

Application of modern GSM telemetry device for bird tracking

Milan Stojanović, Dejan Stevanović, Slavimir Stošović, Draženko Rajković and Stefan Skorić

Abstract – Monitoring endangered and protected bird species is crucial for obtaining information about their movements and behavioral patterns necessary for monitoring the population size of this species and ensuring the survival of species within a defined region. In the ornithology, the scientific study of birds, modern GPS telemetry devices are used for this purpose. The collected telemetry data is used for mapping migration routes, identification of nesting sites and analysis of habitat selection. In this paper, an overview of GPS telemetry bird tracking device types will be presented, along with a detailed explanation of the application of the GSM telemetry device from Canandi (Niš), including an overview of the web portal functionalities for centralized monitoring, visualization of geographic data, and configuration of device parameters.

Keywords – Telemetry, Ornithology, GPS, GSM.

I. INTRODUCTION

When it comes to monitoring birds, the monitoring of individuals reintroduced into the wild after rehabilitation process is of particular importance [1]. Rehabilitation involves caring for an injured bird in controlled conditions until it is capable of returning to its natural environment [2]. After releasing bird in wild, it is necessary to continuously monitor it to see if the rehabilitation process is success and to see how well the bird adapts to life in the wild. Monitoring young birds is also of great importance.

Data collected using telemetry devices provide very good foundation for planning appropriate actions needed to ensure the survival of certain species in the observed area, as well as a basis for adequate management of resources in that area [3], [4]. In addition, the collected telemetry data can give a clear picture of migration routes of migratory birds during the year.

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Section II provides an overview of GPS telemetry devices, their two main types, advantages and disadvantages for both of them, and when to use which type. Section III describes the Canandi GSM telemetry bird tracking device and its functionalities, along with the functionalities of centralized web panel used for device parameters configuration. Section IV present examples and analysis of the collected data.

II. GPS TELEMETRY DEVICES

There are two main types of GPS telemetry devices, radio telemetry devices and GSM telemetry devices, which can be used for bird tracking, and both types are battery powered [5].

Radio telemetry devices have, in general, lower mass and a longer operational autonomy, which are their main advantages. Disadvantage is limited tracking range. The use of such a device requires a special radio receiver for manual acquired data collecting and requires the person collecting the data to be in the field near the birds during collection. This devices have a limited range and are intended for tracking non-migratory birds whose movements are limited to the area surrounding their nests. The parameters of this devices cannot be adjusted after being put into operation.

GSM telemetry devices have larger mass compared to radio telemetry devices. Their disadvantage is a shorter operation autonomy due to the higher consumption of GSM module. Short operation autonomy can be extended if the device has a small solar panel which is used for battery recharging. The range of these devices is defined by the coverage of the GSM network. The main advantage of these devices is that they allow continuous monitoring of birds movements via the web panel, as well as allowing remotely device parameters setting using the same web panel. They are suitable for both tracking migratory and non-migratory birds.

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III. CANANDI BIRD TRACKING DEVICE

The Canandi bird tracking device is a modern GSM telemetry device. Its construction is such that it can be easily placed on the birds back, without interfering with its normal functionalities. Figure 1 shows Canandni bird tracking devices which is used for tracking owls, while Figure 2 shows a device using for tracking birds that are active during the day.



Fig. 1. Canandi bird tracking device used for tracking owls.



Fig. 2. Canandi bird tracking device used for tracking day-active birds.

As can be seen in Figure 2, the device for monitoring birds that are active during the day has a solar panel for battery recharging, which enables a smaller capacity battery to be placed in this device, while maintaining long battery life. With a smaller battery, the overall weight of the device is also reduced, which is especially important since the maximum weight of the device may not exceed 3% of the total bird's weight. This makes the tracker suitable for monitoring bird species that are smaller in size.

These devices, in addition to the GPS module, also has various sensors that are used to collect relevant data. The following data is collected:

- latitude (Lat)
- longitude (Lon)
- date and time
- horizontal dilution of precision (HDOP)
- number of visible satellites (NMST)
- altitude (Alt)
- current acceleration (AccX, AccY, AccZ)
- temperature (T)
- received signal strength indicator (RSSI)

In addition to collecting data on the bird's location at a certain moment, the device also records how precise that location is. This value is called HDOP, or Horizontal Dilution of Precision. HDOP indicates how the positions of GPS satellites in the sky affect the precision of the location [6]. When the satellites are well spread out, the location is more precise, resulting in a low HDOP value. When the satellites are close to each other or poorly positioned, the location is less reliable, resulting in a higher HDOP value.

