



Robotic and Autonomous Systems in Cities

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The Problem

- A pothole is filled every 21 seconds in the UK
- In 2018 Poor road condition costs £22.8 million in compensation in England and Wales
- Costs of street-works disruption > £600 million per year
- 14 road workers were killed and over 300 were seriously injured between 2006 and 2016
- Congested traffic, such as that caused by street-works, emits 4 times as much pollution as free-flowing traffic and contributes to the estimated 40,000 premature deaths

Is this a sustainable management?



Self-Repairing Cities Project



SELF REPAIRING CITIES

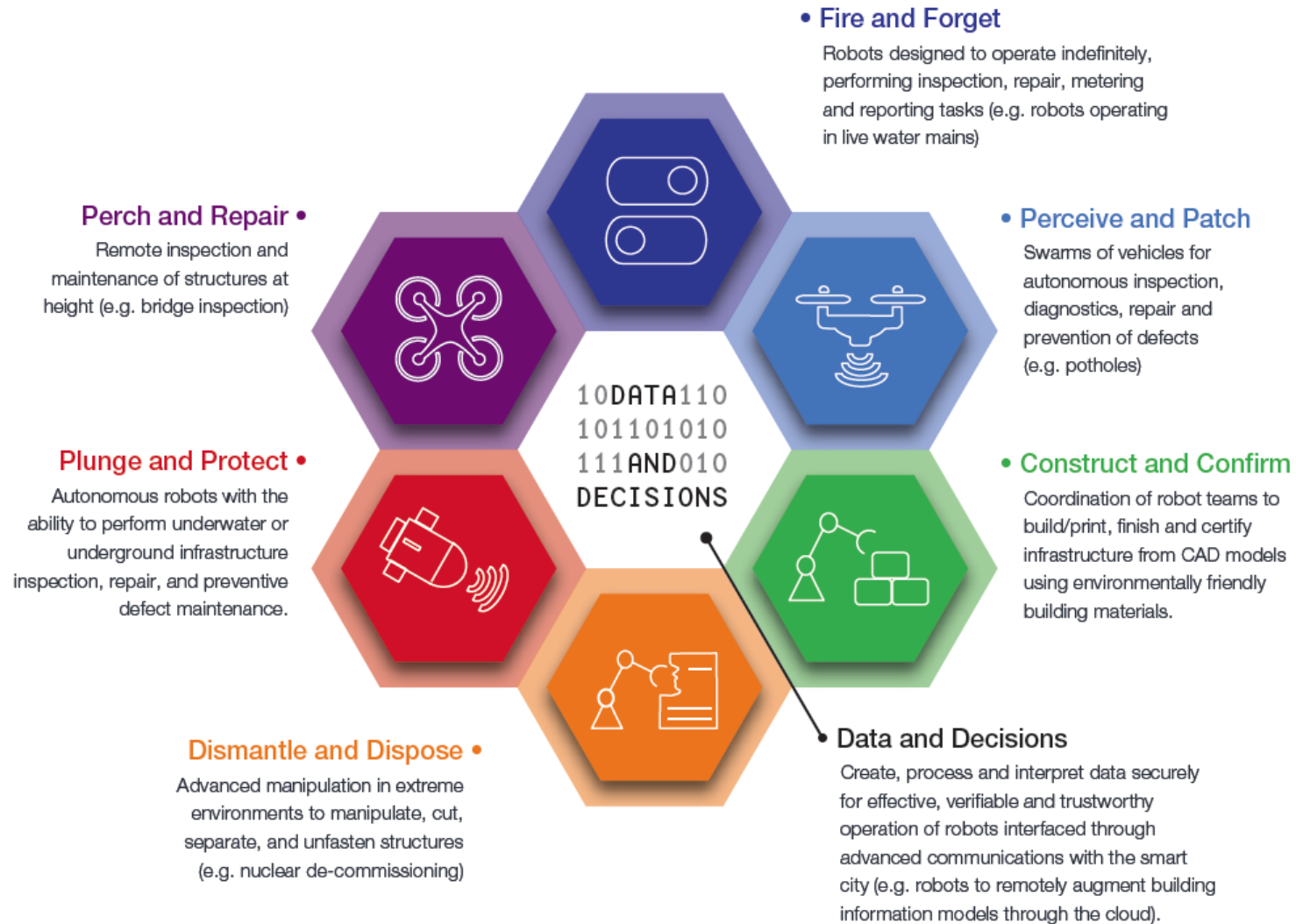
- Funded by Engineering and Physical Science Research Council (EPSRC)
- Grand Challenge: Balancing the impact of City Infrastructure Engineering on Natural systems using Robots
- Vision: **ZERO DISRUPTION FROM STREETWORKS BY 2050**
- Project Partners:
 - University of Leeds (PI)
 - University of Birmingham
 - University of Southampton
 - University College London (UCL)



Self-Repairing Cities

Aiming at a resilient infrastructure where autonomous robots will maintain the crucial infrastructure that we rely on in our daily life.

- Reduce downtime
- Reduce disruption to services
- Reduce risk on the safety of the workforce
- Reduce cost of inspection and maintenance
- Increase quality and reliability of infrastructure services
- Better quality of life







UAVs for Working at Heights



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UAVs on Lampposts



Perching and Manipulation on a Street Lamppost

- Autonomously perching on a street lamppost
- Inspect and maintain the lamppost
- (Un-)Installation on the lamppost with its on-board robotic arm







