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Preliminary Application of a Low-cost Smart Collar Developed for Wild Animal Tracking

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Abstract

Global Positioning System (GPS) technology has been used in many different fields for many years. In recent years, GPS technologies have started to be preferred along with telemetry method in the monitoring and tracking of wild animal. This technology has been widely used especially in developing collars for wild animal tracking. However, due to the high cost of such devices and limited user intervention, they are not commonly used by practitioners or researchers with limited budget. Today, many hardware-based platforms have been developed with the developing technology. The Arduino platform, one of the prominent ones with its technical features, has great advantages of having different sensors and hardware work on single device. Besides, it is possible to produce cost-effective devices using this platform. Within the scope of this study, an Arduino-based wild animal tracking device (FiT-SMART Collar 2.0) with GPS support and remote data transfer via GSM was produced. The produced device was preliminary tested with a vehicle in the city traffic of Bursa, Türkiye. According to the results, the accuracy of the tracking data provided by smart collar was within the acceptable range of 2-3 m. Besides, instant tracking data has been successfully received in the system application using the GSM data transfer system attached on the platform.

Keywords: Smart Collar, Arduino, Wild animal tracking, GSM, GPS.

1. Introduction

The movements of wild animals are an important process in terms of their survival. Particularly, it is essential for animal behaviors such as feeding, sheltering, breeding, escaping from predators, and settling in new habitats (Fahrig, 2007). In addition, understanding the movement behaviors of wild animals in their habitat is very important in terms of wildlife management plans (Fischer et al., 2018). However, availability of spatial tracking data for many animal species are very limited and it is difficult and costly to collect these data (Nathan et al., 2008).

The tracking of wild animals is a work that requires a lot of effort, time and cost (Gompper et al., 2006). The most important reason for this can be explained as the fact that wild animals spread over large areas, they are timid, have the ability to hide well in the land, and some species are few in number. Wild animal tracking devices developed based on GPS technology have been effectively used in wildlife studies for the last 30 years (Moen et al., 1996; Rodgers et al., 1996). This technology has provided important information about the ecology and behavior of species, especially in terrestrial wildlife studies (Cagnacci et al., 2010; Hebblewhite and Haydon, 2010). Although GPS technology used for tracking devices such as GPS collars is commonly used in wildlife studies and there are important developments in GPS technology, positional error rates worry researchers due to the difficulties arising from the habitats of wild animals (Cagnacci et al., 2010; Frair et al., 2010; Montgomery et al., 2010). The performance of GPS collars can be affected by many reasons such as stand characteristics, terrain structure and weather conditions. Before using GPS collars on wild animals, a preliminary assessment is required to identify these potential errors (White and Garrott, 1990; Dussault et al., 1999; D'Eon and Delparte, 2005). In this study, a low-cost Arduino-based GPS collar was developed for wild animal tracking. A preliminary application of the device was implemented and the accuracy of the results from the experiment were compared to that of the industrial GPS device for validation purposes.

2. Materials and Methods

2.1. Development of Smart Collar

A collar with a GPS or UHF radio system is often used to locate or track wild animals. Recently, it is possible to use GPS on the Arduino platform that allows storing the location data received by GPS or transmitting them remotely to another device. In this study, an Arduino Mega 2560 model card was used along with the other necessary modules for developing a wild animal

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tracker called FiT-SMART Collar 2.0. In the first stage, the device was designed with the Fritzing 0.9.3 program (Figure 1). In the Arduino platform, a GPS module (GY-GPS6MV2) was used to for tracking wild animal, a MicroSD card module for storing GPS data, a clock module (RTC) for determining recording intervals, and a GSM module for instant data transfer. An LCD screen was added to monitor and control the data.

For protection and easy attachment to a leash, a special enclosure case was designed using the Catia V5 R20 program (Figure 2). The case conveniently contained all components including the battery. The plastic enclosure case, made of thermoplastic material, was produced using a Creality Ender-3 Pro model 3D printer.

