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REAL-TIME FOREST FIRE DETECTION USING YOLO

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Abstract—

Forest fires, wildfires, and bushfires are a worldwide environmental issue that do significant damage each year. The most important components in fighting forest fires are early discovery of the fire, flame or smoke occurrence, appropriate categorization of the fire, and quick reaction from fire agencies. In this paper, we developed an automatic early warning system that incorporates multiple sensors and a cutting-edge deep learning algorithm that has a low number of false positives and provides good accuracy in real-time data at the lowest possible cost to our drone in order to monitor forest fires as early as possible and report them to the appropriate authorities.

Forest fires are a major environmental and public safety concern, causing significant damage to natural habitats, wildlife, and human communities. Early detection of forest fires is critical to preventing their spread and minimizing their impact. In recent years, deep learning algorithms like YOLO (You Only Look Once) have shown great promise for object detection tasks, including the detection of forest fires. YOLO is a real-time object detection algorithm that can process image and video data quickly and accurately. In this project, we propose a YOLO-based system for forest fire detection. We first train the YOLO algorithm on a dataset of annotated images of forest fires, allowing it to learn to detect the unique visual features of fires, such as smoke, flames, and heat. Next, we implement the trained algorithm on a camera-based system that continuously monitors forested areas for signs of fire. When the algorithm detects a potential fire, it generates an alert to notify authorities, allowing them to respond quickly and prevent the spread of the fire. We evaluate the performance of our system using a dataset of real-world images of forest fires and show that it achieves high accuracy and fast detection times, making it a promising tool for forest fire detection and prevention.

Keywords: CAMERA, YOLO ALGORITHM, NODEMCU

INTRODUCTION

Every year, huge global devastation is caused by forest fires. Although being designated as a "natural phenomena" by the International Union for Conservation of Nature (IUCN) Study "Global Review of Forest Fire 2000," human action is responsible for 90% of wildfires. Wildfires cause enormous forest destruction (6-14 million hectares of forest each year) and contribute 30% of atmospheric CO2. This results in tremendous loss of life, global warming, and the devastation of different natural, recreational, and vital resources. There is an urgent need for a broad, multinational response to forest fires.

Forest fires are a serious environmental issue that can have significant consequences for both natural ecosystems and human communities. The early detection of forest fires is critical to preventing their spread and minimizing the damage they can cause. In recent years, there has been growing interest in using deep learning algorithms for forest fire detection. In this project, we propose a YOLO (You Only Look Once) based system for forest fire detection. YOLO is a real-time object detection algorithm that can process image and video data quickly and accurately. By training the algorithm on a dataset of annotated images of forest fires, it can learn to detect the unique visual features of fires, such as smoke, flames, and heat. The system we propose uses cameras to continuously monitor forested areas for signs of fire. When the YOLO algorithm detects a potential fire, it generates an alert to notify authorities, allowing them to respond quickly and prevent the spread of the fire. In this project, we will discuss the implementation of the YOLO-based system for forest fire detection, including the dataset preparation, algorithm training, and system implementation. We will also evaluate the performance of the system using a dataset of real-world images of forest fires, demonstrating the potential of YOLO for forest fire detection and prevention.

LITERATURE SURVEY

[1] Recurrent neural network (RNN) and long short-term memory (LSTM) have achieved great success in processing sequential multimedia data and yielded the state-of-the-art results in speech recognition, digital signal processing, video processing, and text data analysis. In this paper, we propose a novel action recognition method by processing the video data using convolutional neural network (SVM) and deep bidirectional LSTM (DB-LSTM) network.

[2] Recent years have shown enthusiastic research interests in diagnostic hysteroscopy (DH), where various regions of the female reproductive system are visualized for diagnosing uterine disorders. Currently, the hysteroscopy videos produced during various sessions of patients are stored in medical libraries, which browsed by medical specialists Gynecologists to visualize previous videos of a patient or to study similar cases.

[3] Fire detection is one of the most interesting issues for surveillance. The existing approaches for the fire detection suffer from a high false positive ratio. To solve the problems, we present a patch-based fire detection algorithm with online outlier learning. In the proposed algorithm, the candidates of fire are obtained in the form of patch, while the classical candidates have been based on pixels or blobs. Because the patches of fire have more distinctive shape than the entire fire, the shape classifier can recognize the candidates correctly from fire-like outliers.

[4] Fire is a severe natural calamity that causes significant harm to human lives and the environment. Recent works have proposed the use of computer vision for developing a cost-effective automated fire detection system. This paper presents a custom framework for detecting fire using transfer learning with state-of-the-art CNNs trained over real-world fire breakout images. The framework also uses the Grad-CAM method for the visualization and localization of fire in the images. The model also uses an attention mechanism that has significantly assisted the network in achieving better performances.

