Assistive Lifeguard Technology

How the systems work and what the future holds

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State of play

What is the current state of play for ALT?

Introduction

What is assistive lifeguard technology?

Any technology that assists lifeguards make pools safer

Mirrors

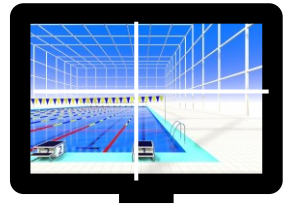
Reflective surfaces used to improve visibility

CCTV

Visual displays showing a live-feed via cameras

Wearable-based incident detection

User-worn devices to alert lifeguards and others to incidents



Camera-based incident detection

Visual displays that alert lifeguards and others to incidents

What can incident detection ALT already do?

> **Key point**
>
> Each ALT system has its own capabilities and may not be able to perform every item in the below lists

Wearable-based

Camera-based

- Detect contact with water
- Monitor heart rate
- Detect submersion
- Raise the alarm
- Provide a casualty's location

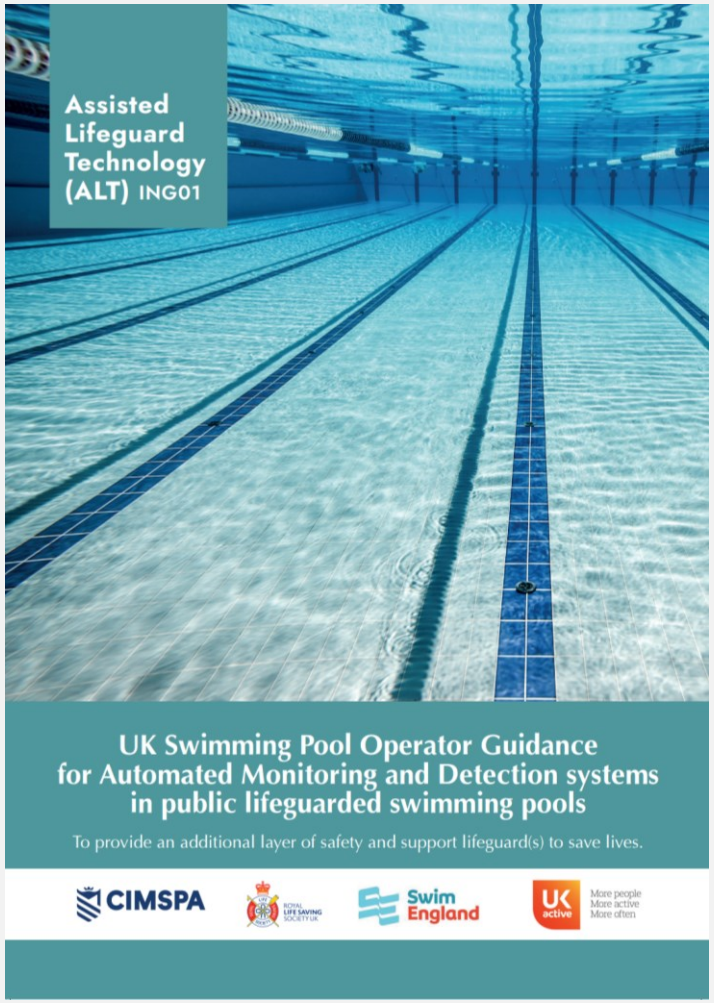
- Detect casualties via submersion duration, movement patterns, orientation, and absence of movement
- Automated occupancy calculations
- Raise the alarm
- Provide a casualty's location

What support is available?

- Camera-based and wearable systems are in operation in the UK
- Speak to operators with existing ALT to understand their experience
- Consult the guidance for further support

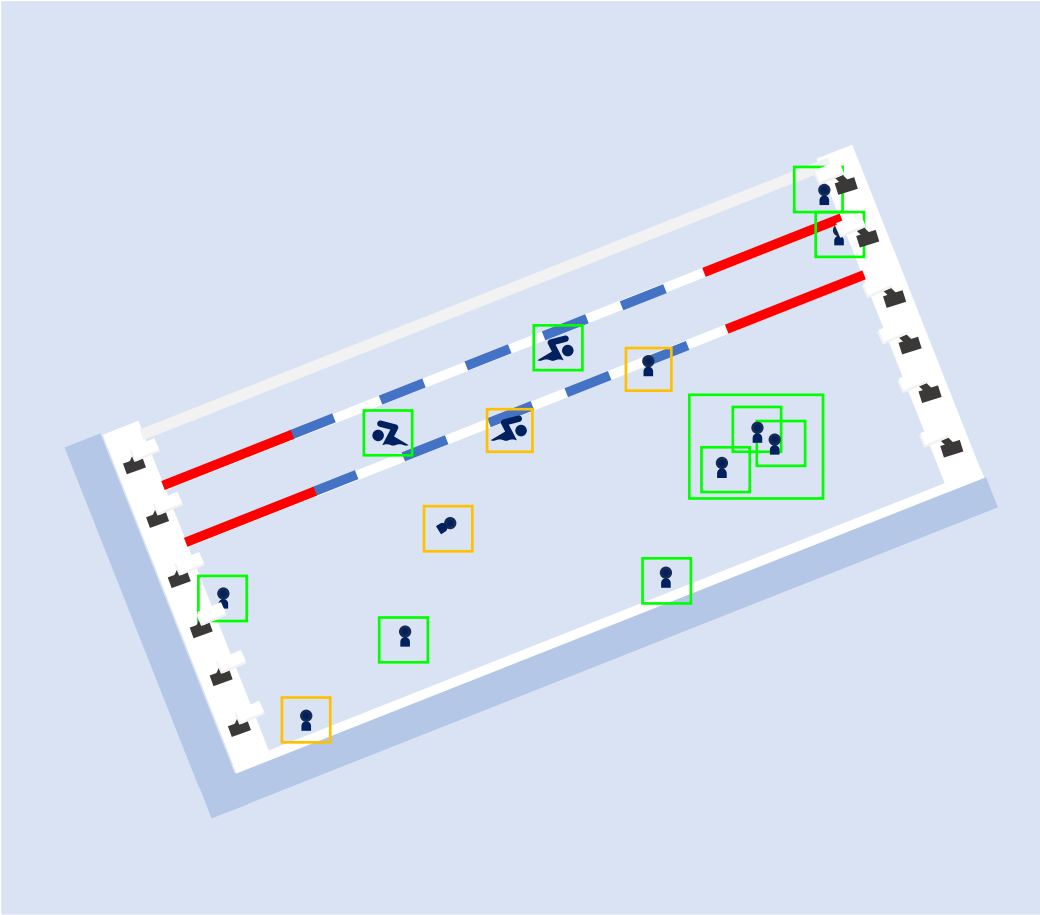
Key point

26 peer-reviewed academic studies have been published on ALT, the first in 2002



Why is the science of ALTs important?

