Forest Fire Detection and Acoustic Based Fire Extinguisher

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Abstract

Forest fire is an important issue due to global warming now-a- days. Forest fire causes tragic loss of lives. Primitives' tribeslosts the livelihood. Modern technologies based on sensors are developed to sense the fire but it is impossible for large acres of forest. In this paper, detection of fire using machine learning and effective extinguishing of fire is based on acoustic method. This approach can detect fire at early stage using KNN algorithm by image processing. There is no assumption of data, KNN algorithm is simple and easy to understand and used for classification and regression. Forest fire detection are difficult to recognize earlier and suppression methods are limited for vast areas. The problems in using sensors are limited to temperature range, cross sensitivity of other gases. This paper is based on artificial intelligence in an application of machine learning in which the features and parameters are trained and tested. Acoustic based extinguishing doesn't need any maintenance and more resources. By using the proposed techniques environment disaster is controlled, economical and physical loss of living being were preserved. KNN algorithm is the easiest algorithm used in machine learning for the purpose of classifying and regressing the images.

Keywords: *detection of fire and smoke, KNN algorithm, artificial intelligence, acoustic based fire extinguisher.*

1. Introduction

Forest fire has become extreme and numerous in the past 10 years all over the world. It is a critical issue in the biosphere-atmosphere interface. Forest Fire is caused by natural and manmade causes. This forest fire is the important problem and should be controlled. Consequently Machine learning is self determined and developed from experience without any intervention of the programmer and feature recognition is simple. The purpose of using acoustic fire extinguisher are leaving no residues and non-toxic. The current method of fire fighting has many problems such as toxic to humans and leaves residue and forest fire crashes towards weather of the universe , Global warming and destruction of the endangered species of plants and animals. Efficient detection in right time is necessary for controlling the forest fire fighting. In order to control the spreading of forest fires, it is necessary to prevent the fire without any proliferation. AditiKansal et al uses a detection of forest fires using machine learning techniques. Forest fires increases the gas emission. Monitoring of Forest environment is based on the raspberry pi model 3, analogical and digital sensors and signal analysis algorithm are used which is either too unaffordable for an average user. The purpose of using machine learning algorithm to detect the forest fire early in simple image classification. The process of machine learning is based on the data collection. The aim is to allow the computer to learn automatically without human actions and using the trained collections of data and new data the computer predict the future data. This study result in the specified features colour RGB value using KNN algorithm.(Noda, S., and K. Ueda et al.. 1994)

Fig1.1 KNN algorithm

1.1 Machine learning with fire detection

Machine learning has several algorithms based on the features, here the features are fire and smoke which needs only a simple algorithm called KNN algorithm and provides high accuracy(K.Priyadarshini et all,2019). In KNN algorithm there is no assumption of data, easy to understand and can be used for classification and regression. In acoustic method the cost reduction, suppress the fire within a second, no need for maintenance.'

This design stated that taking images or video from the camera and given as an input to the computer, using python software that process command are taken from open cv library. The serial converter are used for serial communication, the arduino and the computer are connected through the USB card. If fire or smoke identified arduino alter the amplifier and speaker. SD card is dumped with sound waves at the frequency of 30Hz to 60Hz. Sound has an ability to separate the oxygen and other burning material. If the components gets separated the fire suppressed easily.

2 Analysis

Now a days many system were used to draw an inference and startling the government for the protection of trees from the forest fires. Environmental physical parameters like temperature, humidity, moisture etc are regularly monitored by Electronic devices. The appreciable solution of this problem is Arduino platform based IOT enabled fire detector and monitoring system. In this paper, the fire detector using arduinouno is interfaced with a temperature sensor, a smoke sensor and a buzzer. Consequently, the system senses and alerts the user. The KNN algorithm steps followed,

