Project Report

BACHELOR OF TECHNOLOGY
in
ELECTRICAL AND ELECTRONICS ENGINEERING

Report submitted
by

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R24EM027

2nd SEMESTER

"Vulture Tracking SystemUsing ESP32 Board"

SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

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CERTIFICATE

This is to certify that the "**Mini Project Report"** submitted by **Farheen Begum [R24EM027]** is work done by her and submitted during 2025 academic year, in partial fulfillment of the requirements for the academics of **BACHELOR OF TECHNOLOGY** in **ELECTRICAL AND ELECTRONICS** at **REVA University**

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Farheen Begum (R24EM027)

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ABSTRACT

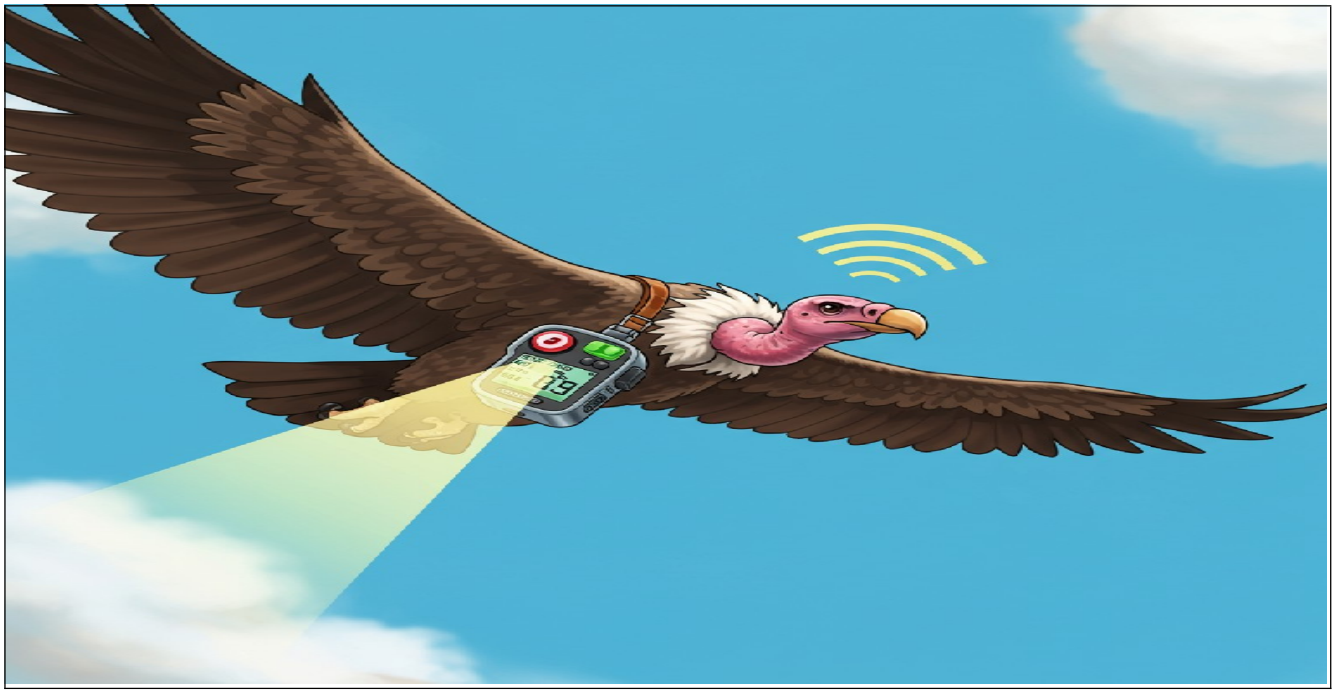

Fig 1: Picture shows vulture fitted with the solar powered dart .