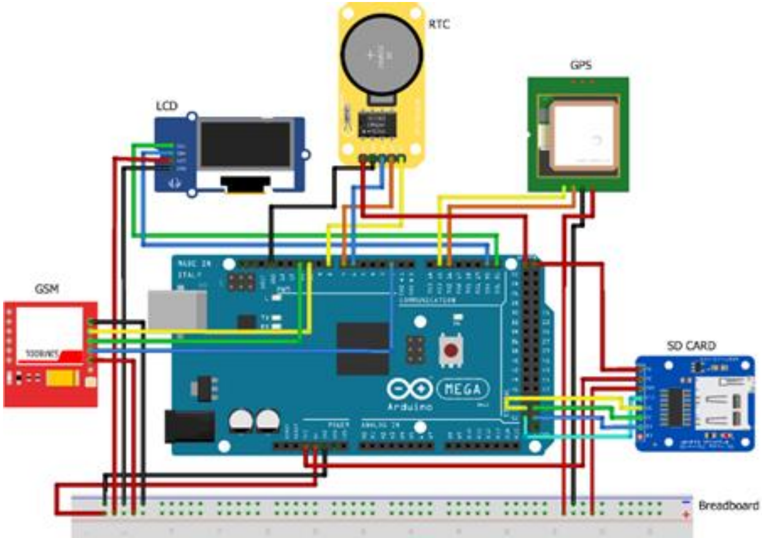

Figure 1. The circuit diagram of the system

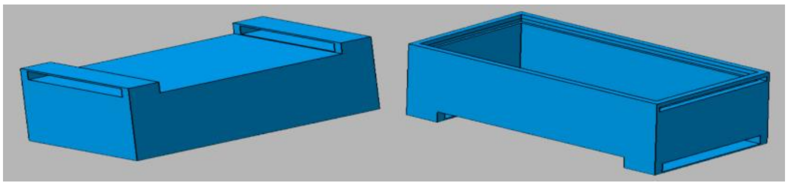
Figure 2. 3D solid model of the enclosure case

2.2. Device Experiment

Arduino-based smart collar (FiT-SMART Collar 2.0), produced for tracking wild animals, was first tested with a vehicle in the city traffic of Bursa and the results were compared to RTK-GPS findings (Figure 3). Data were collected every second during the measurement. The route data obtained using FiT-SMART Collar 2.0 was checked using the Google Earth interface.


Figure 3. Collection of experimental data with vehicle in the city of Bursa

3. Results and Discussion

3.1. FiT-SMART Collar 2.0

The components of the smart collar developed by Arduino platform are indicated in Figure 4. On the device, each module has been used for different functions. The location data obtained by GPS was successfully sent to the MicroSD card module and written into the memory card previously inserted. In this way, the data were stored on the MicroSD card, in the cases where there was no GSM network or when it was out of coverage during the application.

The location data were monitored live on the LCD screen of the device. The clock module (RTC) was functioned well for real-time tracking and instant recording of data. It was also used to operate the GSM module, which needs high energy, at certain time intervals or to make it work after a pre-planned date. A 5000 mAh battery was sufficient as a power source for the device. The plastic enclosure case was produced using thermoplastic filament (Figure 5). The overall weight of the device was approximately 550 grams, consists of Arduino-based components, battery, a case, and a leash.

In a similar study, Bhatt et al. (2019) developed an Arduino based animal tracking device and aimed to send location information to the predetermined phone number. The information about the animal can be obtained from the accelerometer and temperature meter attached to the device, and it can be sent to a phone together with the location information obtained from the GPS module. However, these processes are performed without any data recording on the device. On the other hand, a MicroSD card module is used in FiT SMART Collar 2.0 device to store the data required for animal tracking. However, accelerometer and temperature meter modules are not included in the device. Storing location information is very important for tracking animal movements. In addition, instant location data can be obtained from the device via SMS.