1. Data is loaded

2. Neighbours are initialised with K.

3. for an example of data

    3.1 The distance between the query example and the current example from the data is calculated.

    3.2 Distance and index is added to the ordered collection.

4. Arranging of distance values from smallest to largest.

5. First K entries of the distances are taken

6. Labels of the selected K entries are taken

7. If regression, return the mean of the K labels

8. If classification, return the mode of the K labels

Image segmentation is the process of assigning a label to every pixel. The threshold method is the simplest method of image segmentation. Image segmentation is done by the threshold value of colour images with gray scale images. In this case, tabular datasets contains database where every column of a table represents a particular variable and each row corresponds to a given record of the data set.
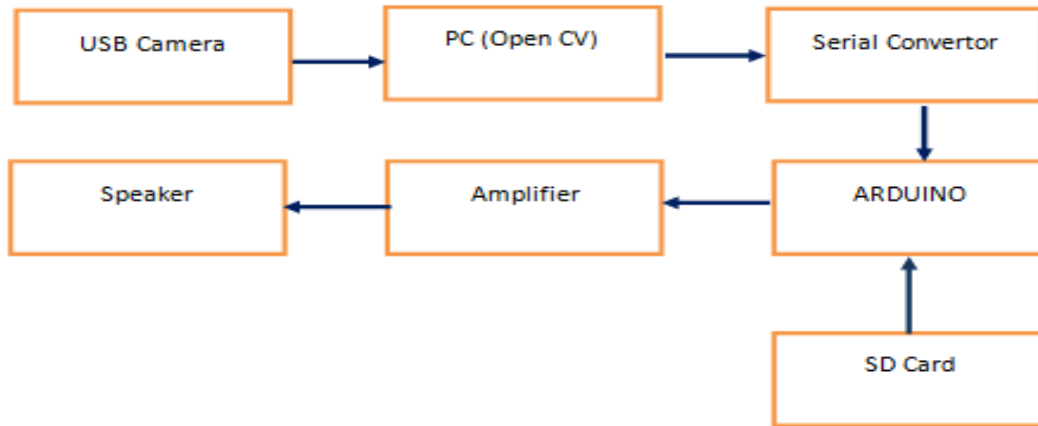
Fig 2.1 flow diagram of analysis

In machine learning algorithm the collected datasets are splitted into training set and test set.(Grivei, A. Rdoi et al 2016). 70% is for training the machine with a sample of data and 30% is for test set. Machine learning model is used to find out the compaision of the training set and the test sets. This split into 4 sets X train, Y train, X test and Y test and taken the comparing result value. Scaling is the final step in the data processing.
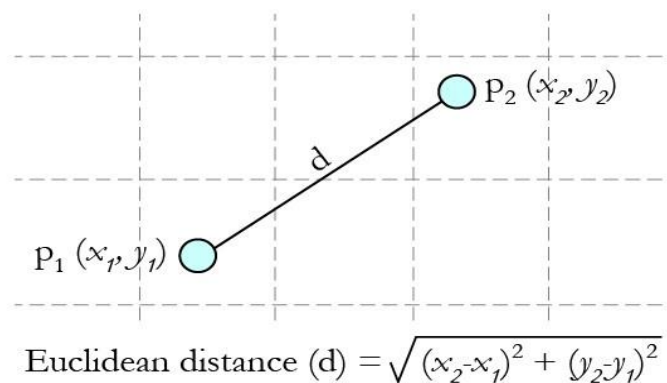
$$\text{Euclidean distance (d)} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Fig 2.2   Euclidean distance calculation

It is one of the methods used to characterise the data. Numbers of machine learning models are based on Euclidean distance. In machine learning equations, the difference with lower value is treated as least preference as if it does not exist.

Confusion matrix is an algorithm for summing up of the execution of a classification algorithm. Classification accuracy misleads to different consequences that is different number of observations in each class or if having more than two classes in the dataset. Calculating a confusion matrix can give a better idea of what classification model is getting right and what types of errors it is making.