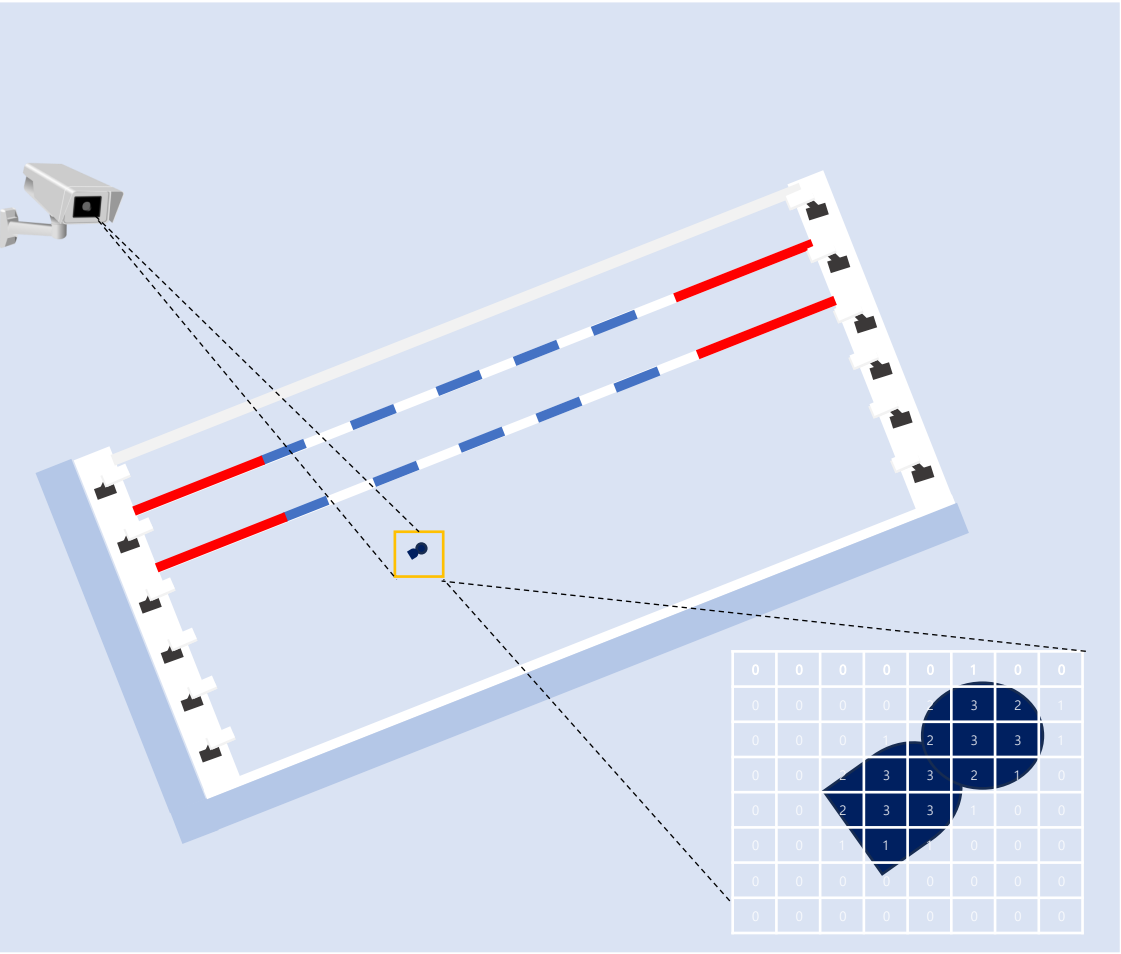
- To help operators understand the strengths and limitations of their systems
- To support risk assessors in undertaking a risk assessment
- To promote innovation amongst manufacturers



How camera-based ALTs work

How do camera-based ALTs detect drowning casualties?

Distinguishing pool users from the surroundings

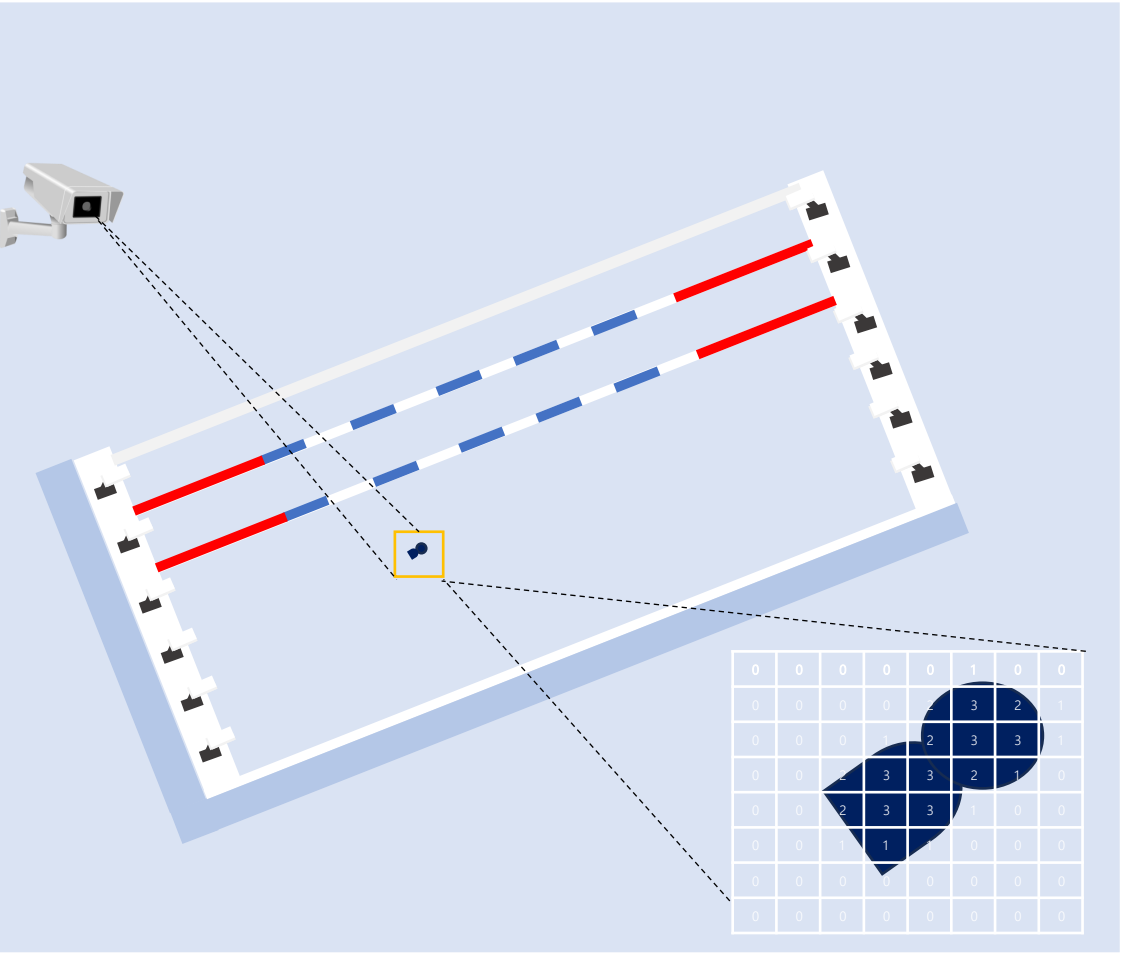


- Divides the visual display into pixels
- Surfaces reflect different amounts of light
- Light sensors in the cameras measure the light reflected across a display
- Algorithm assigns each pixel a score for reflectivity
- Algorithm identifies ‘clusters’ with high reflectivity
- Each ‘cluster’ is assigned an identifier