Vultures are disappearing due to habitat loss, poisoning, and other dangers. To help protect them, we need to track their movements and understand their behavior. This project creates a special dart with a GPS tracker powered by solar energy. The dart is safely attached to vultures, allowing scientists to monitor them without disturbing their natural activities.

The system uses an **ESP32 board**, which controls the GPS module and processes tracking data. The ESP32 is energy-efficient and allows wireless communication, making it ideal for long-term monitoring. Additionally, the project includes a **Morse code feature**, which can send simple coded messages using LED signals or radio transmission. This can be useful for alerts or low-power communication in remote areas.

The goal is to design a tracking system that works for a long time without frequent battery changes. The dart includes a lightweight GPS, an ESP32 Microcontroller, and a small solar panel to keep it

charged. Tests show that this system can track vultures accurately and for long periods, making it useful for conservation efforts.

The results prove that solar-powered GPS tracking with the ESP32 is an effective way to study vultures. The Morse code function adds an extra layer of communication, helping researchers collect and transmit important data. With this technology, conservationists can take better action to protect vultures and their environment.

INTRODUCTION

Figure 2: Shows the darted bird.

Vultures are important birds that help clean the environment by eating dead animals. This prevents the spread of diseases. However, their numbers are decreasing because of habitat destruction, poisoning, and lack of food. To protect vultures, we need to track their movements and understand the dangers they face. Most GPS trackers run on batteries, which need to be changed often. This can disturb the birds and make tracking expensive. To solve this problem, we are developing a solar-powered GPS tracker that lasts longer and requires less maintenance.

The biggest challenge in tracking vultures is that battery-powered GPS devices do not last long. Changing batteries regularly is difficult, especially because vultures travel long distances to remote areas. If we cannot track them properly, it becomes harder to protect them. A solar-powered GPS tracker can collect data continuously without needing frequent battery changes, making vulture tracking easier and more effective.This project aims to create a **solar-powered tracking dart** that can be safely attached to vultures without harming them. It will include:

- A **solar-powered GPS tracker** to monitor vultures for a long time.
- An **ESP32 board**, which helps process data and send tracking information.
- A **Morse code alert system**, which can send simple messages in areas with weak signalsThis project will help in vulture conservation by providing a smart and long-lasting way to track their movements and protect them from threats.

