SoET TEAM #28

Tracking Alpacas in Peru

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We extend our sincere gratitude to our mentor, Prof. James Condron, and our client, Dr. Daniel Salas, for their unwavering support and guidance throughout this project. We would also like to give special thanks to Mr. Mauricio Montoya and Mr. Malin Prematilake for their valuable insights and continuous assistance, which were instrumental in the development and success of our work.

PURDUE UNIVERSITY

Polytechnic Institute

OBJECTIVE

The objective of our project was to design a lightweight, durable, and self-sustaining tracking device capable of operating in the high-altitude regions of southern Peru, to wirelessly collect and transmit data that supports the monitoring, safety, and well-being of alpacas in their natural environment. It needs to impede the Alpacas natural movements as little as possible, so as to preserve the validity of the data collected.

Figure 1

CUSTOMER PROBLEM AND REQUIREMENTS

We are working with a university in the Cuevas de Sombay region near Arequipa to track 200 alpacas in the Andes. The goal is to collect real-time GPS data to improve herd monitoring, locate lost animals, and guide decisions like where to build new stables.

Project Environment:
- Temperatures: 30°F to 75°F
- 4-month rainy season early in the year
- Alpacas roam up to 10 km daily and return to stables with Wi-Fi connectivity

Client Needs:
- Track locations, feeding and watering areas
- Identify frequently visited zones
- Support lost animal recovery and infrastructure planning

Design Requirements:
- Weatherproof and wireless
- Real-time GPS tracking
- Self-sustaining (no frequent charging)
- Detect if animal is alive
- Bite-resistant and non-toxic
- Operates in highland climate conditions

CONCEPTS AND EXPERIMENTATION

While exploring different design concepts the one we spent the most time conducting experiments with was by far the backpack version of the concept. This was largely due to the fact that its size allowed us to use a larger solar panel, which according to test results can power all of our components with no issue. Compared to the other concepts we were working with (i.e. a Collar design) weatherproofing proved to be much easier as well. The main issues with a collar version of our design was securing components, as placing them in an enclosure too large would cause issues with weight distribution on the collar. Placing components in separate enclosures would have led to loose wires between them that the alpacas would have been able to rip out. The backpack design alleviated all those issues, albeit while sacrificing size.

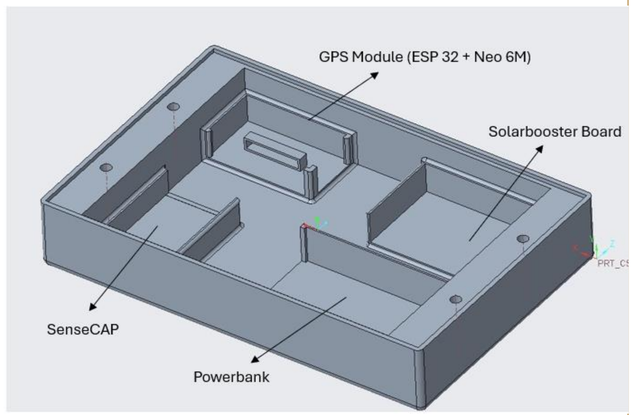


Figure 3

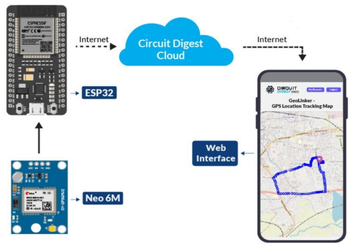


Figure 2

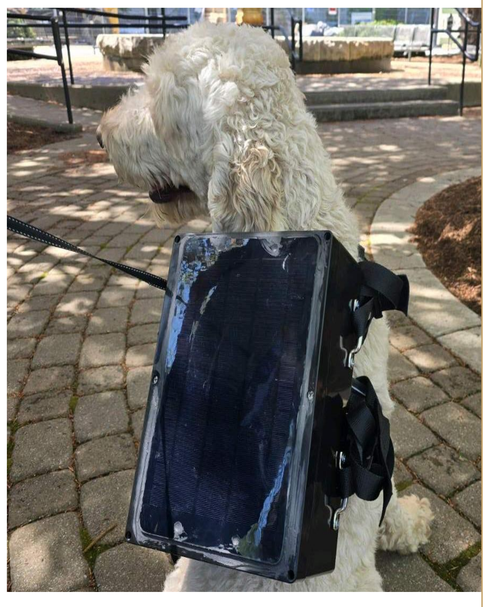


Figure 4

RESULTS

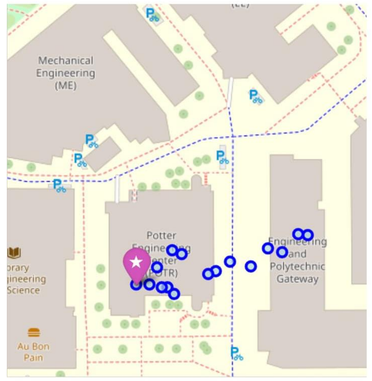
- Real-Time GPS Data: Successfully captured and transmitted real-time location data, allowing accurate tracking of alpaca movement across a 10 km roaming area.
- Accelerometer Data: Collected motion data to help infer activity levels, movement patterns, and potential health or behavioral indicators (e.g., excessive stillness).
- Continuous Power Supply: Maintained stable power delivery to all components through energy-efficient circuit design, enabling uninterrupted device operation.
- Continuous Battery Charging: Integrated a solar-based charging system that kept the battery charged throughout the day, supporting long-term, self-sustained deployment.
- Weatherproof Enclosure: Housed all electronics in a sealed, rugged container that protected the system from rain, dust, and temperature fluctuations common in the Andes Highlands.

TESTING RESULTS

AlpacaTrack

AlpacaTrack

Location:



Reset Map

S.No	Timestamp	Latitude	Longitude
1	2025-04-29 14:25:02	40.427453	-86.911887

Figure 5

CONCLUSION AND RECOMMENDATIONS

Our testing and development process provided valuable technical insights and practical experience in designing remote animal tracking systems for harsh environments.
- Open-source circuit boards like Arduino and ESP32 offered flexibility, ease of programming, and compatibility with various sensors.
- LoRa communication delivered the best range and reliability for transmitting data over the alpacas' wide roaming area.
- The project expanded our understanding of GPS tracking technology, including accuracy, satellite acquisition time, and terrain interference.
- We also gained practical experience in optimizing embedded systems for low power use and environmental resilience.

Recommendation:
- Optimize firmware and hardware for lower power consumption, including using sleep modes and reducing GPS update frequency.
- Make the device lighter by selecting compact batteries and streamlined enclosures to enhance alpaca comfort.
- Use a modular design approach to allow easy upgrades, maintenance, or component swaps in the field.