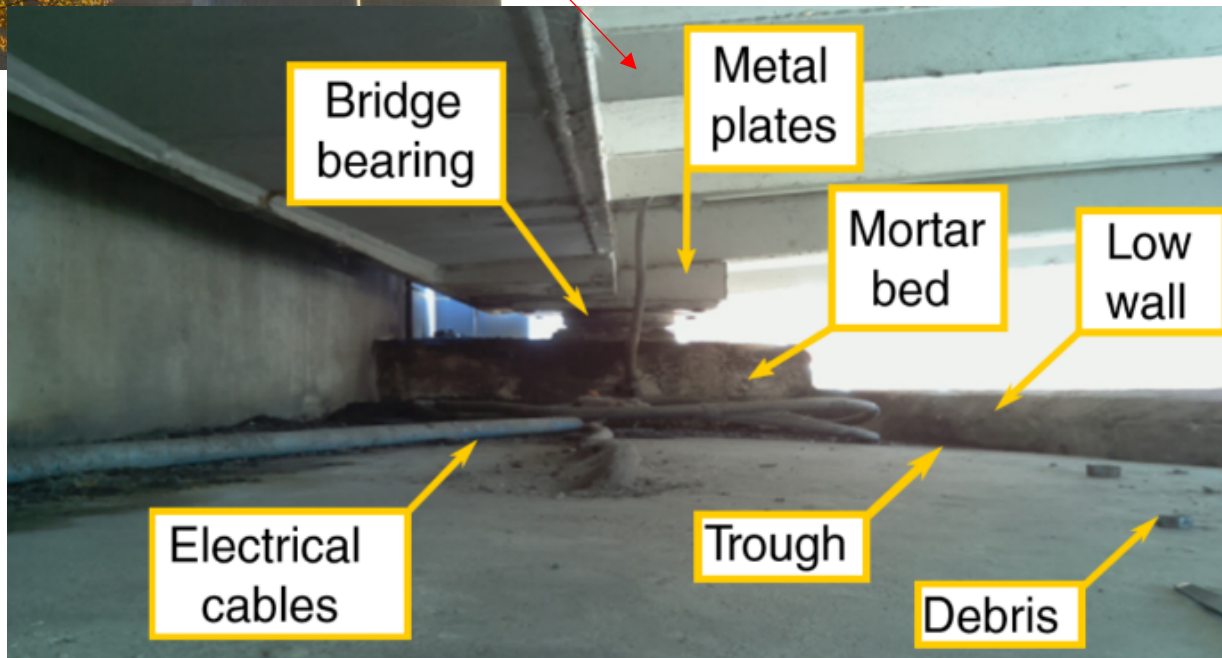
From the perching position,
it is possible to install the camera... [2x Speed]



UAVs on Bridges



Bridge Bearing:
Target Delivery
Location



Bridge bearing

Metal plates

Mortar bed

Low wall

Electrical cables

Trough

Debris

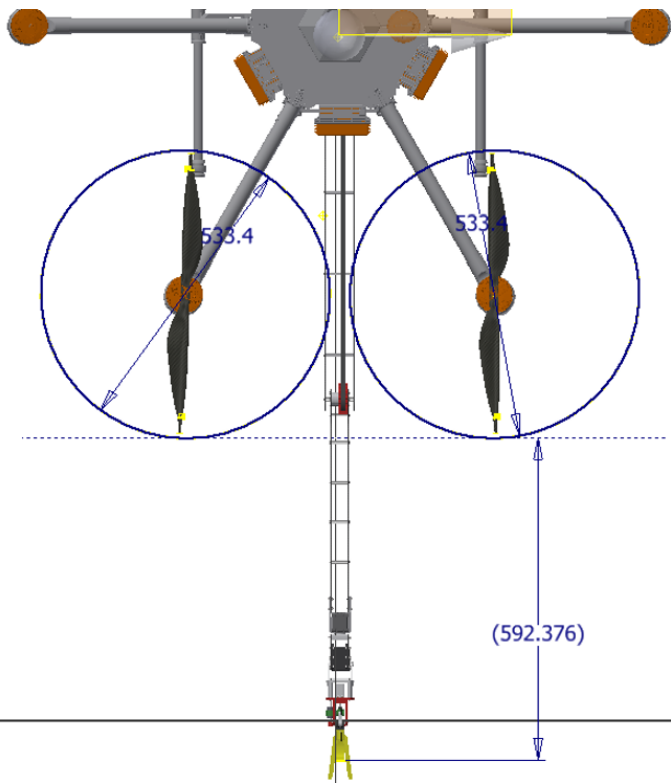


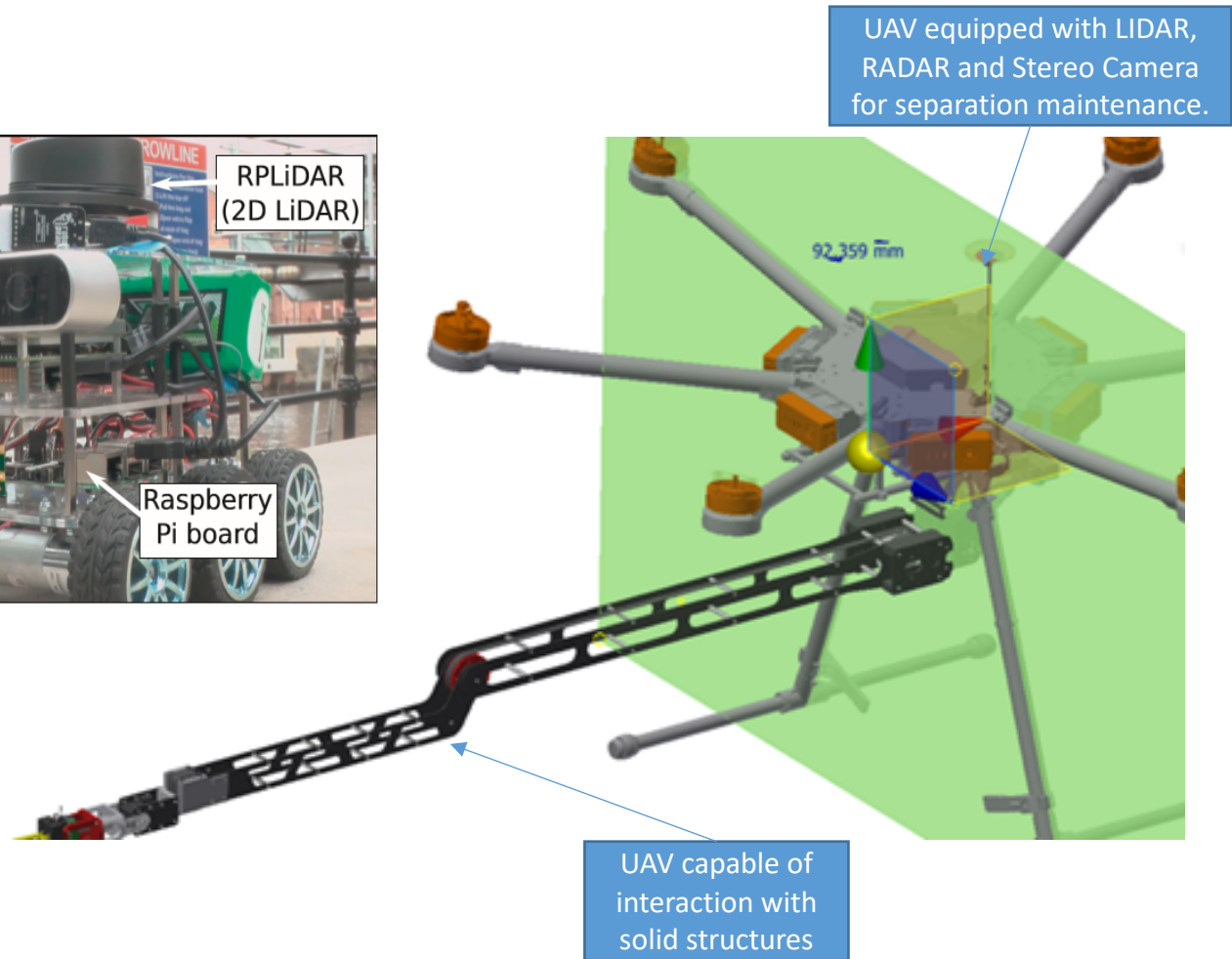
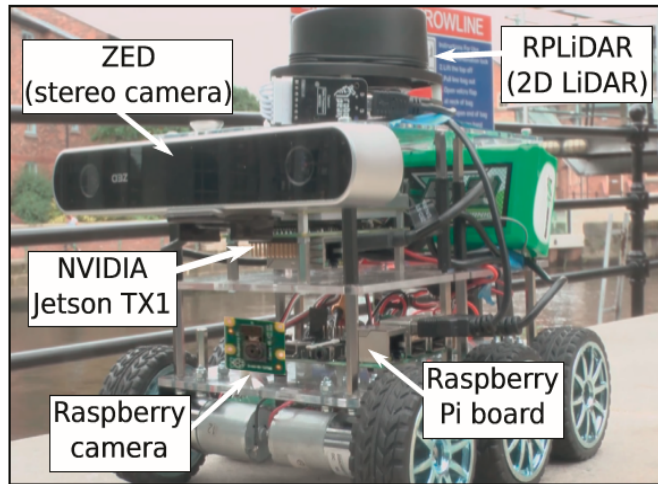
Deployment of UGV onto a Bridge