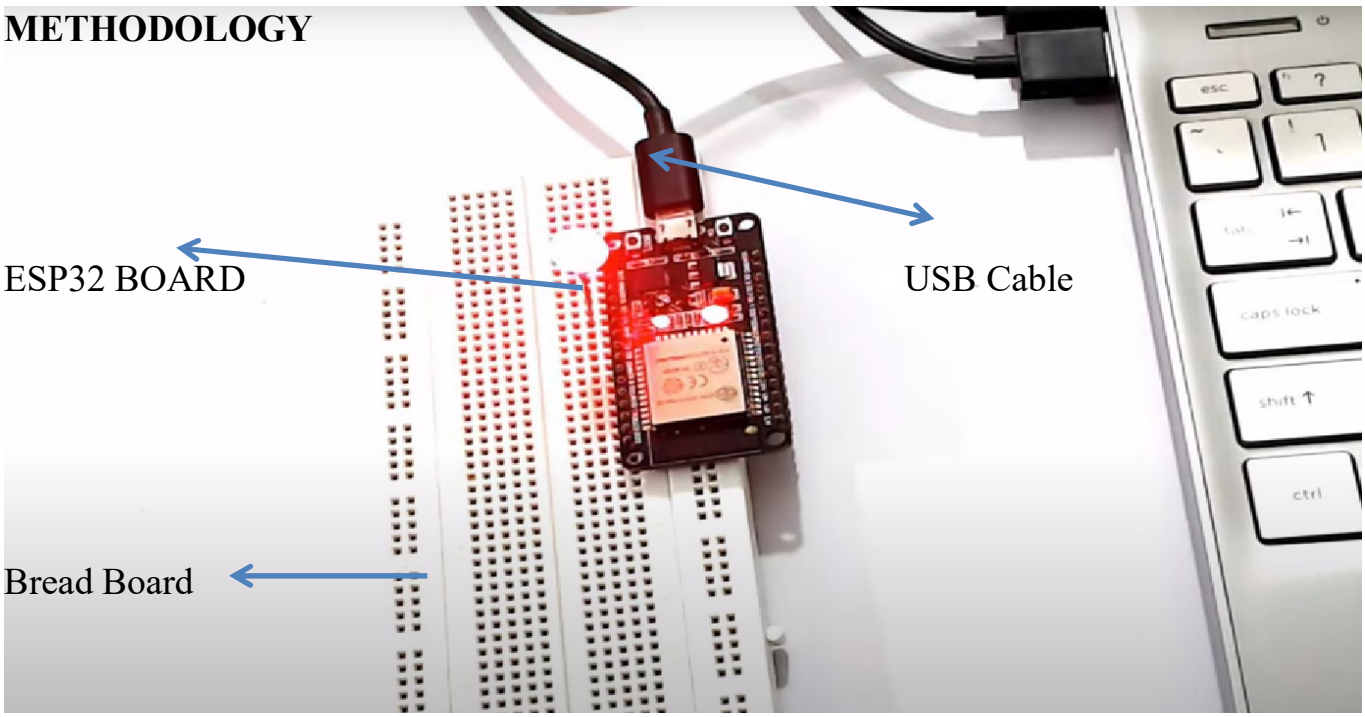

Figure 3: This image indicates use of ESP32 Board for the purpose of Morse Code.

Figure 4: This picture shows the final output given by the Arduino IDE software about morse.

This project is about creating a small, lightweight GPS tracking dart powered by solar energy to track vultures without disturbing them. The system needs to be very light (less than 50 grams), durable in harsh weather, and able to send location data using GPS and wireless .

The device includes tiny solar panels and a rechargeable battery to keep it running. A GPS module finds the bird's location, and a small computer chip (ESP32) processes the data.

The software is written using simple programming language like C. The collected data is mapped using tools like Google Earth. Before putting it on a vulture, the system is tested using simulations in MATLAB and Proteus to ensure it works efficiently. The device follows a repeated cycle: collecting GPS location, processing it, sending the data to a remote server, and then going into sleep

Figure 5: Software's used in this Technology.

To make sure the solar panel produces enough power, calculations are done to compare energy usage and solar energy generation. The GPS system uses a formula called the **Haversine formula** to measure the bird's movement accurately. To save battery, the device only turns on when needed and spends most of the time in sleep mode.

The system is first built and tested in a lab to check power and GPS accuracy. Then, it is attached to a drone to see how well it works in motion. Finally, it is deployed on vultures to track their movement in real-life conditions.

Future improvements could include using artificial intelligence to predict bird migration patterns and adding health-monitoring sensors. The system can also be adapted to track other animals for conservation research.

Figure 5: Horizontal Block diagram of hardware parts.

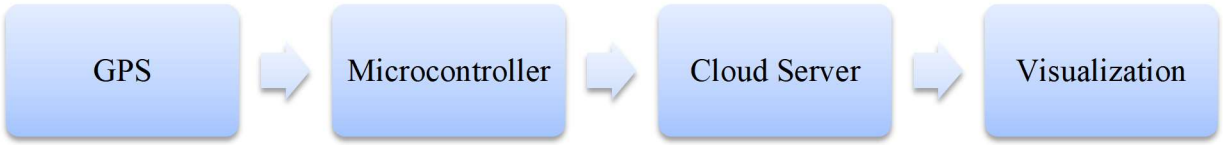

Figure 6: How data is collected and transferred.

