NATIONAL DESIGN PROJECT 2023

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Project title	The Animal Widget

1. Project Overview: what is your problem statement, why the issue you are trying to solve is important, who is your target audience, etc.

We aim to reduce the number of road kills happening around the world. The number of road kills that have occurred in Singapore has doubled from 93 in 2016 to 194 in 2021. Common victims of road kills include the Raffles Banded Langur, Sambar Deer, pangolin and leopard cats. These are endangered animals in Singapore. Other common roadkills also include the long tailed macaque, wild boars and snakes.[10] Reducing roadkills can reduce the number of casualties of critically endangered species. This sensor helps to ensure the safety of drivers going through forested areas which are habitats of local wildlife which reduces the risk of animal collisions and traffic accidents. Animals like deer, elk, bears, and bison are the ones that do the most damage to cars and cause the most injuries and deaths for humans. Reducing road kills not only reduces the number of animal casualties but also decreases the mortality rate of people who die from animal collisions. Our target audience will be governments of respective countries as well as environmental organisations, to help fund and support our project to develop it to a feasible prototype that can be used in Singapore and other parts of the world.

2. Research Findings: what did you find out about the issue you are trying to address through your research (surveys, interviews, articles, etc.)

The number of road kills that have been occurring in Singapore has doubled from 93 in 2016 to 194 in 2021.[6] A critically endangered Raffles' Banded Langur was spotted as roadkill in Upper

Thomson Road on Friday morning (Aug 27).[4] In one accident a year ago, a critically endangered Sunda pangolin was killed, its carcass found on Mandai Lake Road. The road, which runs from Mandai Road to the Singapore Zoo and cuts through a part of the Central Catchment Nature Reserve, is a common crossing for animals in the adjacent forest patches.[7] They include the long-tailed macaques, wild boars and rarer species such as the sambar deers and Sunda pangolins.[1] January to June this year saw 10 reported Sunda pangolin roadkills in Singapore, the highest recorded given the average number has been 3 to 9 per year in the last five years. According to Herptile Roadkill Project, the majority of reptile road kills are at Mandai Road and Holland Road. [8] This is likely due to the presence of parks and forests in the area which are habitats to many reptiles which also results in more road kills.

Humans can generally discern sounds with frequencies between 20 Hz and 20,000 Hz although this range varies significantly with age, occupational hearing damage and gender. The human ear is most sensitive to frequencies around 1,000-3,500 Hz.[5] For workplaces such as textile mills, metal stamping, market or traffic area etc., you can progressively lose the ability to hear higher frequencies which leads to "Noise Induced Hearing Loss (NIHL)"[3] and eventually total deafness. The audible range for Macaques is 55hertz-45kilohertz. Cats can hear sounds from 45Hz up to 64,000 Hz. Dogs can hear 67Hz to 45,000Hz.

There have been multiple efforts taken to reduce the number of roadkills in Singapore and around the world. One such effort in Singapore is the Eco-Link@BKE.[16] It is an ecological bridge that connects Bukit Timah Nature Reserve and the Central Catchment Nature Reserve across Bukit Timah Expressway. Eco-Link is a bridge that animals can use to find a safe passage between the 2 nature reserves. However, this natural corridor does have its limitations. The bridge unfortunately doesn't cover the whole stretch of both nature reserves thus animals can still access the road if they are not near the bridge thus the threat of roadkills still remains. Ideas such as funnel fencing to direct wildlife to the bridge and prevent them from accessing the road have not been executed making the bridge not as effective. Some other current mitigation measures like road signs and speed bumps are also inadequate as wildlife in the vicinity have no structures to aid their movement across the temporary fauna crossing, rendering them vulnerable to vehicular strikes. [2] Our device aims to prevent animals from coming onto the road by immediately sending out a sound that will scare the animal once the animals are detected by our device and thus potentially decreasing the number of roadkills.[12] The device will be switched off during off-peak hours when there is lesser traffic thus animals will be able to cross over to another nature area for food, shelter etc.