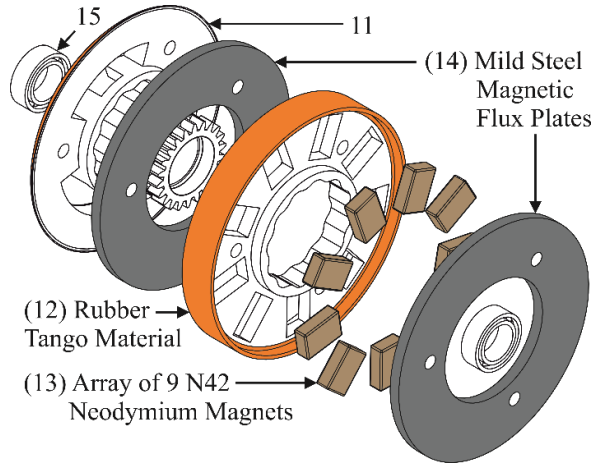
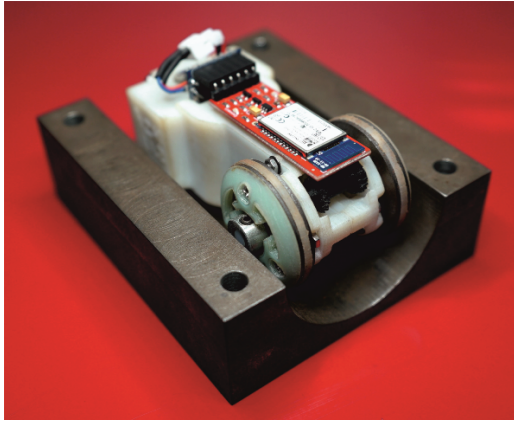
- Reach obstructed areas under the bridge
- Assess the damages to bridge bearings from all sides
- Perform non-destructive tests

Proposed solution:

- Use a drone to deliver and retrieve an inspection robot to the bridge underside