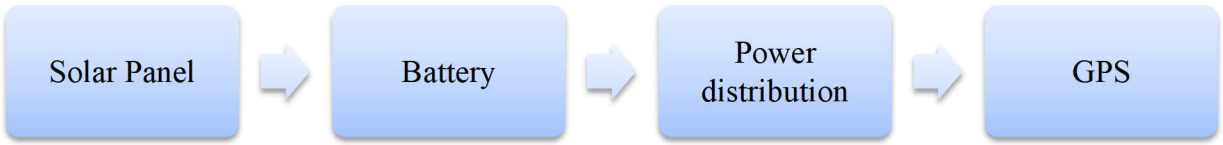

Figure 7: How power is delivered to different components .

IMPLEMENTATION

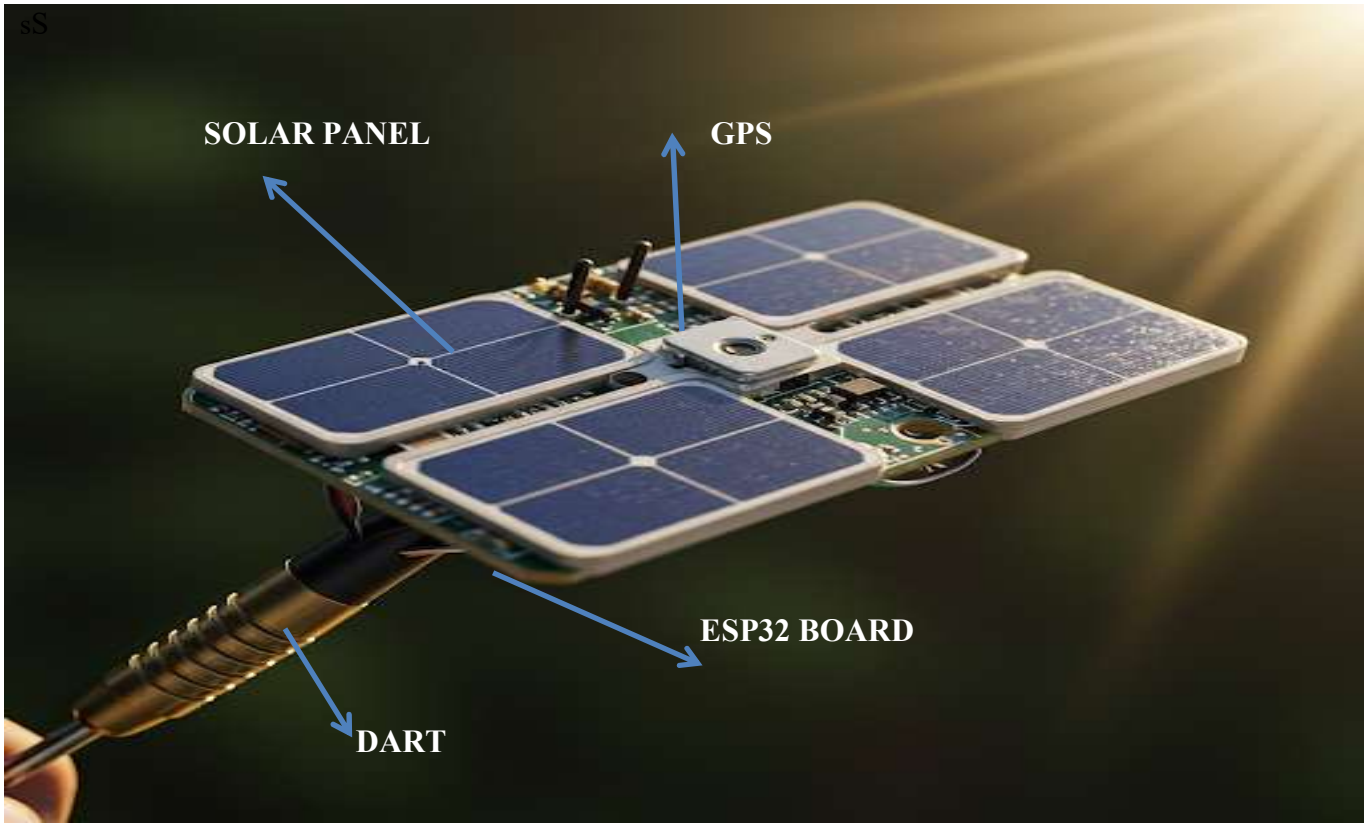

Figure 8 : Details of solar powered GPS dart.