The animal detection system in Rifle Range Road is another effort taken by NParks and the Land Transport Authority.[17] The system uses cameras to detect the movement of animals and upon detection, LED signs are lit to alert drivers of the animals' presence. However, if drivers fail to slow down even after the LED sign lights up, a roadkill may still happen. To prevent this, our device has speakers that send sounds of a particular frequency when an animal is detected to scare them away temporarily until traffic is less. We also have LED signs connected to our device that will light up to alert drivers to slow down upon detection of an animal as an added precaution if animals come onto the road despite hearing the sound emitted from the device.

3. Proposed Solution: Rationale of the proposed solution (why do you think the solution addresses the issue you have identified), how does the solution function.

Rationale of the proposed solution

We aim to implement this as we want to significantly reduce the number of road kills happening every year. Most of the time, when animals cross, they are either too small to be seen or the driver is driving at too fast of a speed to stop in time. We have also researched that road kills usually occur when a driver is driving too fast and does not see the animal in front of them. Thus, in order to preempt drivers, we plan to use lights to signal to drivers that an animal is crossing and they need to stop. However, our main sensor will first detect if an animal is crossing first, so as to not put on the lights when not necessary. The sensor will be used to detect animals that are moving too close to the road. This way, animals can cross safely and drivers will have enough time to react accordingly, achieving our aim.

How does the solution function

We will use Microbit to code the device. In the morning, we intend to use a normal camera to detect the type of animal passing by as infrared would not be effective in the morning.[14] At night, we intend to use an Infared sensor to detect the type of animal approaching up to 5m from all sides. The infrared sensor is a device that detects infrared radiation in its environment and outputs an electrical signal.[13] It can detect movement and measure the heat of an object. After coding the device to detect what animal it is, based on its features, the device will emit a sound that is only able to be heard by that specific animal as the hearing frequencies of various animals vary. Using such frequencies will not affect drivers as well thus reducing the chances of distraction and potential accidents taking place.[11]

At the same time, the microbit is coded so that when the device detects an animal, a noticeable sign board will immediately light up with wording to warn drivers to drive with caution as there are wild animals in the area. This gives drivers time to react and drive slower or to be aware of their surroundings in order to brake in time.
IR sensors are undetectable to the human eye. The main advantages of using these sensors are their low power consumption, simple design, and useful features. IR radiation can be found in the visible and microwave regions. The wavelength of these waves typically range from 0.7μm to 5 to 1000μm. Additionally, we will be turning off the device during non-peak hours so that animals can cross safely without being disturbed and drivers will not be alerted so frequently. This way our device is not restricting animals from crossing the road to another forested area to find food and shelter all the time.

The camera trap will be used to detect wildlife and capture the location of it. The Bushnell NatureView HD Essential Trail Camera offers the ability to capture either 12 MP high-resolution stills or HD video of wildlife, other hunters, as well as trespassers at up to 1920 x 720p with

audio. The camera features a 0.6 second trigger that is ready to capture again after 1 second, as well as a 32-LED flash that has an 80' range. A heat and motion detecting PIR (passive infra-red) motion sensor with a range of over 60.0' and flexible time lapse options increases the likelihood that footage of your intended subject will be captured, while user-selectable high, medium, low, and automatic PIR settings reduce the potential for missed or unwanted footage depending on the temperatures in the area to be surveyed. Field Scan setting allows images to be captured at intervals ranging from 1 minute to 1 hour within two separate time frames such as dusk or dawn.

The camera can function for up to one year and includes a lock channel and latches, is weather resistant, and is operable at temperatures from -4 to 140°F.

