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Acoustic Wave Based Forest Fire Extinguisher and Detection using Deep Learning

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Abstract

Apart from causing tragic loss of lives and valuable natural and individual properties including thousands of hectares of forest and hundreds of houses, forest fires are a great menace to ecologically healthy grown forests and protection of the environment. Every year, thousands of forest fire across the globe cause disasters beyond measure and description. This issue has been the research interest for many years; there are a huge amount of very well studied solutions available out there for testing or even ready for use to resolve this problem. Forest and urban fires have been and still are serious problem for many countries in the world. Currently, there are many different solutions to detect the forest fires. People are using sensors to detect the fire. But this case is not possible for large acres of forest. In this paper, we discuss a new approach for fire detection, in which modern technologies are used. In particular, we propose a platform that Artificial Intelligence. The computer vision methods for recognition and detection of smoke and fire, based on the still images or the video input from the cameras. Deep learning method "convolution neural network "for finding the amount of smoke and fire. The accuracy is based on the algorithm which we are going to use and the datasets and splitting them into train set and test set.

Keywords: Forest fire detection, Deep learning, Computer vision, Sonic fire extinguisher.

1. Introduction

Forests are the protectors of earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous and even impossible at times. The result is devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO2) in the atmosphere comes from forest fires), in addition to irreparable damage to the ecology (huge amounts of smoke and carbon dioxide (CO2) in the atmosphere). Among other terrible consequences of forest fires are long-term disastrous effects such as impacts on local weather patterns, global warming, and extinction of rare species of the flora and fauna.

Fast and effective detection is a key factor in forest fire fighting [1]. To avoid uncontrollable wide spreading of forest fires it is necessary to detect fires in an early state and to prevent the propagation. It is important to move adequate fire equipment and qualified operational manpower as fast as possible to the source of the fire. Furthermore an adequate logistical infrastructure for sufficient supply with extinguishing devices and maintenance is necessary as well as continuous monitoring of fire spread. Moreover the training of personnel is an important component for successful combating of forest fires. An integrated approach for forest fire detection and suppression is based on a combination of different detection systems depending on wildfire risks, the size of the area and human presence, consisting of all necessary parts such as early detection, remote sensing techniques, logistics, and training by simulation, and fire-fighting vehicles.

Different risk levels, the size of the area and human presence define the applied sensing techniques [2],[3] . Small high risk areas can be observed by local staff. For very large and low risk areas satellite and aero monitoring is possible. Especially in the eastern part of Germany several hundred observation towers equipped with camera-based systems have

been setup to observe forests [4]. Recorded image sequences are transmitted to a control center and analyzed by appropriate software [8], [9], [10],[11]. If a fire is clearly identified, fire suppression is initialized by an alarm going directly to the fire brigade. Nowadays, Wireless Sensor Networks (WSNs) are critical components of the increasingly common IoT (Internet of Things) systems [6],[7]. Such systems have a large applicability, and the environmental monitoring field can also benefit from their innovation. [5] The purpose of the IoT concept is to transform the real world and every day electronic devices, appliances, etc., into intelligent interconnected virtual objects. By keeping the user informed on the state of things and giving the users control of things, a better global humans-devices-humans communication can be achieved.