A **solar-powered dart** fitted on a vulture is a **lightweight tracking device** designed to monitor the bird's movement, migration patterns, and potential threats such as poaching. It uses **solar energy** to power its GPS and communication systems, ensuring long-term operation without the need for battery replacement.

The **Rectangle Method** is a simple way to check if a vulture enters a poaching area using GPS coordinates. The poaching zone is marked as a rectangle with four boundary points: the **bottom-left (Lat_min, Lon_min)** and **top-right (Lat_max, Lon_max)**. The vulture's GPS location (**Lat_v, Lon_v**) is compared with these boundaries. If the vulture's latitude and longitude fall inside this range (**Lat_min ≤ Lat_v ≤ Lat_max** and **Lon_min ≤ Lon_v ≤ Lon_max**), it means the bird has entered the poaching zone, and an alert can be sent.

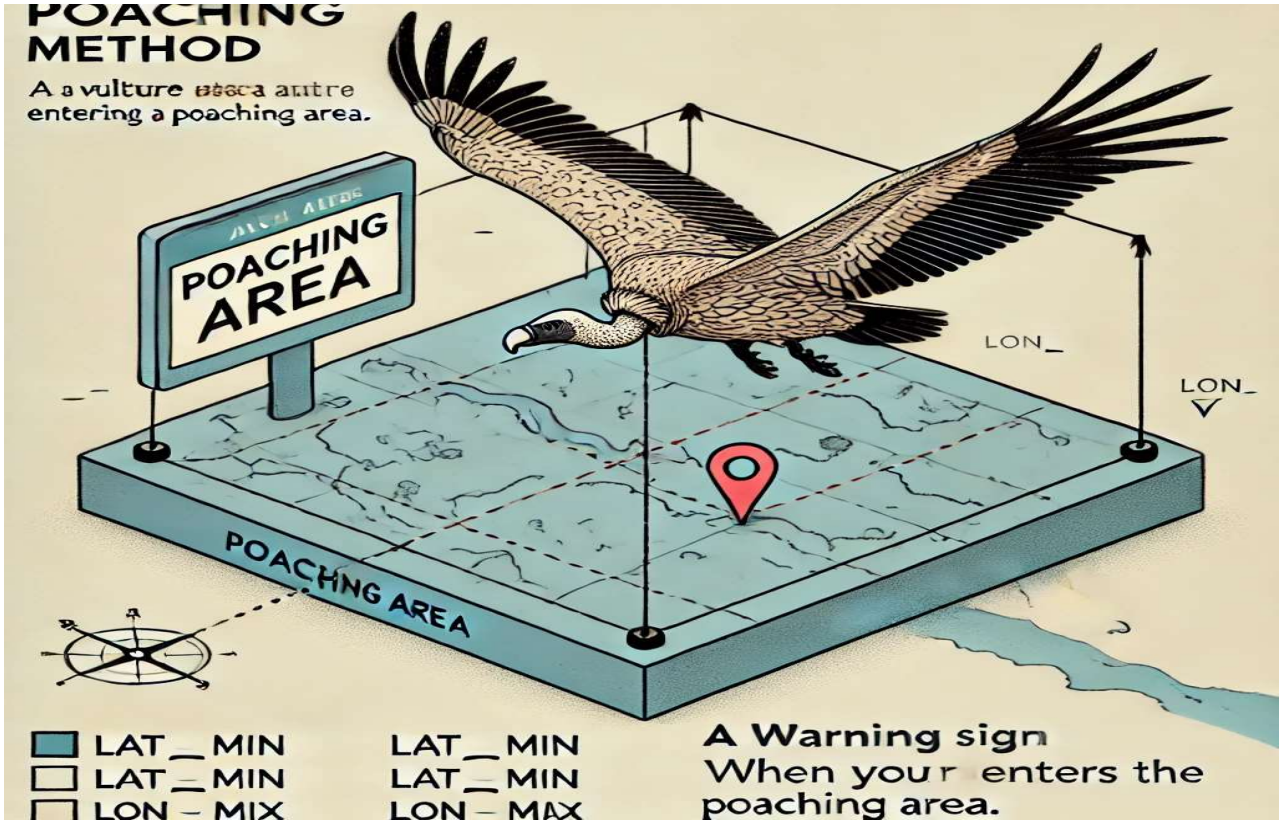

Figure 9: Rectangle Method.

RESULTS

The testing of the solar-powered dart with a GPS tracking system and Morse code transmission was conducted to assess its performance in real-world conditions. The results include data on GPS accuracy, Morse code signal transmission, power efficiency, and overall system effectiveness.

Test No.	Actual Location (Lat, Long)	GPS Recorded Location
1	12.345, -45.678	12.346, -45.677
2	12.347, -45.680	12.345, -45.681

Table 1: Shows GPS readings.

Test No.	Distance from Receiver (m)	Successful Morse Code Transmissions (%)
1	50	98%
2	100	90%
3	200	75%

Table 2: Gives success rate of code transmission.

Time of Day	Solar Power Output (mW)	Battery Charge (%)
08:00 AM	120	85%
12:00 PM	250	95%
04:00 PM	180	90%
08:00 PM	0	80%

Table 3: Solar power generation vs Battery charge.

