

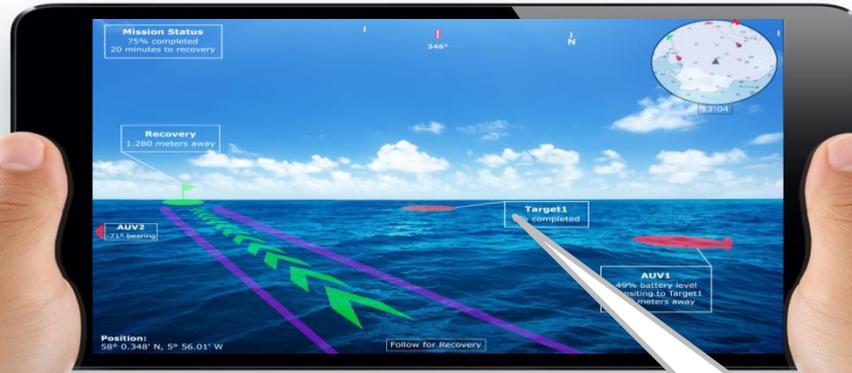
Joining Humans and Robots at the hip, transitioning from command and control to teaming and trust

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Head of Engineering

The 5 Year Vision

seebyte

1. Can you survey the 1 sq. km area immediately outside the harbour?



2. Deck checks complete, on my way. ETA 2 hours.

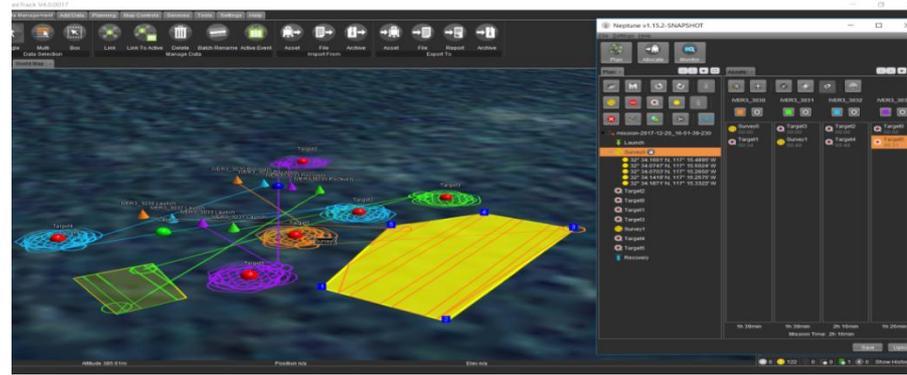
3. I see the ATR has picked up a contact. Send me a snippet for verification

4. ATR Snippet sent. Reminder: can you get maintenance to check to my rudder?

Human-Machine Teaming



Problems to Overcome



Mental Model : The user's belief on what a system can do will strongly impact whether they use it, trust it and determine how they use it

Trustworthy Robotics:

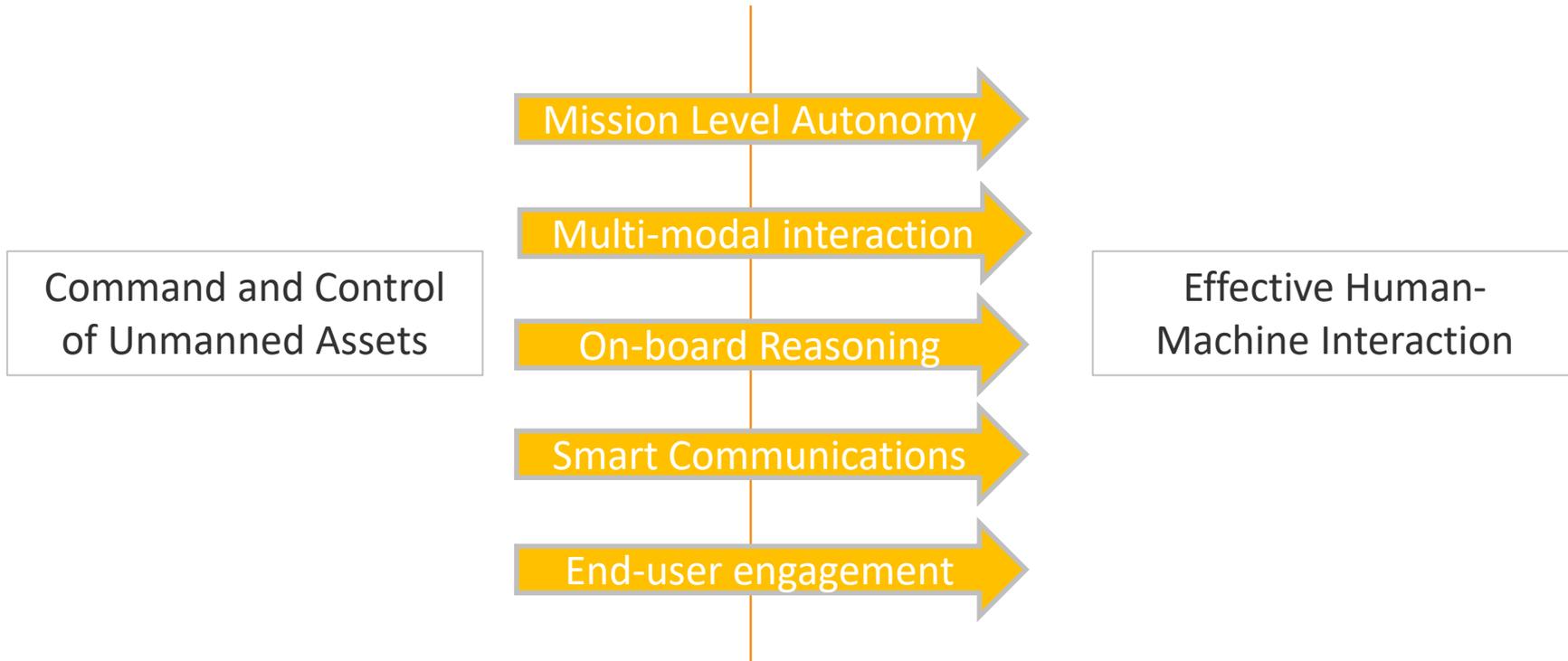
- **Communications:** What is the system doing?
- **Transparency:** How does it work and why is it doing it?
- **Involvement:** The user must feel in control

Dependability and Predictability are key for trust



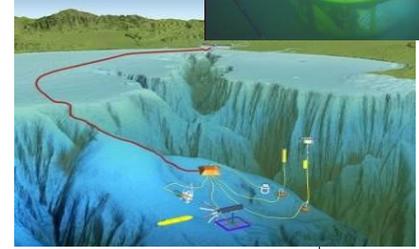
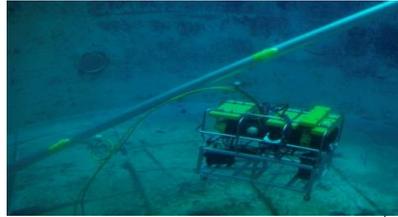
Transitioning to effective HMI

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SeeByte Mission Level Autonomy

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Level 1: Navigate

2003

Level 2: Adaptive

2009

Level 3: Distributed

2014

Level 4: Multidomain

2016

Level 5: Variable

now

Multi-modal Interaction

The screenshot displays the MIRIAM Chatbot interface. At the top, it shows 'MIRIAM Chatbot', 'Video Simulation: ON', 'Normal', 'Real-time mission', 'Missions', 'Help', and 'Log out'. The main area is split into two panels. The left panel is a 3D mission simulation showing a vehicle's path through a terrain with various objectives like 'Launch', 'Survey', and 'Target'. The right panel is a chat window titled 'Mission6862' with the text: 'You are now chatting with MIRIAM', '14:39:50 Welcome. My name is Miriam, I can give you updates on a mission in progress. Just ask in natural language. If you get stuck, type help. Would you like an overview of the current mission?', '14:39:46 The mission has a total of 3 planned objectives, which include 1 survey area and 2 target reacquires', and '14:40:19 The vehicle is in transit to launch'. Below the simulation, there are controls for 'Pause mission', 'Reset mission', 'Simulation speed' (set to x4), and a timer '14:40:32 / 15:10:40'. The bottom left features the 'seebyte' and 'HERIOT WATT UNIVERSITY' logos.

