Design and Fabrication of a Sheep Activity Monitor Platform

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***Abstract*— We present the design and fabrication of a platform for on-line sheep activity monitoring in extensive livestock conditions. The system consists in a wearable collar device that collects movement and location data, and a cloud server that stores data and provides the user interface. Thirty collars were manufactured and are being preliminary tested.**

I. Introduction

Animal activities monitoring systems with accelerometers can play a crucial role in the agricultural development [1]. Having on-line relevant information remotely is key to make on-time decisions, for example information on reproductive status or predator presence. The system should be low cost, comfortable for the animal, and require low maintenance. The recognition of animal behavior patterns is still an open research problem. The proposed platform is our next generation [2], [3], and is capable of monitoring the sheep main activities and its location.

II. Proposed Solution

The proposed system includes a wearable collar device that collects movement and location data (Global Navigation Satellite System, GNSS), a cloud server for storing the data and a user interface to display the information in a computer or cellphone (see Fig. 1 left).

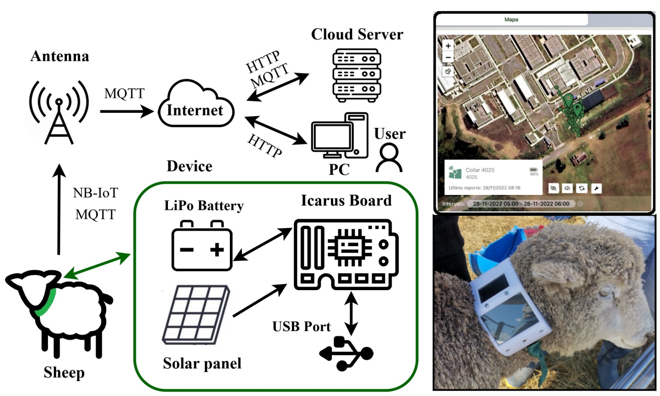

Fig. 1. System diagram (left), user interface showing sheep data (up, right) and designed collar in a sheep (down, right).

The hardware device integrates an Icarus IoT Board from Actinius, with a Nordic Semiconductor's nRF9160. The nRF9160 is a low-power chip with a Narrowband IoT (NB-IoT) modem and GNSS. Also, it works with an ARM Cortex-M33 processor including 1 MB of flash and 256 kB of RAM. The board has a 3-axis accelerometer LIS2DH from STMicroelectronics. Moreover, the board has a power management circuit allowing the device to be powered from 3 solar panels (2.8 W in total), and/or a 2500 mAh Lithium Polymer battery.

The embedded software was developed in *Visual Studio Code* using *nRF Connect* from Nordic Semiconductor. *Zephyr RTOS* was used and the programming language was C. The accelerometer is configured to collect accelerometer data (3 axis) at 100 Hz, while the location data is obtained every 10-30 seconds. Every 50 seconds this information and other parameters (LTE signal level, battery voltage, etc.) are sent to the cloud server through MQTT (Message Queuing Telemetry Transport) protocol and NB-IoT communication.

The cloud server communicates with the collar using *Amazon IoT* and stores data in *DynamoDB*. The user interface is develop in *NextJS* and hosted in *Amazon Amplify*.

III. Experimental results

We manufactured thirty collars in two different sizes to fit different individuals. These collars were tested in our research facilities in Facultad de Veterinaria, Universidad de la República (see right-side of Fig. 1). We ensured our device did not cause any harm to the sheep and the mechanical design was robust enough to be worn by an animal living outside. Additionally, we verified the system's functionality in its entirety, including data collection, real-time data transmission to the cloud server, and data display in the user interface.

IV. Current work

Current work includes testing and hardware validation, as well as training animal activity classifiers (grazing, walking, running, and standing) to be used on the collar itself applying low-power techniques in order to have devices with high autonomy.

References

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