

Executive Summary

African elephants are an endangered species, so it's crucial to learn about how to protect the health and well-being of the species. One such way scientists and researchers have strived to meet that goal is by creating collars and anklets for elephants that enclose sensors, providing pertinent information about their location and movements. Although past projects pertaining to that type of tracking system have been relatively successful, one drawback amongst them has been that the sensors are utilized only a few times before breaking. As a result of focusing on short term data collection, the durability and strength of the mounts and anklets were not a main priority in scope of those projects. Team 20, in conjunction with San Diego Zoo Wildlife Alliance (SDZWA) and UCSD's Engineers for Exploration, aimed to design and fabricate a mount and anklet for housing such sensors, with emphasis on durability and strength in order for the system to be used repeatedly for longer durations. The sensor stack, which consists of accelerometers, gyroscopes, and magnetometers, provides data for elephant gait analysis, which is a topic of interest for SDZWA. The mount and anklet were specifically designed to be attached to the ankles of adult, female African elephants.

Major requirements of the project include:

- Enclosure in which the sensors are housed within is able to withstand the force of an elephant stepping on it
- Must protect sensors from both water and mud
- Easy access to the sensors for the SD card and battery
- Adjustable anklet strap to attach the enclosure to an elephant ankle
- Wireless data acquisition from the sensors is not inhibited

The entire device consists of electronic components (sensors, an SD card, a battery and an antenna), a Blue Robotics watertight enclosure, an external strength enclosure, and two straps with adjustable clips on either end. The sensors are the means through which data is obtained, the SD card stores data, the battery ensures that the electronic components have the power to operate, and the antenna transmits data wirelessly to the external environment. The watertight enclosure is a Blue Robotics waterproof enclosure tube, which houses the electronic components and ensures that the sensors are protected from water and mud. The watertight enclosure was then encased by the external strength enclosure, and had the purpose of shielding the sensors from forces that an elephant could exert. The external housing unit was 3D-printed using Polycarbonate Acrylonitrile Butadiene Styrene (PC-ABS) filament and was designed to hold the Blue Robotics internal waterproofing structure. Adjustable straps (firehose) were attached to the external strength enclosure through slots in the enclosure and was designed to wrap around an elephant ankle and secured via metal clasps.

After a scale model underwent a compression test, it was determined that the full scale model would fail under a load of 20 kN. This result showed that the external strength enclosure ultimately failed to meet the requirement that to withstand the entire weight of an adult, female elephant (roughly 25 kN to 35 kN). There are a few reasons why these results came about, some of which include the accuracy of the scale model, the lack of fasteners in the scale model, and the infill that the model was 3D printed at. While the external enclosure failed to meet all the requirements, Team 20 learned a great deal from the model.

For future recommendations of the design, Team 20 recommends:

- Exploring and testing other strong materials for the external strength enclosure
- 3D printing PC-ABS at higher nozzle, bed, and chamber temperatures
- Increasing the distance between the two strap holes on the anklet for additional support
- Designing a customized buckle to adjust the size of the strap with