2. Proposed Methodology

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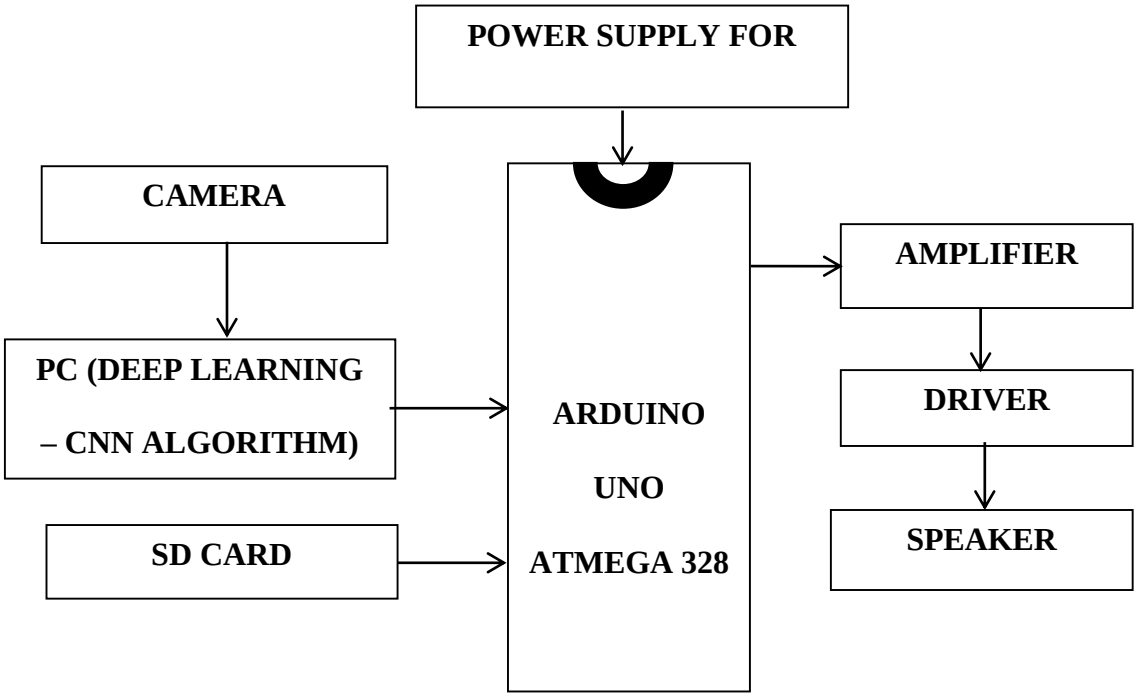
3.1. Block Diagram



3.2 Working Principle

The working principle of a forest fire detection system using CNN with an Arduino controller involves several steps:

Image or video capture: The system uses a camera or multiple cameras to capture images or videos of the forest area.

Preprocessing: The captured images or videos are preprocessed to enhance the features that are relevant to the detection of forest fires. This can include image resizing, color space conversion, and noise reduction.

CNN-based fire detection: The preprocessed images are then passed through a CNN, which has been trained to identify the features that are indicative of a forest fire, such as smoke, flames, and heat signatures. The CNN produces a probability score for each image, indicating the likelihood of a forest fire being present in the image.

