Development of an AI-driven semi-automated air rifle system for wild elephant conservation

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Dart shooting is a widely used remote drug delivery method in the treatment and conservation of wild elephants. However, conventional dart shooting requires a manual gun operator to handle the gun while remaining inside the effective range, often endangering the life of the gun operator. To address these challenges, this study focuses on the development and optimization of an artificial intelligence (AI) based semi-automated air rifle system for wildlife treatment. A custom-designed pre-charged pneumatic (PCP) valve integrated with a pressure reservoir which can handle 150 atm pressure and a triggering mechanism was developed, executing relevant simulations. The biaxial direction control system powered by a YOLOv8-based object detection system was able to locate and track the elephant in real-time. Through a web-based application interface, the user can activate the firing mechanism remotely after confirming the target while ensuring the safety of the wild animal. The system was adapted to identify a testing target, allowing the system to operate in an experimental environment and an extensive amount of testing was done to evaluate the system's accuracy and precision. With the current limitations of resources and considering safety concerns, all tests were carried out with a constant pressure of 5 atm and the target distances varied from 3.5 m, 5 m to 6.5 m. The results indicated mean deviations of 8.3 cm, 16.7 cm and 30.8 cm for the respective target distances, demonstrating a significant increase in dart dispersion of 8.4 cm and 13.1 cm respectively, with the distances under a constant air pressure at 5 bar. Similarly, the standard deviation values of 1.5 cm, 2.7 cm and 4.7 cm for the distances of 3.5 m, 5 m and 6.5 m, respectively, indicate a relatively high level of precision. Design and development of the AI driven air riffle system has the potential to enhance the safety and efficiency of the remote drug delivery in wildlife management.

Keywords: *Remote drug delivery, Artificial intelligence, Pre-charged pneumatic valve, YOLOv8*