Key point

The system is programmed to identify a ‘cluster’ as a person. This can lead other objects to be mistaken as persons

Distinguishing pool users from the surroundings



Benefits

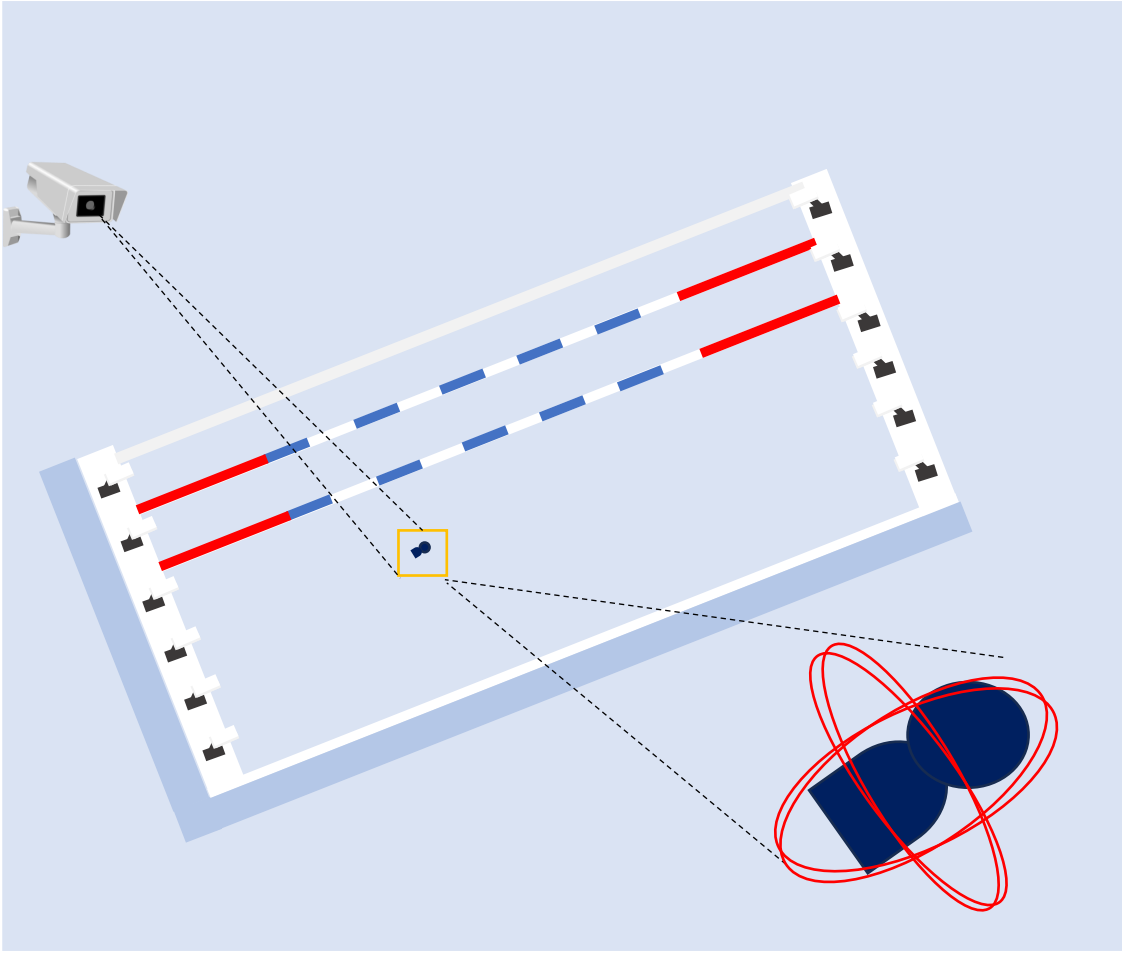
- Essential for cameras to identify ‘people’ within the pool
- Suitable detection method for all age groups

Considerations

- Technology can be sensitive to colour and guest size
- Can mistake pool equipment (i.e., manikins, sinkers) for people
- Overhead cameras less effective than underwater cameras
- Negatively impacted by turbidity

Establishing orientation

- Algorithm used to position a best-fit ellipse around each ‘cluster’
- Sometimes, a second ellipse distinguishes the arms relative to the body.
- Orientation of each ellipse is tracked relative to the pool basin.



Key point

This capability of ALT is likely to grow in significance as systems seek to reduce reliance on underwater cameras and reduce false alarms

