A Time Domain Reflectometry (TDR) Electric Fence Fault Detector and Localiser

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Public and private sector players use electric fences to create protected areas (PAs). These sectors use fences to restrict movement of animals and prevent entry by unauthorised people into the PAs. This helps protect wildlife and reduce human-wildlife-conflicts. When an animal comes into contact with an electric fence, it gets a non-lethal electric shock that scares it away. Over time, the animal learns to avoid the fence hence restricting their movement.

Electric fences are prone to faults. These faults are due to either short circuit, breakage of cables, vegetation overgrowth, or tree branches falling on the fence. Faults affect the effectiveness of the fence. They need to be detected, localised and corrected as soon as they occur. Current methods of fault detection in electric fences are inefficient. The most common method involves walking along the fence with a meter measuring the voltage or current in the fence to pinpoint the exact point of occurrence of the fault. This method is laborious and time consuming given the long cables used to make the fence. Another method is installing sensors along the fence. These sensors measure the voltage or current in the fence and the measured values are used to determine if a fault has occurred in the fence. The sensors relay the information to a central device. This method is expensive, and the system is prone to faults too.

This research seeks to develop a low-cost time domain reflectometry (TDR) electric fence fault detector and localiser. TDR is based on the principle of reflection of incident electric signals by impedance discontinuity in cables. By applying a fast-rising rectangular pulse to a cable and analysing it at the input port, it is possible to detect impedance discontinuities in the cable. Different impedance discontinuities cause different reflections. Impedance discontinuities with magnitudes lower than the characteristic impedance of the cable cause reflections that are out of phase with the incident signal. On the other hand, impedance discontinuities with magnitudes higher than the characteristic impedance of the cable cause reflections that are in phase with the incident signal.

A TDR system checks for reflections to determine presence or absence of faults. The distance to the point of occurrence of the fault is calculated using the time delay between the incident and the reflected signals. Therefore, the phase of the reflected signal is used to tell the type of fault and the time delay of the reflected signal is used to calculate the distance to the fault. TDR systems exist in the market. However, these systems are expensive, and they require human intervention during use. The TDR system proposed in this abstract is based on the Raspberry Pi. The system is built using cheap off-the-shelf components and can be used to detect hard (open circuit and short circuit) faults in electric fences.

The TDR system comprises a Raspberry Pi 4, a 65 MSPS AD9226 Analogue to Digital Converter (ADC) and a Schmitt trigger pulse generator. The Schmitt trigger is used to generate a near 50% duty cycle rectangular pulse with an amplitude of 5 V and 8.3 kHz. The

pulse is applied to an electric fence and then it is sampled at the input port at 31 MSPS using the ADC. The sampled signal is fed to the Raspberry Pi for visualisation and processing. Short circuits were simulated at different points along a section of the Dedan Kimathi University of Technology Conservancy electric fence that is 106 m long. The experiment was also done with the whole section of the fence as an open circuit and data was collected and saved. From visualisation of the data, it is possible to differentiate open circuit fault and short circuit fault. The data has been used to develop a TDR algorithm to compute the distance to faults in cables. The algorithm has a Root Mean Square (RMS) of 1.55 m and a Mean Absolute Error (MAE) of 1.18 m.