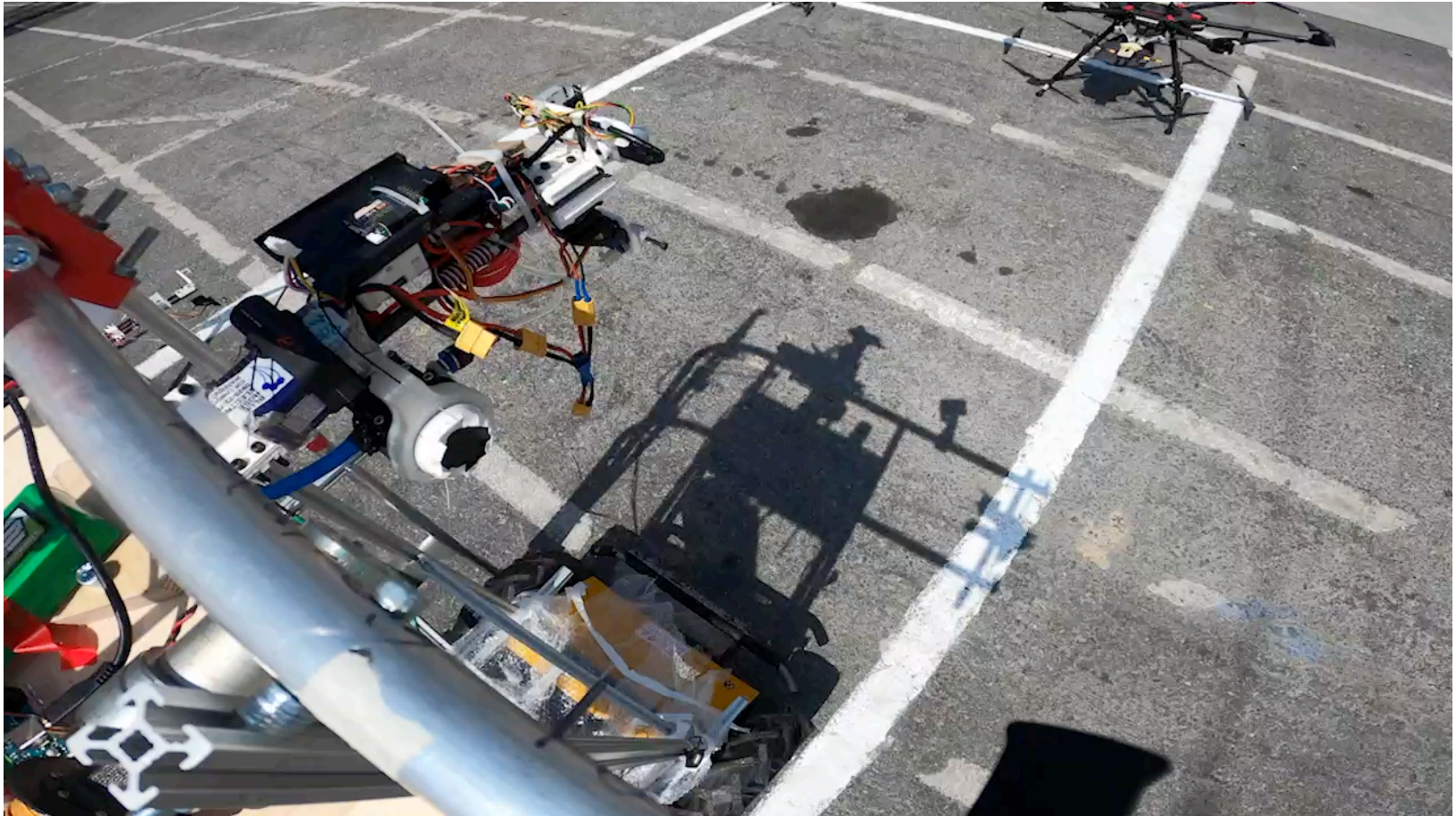


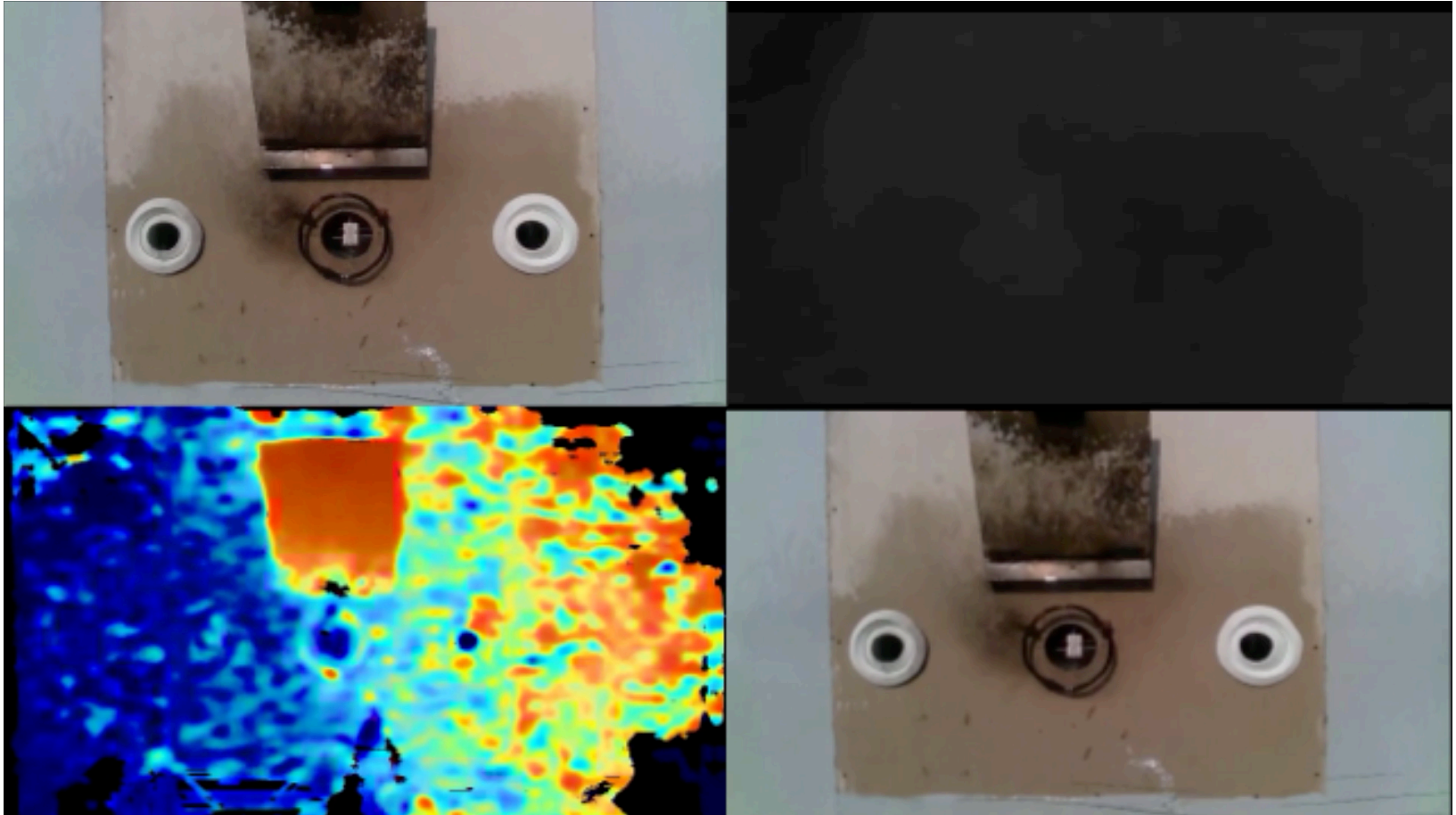




UAVs Firefighting



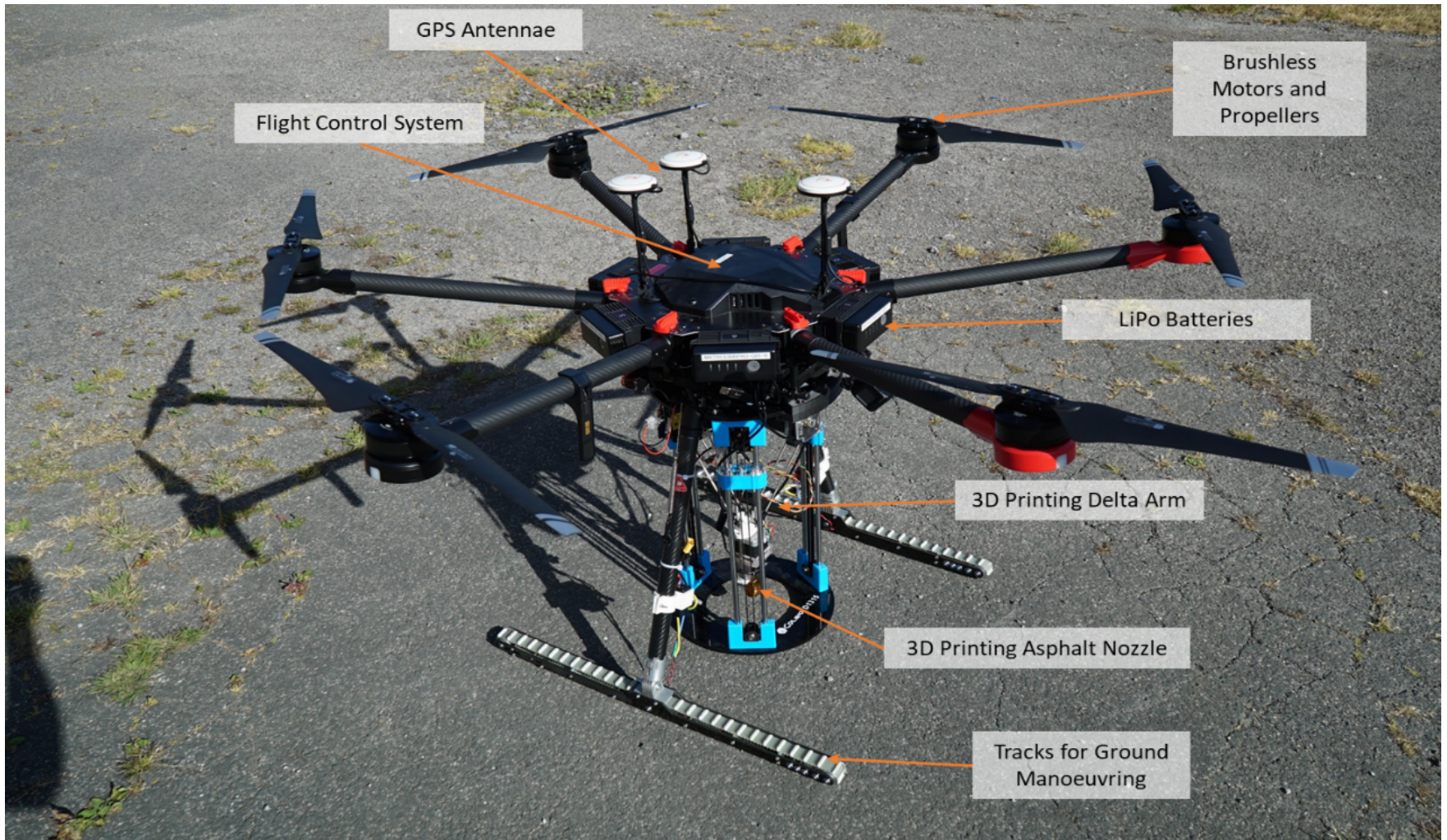