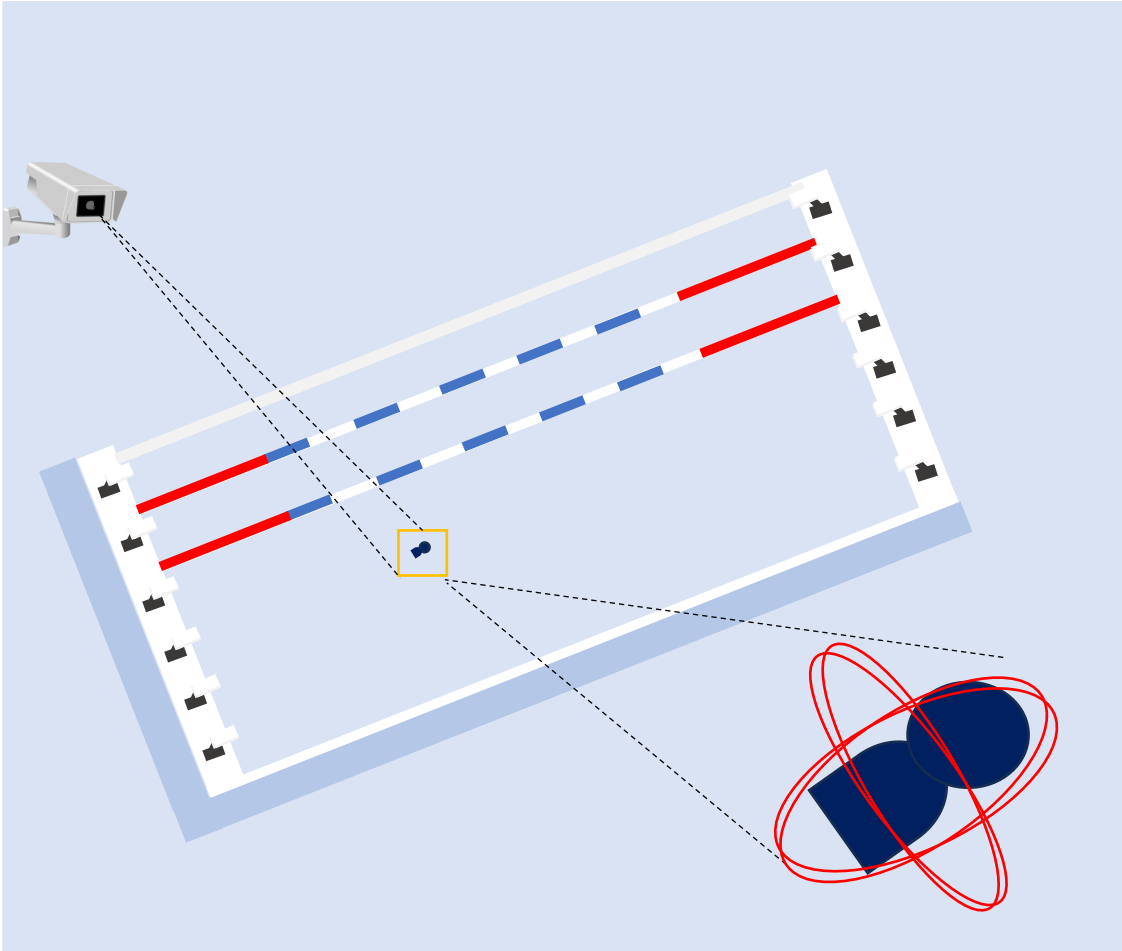
Establishing orientation

Benefits

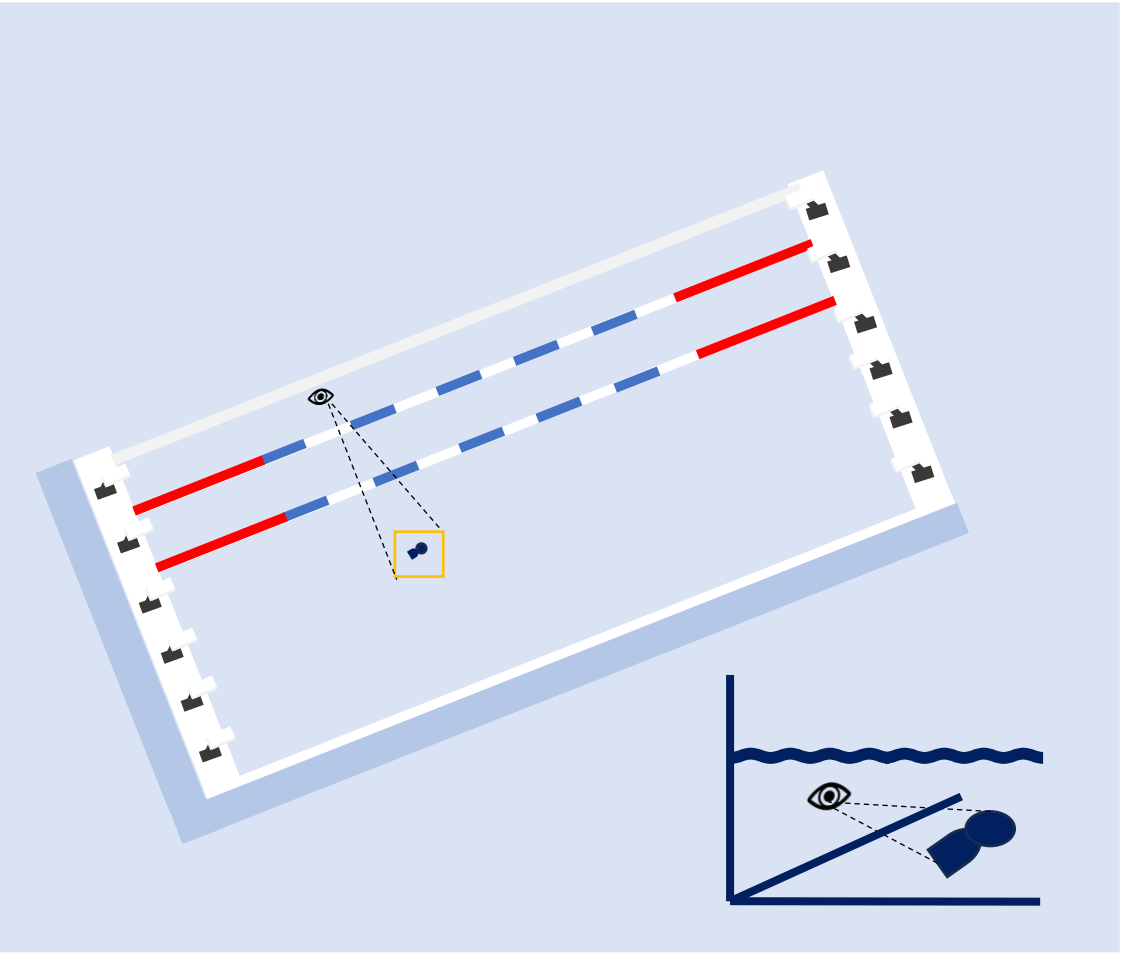
- Additional identification mechanism
- Also works with a heat signature from an infrared camera

Considerations

- Many casualties do not drown from a vertical position
- Can be used to predict the direction of travel