A confusion matrix is a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known. It allows the visualization of the performance of an algorithm. Confusion matrix

is 2*2 matrix where row represents the predicted class column represents the actual class. Numpy command is used to create theconfusion matrix in Python.

How to code ML algorithm from scratch including KNN, decision tree, neural nets, ensembles.

- Adaptive algorithm(KNN) is chosen
- Different learning sources is selected
- Chosen algorithm in to chunks
- Implementation and processing is done.

3   Design methodology

The collected dataset trained to the computer and the tested result value in RGB value which is converted into HSV and store in the csv file to support from the python.

Collecting many values of fire and smoke on image of forest. After collecting all the values create the dataset in excel sheet and convert into csv file. (Chen, Thou-Ho et al.. 2003) Next importing the dataset using pandas libraries and numpy libraries. Reading the dataset every row and column using pandas library with list. Divide the dataset into independent and dependent variable as input and output. Convert the categorical output to labelled number output. After that splitting dataset into x train, Y train, X test, Y test that is 70% data for training and 30% data for testing. K nearest neighbour is a classification algorithm to classify fire and smoke Y test and Y predict. Compares the Y test and prediction using true positive, true negative, false positive, false negative. Testing accuracy based on confusion matrix above 95% accuracy, new data will gives to the camera which provides results.

Consider the input video of forest fire and smoke and interface through the python programming the confusion gives the result based on fire and heavy smoke, heavy fire and heavy smoke, no fire and no smoke and smoke. When the fire and smoke occurs ardino alert the amplifier and speaker produce the sound waves. Chen, Thou-Ho, et al.2006)
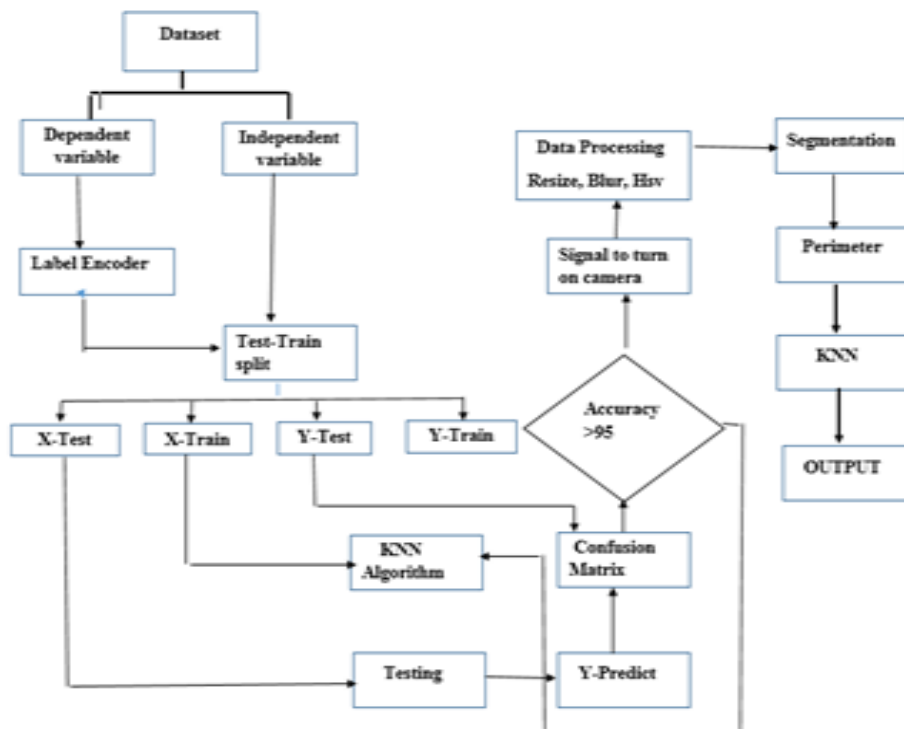