The number of visible satellites used by the device to determine the location also has influence on the HDOP value. More visible satellites improve precision because the device can select quality signals from the satellites, prioritizing those with higher signal-to-noise ratio (SNR) value.

The device has an internal memory in which all these data are stored, and then are periodically sent to the server. Later that data is available for viewing on the web panel, which will be described in section IV.

To send data to the server, the device uses a GSM module which supports 2G technology. The 2G mobile network operates on the 900 MHz and 1800 MHz frequency bands, providing wide coverage even in rural and isolated areas. The module measures the Received Signal Strength Indicator (RSSI), which reflects the power of the signal received from the base station and provides an estimate of connection quality. Although data transfer over 2G network is slower than newer 3G, 4G, and 5G technologies, it ensures a stable connection in challenging and difficult terrain, which is essential for monitoring birds in their natural environment.

The device settings can be configured through the web panel, operating period during which it collects data, the time interval for data collection, the time interval for collected data transmission, the maximum duration of data collection, and the maximum duration of data transmission for each active device.

IV. EXAMPLE AND ANALYSIS OF THE COLLECTED DATA

On the web panel, it is possible to track the movement of the bird over time. For each recorded point of movement in space, the collected data mentioned in section III are available. Figure 3 shows an example of the bird's movement on the map, an example of one package of collected data received from the device.

On the map, red circles indicate the locations where the bird was. When multiple location points are close together, they are grouped to simplify the map view. Up to 10 points are represented by a single green marker; 10 to 100 points are shown with a yellow marker; and more than 100 points are grouped under an orange marker. Zooming in on the map allows each individual point to be seen separately, even if they were previously grouped. Grouping points in this way makes it easier for researchers to locate nests or to field identify if a bird has remained stationary for a long period.

Figure 3 shows the movement of an Eurasian griffon vulture (*Gyps fulvus*), a protected raptor species in Serbia. The vulture was tagged and released into the wild with a tracking device at the Uvac Special Nature Reserve. After spending several days within the reserve, it began to range more widely. Figure 3 illustrates its journey from Zlatibor, across parts of Šumadija, and further to Čuprija.