Example Interactions

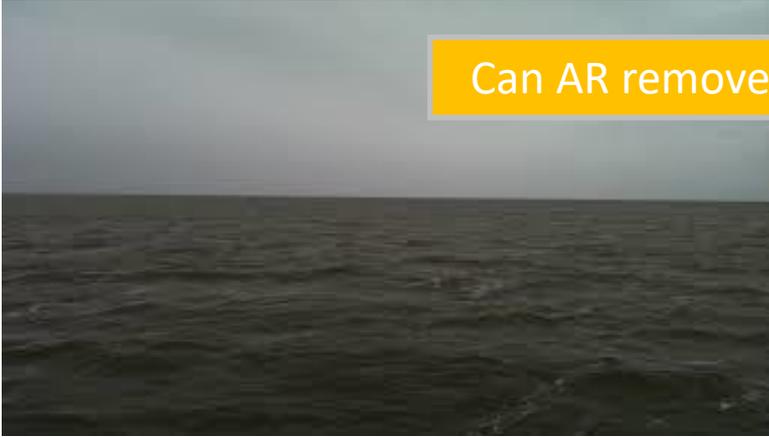
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Integrating AR into Interactions

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Can AR remove the water problem?



Participating with AR

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Compass – heading

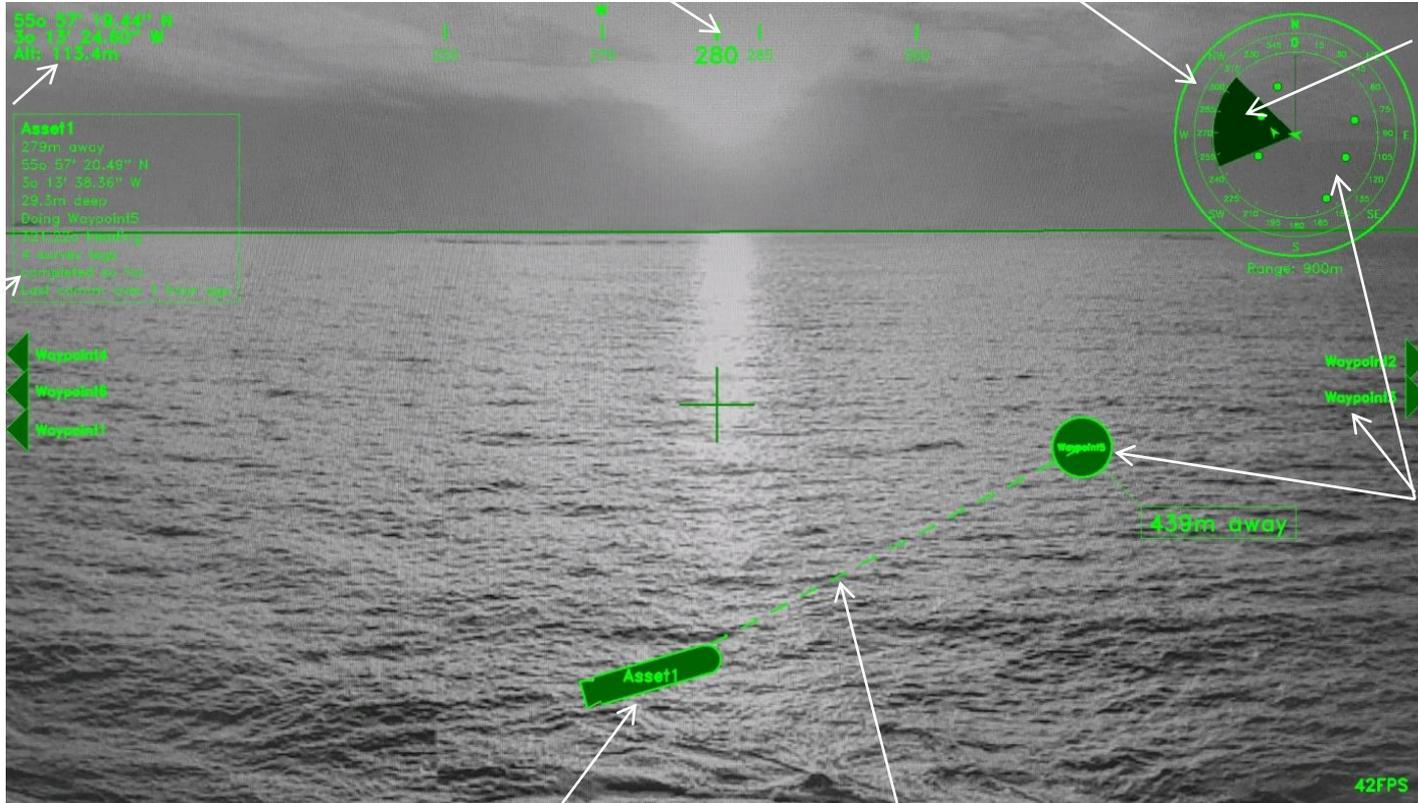
Map

Field of view

Location