Time submerged

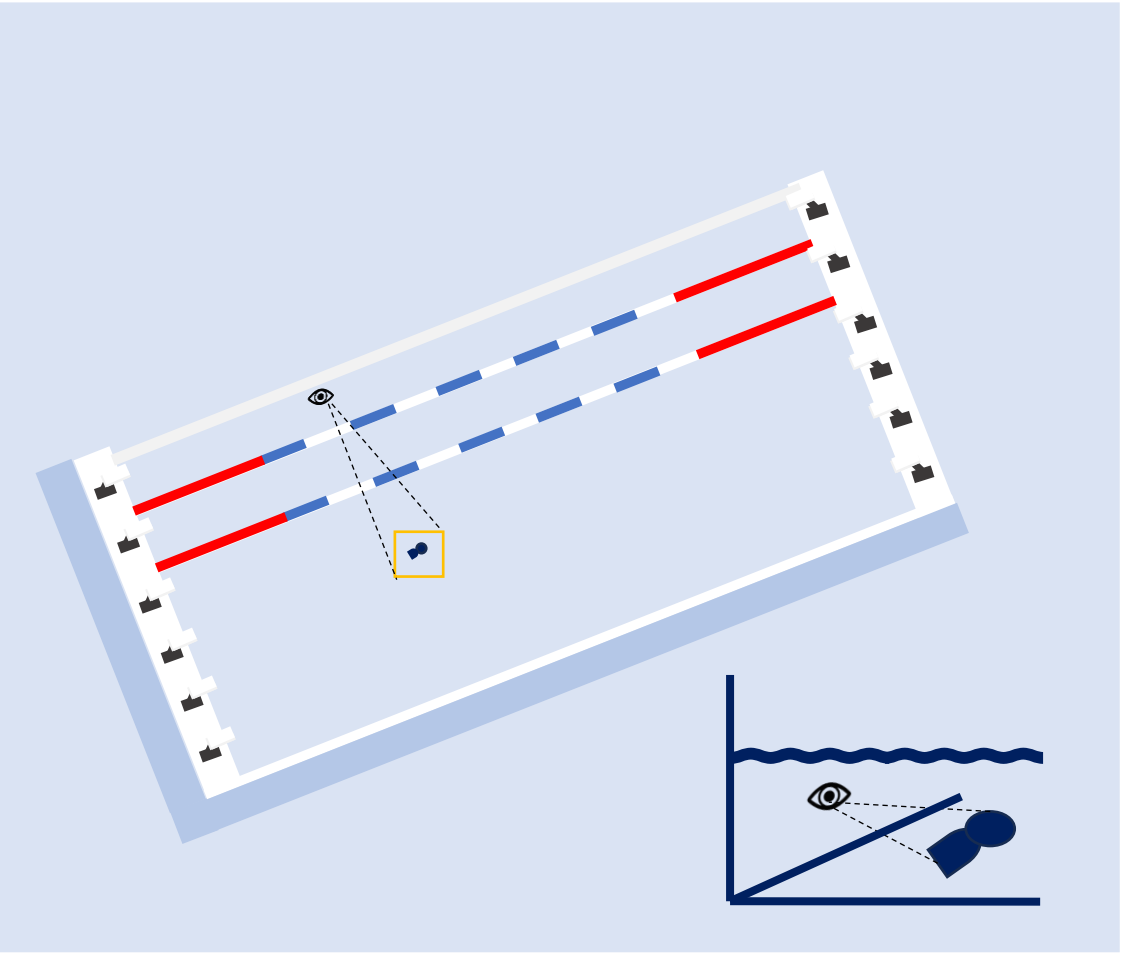


- Overhead cameras cannot identify submersion.
- Underwater cameras regularly rely on submersion duration before sounding an alarm.
- Typically, submersion duration is measured by how long an object is stationary and submerged.
- Small children and equipment in the pool can trigger many false alarms, especially where this is the sole trigger relied on to activate an alarm.

Key point

Some casualties display involuntary movements after cardiac arrest or hypoxic blackout which can delay detection

Time submerged



Benefits

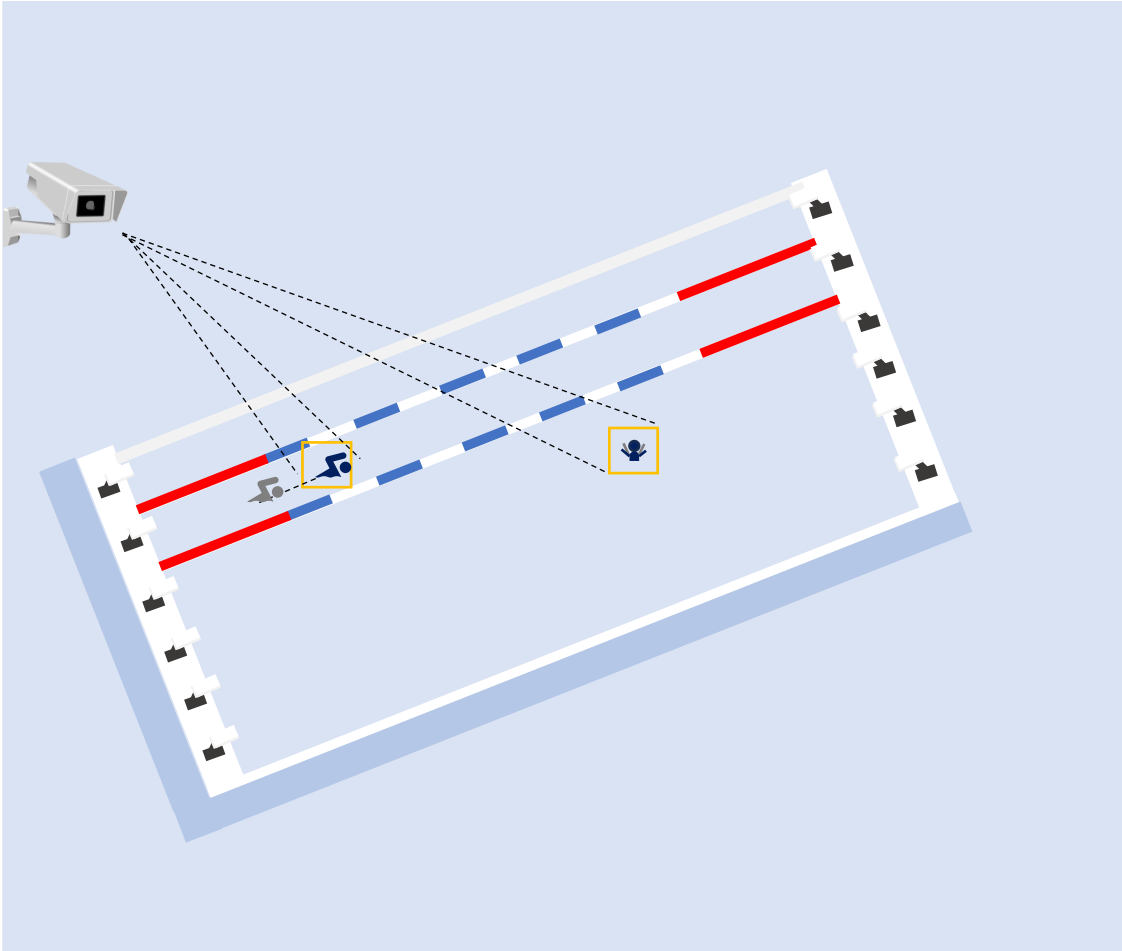
- All casualties submerge in fresh water, eventually
- Not affected by involuntary body movements

Considerations

- Relies largely on underwater cameras
- Can’t detect a casualty unconscious on the surface
- Timer re-starts each time casualty surfaces
- Hypoxic training can set off false alerts

Movement patterns

- Algorithm combines best-fit ellipse with light reflectivity data and trajectory to distinguish ‘drowning’ behaviours
- Systems are trained to look for:
  - Vertical position
  - Flailing arms
  - Followed by stationary horizontal orientation



Key point

Some systems are programmed to sound an alarm where a vertical orientation is accompanied by ‘flailing’ arms

