



DEVELOPMENT OF LONG RANGE ANIMAL TRACKING SYSTEM USING IOT TECHNOLOGIES

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Abstract

The population of our planet is growing at a rapid pace, with an annual growth of 1.1 percent. The population is expected to continue to grow and reach 8.4 billion by 2030. Although this is a fairly positive fact, this phenomenon carries with it enough negative aspects. And one of which is the lack of food, which requires the rapid development of agriculture. Agriculture will have to increase its production massively by 70 percent. The solution to this problem is the technology of the Internet of things. With the help of technology we can avoid morbidity in livestock, excess in power consumption and generally make life easier for the farmers. In this work, a strong focus will be placed on tracking the location of animals, which will be quite cheap and of high quality. This research aims to find the most optimal technologies to track animals on long ranges, while being low-priced and effective enough.

Keywords: agriculture, technology of internet of things, livestock, farmers

Introduction

The cow runs away from the pasture for various reasons: frightened by a stranger, other animals or annoying insects, in search of tastier grass or better weather. And even if there is a shepherd nearby, it is not always possible to quickly find an animal lost in the forest or fields. And when grazing, animals can often leave the pasture, get lost, or even worse, they can simply be stolen. To find the lost cattle, one has to travel tens and even hundreds of kilometers. It can take days, and sometimes weeks, and the animals can still be found. So in order to solve this issue, the farms should become 'smart'. But in order to equip an agricultural enterprise, it will be necessary not only to buy specialized equipment, build a complex of buildings, hangars, but also properly organize the care of cattle. Depending on the type of animal, the rules of care also vary.

In order to ensure the rapid growth of cattle, it is necessary to provide comfortable conditions indoors - the optimal level of humidity, temperature and constant air flow. It will be required from the owner not only to install a ventilation system that will provide an influx of fresh air mass, but also to monitor cattle. This is a professional set of activities that is aimed at facilitating the procedure for breeding livestock by obtaining information about health, current indicators indoors. Such a system must be carefully calibrated and designed in a robust manner to ensure accurate measurements.



Modern technologies are being actively introduced in agriculture, helping farmers to automate routine processes with maximum convenience. One such solution is livestock tracking. Livestock tracking allows you to protect your animals from theft, injury, and natural disasters. In addition to tracking movements and recording livestock, the system allows you to track the most frequent areas of his stay for further walking planning and searching for the best pastures and territories. The used equipment based on LoRaWAN technology effectively monitors and transmits data to the cloud over very long distances. In addition, due to low power consumption, trackers work much longer and do not require cellular communication.

Technology used

A. Internet of Things

The Internet of Things (IoT) is about the vast array of "things" that are connected to the Internet to communicate with other things - IoT applications, connected devices, industrial machines, and more. Internet-connected devices use builtin sensors to collect data and, in some cases, act on it. IoTconnected devices and machines can improve the way we work and live. IoT application examples range from a smart home that automatically regulates heating and lighting to a smart factory that monitors industrial machines to find problems and then automatically adjusts to avoid failures.

Today we live in a world where there are more devices connected to the IoT than people. These devices can be either smartwatches or RFID inventory tracking chips. IoT connected devices communicate through networks or cloud platforms connected to the Internet of Things. Real-time information from the IoT is driving digital transformation closer. The Internet of Things promises many positive changes in health and safety, business operations, performance and global environmental and humanitarian issues.

Many industries are using IoT to understand consumer needs in real time, increase agility, instantly improve the quality of machines and systems, streamline operations, and find innovative ways to work as part of their digital transformation efforts. And the agriculture is not an exception. In agriculture, "smart" farms and greenhouses dispense fertilizers and water themselves, and "smart" animal trackers notify farmers in time not only about the location of animals, but also about their health status, analyzing heartbeat, body temperature and general activity.

B. Arduino Nano 33 IoT

The Nano 33 IoT is based on a 32-bit Microchip ATSAMD21G18 microcontroller with a



48 MHz ARM Cortex- M0 + computing core, 256 KB of flash memory and 32 KB of RAM. The U-blox NINA-W102 module based on the ESP32 chip is responsible for wireless communication. It supports Wi-Fi 802.11 b / g / n networks in the 2.4 GHz band and data exchange via Bluetooth v4.2. The platform was supplemented with the STMicroelectronics LSM6DS3 inertial module, which includes a three-axis accelerometer and a three-axis gyroscope for precise orientation in space.

Along the edges of the board are two pin plugs of 15 pins with a pitch of 2.54 mm, which allows you to install it on a breadboard for prototyping a device with various electronic components. The Nano 33 IoT has a total of 22 general purpose I/O ports. Some of them have additional features:

- 8 pins with ADC can represent analog voltage in digital form with sampling up to 12 bits.
- 5 pins are capable of outputting an analog signal in the form of PWM with a resolution of up to 12 bits.

Hardware interfaces SPI, I²C and UART are also available on the board.

C. LoRaWAN

With the development of IoT technologies, networks of the LPWAN (Low Power Wide Area Networks) family, energyefficient long-range networks, have emerged as a separate segment. However, for several years, the main problem was the lack of a unified protocol with the support of the main market players. In other words, dozens of communication protocols similar in characteristics, but not compatible with each other, have appeared. Another important problem is the proprietary nature of each protocol, i.e. closed technology (belonging to only one company). In March 2015, IBM Research and Semtech presented a new technology for energyefficient long-range networks - LoRaWAN (Long Range Wide Area Network), which has a number of advantages over conventional technologies for providing M2M (Machine-toMachine) communications.