[5] In this paper we propose a method able to detect fires by analyzing the videos acquired by surveillance cameras. Two main novelties have been introduced: first, complementary information, respectively based on color, shape variation and motion analysis, are combined by a multi expert system. The main advantage deriving from this approach lies in the fact that the overall performance of the system significantly increases with a relatively small effort made by designer..

[6] Forest fires are still a large concern in several countries due to the social, environmental and economic damages caused. This paper aims to show the design and validation of a proposed system for the classification of smoke columns with object detection and a deep learning-based approach. This approach is able to detect smoke columns visible below or above the horizon. During the dataset labelling, the smoke object was divided into three different classes, depending on its distance to the horizon,

[7] This paper proposes a secure surveillance framework for IoT systems by intelligent integration of video summarization and image encryption. Firstly, an efficient video summarization method is used to extract the informative frames using the processing capabilities of visual sensors. When an event is detected from key frames, an alert is sent to the concerned authority autonomously. As the final decision about an event mainly depends on the extracted key frames, their modification during transmission by attackers can result in severe losses.

[8] Fire hazard is a condition that has potentially catastrophic consequences. Artificial intelligence, through Computer Vision, in combination with UAVs has assisted dramatically to identify this risk and avoid it in a timely manner. This work is a literature review on UAVs using Computer Vision in order to detect fire. The research was conducted for the last decade in order to record the types of UAVs, the hardware and software used and the proposed datasets.

[9] Early detection and classification of wildfires using aerial image-based computer vision algorithms like convolution neural networks and image processing techniques have lately gained much attention due to the record-setting wildfire events worldwide. Past studies have demonstrated varying degrees of success in implementing forest fire classification algorithms using variants of well-known sophisticated convolutional neural network architectures, which require extensive computation time for training but suffer comparatively low predictive power and high false alarm rates.

[10] In this paper design and develop a smart intruder detection and alert system which aims to elevate the security as well as the likelihood of true positive identification of trespassers and intruders as compared to other commonly deployed electronic security systems. Using multiple sensors, this system can gauge the extent of danger exhibited by a person or animal in or around the home premises, and can forward various critical information regarding the event to home owners as well as other specified entities, such as relevant security authorities.

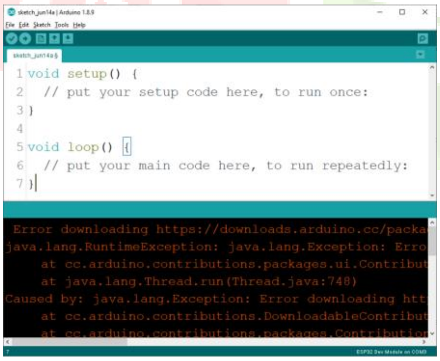
PROPOSED METHOD

The first step in developing the system is to prepare a dataset of annotated images of forest fires. This dataset should contain a diverse range of images of fires, including different lighting conditions, weather conditions, and types of fires. The images should be annotated with bounding boxes around the areas of the image where fires are present. Next, we train the YOLO algorithm on the annotated dataset of forest fire images. The YOLO algorithm is a deep neural network that can be trained using a variety of deep learning frameworks, such as TensorFlow or PyTorch. The training process involves optimizing the algorithm's parameters to accurately detect fires in the input images. System implementation: Once the algorithm is trained, we implement the system using cameras that continuously monitor forested areas for signs of fire. The cameras are connected to a computer system that processes the video stream from the cameras in real-time. The YOLO algorithm is applied to each frame of the video stream, and when a potential fire is detected, an alert is generated to notify authorities. Performance evaluation: To evaluate the performance of the system, we use a dataset of real-world images of forest fires. We compare the algorithm's performance to that of other existing methods for forest fire detection, such as threshold-based approaches or other machine learning algorithms. We measure the accuracy and detection time of the YOLO-based system and demonstrate its potential for forest fire detection and prevention.