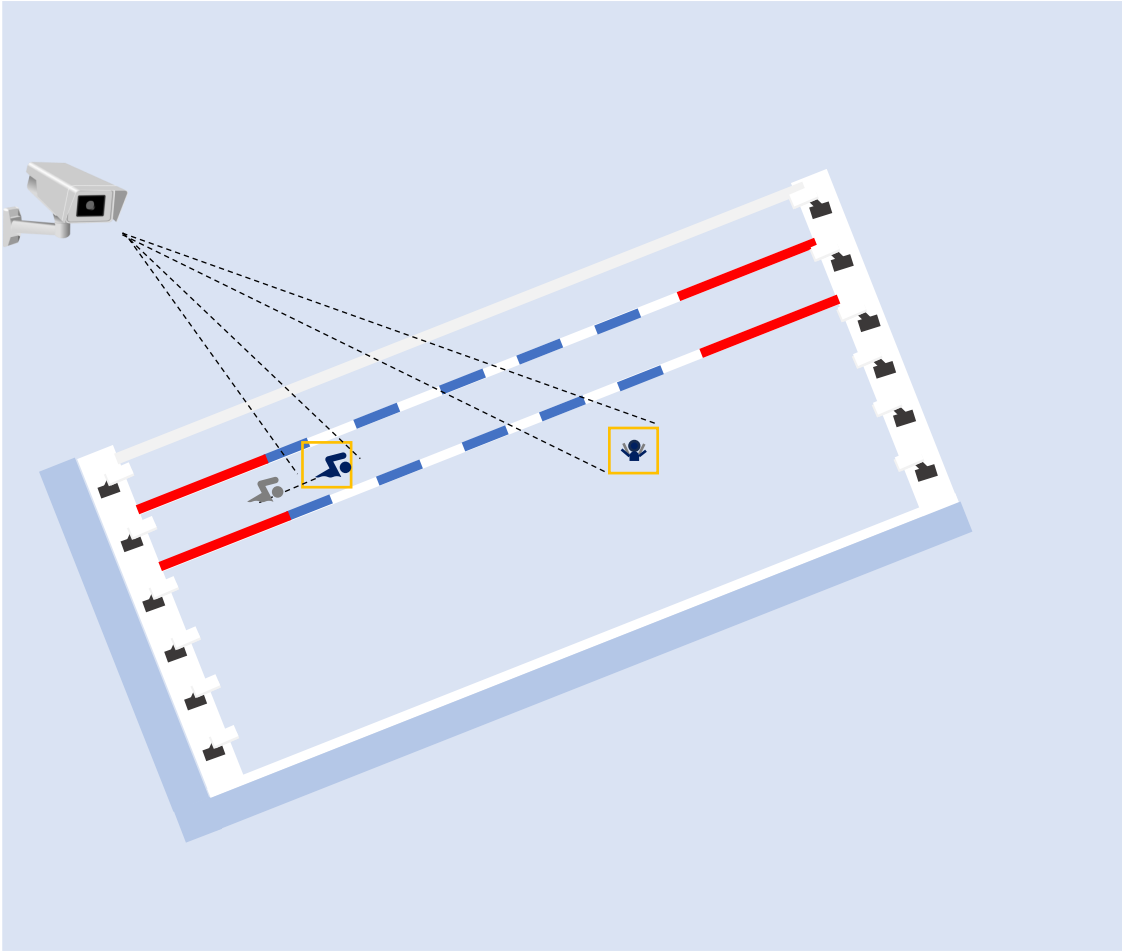
Movement patterns

Benefits

- Additional identification mechanism
- In the future, deep learning is likely to improve the accuracy of detection significantly

Considerations

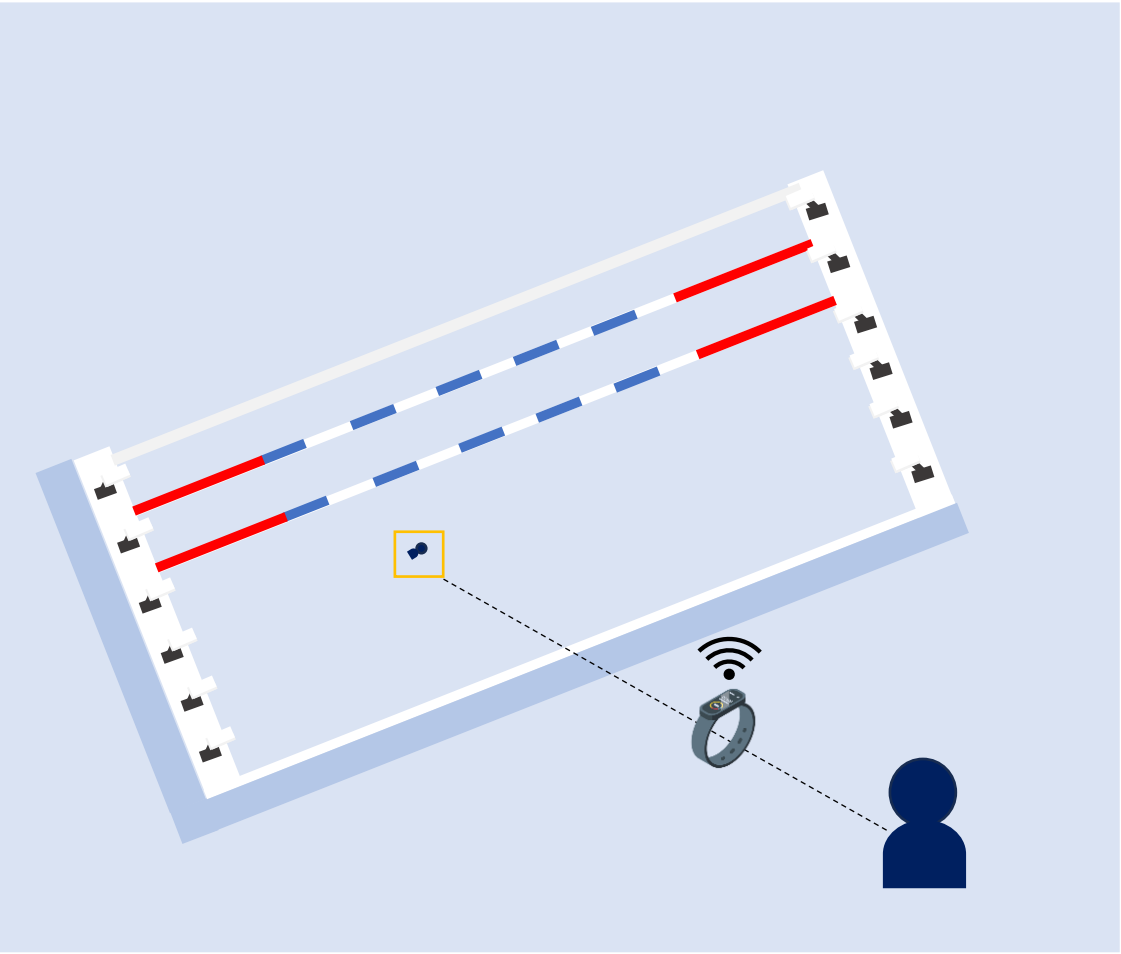
- Many casualties do not display rapid arm movements before falling unconscious
- System can lead to a high number of false alerts



