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Camera system in the hunting grounds

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Contents

Abstract

The security of nature and our forests is increasingly desperate today in terms of pollution and the protection of wildlife. In my work, I would like to outline a specific effective alternative that could help us protect against poaching, litter, and possibly forest fires in our woods. To this end, I believe the most suitable solution would be to establish a camera system capable of monitoring human activity in the area. As a hunter, I know that cameras are still used in state hunting grounds, but in many cases, they are not used properly and not on a systematic level.

In this work, I would like to analyze the structure of the network and the operation of the camera system, the storage of recorded information, the power supply of the system, and the selection and placement of the system's hardware components. I believe this area has significant potential for development and expansion of use, so I would like to explore this as well.

Introduction

Forests play a crucial role in the health of our planet, providing oxygen, clean air, and serving as habitats for countless species of plants and animals. However, forests are also threatened by various human activities, including illegal logging, poaching, waste dumping, and land clearing. Addressing these threats requires innovative technologies and strategies that can help protect forests and prevent further damage.

One such technology is a forest security camera system, capable of monitoring forests in real time for signs of illegal activity and alerting authorities to potential dangers. In recent years, advances in machine learning and image recognition technology have enabled the analysis of vast amounts of data from security cameras, allowing for the automatic identification of potential threats. This technology could revolutionize efforts to protect forests, enabling faster responses and more effective strategies for safeguarding these vital ecosystems.

However, implementing a forest security camera system also poses challenges, including high equipment costs and the need for continuous maintenance and data analysis. In this project, we explore the use of a forest security camera system to monitor and protect forests from deforestation and other threats. We will install cameras in strategic locations, describe the machine learning system for analyzing footage captured by the cameras, and develop a response plan for potential threats. We will also detail the specifications of the system's hardware components and prepare a budget. Our goal is to demonstrate the effectiveness of this technology and provide a model for future forest protection efforts.

Analysis

When discussing camera systems, it is necessary to establish several fundamental questions that are important to analyze for their operation. These include the operation of the camera system, network structure, power supply, storage of recorded information, selection of hardware components, hardware specifications, and technical equipment.

Operation of the camera system

One way to use camera systems to save forests is by implementing a forest monitoring program.

Here are a few steps that can be taken:

Install cameras in strategic locations

First, cameras need to be installed in areas that are at high risk of deforestation, such as near roads or in regions frequently targeted for logging or other illegal activities.

Utilize machine learning to identify threats

Machine learning algorithms can be used to analyze images captured by the cameras and detect any signs of deforestation, such as tree cutting, illegal logging, or land clearing.

Alert the authorities

When the machine learning algorithms identify a threat, authorities can be immediately alerted, allowing them to respond quickly and prevent further damage.

Data collection for analysis

Data collected by the cameras can be analyzed over time to identify patterns and trends in deforestation, which can be used to develop more effective strategies for forest conservation.

Network structure

In this work, I specify plans for hunting areas in Slovakia. This is due to the fact that hunting areas in Slovakia are more rugged, so most of the territory consists of areas with less oversight, and the forested areas are also relatively rugged. Therefore, this factor is an important consideration when selecting the type of network. I am examining two methods:

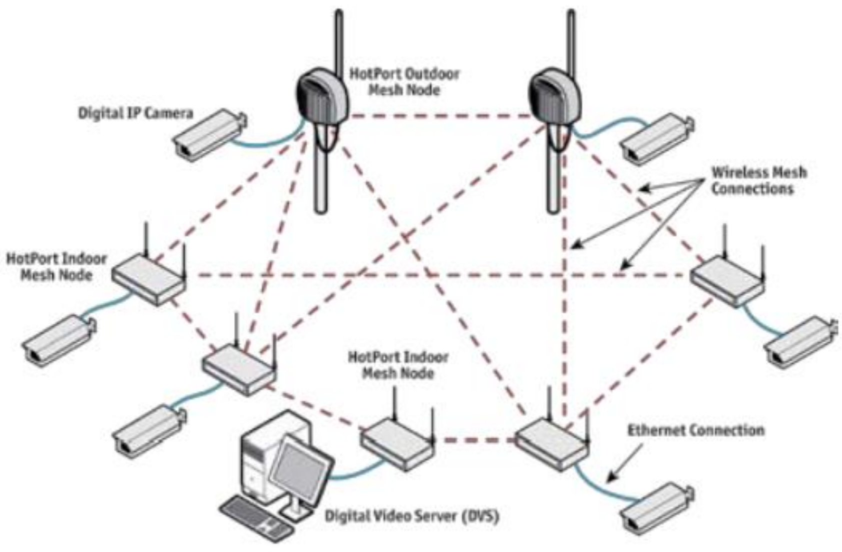
Wireless mesh network

A wireless mesh network is a decentralized network that uses multiple access points to cover a large area. This type of network is suitable for a forest security camera system because it can provide reliable coverage even in remote areas with limited infrastructure.