UAVs for Road Maintenance

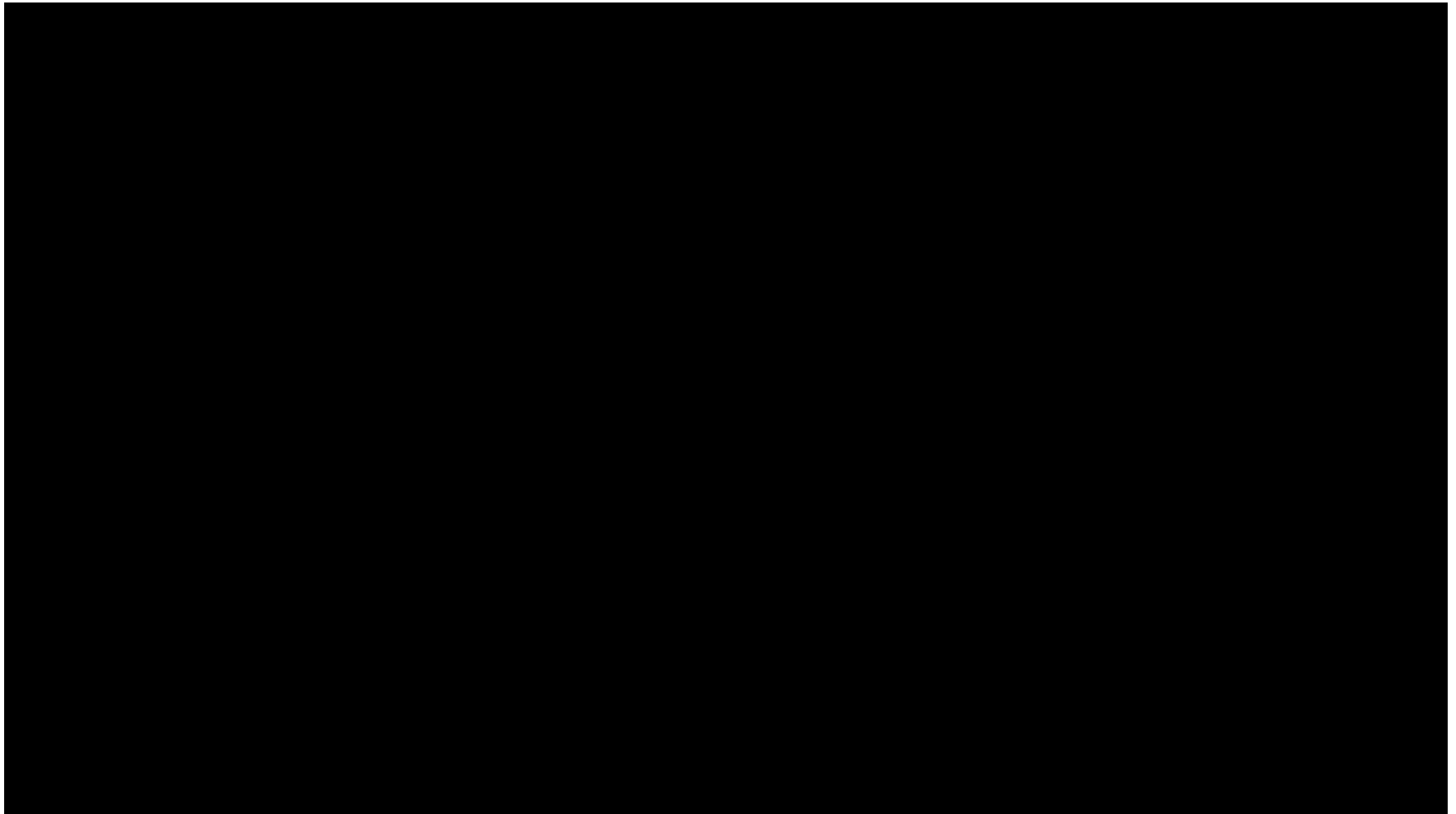


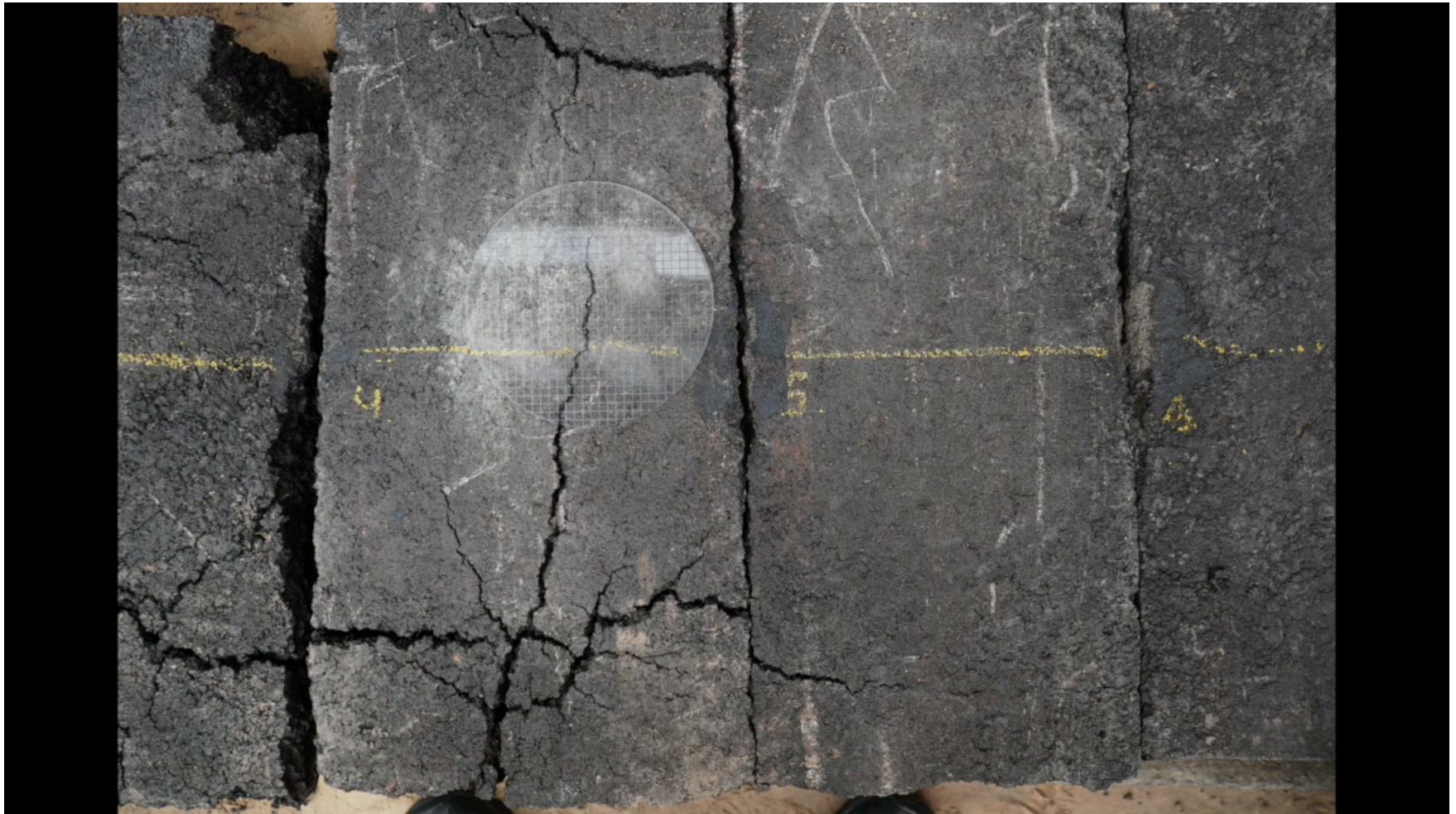


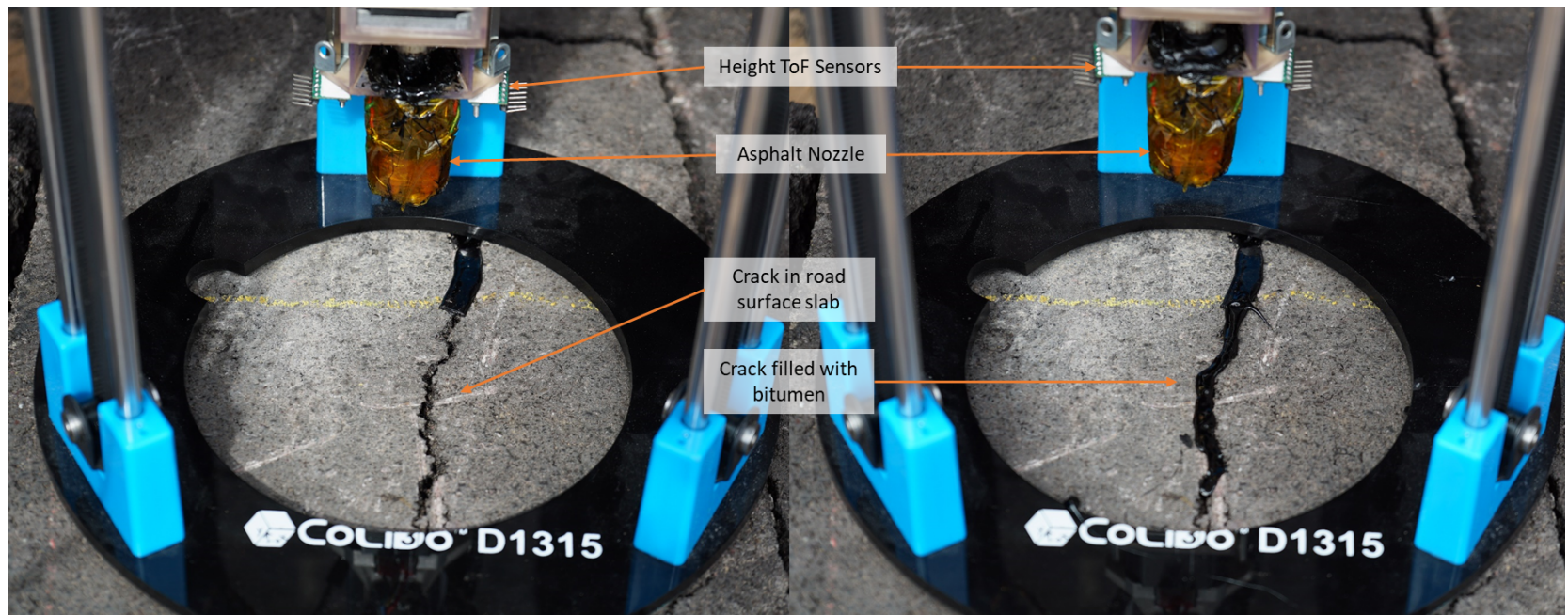