Vehicle information

Objectives



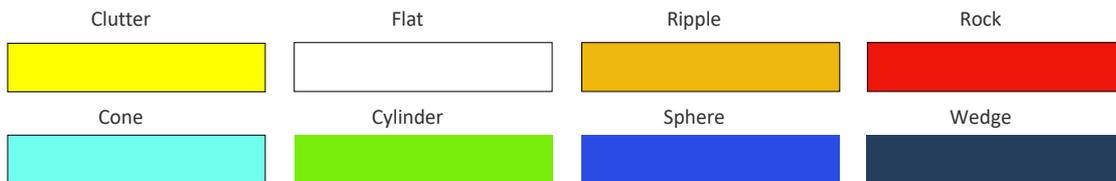
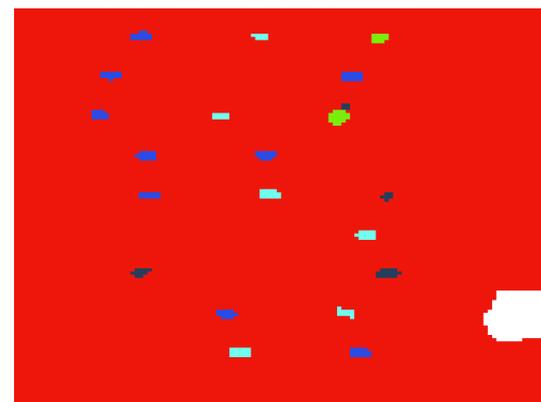
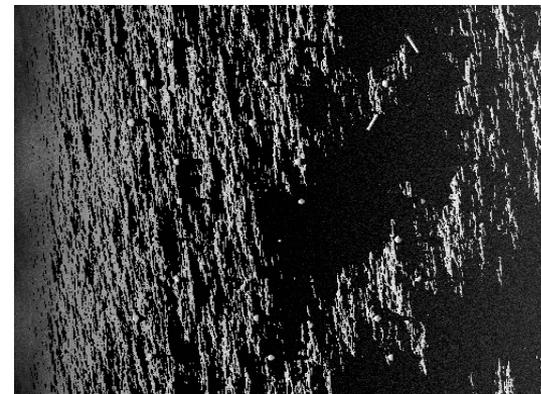
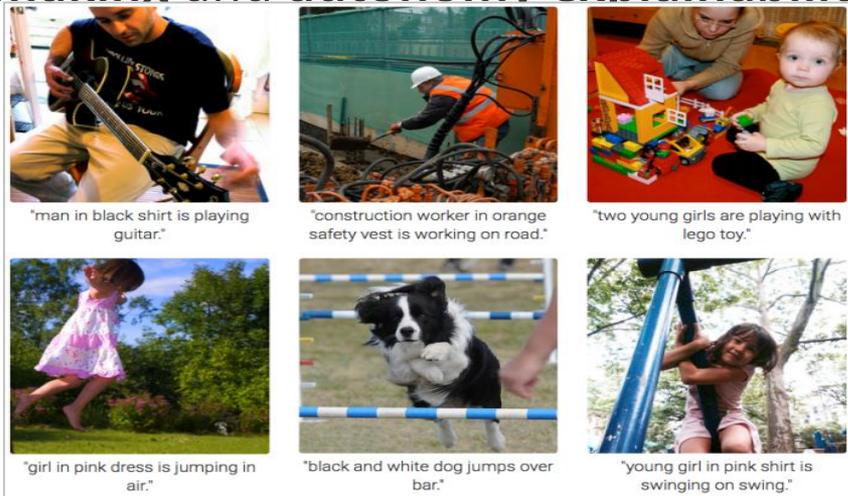
Vehicle

Vehicle path to objective

[\(click image for video\)](#)

On-board Reasoning

- Richer levels of on-board classification allow **autonomous decision making** and **autonomy explainability**

