

Wakanda Autonomous System for Poaching Protection (WASPP)

Hidden in the mountains of equatorial Africa lies the country of Wakanda. Wakanda hosts a large nature reserve area (Wakanda Nature Park – WNP) that is home to a number of endangered species, such as the black panther, the tanapuli orang utan and the Wakanda reed warbler (a songbird in the genus *Acrocephalus*). Many people that live near the WNP earn a sustainable income by offering guides nature safaris, and associated industries such as lodging and sales of crafts.



The aim of this assignment is to design the architecture of a system that can protect the nature park. The main threats to the WNP are: poaching – illegal killing of the animals (often for illegal trade), illegal foresting, and illegal building of housing.

This system consists of a group (up to 100) unmanned autonomous drones. These drones include both air-borne drones and land-based rovers. The system also has a ground station. The ground station is managed by a group of rangers. All drones are equipped with a mobile communication subsystem through which they can send messages to the ground station.



These images are for inspirational examples only. Actual implementation may vary.

Each machine contains a battery and can propel itself autonomously. Of course, the action-radius of the drones is limited: one battery-charge can sustain a drone for 6 hours. And the drone must return to the charging station before its battery runs out. There are 10 charging stations throughout the WNP. Some of the functions/missions that this system must be able to perform are:

- M0: All drones are equipped with regular optic cameras. Airborne-drones are also equipped with heat-sensing cameras. Air-borne drones can fly up to heights of 150m, which is well above tree level, but they can also hover at lower levels between trees of forests. All drones are equipped with a GPS positioning-device. Land-based drones are equipped with microphones for audio-recordings. All drones are equipped with sensors for detection objects in their path (in order to avoid colliding with these objects - e.g. trees, telephone poles, buildings). All land-based drones are equipped with a thermometer and can register temperature. Land-

based drones carry a torch. The torch and heat-sensor are crucial for night-missions. The drone can move around its torch in order to point the light beam at objects.

- M1: The drones themselves split up a particular region: each sub-region of the WNP should always have one land-based drone and one air-borne drone operating. Air-borne drone can work in-tandem with land-based drones. Either of these can call a counter-part to explore the region where there are currently positioned: e.g. a land-based drone can ask an air-borne drone to 'look' at a region across a river or ravine (but only within 50 meters of the borders of the WNP).
- M2: Surveillance for security: drones can be tasked to do surveillance of a region of the WNP. When on a surveillance mission, their priority is to detect any humans encroaching the park.
- M3.1: Drones can detect humans on the ground via their image and heat-camera. If they detect a human in the WNP, then will: i) send a message to the rangers in the ground station, ii) follow the human, iii) try to make photos and videos of the human, and iv) send out warning sound so as to scare away animals in the neighbourhood of the human.
- M3.2: Drones can also identify rangers through a special signal heart-beat signal that is sent out from a small device that rangers carry when moving through the WNP.
- M4: During surveillance of region, drones can be tasked make photographs, videos or audio-recordings of interesting animals and plants. For this each drone must be able to (gently!) follow an animal as it moves around. To this end, the ground-station can upload a list of 'interesting animals' as well as configure an image-recognition subsystem to recognize these animals.
- M5: The ground station has a large display of a map of the WNP. This is updated with the positions of the drones. Also, the map shows sightings of interesting animals. The sightings are updated with the newest information received from drones. Also, sighting data is stored for longitudinal studies of animal movement behaviour throughout the park.
- M6: While drones are moving on a mission, they use a heart-beat tactic to signal to the ground station that they are still 'alive'. This heartbeat message can also include status information about the various subsystems of the drone, as well as its battery status.
- M7: Forest Fire alarm: land-based drones can detect fire. In case of fire, they will i) signal the ground station, and ii) move away from the fire.
- M8: Malfunction: If due to some unforeseen circumstance/malfunction, a drone cannot revert back to the ground station, then it will send out an emergency signal.

The rangers upload missions to drones when the drones are not on a mission. The ground station can call individual drones back to the ground station – e.g. if there is a concern that some part of the drone need maintenance.