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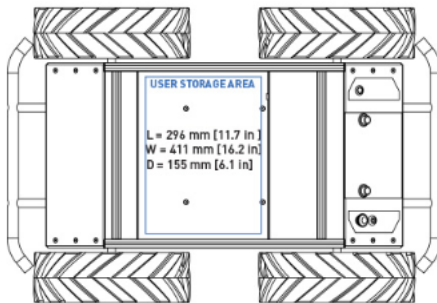
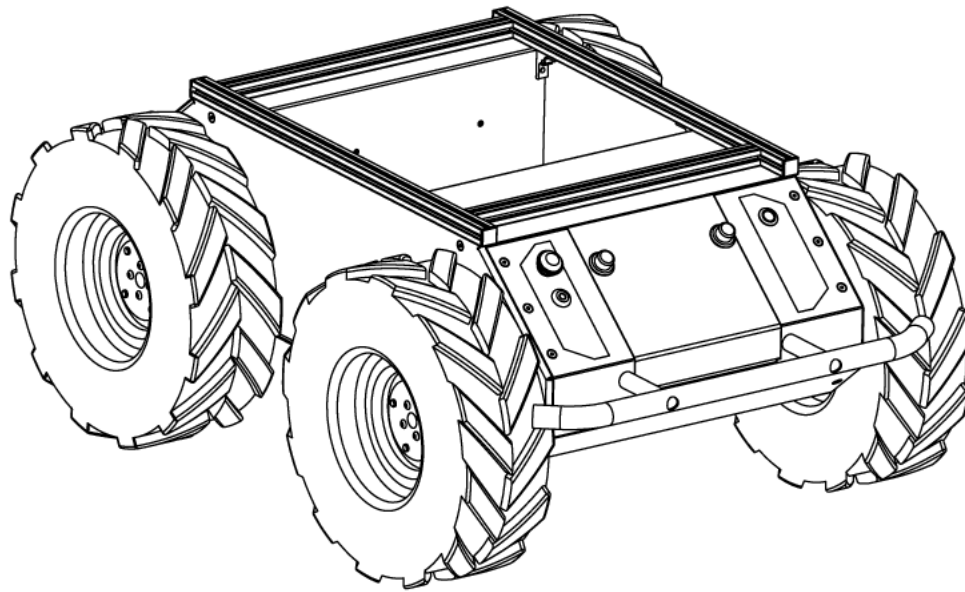




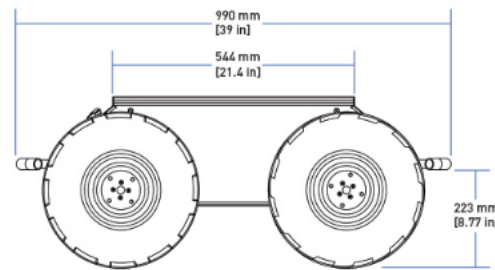
(a)

(b)

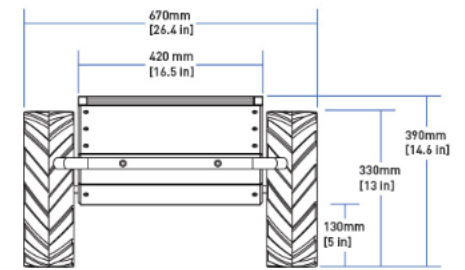
(a) Irregular crack to be filled (b) Crack autonomously filled with asphalt