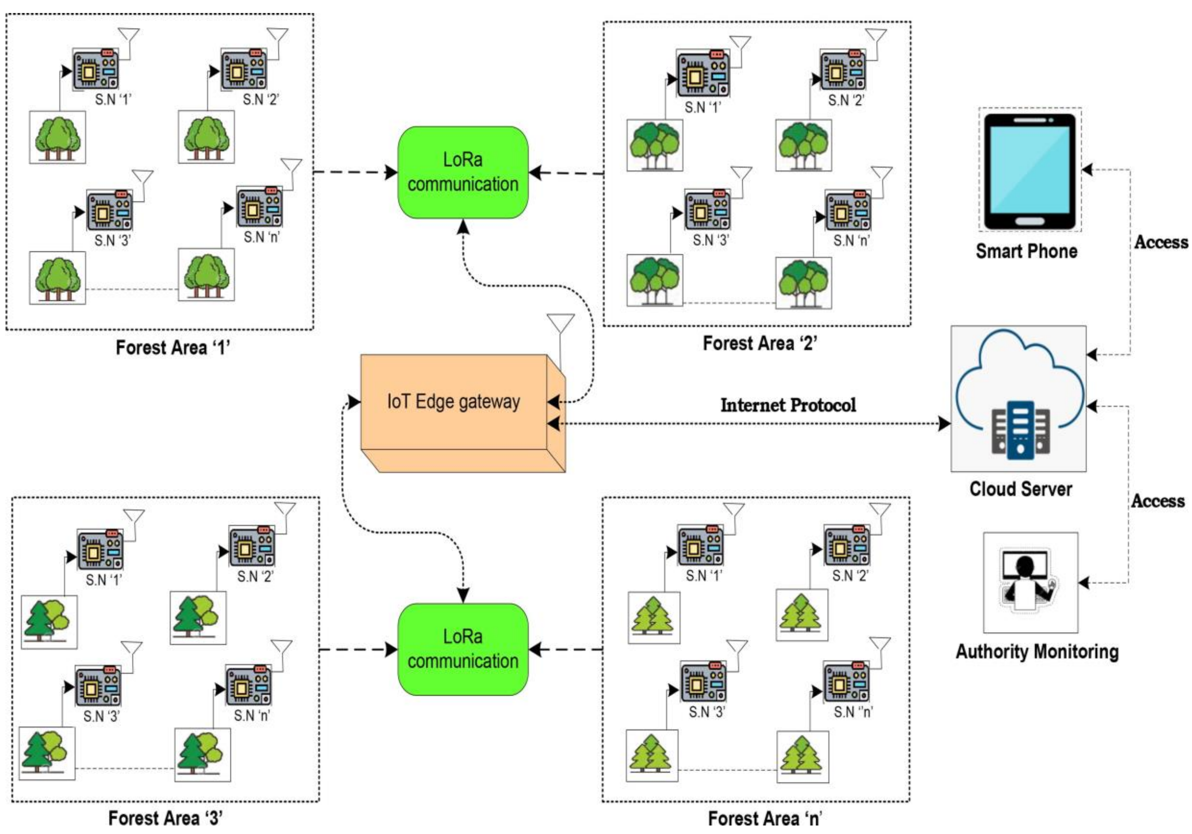
Satellite network

Another option is to use a satellite network to transmit data from the cameras to a central location. This would require a specialized satellite modem and antenna to communicate with the satellite, but it could provide coverage over a much larger area than a wireless network.

Of the two methods, we are choosing the wireless mesh network because, as I mentioned, I am currently dealing with the situation where a smaller oversight body (hunting society) wants to establish a camera system. A satellite network would be a suitable form of the system's network if we were discussing a nationwide solution.



Wireless mesh network



Network expectation

Powering the system

When discussing powering the system, we must consider efficiency, simplicity, and cost. A power source must be secured for each individual camera and router.

Implementation of central power

This method could be quite challenging and costly to implement, as installing the system in a forested area far from the central electrical grid would require a lot of cabling and labor. Even if the distance to be bridged by wires is relatively small, these costs cannot be overlooked, and supplying power to individual cameras remains problematic.