SOFTWARE DESCRIPTION

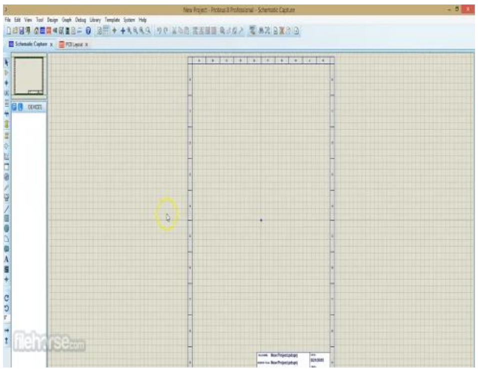
ARDUINO IDE

The Arduino Integrated Development Environment, often known as the Arduino Software (IDE), is offered in addition to a text editor for writing code, a message box, a text terminal, a toolbar with buttons for frequently performed activities, and a variety of menus. It connects to the Arduino hardware in order to upload and communicate with programs. Sketches are computer programs written in the Arduino programming language (IDE). These illustrations are made with a text editor and saved as.ino files. The editor has text replacement and text search functions. The message area gives feedback and displays issues while storing and exporting. The terminal displays text created by the Arduino Software (IDE), including complete error messages and other data.The configured board and serial port are shown in the bottom right corner of the window. You may use the toolbar buttons to validate and upload programs, generate, open, and save drawings, and launch the serial monitor.

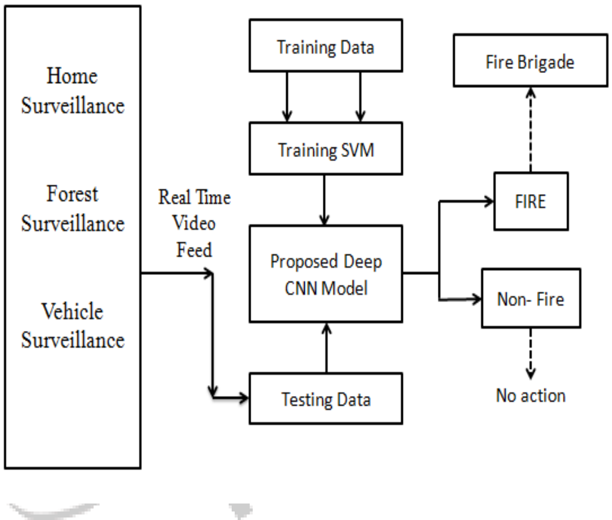


PROTEUS

The capacity of Proteus VSM to mimic the interaction between software running on a microcontroller and any analogue or digital devices linked to it is its most intriguing and crucial feature. The microcontroller model, along with the other components of your product design, is shown on the schematic. It emulates the execution of your object code (machine code) in the same way as a real chip would. If your program code writes to a port, the logic levels in the circuit change correspondingly, and if the circuit changes the state of the processor's pins, your program code will notice, just as in real life. The VSM CPU models completely emulate all I/O ports, interrupts, timers, USARTs, and other peripherals found on each supported chip. It is not a simple software simulator since the interaction of all these peripherals with the external circuit is thoroughly described down to the waveform level and so the entire system is emulated. Proteus VSM remains the best choice for embedded simulation, with over 750 supported microprocessor types, hundreds of embedded SPICE models, and one of the world's biggest libraries of embedded simulation peripherals.

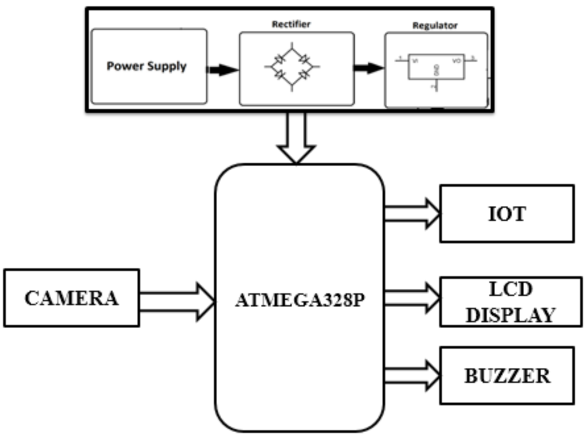


SOFTWARE BLOCK DIAGRAM



SOFTWARE BLOCK DIAGRAM

HARDWARE BLOCK DIAGRAM



HARDWARE EXPLANATION

Deep learning (DL) architectures are proposed for this topic, as well as a cost-effective CNN framework for detecting flames in CCTV surveillance recordings. Our approach eliminates the time-consuming and difficult process of feature engineering by automatically learning rich characteristics from raw fire data. We trained and fine-tuned a model with architecture comparable to Google Net for fire detection, which successfully dominated existing fire detection techniques, using transfer learning strategies. As compared to state-of-the-art fire detection systems, the suggested framework balances fire detection accuracy and computational complexity while also reducing the frequency of false alerts. The measured parameters are presented on an LCD display and sent to the Internet. If a fire is detected by the camera, the buzzer will sound. Everything is controlled via an Arduino board.