An ultrasonic animal repeller speaker consisting of a PIR sensor is used to chase away animals from the road. It has a 360 degrees infrared sensor range.[15] Increasing the sensitivity to detect animals at a further distance of up to 12 meters will allow the volume to increase accordingly. The opposite would be decreasing the sensitivity to detect at a closer distance with a decreasing volume. The speaker has 5 different modes: mode 1 being ultrasound 15kHz-65kHz, mode 2 is an SOS Alarm sound or an ultrasonic horn emitting bird calls of repelling, mode 3 is a red and white LED flashing light, mode 4 emits animal sounds, mode 6 is a cycle of the combination of all first five modes, until the animal is driven out of the inductor range. Last but not least, the buzzer mode which produces seismic waves and works at night only. There are 2 charging methods, one using a USB and the other through the solar panel on top of the speaker to save energy. It is waterproof and automatically bursts light at night to supplement the machine should it stop working when the infrared induction fails on cloudy and rainy days.[18]

The microcontroller in our device is used to store the videos and footage for future use when we would like to evaluate how effective this device has been in reducing the number of roadkills.

The shelter will be made of a shiny material and will be used to prevent the camera from getting wet as the water droplets may obstruct the view of the camera. The shelter is also used to prevent overheating as the shiny surface acts as a reflector of radiation. The whole box is white as white is a good reflector of radiation and prevents overheating as well.

The box is going to be placed on a pole as this allows for the camera to have a greater view of the surroundings in order for animals to be detected. There are metal spikes on the pole and on the shelter to ward off birds or any climbing animals from obstructing the camera.Each device will be placed 800 metres apart from each other. It will be placed along the sides of roads with a relatively high amount of greenery on both sides of the road or roads where roadkills are most commonly seen for example Bukit Timah Expressway, Mandai Lake Road etc.

In order to power our device, a solar panel is attached to the device. This way a renewable source of energy is used to power our device reducing energy consumption from non-renewable sources of energy.

A signboard is also going to be connected to the device to light up when an animal is detected. The board will be black with yellow colour LED lights mentioning the words “slow down, animal ahead”. This way the signboard can be visible from a long distance and will be effective in alerting drivers to slow down. (Refer to Fig. 2)

Another feature we intended to carry out includes application notifications. We wanted to partner with navigation applications so that an alert will appear on the driver’s phone when a wild animal is in the vicinity. When our device senses an animal, it will automatically trigger the alert on the application. This allows for drivers to be alerted to slow down in case they missed the signboard. However, not all drivers may have a navigation application downloaded so the signboard will still be the first option in terms of warning the driver. (Refer to Fig. 3)

Process of events taking place in the device

1. The infrared cameras and regular cameras will detect the animals. (The infrared cameras will detect the animals using thermal sensors and regular cameras will function like a regular camera.)
2. The infrared cameras and regular cameras will send the results collected to the microbit and a series of events will follow.
3. If an animal is detected, the microbit will activate the frequency speakers, and send out the necessary frequency to scare away the animal. For example, if a wild cat is trying to cross the road and a car is coming, we will send out a frequency of 64000 Hz, the highest frequency they can hear, to scare them away and make them flee from the road.
4. As an added precaution, the microbit will also send the information to our signboard to light up and warn the drivers that an animal is crossing the road, this way the driver can have enough reaction time to stop their vehicle, preventing roadkills.
5. As another added precaution, we have decided to collaborate with navigation apps such as Google Maps, and our microbit will be able to send a notification to such apps, to inform drivers near the area that an animal has crossed a certain road and to alert them to drive carefully around these areas.
6. The microbit will also need to be charged, and it will be powered by the solar panel on the top of the roof of our device, to trap heat and convert it into electricity. Therefore, the microbit will never run out of electricity and it will work for a long time.

