Following an unprecedented series of shark attacks off Australian beaches, the need to find practical solutions is intensifying.

Aerial drones could be an important tool for reducing risk of shark attacks on our beaches within the coming years. Here's how it would work. Drones would fly autonomously over beaches continuously scanning for sharks with image recognition software.

If a shark is detected, real-time video will be instantly sent to beach authorities, such as lifeguards. If it is a dangerous shark, appropriate action can be taken to ensure public safety, such as sounding alarms and clearing people from the water.

Like other shark bite mitigation measures, this cannot completely eliminate the possibility of a shark attack. However, it could help to reduce the risk to an acceptable level for the majority of beach users.

Importantly, the drone-based approach to shark bite mitigation does not harm sharks or other marine wildlife, such as whales, dolphins, rays and sea turtles, unlike more controversial shark control measures such as mesh nets or baited drum lines.

Surfer has a close encounter with a great white shark as seen by a drone.

## Testing drones

As part of the NSW government's A$16 million Shark Management Strategy , researchers from the NSW Department of Primary Industries (NSW DPI) and Southern Cross University (SCU) have demonstrated that drones can reliably detect sharks off Australian beaches.

NSW DPI researchers have also compared the costs and benefits of marine wildlife sightings between drones and helicopters, as well as established environmental conditions suitable for drones to provide effective shark detection capabilities.

This summer, a team of SCU and DPI researchers completed an intensive drone trial on five

important beaches in NSW to verify that drones will work in the long term. As part of the trial, drones performed six 20-minute patrols each morning on each beach for every day of the school holidays.

Researchers monitoring drone footage spotted great white, bull, whaler, mako and hammerhead sharks off NSW beaches. They also saw many dolphins, sea turtles and less dangerous shark species, such as shovel-nosed sharks.

These trials included experiments comparing “people versus machines” by evaluating the utility of automated flight paths and shark recognition software.

Drone captures a great white shark cruising the shallows of Northern NSW.

## Automating the drone-based approach

The overall objective of this research is to develop a fully automated drone-based shark surveillance system in the near future.

We envisage that a team of aerial drones could run continuous shark detection missions during the hours when most people are on our beaches.

When required, each drone will automatically take off, patrol for sharks, land itself and charge up again, ready for the next mission. If a drone detects a shark, to can alert beach authorities.

Their response will vary depending on the species of shark detected and its location. This will be immediately apparent from the live video feed and location data they receive. As well as tracking sharks, the drones will also be fitted with sirens and lights to contribute to any emergency actions.

Great white shark off a beach in Northern NSW.

## Problems to solve

There are still at least five major challenges to overcome before establishing a fully functional automated drone-based shark surveillance system. But these could be gradually overcome within the next few years.

## Civil aviation regulations

Aviation regulations restrict the use of fully automated drones in most airspace. We could overcome this problem by modifying the law or establishing restricted zones over beaches where drones can fly.

## Public safety concerns

We need to minimise the risk of injury as a result of drone failure, by making sure their flight components are failsafe and having flight paths clear of beachgoers. We also need airspace safety systems to ensure that drones are grounded when emergency and other aircraft are in the vicinity.

## Public privacy concerns

A drone-based shark surveillance system would require public acceptance. For this, beachgoers need to be aware of the sorts of data being collected by the drones, and to rest assured that this does not breach privacy legislation.

## Reliable hardware

Although aerial drones can already automatically take off, fly routes, land and charge themselves, it is not clear how reliably this technology will stand up to the Australian beach environment. To be effective, we will need drones that can reliably function under heavy workloads in coastal conditions. Similarly, data transfer platforms also need to be fast and reliable.

## Purpose-designed software

Image analysis software needs to be further developed to automatically detect sharks with a high level of accuracy. Customised software will also need to be developed to coordinate the missions of a team of drones and to ensure seamless video streaming to the portable wireless devices of beach authorities and users.

In terms of the hardware and software challenges, there are a number of research groups racing towards solutions with the goal of commercialising their products. Once an automated drone-based technology for shark bite mitigation is in place, it should be possible to solve issues regarding legislation, safety and privacy.

Given the current rate of technological development and the falling costs of commercially available drones, fully automated drones could be reducing the risk of shark attacks on Australian beaches within five years. However, for many nervous beachgoers, this may not be soon enough.

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