However, a system implemented in this way would have the advantage of always providing a stable power supply.

Solution of rechargeable batteries

I don't even mention the solution of non-rechargeable batteries because such a solution would be extremely expensive if we always had to buy new batteries whenever the camera runs out.

The solution with rechargeable batteries also has its drawbacks. Such a system would need to be maintained regularly and at a relatively frequent interval, as most cameras suitable for forest monitoring last about 2-3 months in a moderately frequented area during the summer, and much less in winter (at most 1 month). These figures are based on my practical experience, as my fellow hunters and I have been using battery-operated cameras for a long time.

This solution also has its advantages. For example, in cases where we want to establish a system for a shorter duration (for a few months or 1-2 years) or if our system contains only 2-3 cameras. In such cases, we would still need to change the batteries frequently, but it wouldn't take as long.

Solar solution

I believe that a solar solution would be suitable for powering the system. It's true that a solar system would require a larger initial investment, but among the other alternatives, it is clearly the most efficient, low-maintenance, durable, and environmentally friendly solution. Consider this: a solar panel, once installed next to the camera, continuously supplies power to the camera, eliminating the need to pay for electricity or perform maintenance since, as long as the sun is shining, the camera will operate using the energy generated during the day.

There are cameras that come equipped with a solar panel from the factory. However, I would recommend keeping the camera and the solar panel as two separate units, as this would allow us to upgrade our system more cheaply if desired.

One potential issue is that after a certain period, the battery of the solar panel may degrade. However, the time it takes to reach significant degradation is quite long, as the camera's consumption is low. It may take decades to reach a level of critical degradation.

The real problem is that in winter, snow may cover part of the solar collector. Solar panels are usually installed at a certain angle, and the surfaces are glass or glass-like. While in operation, the solar panel generates a little heat, causing any snow that falls on it to slide off very quickly. However, in very cold weather, there may be cases where you need to go outside and sweep the surface of the solar collector, as in this case, the solar panel may become ineffective for 2-5 days. Alternatively, if we install the system in an area where such situations are common, we could install some form of snow protection on the solar panel.

Storing recorded information

The most suitable way to store recorded data is in the cloud. Various applications for camera systems exist that also include cloud storage.

Cloud storage

The camera system can have the option to upload recorded footage to the cloud for storage. This method allows remote access to the data, and the storage capacity is not limited. However, it may require a subscription or additional fees for the cloud storage service.

Selection of hardware components and specifications.

Cat6 outdoor 4G LTE router

An integrated 27dBm Wi-Fi booster and 4G router creates a powerful wireless hotspot, covering a radius of up to 130-270 meters in open space. It can support up to 57 simultaneous Wi-Fi users. You can adjust the Wi-Fi power or turn it off.

Y6U Y6E & Y6O – Cat.6 LTE-A Mobile Modem	
LTE Category:	CAT.6 (3GPP E-UTRA Release 11)
4G FDD Bands:	B1/B3/B5/B7/B8/B20/B28/B32Rx
	Download max 300Mbps / Upload max 50Mbps
4G TDD Bands:	B38/B40/B41
	Download max 260Mbps / Upload max 28Mbps
2xCA	B1+B1/B5/B8/B20/B28
Carrier Aggregation:	B3+B3/B5/B7/B8/B20/B28
	B7+B5/B7/B8/B20/B28
	B20+B32Rx | B38+B38
	B40+B40 | B41+B41
3G Bands:	B1/B/3B5/B8
	DC-HSDPA: DL Max 42Mbps
	HSUPA: UL Max 5.76Mbps
	WCDMA: DL 384Kbps / UL 384Kbps
Bandwidth:	1.4/3/5/10/15/20/40(2xCA)MHz
Support Antenna:	DL MIMO, supports Rx-diversity
Temperature:	Working: -40°C ~ +80°C
Working Area:	EMEA: Europe, the Middle East and Africa
	APAC: Asia-Pacific (Excluding Japan and CMCC)