For many years, the enormous potential of the IoT has been held back by technical challenges such as short battery life, short range, high cost, and lack of uniform standards. LoRaWAN technology has overcome all these obstacles. Based on a new specification and protocol for LPWAN using an unlicensed frequency band, LoRaWAN technology has allowed sensors to be connected over long distances while offering optimal sensor battery life and minimal infrastructure requirements. The advantages of LoRaWAN include [4]:



- use of the non-licensed frequency range of 868 MHz, which does not require permission and payment for use;
- data transmission range up to 10 km;
- high energy efficiency of end devices, providing a service life of up to 10 years from one battery;
- network architecture that allows easy scaling to different territories;
- the ability to remotely control and set up a schedule for transferring data from devices.

The main disadvantage of all LPWAN wireless technologies is associated with the limited size of the transmitted data packet and the periodic nature of their sending. As a result, technologies cannot be used to monitor parameters in real time.

D. ThingSpeak Cloud

As a cloud server used by the system, the ThingSpeak server [11] is proposed, which is a platform that provides various services designed exclusively for creating IoT applications. It provides the ability to collect data in real time, visualize the collected data in the form of charts, the ability to create plugins and applications for collaboration with web services, social networks and other APIs. The core element of ThingSpeak is the "ThingSpeak channel". A channel stores data sent to ThingSpeak and consists of the following elements:

- 8 fields for storing data of any type - they can be used to store data from a sensor or from an embedded device;
- 3 location fields - these can be used to store latitude, longitude and altitude. They are also very useful for tracking a moving device;
- 1 status field - a short message describing the data stored in the channel.

To use ThingSpeak, you must register and create a channel. You can then send data that allows ThingSpeak to process it, as well as receive it back.

Implementation

The main idea of this paper is that the trackers are attached to the animal in the most convenient way, most often it is a collar. Data from the tracker is received by LoRaWAN gateways, which, depending on the terrain, are installed at a distance of 8 to 30 km. Gateways can be connected to the Internet via satellite. The cloud software (in our case ThingSpeak) displays the data collected by the gateways, providing tools to analyze the movement of animals over long distances. The tracker uses the GPS positioning system and sends the location coordinates to the



ThingSpeak server via the LoRaWAN wireless network by default.

Special devices will be connected to cattle, which will include the technologies already listed - LoRaWAN, Arduino Nano 33 IoT and GPS tracker. The GPS tracker will read the current location of the livestock on the map via satellite. Further, the LoRaWAN device will send coordinates (longitude and latitude) to a common gateway up to 10 kilometers. The gateway, also equipped with a LoRaWAN device, will receive data from all sensors connected to the cows. Being the only device connected to the Internet, the gateway will send the received data to a special channel created in the ThingSpeak cloud. The received data can be read thanks to the API of ThingSpeak itself and read through the application on iOS or Android, or read this data directly through the web application.

The data on the API is displayed as a json request, which has a special syntax. With the help of programming, this query can be parsed and formatted into a human-readable form. This application can be used by both shepherds and special responsible people in the farm.

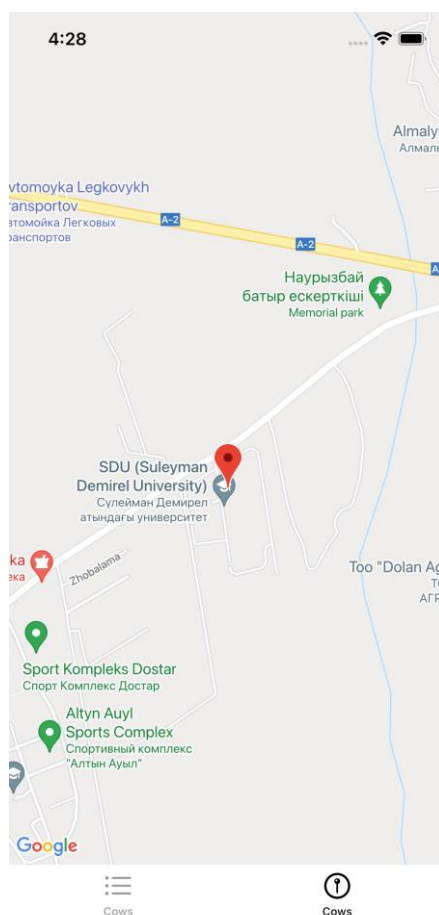


Fig. 1. Screenshot example of an application on iOS.



Future work

This project focuses on livestock tracking and data acquisition and display. But this project has a bunch of different possible additions that will make this project even more useful and exciting. One of the primary tasks after the completion of all work is the implementation of machine learning through the ThingSpeak cloud, which provides these functions for the data stored on their servers. Thanks to this innovation, it will be possible not only to read the location of cattle, but also using the obtained data to prevent illness and death of animals and collect data on the most prolific territories. Already having these data, you can greatly simplify the life of farmers, while reducing livestock mortality and accidental losses.

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