Pictures of our prototype:

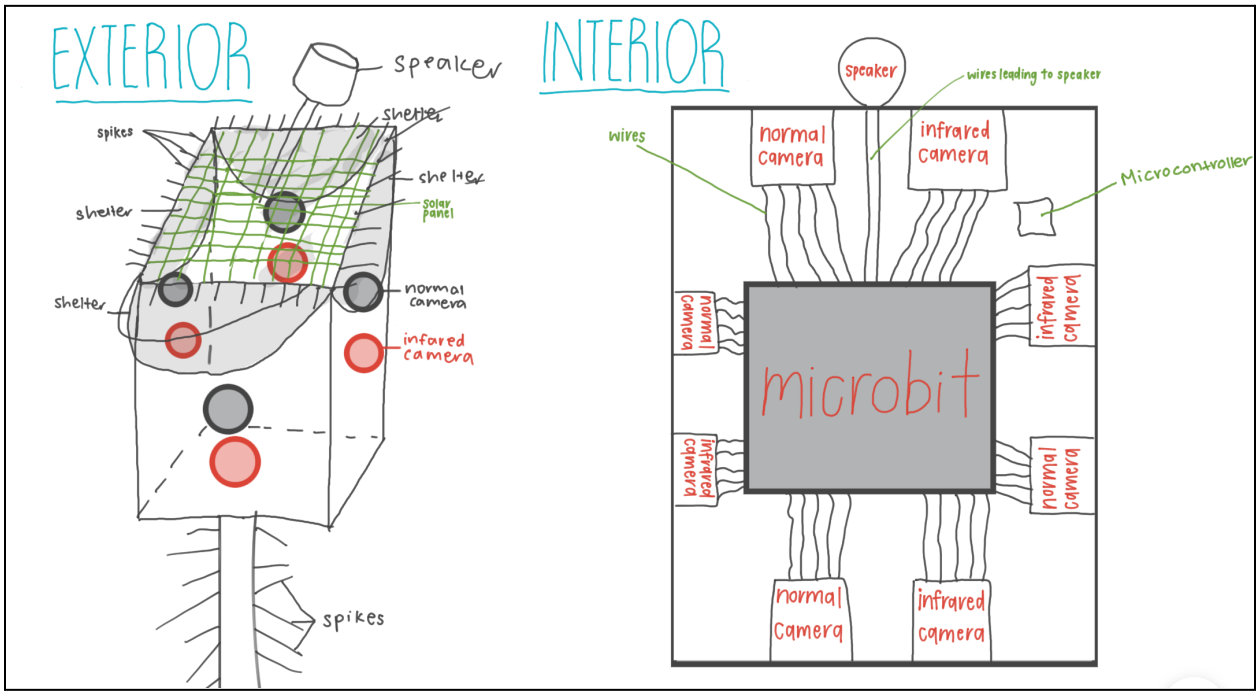

Fig. 1: Diagrams of the exterior and interior of the device

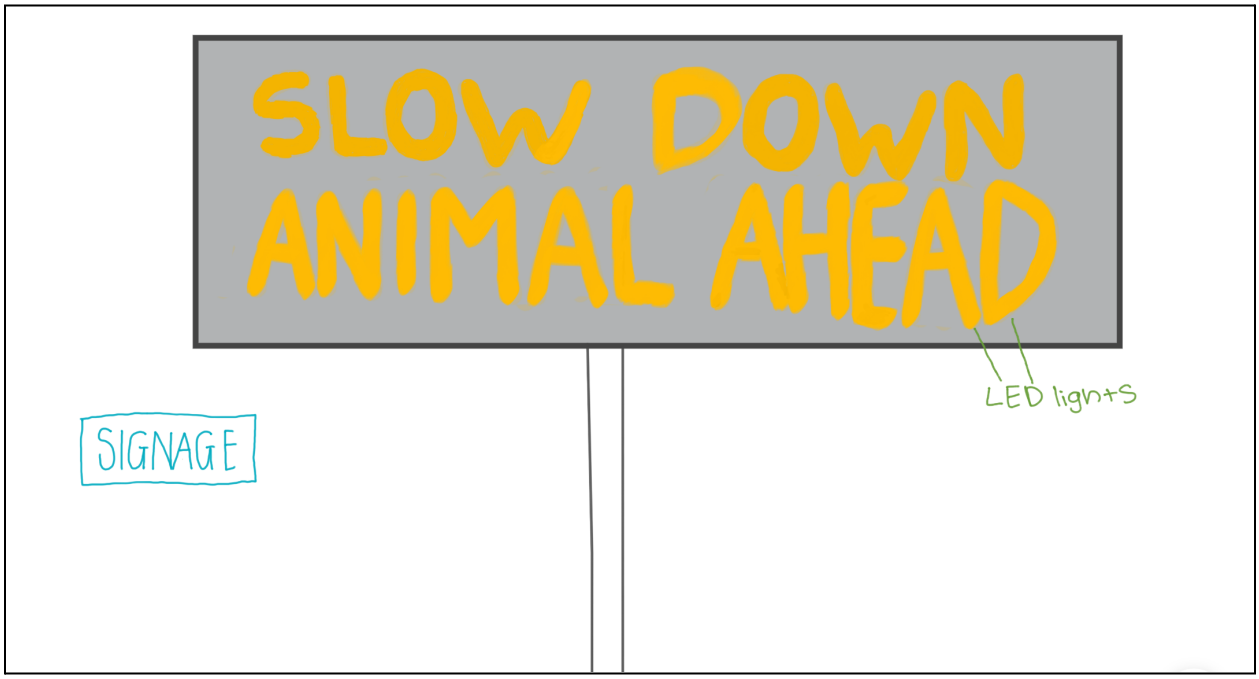

Fig. 2: Diagram of the signboard that will