How wearable detection systems work

How do wearable ALTs detect ‘drowning’ casualties

Submersion detection



- Submersion sensor embedded in the wearable detects when a person becomes submerged and for how long

Benefits

- All casualties submerge in fresh water, eventually
- Not affected by involuntary body movements

Considerations

- Can detect a casualty unconscious on the surface
- Timer re-starts each time casualty surfaces
- Hypoxic training can set off false alerts

Heart rate

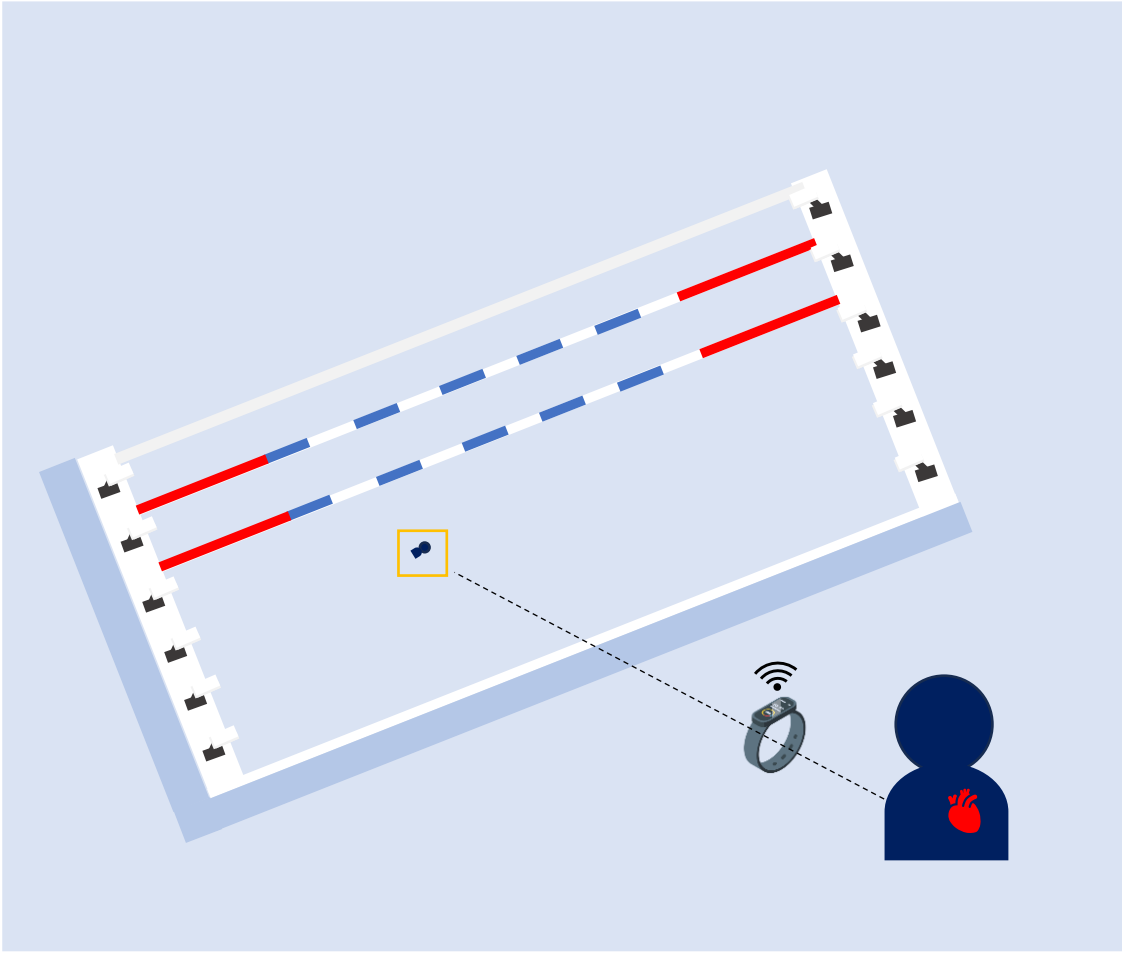
- Watch monitors the electrical signal from the heart.
- If an abnormal rhythm is detected, the lifeguard and/or the user are alerted.

Benefits

- Can detect cardiac and respiratory events

Considerations

- Delayed detection in hypoxic blackout cases
- Individual experiences trauma before detection



Looking to the future…

What is on the horizon for ALT

What do we want from our pools in the age of Industry 4.0?

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Safer

A swimming pool that provides a safe environment for its people and the community it serves

Great place to swim, play, learn, and work

Providing accessible, effective, and enjoyable experiences within communities to help people swim, play, learn and work around water

