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A Vision-Based Early Warning System to Prevent Elephant-Train Collisions

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Abstract : One serious facet of the worsening Human-Elephant conflict (HEC) in nations such as Sri Lanka involves elephant-train collisions. Endangered Asian elephants are maimed or killed during such accidents, which also often result in orphaned or disabled elephants, contributing to the phenomenon of lone elephants. These lone elephants are found to be more likely to attack villages and showcase aggressive behaviour, which further exacerbates the overall HEC. Furthermore, Railway Services incur significant financial losses and disruptions to services annually due to such accidents. Most elephant-train collisions occur due to a lack of adequate reaction time. This is due to the significant stopping distance requirements of trains, as the full braking force needs to be avoided to minimise the risk of derailment. Thus, poor driver visibility at sharp turns, nighttime operation, and poor weather conditions are often contributing factors to this problem. Initial investigations also indicate that most collisions occur in localised “hotspots” where elephant pathways/corridors intersect with railway tracks that border grazing land and watering holes. Taking these factors into consideration, this work proposes the leveraging of recent developments in Convolutional Neural Network (CNN) technology to detect elephants using an RGB/infrared capable camera around known hotspots along the railway track. The CNN was trained using a curated dataset of elephants collected on field visits to elephant sanctuaries and wildlife parks in Sri Lanka. With this vision-based detection system at its core, a prototype unit of an early warning system was designed and tested. This weatherised and waterproofed unit consists of a Reolink security camera which provides a wide field of view and range, an Nvidia Jetson Xavier computing unit, a rechargeable battery, and a solar panel for self-sufficient functioning. The prototype unit was designed to be a low-cost, low-power and small footprint device that can be mounted on infrastructures such as poles or trees. If an elephant is detected, an early warning message is communicated to the train driver using the GSM network. A mobile app for this purpose was also designed to ensure that the warning is clearly communicated. A centralized control station manages and communicates all information through the train station network to ensure coordination among important stakeholders. Initial results indicate that detection accuracy is sufficient under varying lighting situations, provided comprehensive training datasets that represent a wide range of challenging conditions are available. The overall hardware prototype was shown to be robust and reliable. We envision a network of such units may help contribute to reducing the problem of elephant-train collisions and has the potential to act as an important surveillance mechanism in dealing with the broader issue of human-elephant conflicts.

Keywords : computer vision, deep learning, human-elephant conflict, wildlife early warning technology
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