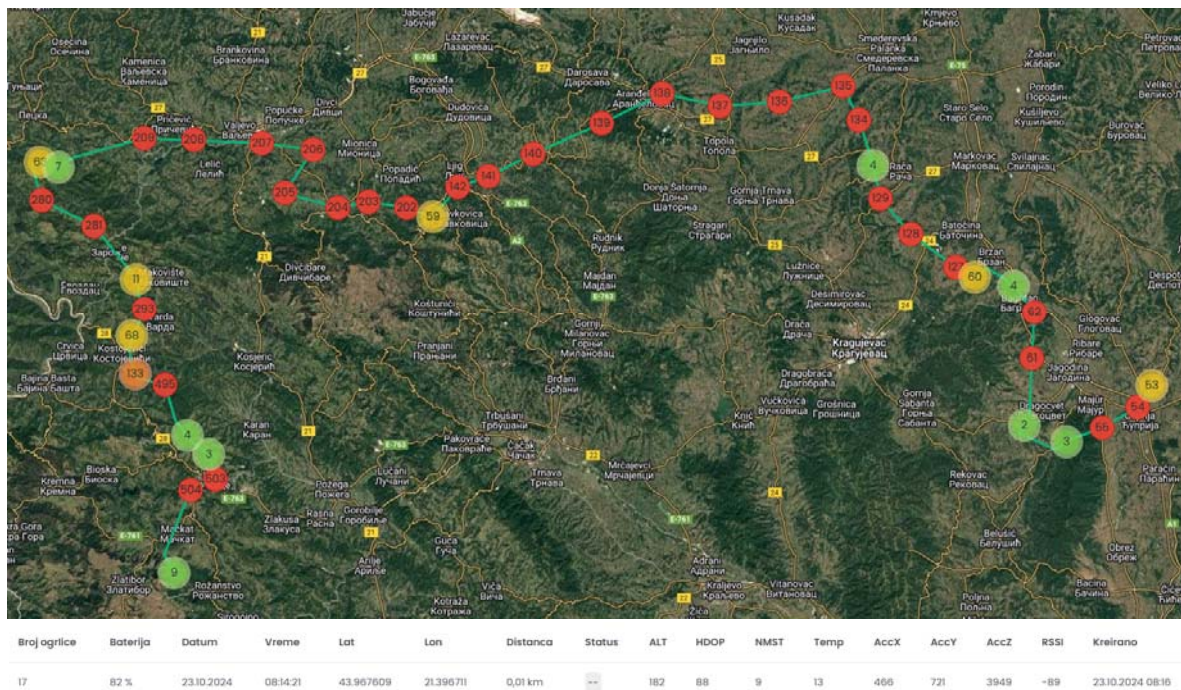


Fig. 3. Example of bird movement tracked on the map.

As can be seen in Figure 3, there are several location where point are grouped. In the following text, it will be explained how data from device can be used to determine what is happening with the bird at that moments.

In addition to displaying movements on the map, the web panel allows viewing the bird's traveled distance statistics for a specified time interval, as shown in Figure 5. This statistic can be valuable for determining whether the bird is traveling shorter distances than expected. If that occurs, there may be a problem and other statistics also should be reviewed.

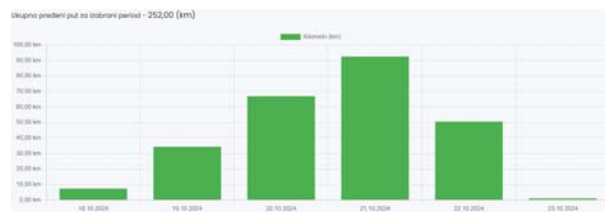


Fig. 5. Traveled distance of the bird over a specified time interval.

The temperature statistic, shown in Figure 6, is also significant. The bird's body warms the device, so its temperature stays close to the bird's normal body temperature. Measured temperatures may increase if the device is exposed to sunlight for a long time. However, a drop in temperature should be considered a warning. As illustrated in the Figure 6, the temperature suddenly drops at the end of the observation period, which corresponds to a

drop in the bird's body temperature.



Fig. 6. Temperature statistics of the device.

Based on the review of the current acceleration data statistics, shown in Figure 7, it can be seen that there are changes in the current acceleration of the device, followed by a sudden stop of movement, indicating that the device remained stationary for a long time at the end of the observation period, suggesting that the bird died.



Fig. 7. Current acceleration of the device during observation period.

During the field inspection, it was determined that the bird died from an electric shock. The bird was found on a power line pole, as shown in Figure 8. Interestingly, the device continued to collect and transmit data after the incident, and analysis of this data indicated that something was wrong.



Fig. 8. Bird found electrocuted on a power line pole.

Electric shocks on power lines are a significant cause of mortality for many bird species [7]. Birds may rest on power lines or fly between cables, resulting in fatal electric shocks. This often occurs in areas with dense transmission networks, where birds, particularly raptors, are at high risk. Raptors such as the griffon vulture and the white-tailed eagle (*Haliaeetus albicilla*) are among the most vulnerable. Frequent incidents of this kind can lead to population declines in species population. To reduce these risks, protective measures are employed, including insulation of conductors and metal parts, resting platforms, or specially designed “raptor-safe” poles, allowing birds to perch or fly safely without coming into contact with electrical current.

Figure 9 shows the battery percentage statistics. It can be seen that the battery level increased at certain points during the observation period, indicating that the solar panel effectively recharged the device.



Fig. 9. Battery percentage statistics.

Monitoring battery percentage is essential for evaluating the reliability and autonomy of the device, particularly when it is deployed in the field for extended periods, as is the case with these telemetry devices. The

graph also provides information on how effectively the panel recharged the battery.

V. CONCLUSION

In this paper, we presented the practical use of the Canandi GSM telemetry device for bird tracking and emphasized its importance in collecting key data on bird movement and behavior. These data are essential for monitoring bird populations and protecting species, especially endangered ones. The device provides accurate, real-time information, making it suitable for long-term ecological studies. As an example, telemetry data showed that a tracked bird died from an electric shock on a power line, highlighting the value of such devices in planning preventive measures and reducing bird mortality.

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