METHODS

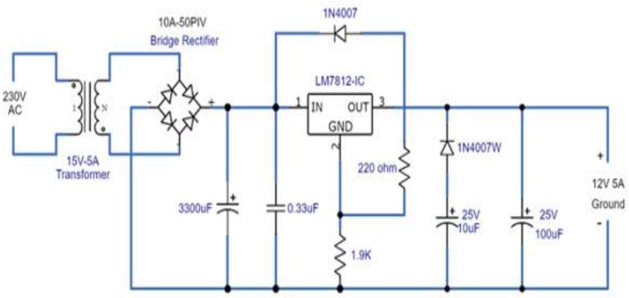
MODULE LIST

- ARDUINO UNO
- POWER SUPPLY
- CAMERA
- LCD DISPLAY
- NODEMCU
- BUZZER

MODULE DESCRIPTION

POWER SUPPLY

12V power supplies (or 12VDC power supplies) are among the most widely used power sources today. A 12VDC output is often created from a 120VAC or 240VAC input by a combination of transformers, diodes, and transistors. There are two kinds of 12V power supplies: regulated power supplies and unregulated power supplies. There are three types of 12V regulated power supplies: switching regulated AC to DC, linear regulated AC to DC, and switching regulated DC to DC. A dissipative regulating circuit is used to regulate the output of linear regulated 12VDC power sources. They are exceedingly stable, have very minimal ripple, and no switching frequencies that generate EMI. Galvanic isolation is standard in our 12VDC linears, giving our customers maximum adaptability by providing input to output and output to ground isolation. AC to DC single and broad adjust output Acopian linear regulated power supply are offered.



Ardino uno

The Arduino UNO is a standard Arduino board. UNO means "one" in Italian. The initial release of Arduino Software was labelled as UNO. It was also the first USB board made available by Arduino. It is regarded as a powerful board that is employed in a variety of tasks. The Arduino UNO board was created by Arduino.cc. The Arduino UNO is built on the ATmega328P microprocessor. In comparison to other boards, such as the Arduino Mega, it is simple to use. The board is made up of digital and analogue I/O pins, shields, and other circuitry. The Arduino UNO has six analogue input pins, fourteen digital pins, a USB connection, a power jack, and an ICSP (In-Circuit Serial Programming) header. It's written in IDE, which stands for Integrated Development Environment. It is compatible with both online and offline platforms.

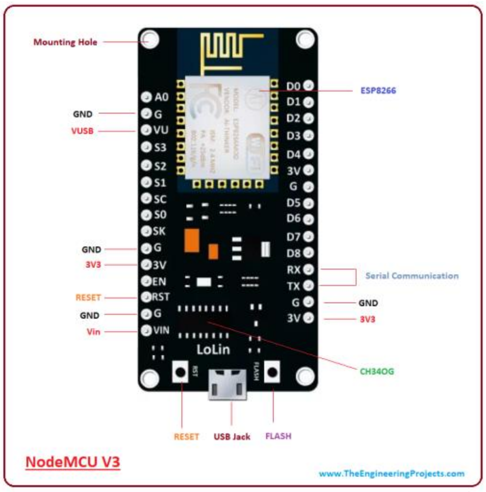
Camera

A camera is an optical device used to capture images. The majority of cameras can record 2D photos, however some more powerful versions can also take 3D images. Most cameras, at their most basic, consist of a sealed box (the camera body) with a tiny hole (the aperture) through which light may travel and capture a picture on a light-sensitive surface (usually a digital sensor or photographic film). Cameras use a variety of technologies to regulate how light falls onto the light-sensitive surface, such as lenses that concentrate the light and shutters that control how long the photosensitive surface is exposed to light. The still picture camera is an important tool in the art of photography. Recorded photos can later be recreated using techniques such as digital imaging or photographic printing. Film, videography, and cinematography are similar artistic professions in the moving-image camera realm. The term camera is derived from the Latin word camera obscura, which means "dark chamber" and refers to the initial instrument used to project a 2D picture onto a flat surface. The camera obscura gave birth to the contemporary photographic camera.

Node mcu

The word "NodeMCU" strictly refers to the firmware rather than the related development kits. Both the firmware and the prototype board designs are available as open source. The Lua programming language is used in the firmware. The firmware is developed using the Espressif Non-OS SDK for ESP8266 and is based on the eLua project. Because NodeMCU is an open-source platform, its hardware design is available for editing, modification, and building. The ESP8266 wifi enabled chip is used in the NodeMCU Dev Kit/board. The Espressif Systems ESP8266 is a low-cost Wi-Fi chip that supports the TCP/IP protocol. The ESP8266 WiFi Module has further information about the ESP8266.