	and Brazil
Certification:	CE / RCM / GCF / Deutsche
EZEN3X – Motherboard	
CPU:	Qualcomm Atheros QCA9531
Frequency:	650MHz
Memory:	DDR2 RAM 128MB
Flash:	SPI FLASH 16MB
SIM card slot:	Double Nano-SIM Cards (12.3×8.8mm)
WAN/LAN port:	10/100Mbps on PoE adapter
Indicator:	System / Wi-Fi / SIM1 / SIM2
Temperature:	Working: -40 to +80°C
	Storage: -50 to +90°C
Humidity:	10%~90% RH
Measurement:	Router 230x175x70mm / 980g
<h3”>**Wi-Fi Network**	
Wi-Fi standards:	IEEE 802.11 a/b/g/n
	IEEE 802.3 and IEEE 802.3u
MIMO Wi-Fi:	2T2R MIMO (multiple-input multiple-output)
Transmission rate:	300Mbps
Frequency:	2.4GHz – 2412~2484 MHz
Channel:	1~13
Bandwidth:	20/40 MHz or Auto
Output power:	802.11b: 27±2dBm

	802.11g: 25±2dBm
	802.11n: 23±2dBm
Wi-Fi mode:	11b / 11g / 11n only
	11b/g mixed or 11b/g/n mixed
Concurrent user:	57 users
4G WiFi Antenna	
2 x 4G LTE antenna:	Frequency: 698~960 / 1710~2700MHz
	Gain: 3~4dBi / V.S.W.R.: ≤ 2.0
2 x Wi-Fi antenna:	Frequency: 2400~2500MHz
	Gain: 5dBi / V.S.W.R.: ≤ 2.0
Measurement:	Φ22×180mm
Connector:	N Male
Polarization:	Vertical
Impedance:	50 Ω
Max Input power:	10 Watt
Power Sources	
PoE Adapter:	Input: 110~24oVAC 50/60Hz
	Output: 48Volt 0.5Amps
LAN Cable:	30-feet LAN cable included. Max 320-feet.
PoE Wiring:	Ethernet 1, 2, 3, 6
	DC+ 4, 5 | DC- 7, 8
DC Socket:	9~48Volt 1.5Amps
Software Systems	

Router Firmware:	OpenEzen System
Log in:	IP address: 192.168.30.1
	Password: root
Computer:	Windows / Mac / Linux / etc
Bootloader:	EzBoot (192.168.1.1)

Price: 359 Eur

WAVLINK AC1200 High Power Outdoor WiFi Range Extender

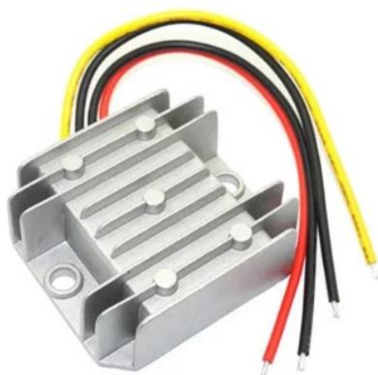
With the setup of four antennas providing omnidirectional transmission, one of these devices can ensure a reliable Wi-Fi signal up to a distance of 270 meters. This WAP could provide coverage for a small forest.

Model	WN572HG3
Ports	1 x 10/100/1000Mbps WAN 1 x 10/100Mbps LAN
Buttons	1 x Reset button
LED	1 x Power 1 x WAN 1 x LAN 1 x WiFI 3 x Signal
Power Supply	DC24V / 0.5A Power over Ethernet (Passive PoE)
Rated Voltage / Frequency	input:100-240 Va.c. 50/60Hz
DIMENSIONS	
Unit Dimensions	180mm x 50mm x 50mm (L x W x H)
WIRELESS	
Standard	IEEE 802.11a/b/g/n/ac
Speed	IEEE 802.11ac: up to 867Mbps IEEE 802.11n: up to 300Mbps IEEE 802.11g: 54Mbps IEEE 802.11b: 11Mbps IEEE 802.11a: up to 54Mbps
Frequency band	2.4GHz, 5GHz
Wireless Security	WPA-PSK/ WPA2-PSK encryption
Antennas	4 x 7dBi Detachable Omni Directional Antennas

Price:280 Eur

Voltage Inverter from 12V to 24V, 3A, 72W, IP68

Vstupné napätie	12V DC
Výstupné napätie	24V DC
Výstupný prúd	3A
Výstupný výkon	72W
Krytie	IP68
Životnosť	100 000 hodín



Price: 23.73 Eur

WG8000 solar panel

Max. power	3W
Li battery Capacity	8000mAh
External Input	5V/2A
Maximum Output	DC 12V/1.2A; 9V/1.6A; 6V/2.4A
Solar Panel Size	188(L)*157(W)*36mm(H)
Working Temperature	-20°C to 60°C/-4°F to 140°F
Waterproof	IP66
Certificate	CE FCC ROHS

