ✔ Cooperating with a municipality for the pilot run

Challenges of our solution are...

- ✔ Trust acceptance from the citizens
- ✔ Responsibility (safety issue, mapping)
- ✔ Data safety and privacy issue

Resources needed are...

- ✔ Robotics hardware
- ✔ Financial resources
- ✔ Mapping software
- ✔ Skilled tech team

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Research

COLLECT ALL INTERESTING THOUGHTS AND LINKS HERE

Human-Robo Interaction

Ruilin & Aastha

converting reactive maintainance to predictive one

Hotel Robots: What Are the Trends?

Digital Infrastructure (Fiber, Cables, etc.)

Water, Sewage, Pipes in general

Transport Infrastructure (Roads, Bridges, etc.)

What type of infrastructure?

How to map infrastructure?

Mapping of Infrastructure

Ben & Marius

Why is there a problem?

lacking consistency of documentation

DIN Norms for machines on public roads (Regulations)

QUESTION AND TASK

Your task is to design (walking or driving) robots using technologies such as ground radar or LiDAR that can be used in public spaces.

Think beyond pure efficiency gains: social issues such as transparency, acceptance, and feasibility are also important. Develop creative, responsible, and practical concepts based on the following key questions:

1. How could Smart Country Scouts be designed to systematically record existing infrastructure in public spaces? (Technical requirements, equipment, walking or driving robots, access to hard-to-reach areas)
2. How can the recorded heterogeneous data (radar, scan, photo/video, etc.) be evaluated in such a way that valid digital twins for fiber optic or energy projects are created?
3. What forms of human-robot interaction promote trust and acceptance among citizens?

what does it mean "hard-to-reach" area?

I still think the one staying with DHL deliver people works the best. No one bothers a (stupid) DHL device😜

NON-DESTRUCTIVE TESTING

Bodenradar | Worldoftest

References from the documentation

Autonomous drone docks (BVLOS flights)	In Germany, the first operating license for the DJI Dock was granted in 2023. This enables recurring, fully automated flights, for example to document construction sites. Manufacturers and partners are working on an EU-wide path for BVLOS (Beyond Visual Line of Sight) and are demonstrating initial applications for digital construction logs.	Understanding EU Drone Regulations for Doc...
Quadruped robots on construction sites	Robots such as Boston Dynamics' "Spot," combined with Trimble sensor technology, run standardized routes on construction sites, create 3D scans and digital twins, and compare this data with the construction plans (as-built vs. BIM).	Robot dog agreement for Trimble and Bos...
Pipe and sewage inspection	German suppliers such as IBAK and iPEK have been developing crawler and rehabilitation robots for sewer inspection and maintenance for years. This technology can be directly transferred to monitoring tasks in the course of fiber optic expansion and other civil engineering projects.	Leading Manufacturer of Advanced Se...
Ground-penetrating radar & subsurface mapping	GPR is being used in various smart city pilot projects to detect invisible pipes and update geodatabases. Initial mobile systems (on vehicles or robots), see, among others, Gesellschaft für Boden- und Raumordnung (GESBRO).	GESBRO - KI-gestützte Bauvermessung...

Random Ideas

Use E Scooter with added sensors for mapping cities

Use exisiting Data from Electricity and Telecommunication and extrapolate data

Hypothesis: Autonomous Drones are less problematic to the public since they are farther away, compared to creepy walking dogs

Gamified app that lets citiziens control ground robots with GPR and cameras.

Delivery person with added sensors

Autonomous Drones are creepy? Russian drones?

Create a flexible remote job for e.g. students (They do that for Tram in munich as well)

plzplzplz consider the snow cleaner

Stakeholder

Local authorities (efficiency, less bureaucracy)

citizens (transparency, concerns about surveillance)

construction and telecommunications companies (better documentation, risk minimization)

aconium

cleaner

Technical requirements

Why it hasn't been done before

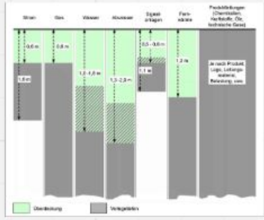
1. Autonomous robots weren't cheap, reliable, or robust enough
2. GPR data processing used to require human experts
3. No standardization in sensors or workflows
4. Cities didn't think of infrastructure mapping as a continuous process
5. The market structure worked against innovation
6. Software for merging GPR, GPS, IMU, and mapping didn't exist

Still an issue?

needs a lot of experts to make it a AI model

Continuous mapping becomes cheaper than doing it once manually.

Where we come in :)



energy infrastructure

GPR stands for **Ground Penetrating Radar**, a geophysical method that uses radar pulses to create images of what lies beneath the ground's surface. It works by transmitting electromagnetic waves into the ground and detecting reflections from objects, layers, and changes in material properties. This non-destructive technique is used for various applications, including archaeology, utility locating (pipes, cables), road and pavement inspection, and environmental studies.

ICT infrastructure

new built ICT lines usually contains the metal trape wire which repond to EM detector, while the old one doesn't.

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mobility infrastructure

LiDAR is a remote sensing technology that uses lasers to perform precise distance measurements and create 3D models of environments.

Photogrammetry is a process in which software is used to create three-dimensional models or data from two-dimensional photographs.

robot

LiDAR is a remote sensing technology that uses lasers to perform precise distance measurements and create 3D models of environments.

Real-Time Kinematic (RTK) is a technology for high-precision positioning in the centimetre range based on global navigation satellite systems (GNSS).

A **GNSS rover** is a mobile measuring device for high-precision positioning using satellite navigation systems such as GPS.

LiDAR and Ground radar

Pitch Story

1. **The Problem: Costly Unknowns Underground**
   1. 46.9 billion was spent on Public construction in 2024
   2. 12 % of that lost each year due change of plans and the need of rework -> poor project data or communication
   3. 11.8 Million in repairing infrastructure (pipe) damage
   -> 500 Mio. Costs for economy (outage ...)
   4. Outdated or missing documentation is the root cause
      1. manual documentation is laborous and repetitive
      2. costs can be decreased?

2. **The Vision: Always Know What's Underground**
   1. A world where (underground) infrastructure is reliably mapped
   2. No more guessing—high-confidence data before any construction
   3. Without Human interaction?
   Digital Twin?

3. **The Solution: Smart Country Scout DINO (Digital Infrastructure Notation Operater)**
   1. Robots equipped with SensorKit (GPR + navigation)
   2. Fully autonomous operation: deploy → scan → return
   3. Data collected and processed automatically
   4. Produces precise, up-to-date infrastructure maps

4. **The Benefits: Smarter, Safer, Cheaper Infrastructure Work**
   1. Avoid damaging pipes, cables, and utilities
   2. Better planning and fewer delays
   3. Easier maintenance through a living digital twin

5. **The Impact: Redirect Billions to What Matters**
   1. Reduced waste in public projects - Better foundation - more accurate data - less rework
   2. Budget goes to improvements—not repairs

Data/ Digital