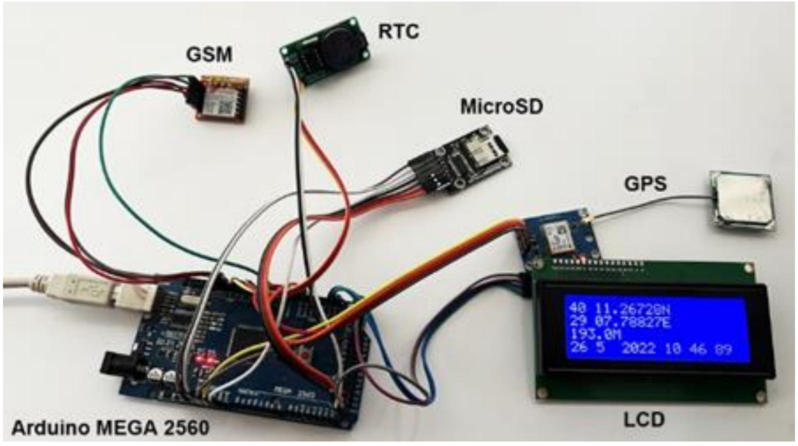

Figure 4. The components of the smart collar


Figure 5. The plastic enclosure case

3.2. Preliminary Application

As a result of the trials with FiT-SMART Collar 2.0, the points taken with RTK-GPS were compared and an error of about 2-3 m was found. This minor error is not a notable amount in tracking wild animals; therefore, using the device does not pose any major problem in terms of positional accuracy (Jung et al., 2018). Considering the battery life of the device, some disadvantages arise during the experiment. Especially in cases where the GSM module was operated continuously or for a long time, and the signal strength weakened, the battery life was considerably shortened (about 48 hours) due to excessive energy consumption. The enclosure case produced with a 3D printer for the device was suitable for storing all the components. However, it was noticed that the weak parts of the enclosure case may not fully prevent the potential impacts on the device. Additionally, its angular structure is seen as an element that can cause discomfort for the future studies to be implemented with real wild animals. In this study, the overall cost of the device was also estimated. The total cost of the device was only 92 euro which is much lower than the price of industrial type animal tracking devices (such as Garmin T5 with the cost of 400 euro) (Table 1). The most cost intensive part of FiT-SMART Collar 2.0 was Arduino Mega 2560, followed by GPS Module, GSM Module and battery.

Table 1. The costs of device components and attachments

Components and attachments	Costs (Euro)
Arduino Mega 2560	35
GSM Module	11
GPS Module	14
MicroSD Cart Module	1
RTC Module	1
LCD	8
Cables	2
Battery	11
Enclosure case (Filament)	4
Leash	5
Total	92

Gor et al. (2017) developed an Arduino-based animal tracking system using an accelerometer, Wifi module and GPS module. When the animal moves with the accelerometer, location information is obtained with GPS. The location information is shared via Wifi module which must be connected to a Wifi network provider. Since the data transfer is provided with the GSM module in the FiT SMART Collar 2.0 tracking device, it is possible to receive data from anywhere with access to the GMS network, regardless of distance.

4. Conclusions

Professionally produced animal tracking systems have some disadvantages as they are quite expensive and not open to development. One of the most important advantages of the Arduino-based wild animal tracking device is that it is produced with very low costs. In addition, the device can be developed in short amount of time using specified software and certain hardware. Other advantages of this Arduino-based devices are that different equipment and sensors can be attached into the device to collect various data from wild animals.

The instant location data can be easily accessed using GSM module. It is a great advantage that the current location can be received as a Google Maps link in response to GSM commands from the device. In this way, the instant location of the wild animal, which is tracked on Google Maps, can be seen by clicking the SMS link from the device. Data recording intervals can be determined by the RTC module which allow users to operate the device in a timely manner. Therefore, it is possible to increase the operation time and battery life.

The results from the preliminary application suggested that improvements should be made in the enclosure case produced for the device. The case should be produced in more rounded lines rather than angular structure, and the potential disturbing features should be eliminated for future experiments on wild animals. In addition, it is considered that if the case is made of a little more flexible material, its resistance to potential impacts will increase. As a result, it would be appropriate to produce a more robust and not angular enclosure case in the future projects.

Since the location information of the device can be obtained via GSM, it is possible to receive it over the wild animal. With a simple servo motor to be added to the device, the collar can be converted to a releasable structure. Thus, the device, which can be dropped with the GSM command and located in the field based on the last location information received, will be used again for many applications.

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