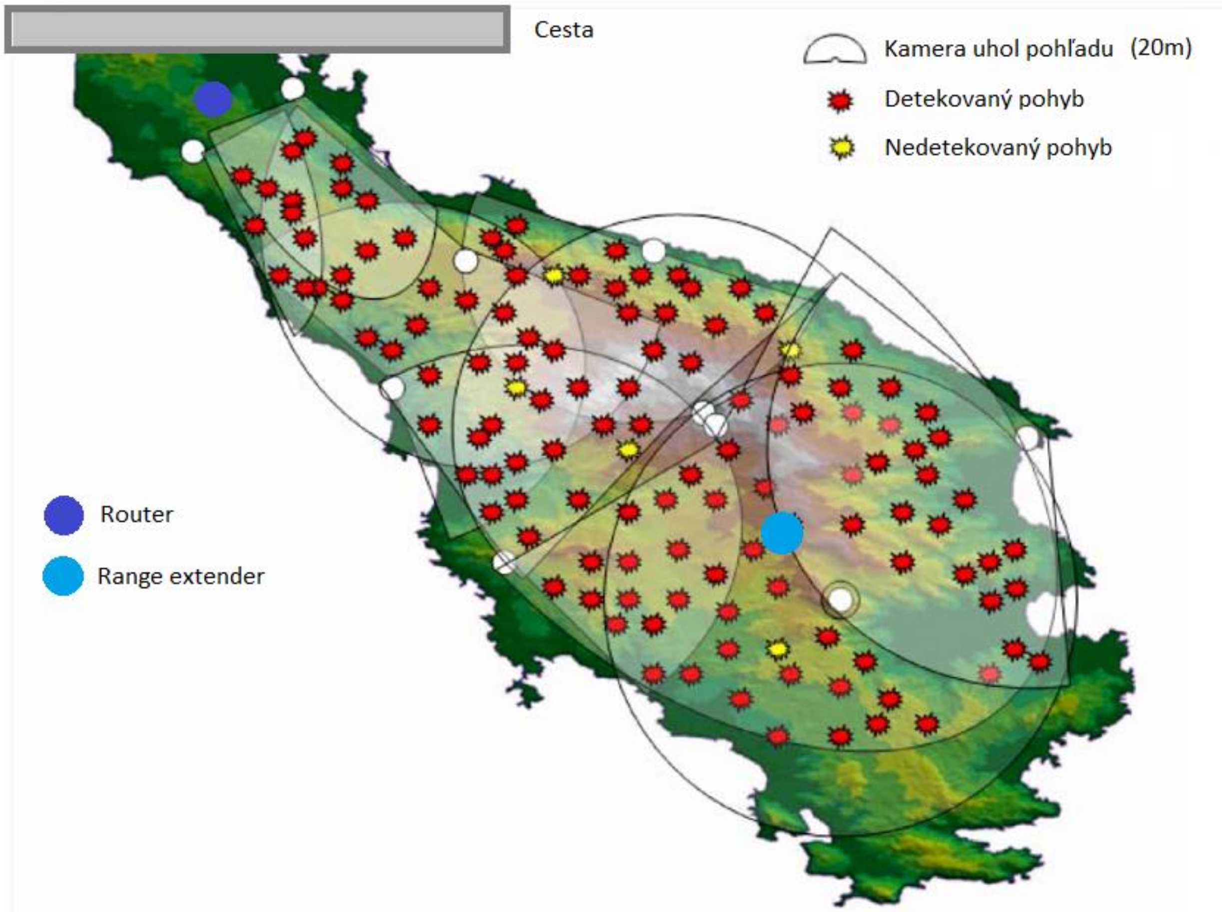
Price: 69.99 Eur

Argus PT Smart 2K 4MP Pan & Tilt Wire-Free Camera

Image Sensor	1/3" CMOS Sensor
Video Resolution	2560 x 1440 (4.0 megapixels) at 15 frames/sec
Video Format	H.265
Field of View	Fixed lens, 122° diagonal
Infrared Night Vision	Up to 10 meters (33ft) (LED: 6pcs/14mil/850nm)
Digital Zoom	16X digital zoom
Audio	Two-way audio
Smart Alarm	PIR detection/human detection/vehicle detection
PIR Detecting Distance	Adjustable up to 10m (33ft)
PIR Detecting Angle	100° horizontal
Audio Alert	Siren (Customizable)
Recording	Motion triggered recording
Operating Frequency	2.4GHz/5GHz
Wireless Standard	IEEE 802.11a/b/g/n
Wireless Security	WPA-PSK/WPA2-PSK