light up when an animal is detected

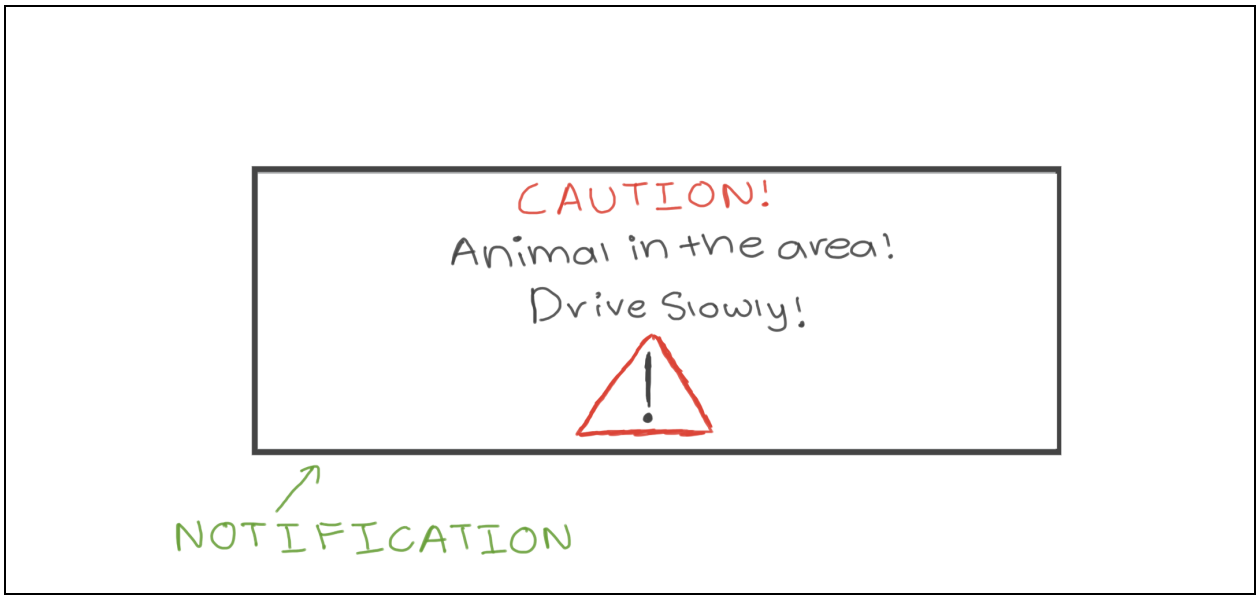

Fig. 3: Diagram of the notification that will be sent to drivers using the app

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