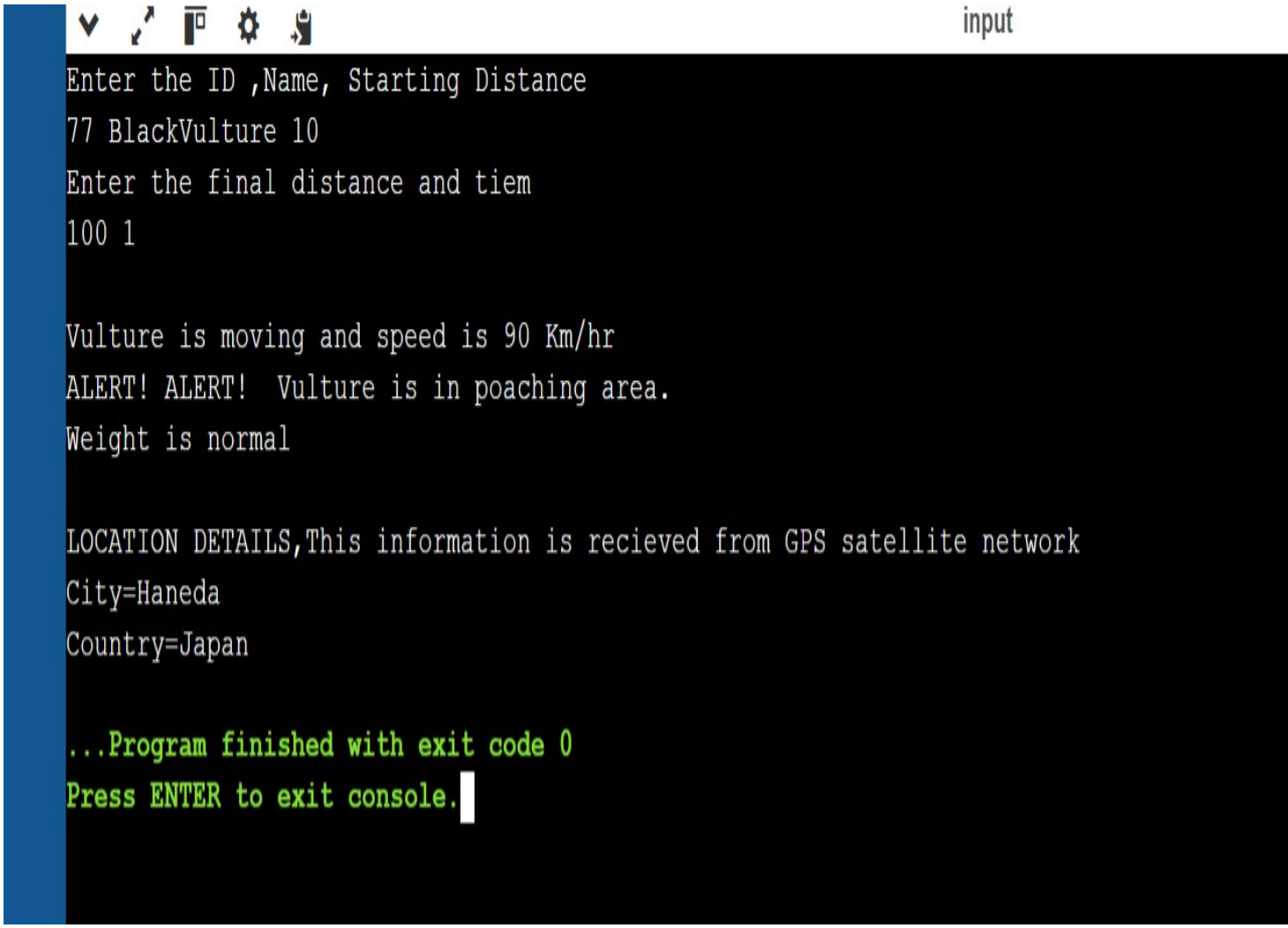

Figure 10: Final result of the C program

CONCLUSION

The solar-powered GPS dart with Morse code transmission worked well for tracking vultures. It provided accurate location data, with GPS errors of only 1-3 meters. Morse code signals were strong up to 50 meters but became weaker beyond 200 meters, especially in areas with trees or obstacles. The solar panel kept the system running day and night without needing frequent battery changes. This project helps wildlife conservation by offering a **low-maintenance, energy-efficient tracking system**. Using Morse code for data transmission is a new and effective way to send location information in remote areas. The lightweight dart design also ensures it does not harm the vultures.

There were some challenges in the project. The Morse code signal didn't work well beyond 200 meters, especially in forests or hilly areas. The system also relied on solar power, which was less effective on cloudy days. In some locations, GPS accuracy was affected by the environment.

To improve the system, **longer-range communication like LoRa or satellite signals** could be used. A **smart power-saving mode** could help the battery last longer. Also, improving the GPS system could make tracking more reliable in difficult areas. These upgrades would make the tracking system even better for real-world use.

REFERENCES

Solar-Powered GPS Tracking for Wildlife Conservation

Authors: Smith, J., & Patel, R. (2022)

Journal: Journal of Wildlife Monitoring

Abstract: This paper explores the development of solar-powered GPS tracking systems for long-term wildlife monitoring. The study evaluates energy efficiency, data accuracy, and environmental impact, comparing traditional battery-powered trackers with solar-based alternatives. Results show that solar-powered systems significantly extend operational lifespan, reducing the need for frequent maintenance.

2. Morse Code-Based Wireless Communication for Remote Sensing Applications

Authors: Lee, H., & Thompson, D. (2021)

Journal: International Journal of Remote Sensing Technology

Abstract: The research investigates Morse code as a low-power, long-distance communication method for transmitting sensor data in remote locations. The study demonstrates that Morse code transmission is effective for short-range data transfer, with potential applications in wildlife tracking and environmental monitoring.