# Shark!



# Machine learning for beach safety

**The Shark Spotters programme operating at eight of Cape Town's beaches has improved the safety of water users since its inception in 2004.**

The programme deploys lookouts at elevated positions near the beaches to keep watch for sharks as well as other marine activity that may indicate the presence of sharks, such as large shoals of fish or 'feeding frenzies' by seabirds and dolphins. Equipped with binoculars, polarised sunglasses and two-way radios, these 'mountain spotters' contact 'beach-based spotters' if they see a shark, so that a white flag can be raised and a siren set off to warn beachgoers to leave the water immediately. To date, over 2 300 shark sightings have been recorded by the programme, which is funded by the City of Cape Town and Save Our Seas Foundation.

Recently, the Shark Spotters programme has embarked on a research project to create an automated shark-spotting system, with the aim of enhancing the beach safety service. The project came about after Dr Krzysztof Kryszczuk – a keen kitesurfer and the co-founder of PatternLab, a scientific consulting company in Switzerland with expertise in machine learning – approached the Shark Spotters team while visiting Cape Town. The Institute for Communities and Wildlife in Africa, based at the University of Cape Town (UCT), subsequently became involved too, and a project to research and develop an automated system using fixed cameras above beaches was designed.

At a public event in February to launch the project, Shark Spotters CEO Sarah Waries explained that there is no intention to replace human 'spotters' with robotic ones. Currently, the programme can only operate at beaches where the required elevation is available (usually in the form of a mountain slope), and human fatigue can inevitably set in after some time scanning the sea, increasing the ever-present possibility of the spotters missing a shark. Being able to monitor beaches remotely using cameras fixed to a pole or tower would not only allow the programme to be extended to other beaches, but could also increase the accuracy of shark detection at the existing ones.

The initial fieldwork for the project, which involved collecting video footage of sharks in order to build the automated detection algorithm, took place at Fish Hoek beach. Since shark sightings are sporadic and unreliable, a realistically sized shark decoy was also constructed for towing behind a boat. This allowed footage to be collected under a wide range of conditions. Krzysztof reported that wind and glare on the sea surface, cloud cover and particular sun positions all created challenges, sometimes to the extent that neither an automated system nor a human spotter would be able to rule out the presence of a shark. The footage will be analysed to differentiate how sharks move compared to other marine life or objects, such as a piece of floating kelp, in a process known as heuristic filtering.


**Construction of a decoy shark for towing behind a boat ensured that enough data could be collected for development of the automated shark-spotting system's machine learning algorithm, without having to rely on sporadic sightings of real sharks.**

The concept of automated shark detection is not a new one. In 2018 the Australian Information Industry Association's National iAward in the category 'Artificial Intelligence or Machine Learning Innovation of the Year' was won by the University of Technology Sydney (UTS) and the Ripper Group for their SharkSpotter© technology. In this case, the video surveillance is done using drones, which were deployed at more than 50 locations across Australia last summer. According to the Ripper Group, which own and operate the drones, the AI algorithm developed by UTS can differentiate between sharks and 16 different objects: rays, dolphins, whales, turtles, large fish, swimmers, surfers, other humans, various different boat types, drones and beach tents. The system's advanced machine learning techniques ensure shark detection accuracy of 90%, compared to conventional techniques such as helicopters with human spotters (18%), fixed-wing aircraft spotters (12% accuracy) and humans analysing aerial imagery (20–30%).

At the launch of the Cape Town-based project, however, Sarah pointed out that drones are compromised by short battery life and cannot operate in strong wind, they have a relatively small field of view, they are not used continuously and they are expensive, plus the legislative restrictions controlling drone use and the strict certification requirements in South Africa means that they aren't feasible for use in the local Shark Spotter programme. Four of the beaches in Cape Town are monitored by human spotters from 8 am to 5 or 6 pm for 365 days per year, while the other four only operate during spring and summer. With the added benefit of the so-called 'computer vision' currently being developed by PatternLab for the automated shark-detection system, beachgoers should in future be able to enjoy a swim in the sea in more spots along the coastline, safe in the knowledge that the Shark Spotters programme is looking out for them. The project is due to be completed during 2020.


**A member of the Shark Spotters team waits at an elevated location above Fish Hoek bay to collect footage of sharks and the towed decoy.**

The project is funded by Eurostars, which aims to support innovative projects by small- and medium-sized enterprises working in the research and development arena (R&D-performing SMEs). Eurostars is a joint programme between EUREKA – an intergovernmental organisation for pan-European R&D funding and coordination – and the European Commission. Eurostars funding for the South African partners in the project, Shark Spotters and UCT, is administered by the Department of Science and Innovation (DSI). South Africa is a EUREKA Associate country, and the DSI had already administered funding for six EUREKA projects, but the Automated Shark Spotting project is its first under the Eurostars programme. The Swiss counterpart of DSI, Innosuisse, administers Eurostars funding for PatternLab's involvement in the project.