Fig 3.1 Design Process

The new research in this paper using KNN algorithm for featuring forest fire and smoke and suppression method using acoustic.
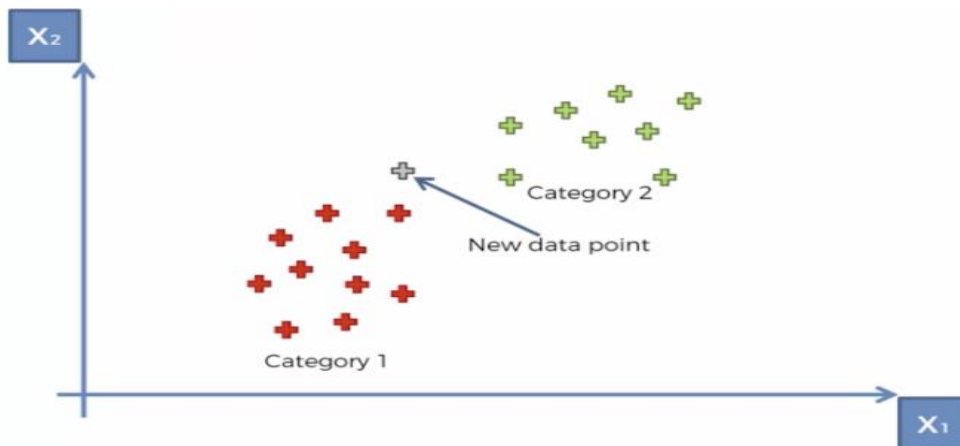

Fig 3.2 comparison of Data sets

The x1 and x2 are the distance and category 1 represents affected area and category 2 represents the unaffected area. According to the K value it compares exist data with new data resulting value of Euclidean distance. The important steps to gather all data is taking care of missing data in dataset, the common idea to handle the problem is to take a mean of all the values of the same column and have it to replace the missing data. The library used for the task is called scikit learn pre-processing.

Fig 3.3 Output of Fire and Smoke

Fig 3.4 output of accuracy

4. Implementation

The data collected is sent to the arduino through USB card. The main component of the module is power supply. Power supply is a source of electricity in the project. Transformer is to convert high to low voltage. A rectifier is used to produce dc (Krivtsova et al.2016). A capacitor is used for smoothening the pulsating current from the rectifier. These pulsations occur at a frequency related to the ac power frequency. Voltage regulator ICs are available with fixed or variable output voltage. Arduino uno microcontroller is based on the ATmega328p. Web camera is a video capture device that is connected to computer, often using a USB port or if connected to a network, Ethernet or WI-FI or built in for certain types of laptops (G.Gomathi et al..2018) A loudspeaker an electroacoustic transducer a device which converts an electrical audio signal into a corresponding sound. (Wang, Da-Jinn et al..2018)
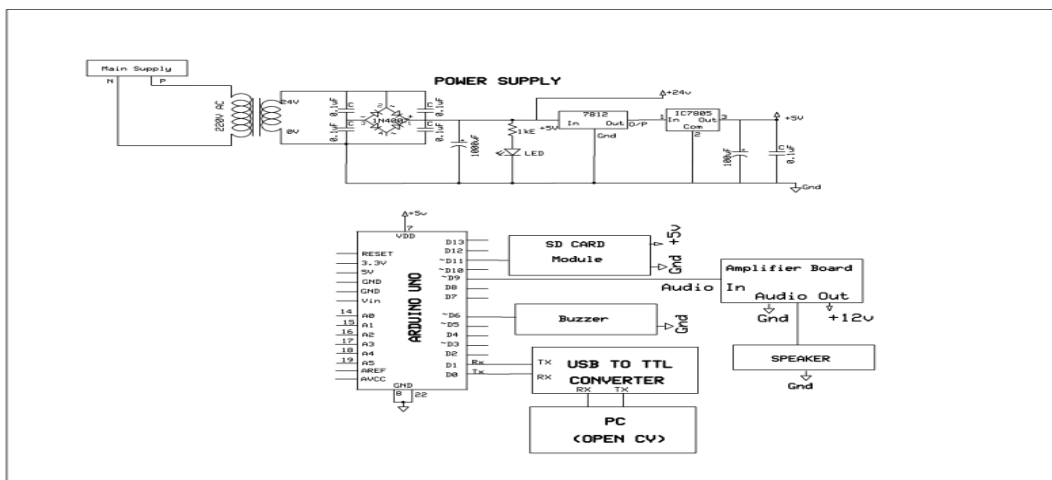