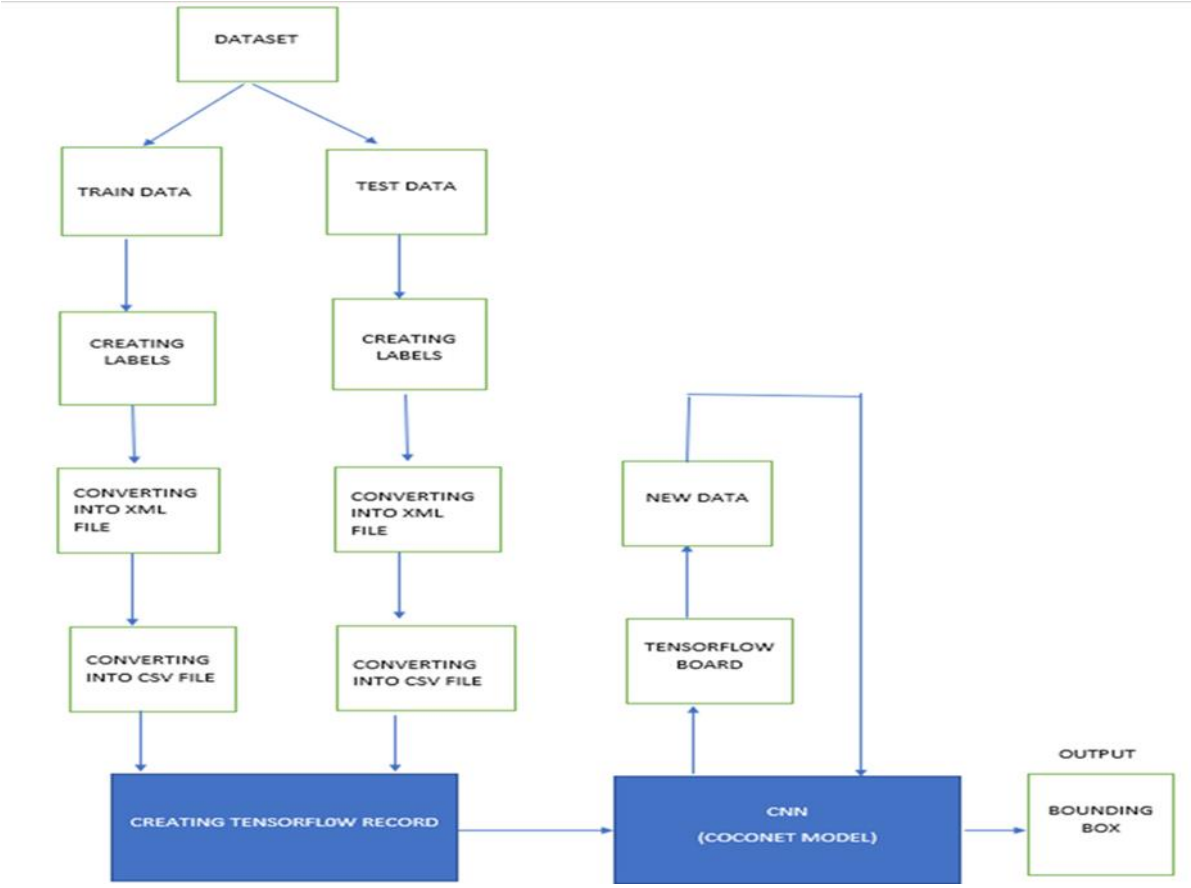
Decision-making: The probability scores from the CNN are analyzed by the Arduino controller, which decides whether a forest fire is present or not. If the probability score is above

a certain threshold, the system sends a notification to the authorities, indicating the presence of a forest fire.

Real-time monitoring: The forest fire detection system continuously captures images or videos and analyzes them in real-time to detect any changes in the forest area. This allows the system to detect forest fires as soon as they occur and alert the authorities quickly.

In summary, the forest fire detection system using CNN with an Arduino controller works by capturing and analyzing images or videos of the forest area in real-time using a CNN, which is trained to identify the features indicative of a forest fire. The system can then send notifications to the authorities, allowing them to take quick action to contain the fire and reduce the damage caused.

3.3. Flowchart



4. Result and Discussion

A forest fire detection system using CNN with an Arduino controller can have several advantages over traditional fire detection systems. The use of a convolutional neural network (CNN) can enable the system to detect forest fires more accurately by analyzing the images or videos captured by the camera. The Arduino controller can also be used to process the images and send notifications to the authorities in real-time, which can be helpful in containing the fire and reducing the damage caused. The accuracy of the system depends on several factors, such as the quality of the camera, the size of the dataset used for training the CNN, and the complexity of the CNN architecture. With proper training and optimization of the CNN, the system can achieve high accuracy in detecting forest fires. The discussion of such a system can also include its potential limitations, such as the need for a stable power supply, the vulnerability of the system to environmental factors, and the cost of implementation. However, with advancements in technology and the availability of low-cost components, these limitations can be overcome. a forest fire detection system using CNN with an Arduino controller can have significant potential in improving the accuracy and efficiency of forest fire detection and can be a valuable tool in preventing and mitigating the damage caused by forest fires.

5. Conclusion

The recent improved processing capabilities of smart devices have shown promising results in surveillance systems for identification of different abnormal events i.e., fire, accidents, and other emergencies. Fire is one of the dangerous events which can result in great losses if it is not controlled on time. This necessitates the importance of developing early fire detection systems. Therefore, in this research article, we propose a cost-effective fire detection CNN architecture for forest architecture. Translations and content mining are permitted for academic research only. Although, this work improved the flame detection accuracy, yet the number of

false alarms is still high and further research is required in this direction. In addition, the current flame detection frameworks can be intelligently tuned for detection of fire. This will enable the video surveillance systems on forest to handle more complex situations in real-world

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