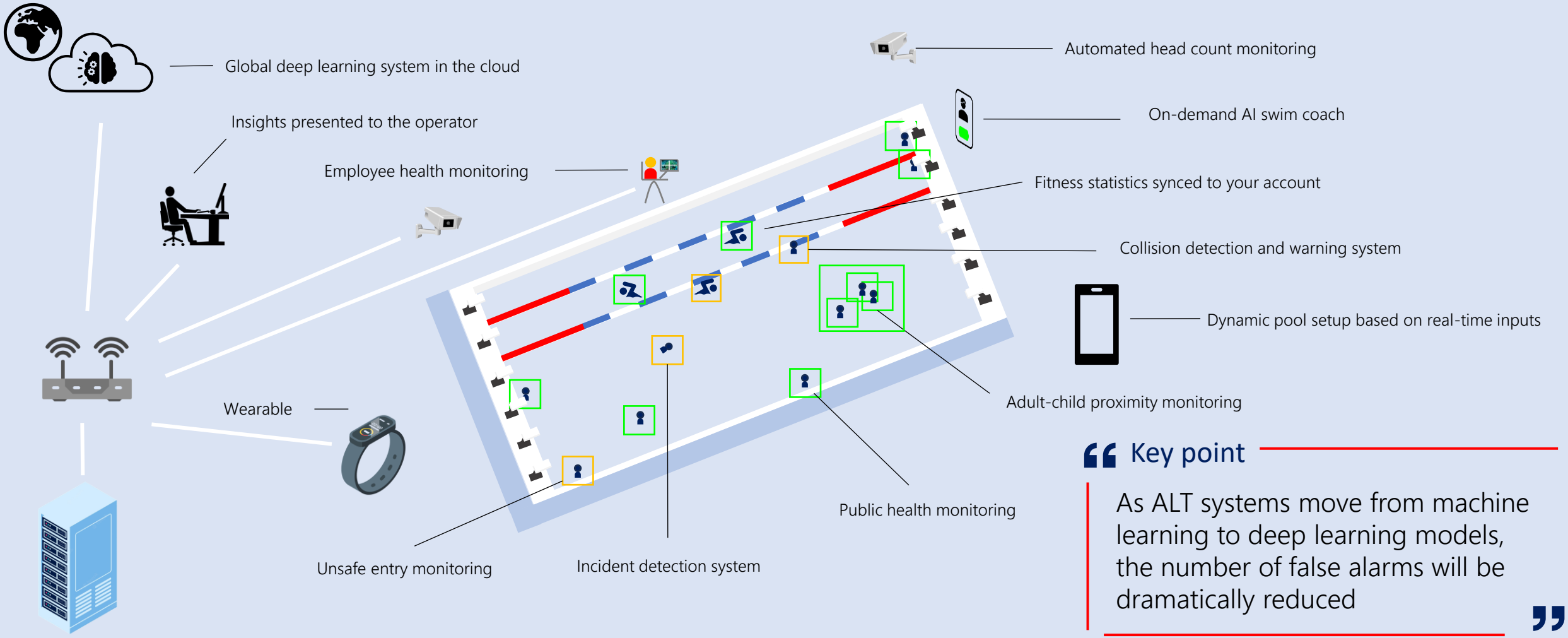
More sustainable

A net zero swimming pool that has a positive impact on the environment, its people, and the communities it serves

Data-driven optimisation

Using digital technologies to optimise the product offering through digital insights and experiences

What the future of pools might look like

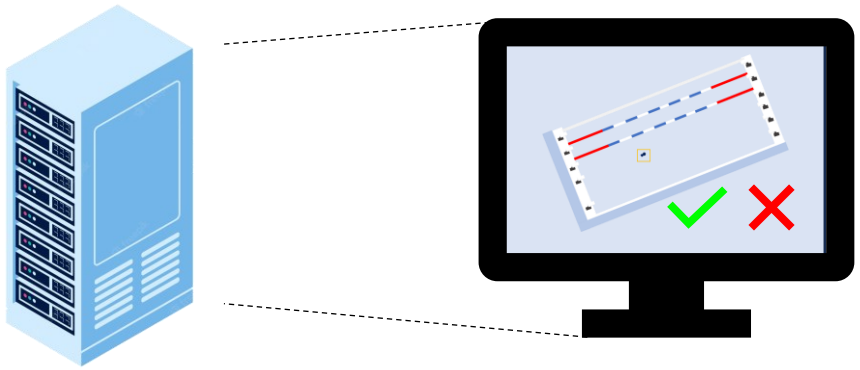


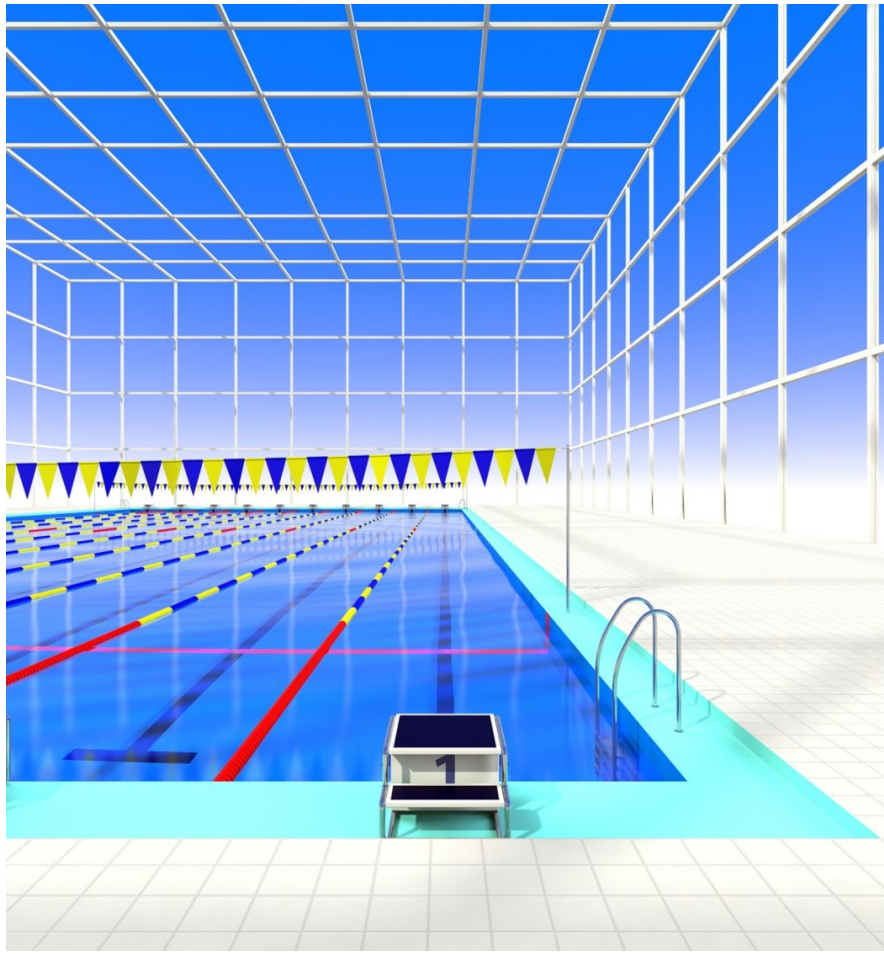
Key point

As ALT systems move from machine learning to deep learning models, the number of false alarms will be dramatically reduced

From machine learning to deep learning

- Machine learning relies on programmable ‘rules’
- Deep learning learns its own rules
- Deep learning requires thousands of hours of high-quality recordings with actual drowning events
- The real benefit of deep learning is more accurate detection rates





Greater third-party verification needed

- Need to differentiate system features and overall detection performance to support operators in selecting the right systems for them
- Independent third-party verification could help operators and protect manufacturers and reduce liabilities
- A clear categorisation and labelling system may help consumers and producers of guidance distinguish systems

Possible ALT categorisation

Categorising systems may make it easier to compare and contrast features and capabilities

Type 1a

Overhead CCTV cameras with a positive detection performance of over 75%

Type 1b

Overhead CCTV cameras with a positive detection performance of over 90%

Type 2a

Underwater CCTV cameras with a positive detection performance of over 75%

Type 2b

Underwater CCTV cameras with a positive detection performance of over 90%

Type 3a

Combined underwater and overhead CCTV with a positive detection performance of over 75%

Type 3b

Combined underwater and overhead CCTV with a positive detection performance of over 90%

Type 4a

Wearable with a positive detection performance of over 75%

Type 4b

Wearable with a positive detection performance of over 90%

Type 5

All other systems with a positive detection performance of over 75%

Future considerations

- Develop new ALT guidance to cover beach systems
- Training for risk assessors to understand how to assess ALT systems

Key point

Know how your ALT system works and consider its strengths and weaknesses in your risk assessment

Questions?