Fig 4.1Implementation process

Machine learning have better accuracy when training with huge amount of data and learned to make intelligent decisions. Acoustic based fire extinguisher are better than the other fire fighting methods. It works by deep bass sounds this prototype focuses the sound waves in a specific direction instead of spreading them even the portable acoustic fire fighting are implemented. The tone generated is interfaced with the subwoofer, which converts the low frequency waves into sound waves these waves are amplified using amplifier. The generated sound waves are made to travel to the vortex tube.(J. Papán et al.. 2012). The waves are further tuned in a frequency generator until they extinguish the fire. The characteristics of portable fire extinguisher are,

1. No residue compared to chemical fire extinguisher
2. Light material weight
3. Less damage to surroundings
4. Non toxic
5. No expiration date
6. No refilling.
7. Limitations are due to vast areas it is expensive to install a tower, camera and man
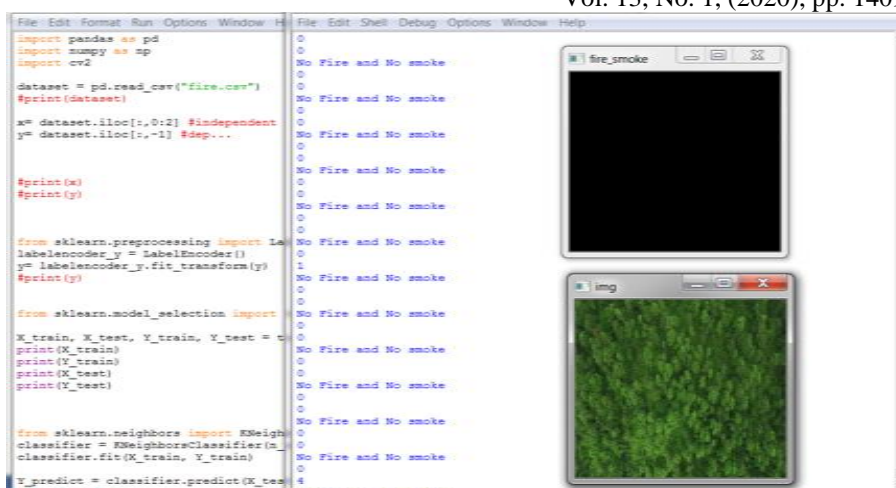
   power.

Fig 4.2 Output of NF and NS

Fig 4.3 Output of NF and NS

5. Conclusion

The recent improved processing capabilities of smart devices have shown the results for identification of different abnormal events such as 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 is controlled by early detection systems. In this paper a cost effective KNN algorithm is used for fire detection, although this work improved the fire detection accuracy but number of false fire detection are high and further research is required in this direction. The acoustic fire extinguisher are the better approach to put of the fire even this method is best for compact places. The people, animals and environment are benefitted due to this prevention method. In future supporting the research to understanding of forest fire and their ecological, social costs and benefits. Developing and enforcing compatible, mutually reinforcing land use laws that provide legal basis for the ecologically appropriate use of fire. Prevention further forest loss and degradation from recurrent catastrophic fires, and reduce fire risk in forested landscapes, through ecologically appropriate restoration. The sensor nodes can be used for the future detertion of the forest fire.(RoselinSuganthi J ,2018)

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