TOP



SIDE



FRONT

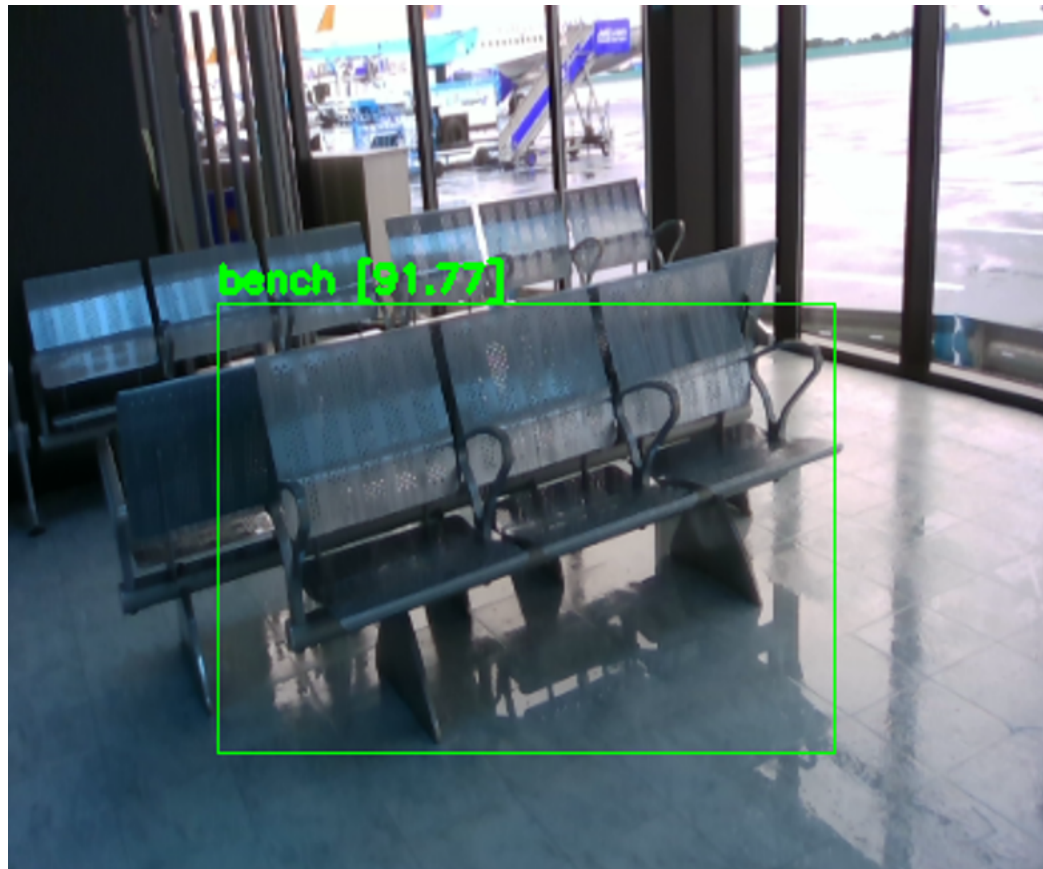


- Preventive maintenance approach that aims to seal cracks to stop water ingress preventing potholes from forming.
- Both systems can be remotely piloted.
- Crack detection and filling is done automatically.
- Aerial platform is suitable for locations that are hard to reach, and widely distributed.
- Ground platform is suitable for locations requiring larger material volume and defects that are relatively close to each other.



COVID-19 Response: Disinfection Robots





bench [91.77]





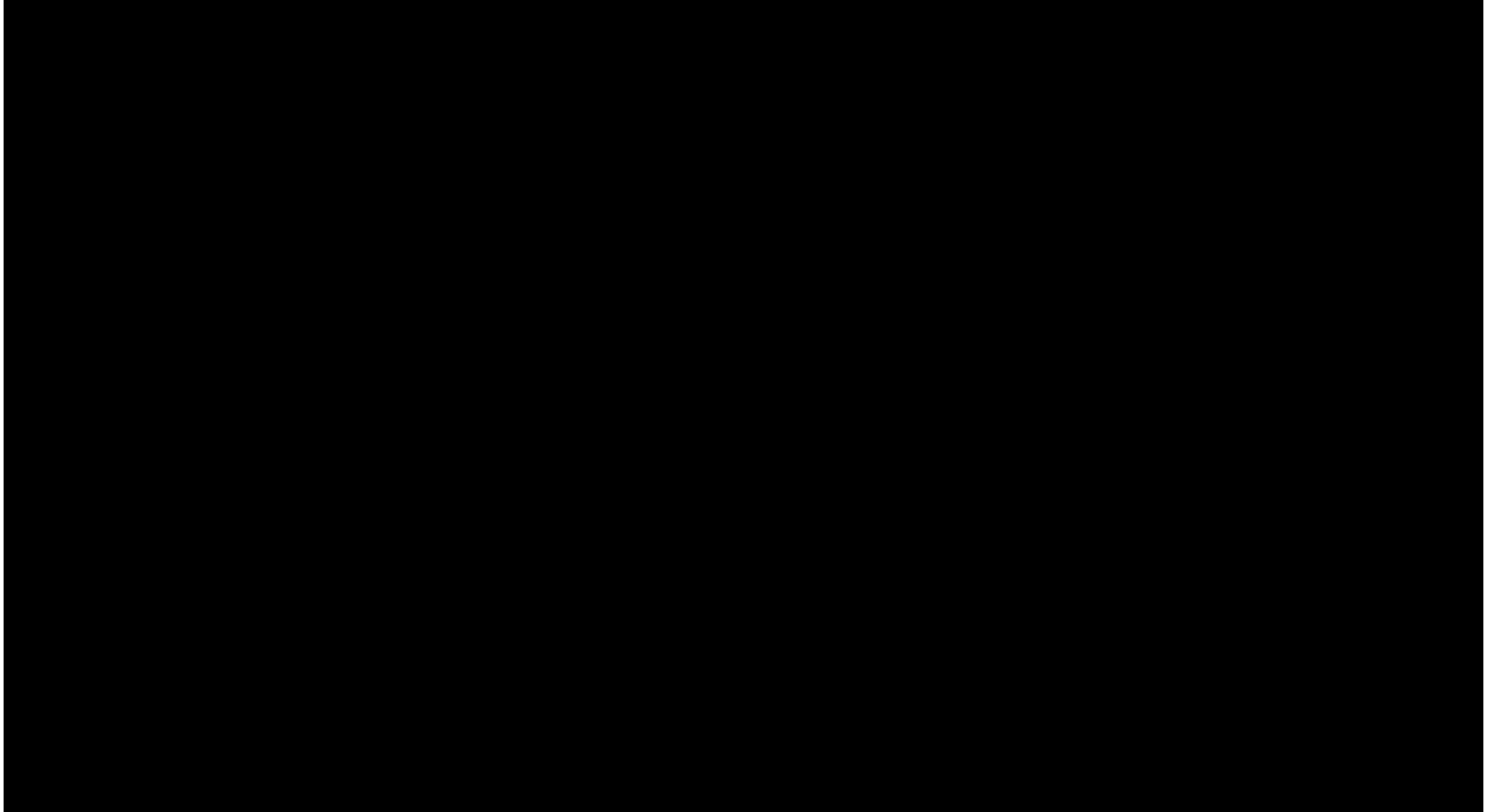








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Challenges

- Localization in urban canyons due to degraded GPS signal
- Image processing and object identification
- Endurance for long term operations
- Autonomous path planning and inspection planning
- Resource allocation and management of inspection assets
- Collision avoidance requirements
- Material handling and manipulation
- Limited access to occluded areas
- Loss of craftsmanship
- Social acceptance and workforce perspective
- Big data and information management
- Legislation, Regulations and Rules !





Relevant Links:

<https://www.youtube.com/watch?v=mcK1xGfDWg0>

<https://www.youtube.com/watch?v=p4UuHPHbedg>

<https://vimeo.com/431957649>

<https://www.realrobotics.co.uk>