Version2 (V2) of the NodeMCU Dev Kit is available, i.e. NodeMCU Development Board v1.0 (Version2), which typically comes in black coloured PCB. NodeMCU Dev Kit contains Analog (A0) and Digital (D0-D8) pins similar to Arduino. It supports serial communication protocols such as UART, SPI, I2C, and others. We may link it to serial devices as I2C equipped LCD displays, Magnetometer HMC5883, MPU-6050 Gyro metre + Accelerometer, RTC chips, GPS modules, touch screen displays, SD cards, and so on using such serial protocols.



LCD DISPLAY:

We now see liquid crystal displays (LCDs) everywhere; nonetheless, they did not emerge overnight. It took a long time to progress from the invention of the liquid crystal to a wide range of LCD applications. Friedrich Reinitzer created the first liquid crystals in the year 1888. (Austrian botanist). As he dissolved a substance such as cholesteryl benzoate, he saw that it first became a turbid solution that cleared up as the temperature rose. After cooling, the fluid became blue before finally crystallising. In 1968, the RCA Company created the first experimental liquid crystal display. Following that, LCD makers steadily built inventive changes and advancements on the technology by using this display gadget. A liquid crystal display is made up of many layers, including two polarised panel filters and electrodes. LCD technology is used to show images in laptop computers and other electronic devices such as tiny computers. A lens projects light onto a liquid crystal layer. The coloured picture is generated by combining coloured light with the grayscale image of the crystal (which is formed as electric current travels through the crystal). The picture is then shown on the screen.

Buzzer

Piezoelectric buzzers, often known as piezo buzzers, were created by Japanese manufacturers and used in a variety of items from the 1970s through the 1980s. This improvement was mostly the result of collaborative efforts by Japanese industrial companies. They formed the Barium Titanate Application Research Group in 1951, which allowed the industries to be "competitively cooperative" and create various piezoelectric advancements and inventions. Early systems used an electromechanical mechanism similar to that of an electric bell, but without the metal gong. Similarly, a relay may be wired to disrupt its own actuation current, causing the contacts to buzz (the contacts buzz at line frequency if powered by alternating current) These devices were frequently mounted to a wall or ceiling to serve as a sounding board. The term "buzzer" derives from the rasping noise emitted by electromechanical buzzers.

CONCLUSION

In conclusion, YOLO-based forest fire detection is a promising solution to help prevent forest fires from causing further damage. As with any deep learning application, it requires a robust dataset and continuous testing and refinement to ensure its accuracy and effectiveness. With further research and development, YOLO-based forest fire detection could become a valuable tool for environmental monitoring and disaster response.

Forest fires are a major environmental disaster that can cause significant harm to both wildlife and humans. The timely detection and suppression of these fires are crucial to prevent further damage. One potential solution is to use deep learning models like YOLO (You Only Look Once) to detect forest fires. The YOLO model is a popular object detection model that can quickly and accurately identify objects in real-time. By training the model on a large dataset of images of forest fires, it can learn to recognize the unique features and patterns of these fires. Once trained, the model can be used to analyze new images and videos in real-time to detect the presence of forest fires. Using YOLO-based forest fire detection has several advantages. It can quickly and accurately identify fires, allowing emergency responders to take action more quickly. It can also cover large areas of land, making it an efficient tool for monitoring vast forested areas. However, the model's effectiveness depends on the quality and quantity of the training data used to train the model. Therefore, it is crucial to ensure that the dataset used to train the model is diverse and contains enough images of forest fires in different conditions.

ADVANTAGES

Real-time detection

High accuracy

Large coverage area

Cost-effective

Easy integration

Continuous learning

DISADVANTAGES

- Limited by training data
- False positives and false negatives
- Environmental factors
- Equipment and maintenance costs
- Ethical considerations.

APPLICATION

- Early warning systems
- Environmental monitoring
- Fire prevention Surveillance and response
- Resource management

FUTURE WORKS

- Improvement of training data: The accuracy of YOLO is heavily reliant on the quality and quantity of the training data. Therefore, further research is needed to improve the quality and diversity of the training data to improve the model's accuracy.
- Integration of additional sensors: While YOLO can detect forest fires from visual images, the integration of additional sensors, such as thermal cameras, can improve the accuracy of detection in low-visibility conditions.
- Optimization for low-power devices: The use of YOLO for forest fire detection requires specialized equipment, which can be costly. Therefore, further research is needed to optimize the model for use on low-power devices, making it more accessible and cost-effective.

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