Price: 179.99 Eur

Orientačný cenový výpočet



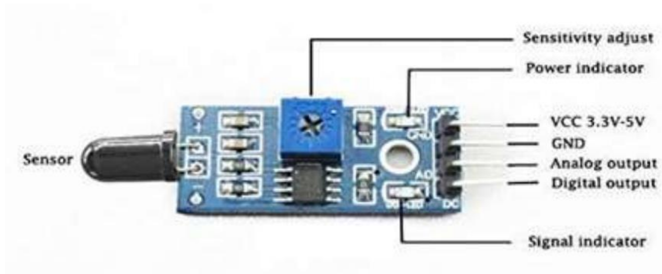
1 x **Cat6 outdoor 4G LTE router**	359.00
1 x **WAVLINK AC1200 High Power Outdoor WiFi Range Extender**	280.00
11 x **Argus PT Smart 2K 4MP Pan & Tilt Wire-Free Camera**	1979.89
1 x **Menič napätia z 12V na 24V, 3A, 72W, IP68**	23.73
13 x **WG8000 solar panel**	909.87
Suma (Eur)	**3552.49**

The budget does not include costs for installation, installation materials, or the 4G SIM card.

Options for further development

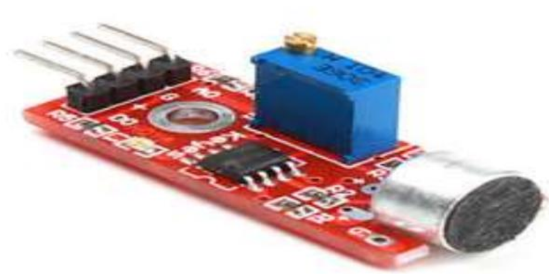
The system implemented in this way has many options for further development. While exploring the topic, I came across several such possibilities. In this section, I will present a few of them.

Fire sensor



A fire sensor is a device designed to detect and respond to the presence of flames or fires. It is more precise and reacts faster than a heat or smoke sensor. The fire sensor module consists of a photodiode that detects light and an operational amplifier that controls sensitivity. When the sensor detects a fire, it sends a HIGH signal to the Arduino, which processes the signal and activates the alarm by turning on a buzzer or LED. The flame or fire needs to be placed in front of the photodiode to activate the sensor, and the output varies based on the intensity of the flame, which is read from the ADC of the microcontroller. The code is written with conditions that determine the output or warning message to be sent.

Sound sensor



Zvukový senzor je zariadenie, ktoré detekuje zvukové vlny a premieňa ich na elektrické signály na základe ich intenzity. Jeho funkcia je podobná našim ušiam, ktoré pomocou membrány premieňajú zvukové vibrácie na signály. Rozdiel je v tom, že zvukový senzor má vstavaný kapacitný mikrofón, špičkový detektor a vysoko citlivý zosilňovač (LM386), ktorý zosilňuje zvukový signál. V našom projekte používame tento princíp na detekciu ohybu a hodnoty snímača sú snímané pomocou ADC mikrokontroléra.

Senzor vibrácií

A vibration sensor is a device that measures the frequency of vibrations in a system. It contains a transducer that converts the force caused by vibrations into an electric current. The sensor provides constant values when stationary, but when shaken, it generates varying values depending on the intensity of the vibrations. These values are used to set a threshold for detecting tree cutting.

Artificial Intelligence

Artificial intelligence can improve the functioning of the system in several ways. Depending on the application we choose or create for our system, there are currently applications that utilize a so-called human tracking feature. This means that the intelligent system can recognize a human figure and track it by moving the camera, thus enhancing the monitoring of human activity in a given area.

Similarly, it would be beneficial to develop an intelligent algorithm that detects fires. There are advanced projects utilizing this method, and implementing it for this type of use would be advantageous.

Naturally, as a hunter, I also have a vision of what opportunities such a system could offer for monitoring wildlife in the future. Nowadays, various intelligent programs for animal recognition exist. This means that in the future, it would be possible to create an algorithm capable of recognizing even the wild game living in our forests. These recorded videos could be tagged and possibly stored in separate sections of storage. This innovation would significantly ease the documentation of both protected and game species in the area, making it easier to create and refine the annual hunting management plan. It would be possible to more accurately determine the likelihood of various wildlife species occurring in different areas, allowing us to optimize the locations where we place feeders, salt licks, and watering spots for animals.

Resources

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