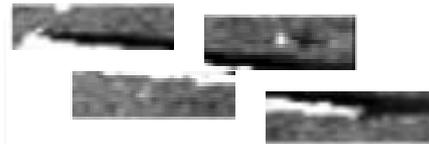


Smart Communications

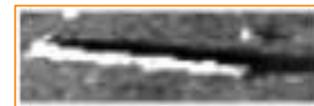
20 bytes / packet



Transmission



200 packets



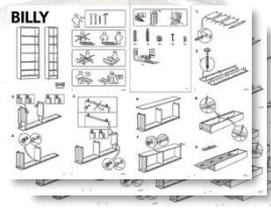
4096 bytes

Original

8192 bytes

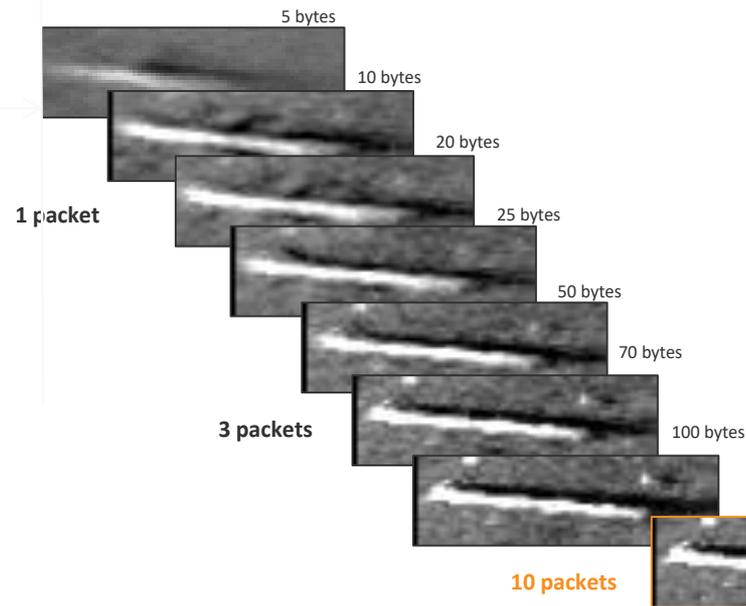


(JPG compression)



(semantic compression)

Reconstruction



ORIGINAL



DATA

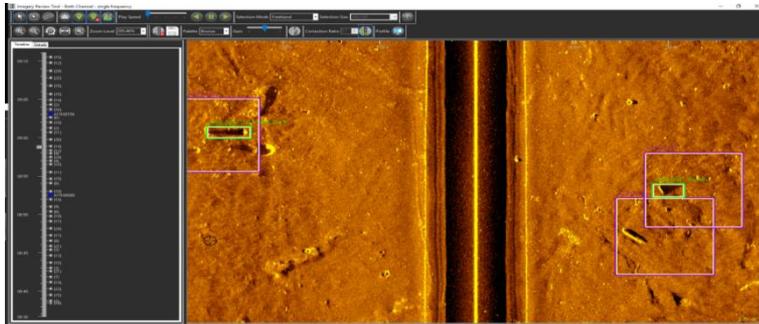


MODEL

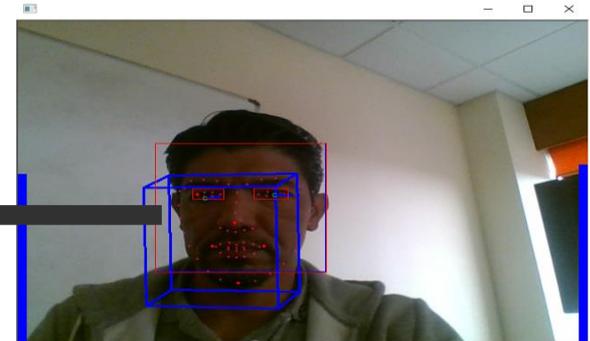


End User Engagement

- On-going, iterative engagement with the end-user is vital to ensure the **autonomy technology adds capability**
- The **User Experience** is key – the technology must be simple, intuitive and add value
- Technology must be delivered that can operate within SOP's



Tracking of eyes can stop
/ start PMA



Summary

Current autonomy operations focus principally on planning after which operators are “autonomy observers”

Transitioning to effective Human-Machine Autonomy requires:

- **Mission Level Autonomy** allowing dynamic re-tasking and re-planning
- **Multi-modal interactions**
- **Improved on-board perception** to allow **explainability**
- **Smart communications** to leverage available bandwidth and prioritise data sharing
- **Continual end-user interaction**