Fire Detection System Using Image Processing

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Abstract— The project aims to detect fire using image processing from image database created and trained using Artificial Neural Networks and will inform people of early detection. As there are many automatic fire alarm systems already created and are being used as a sensor, still they have some limitations and is designed to detect smoke in the fire and work well in limited areas. To reduce limitations and improve with new technologies, the project is proposed. Here we used MATLAB which will train the dataset and test the outcome.

Keywords: Image Processing, Artificial Neural Network, Feature Extraction, Fire Detection

I. INTRODUCTION

The project aims to create a high-quality device based on Image Processing to detect fire. As we all know, disasters are on the rise these days. One such major disasters involves fires starting in homes/offices, etc... Fires are very dangerous because they cause great loss of life and property. Thousands of fire-related accidents occur worldwide as a result of power failures, accidental fires, natural lightning, and so on. So to control the fire, the Various detection systems was developed and upgraded. Sensory-based fire detection is a process that uses carbon, heat and smoke sensors. An important point in smoking and fire machines is they are often used to detect certain particles formed by smoke and fire through ionization or photometry or ionization.

These systems are in the form of smoke sensors and sprays that emit smoke and are designed to activate after reaching a particular level of temperature which is already programmed. And another feature of the existing system is difficult to use in open space and on large infrastructure. To compensate for these problems, fire detection methods in image processing techniques are used.

This project is implemented by Artificial Neural Networks(ANN) and image processing technique to create and train dataset to detect the fire and Peripheral Interface Controller as a central processing unit which controls the Liquid Crystal Display(LCD) and Buzzer to give audio and visual indications. We used MATLAB to simulate the output and performance is tested. MATLAB works very well as it has many tools built for neural network performance and image processing process. Benefits of MATLAB launch and test your algorithms easily.

- Improve computational codes easily
- Fix an error easily.
- Use a large database with a built-in algorithm.
- Process photos and make role-playing videos.
- Figurative calculation can be done easily.
- Call external libraries.
- Perform comprehensive data analysis and visualization
- Upgrade app with GUI

It is also used for algorithm development, modeling simulation, prototyping, Testing, Data Acquisition, and Application Development, including graphical interface construction.

II. OVERVIEW OF PROJECT

This is an image processing tool using Artifical Neural Networks. Fire detection was performed by Feature Extraction using ANN and MATLAB. Here in finding fire, we use ANN to extract features such as energy correlation, homogeneity and contrast between images to detect fire. The Peripheral Interface Controller linked to the computer port acts as a central processing unit and switches ON the buzzer that starts the beep sound and the system status will be displayed on the lcd display when there is a detection of fire.The proposed system uses image processing. Image processing basically involves the following three steps:

- It Imports the image via image acquisition tools.
- Analyse and manipulate the image.
- Output in which result can be a altered image or report that is based on analysis of image.

The microcontroller used in this project comes from the PIC series. The microcontroller which is utilized in this project comes from the PIC seriesOS (complementary metal oxide semiconductor). It is the first RISC-based microcontroller developed in CMOS (a complementary metal oxide semiconductor) that uses a separate bus to teach and data that allows simultaneous access to system and data memory. The main benefit of the combination of CMOS and RISC is the less power consumption resulting in a very small chip size with a small pin value. Few of the memories are the newly formed FLASH. Flash technology is the technology used in pic16F877, so that data will be stored even when power is switched off. The features of PIC include Easy Programming and Erasing. Some of the memories are EEPROM, EPROM, FLASH etc. in which FLASH was recently launched.

Here we use a 16×2 LCD. Liquid Crystal Display is the full form of LCD. It is named after it has 16 columns and 2 rows. These are often used extensively for embedded projects, due to low prices, availability and a friendly system

The Active Buzzer module we used contains a piezoelectric buzzer with a built-in oscillator. It produces noise of about 2.5 kHz when the signal is high. The buzzer is a small yet effective device to add audio features to our project / program. The size is very less and compact two-pin device making this the most widely used component of many electrical systems.

III. LITERATURE REVIEW

A. K. Muhammad, J. Ahmad, I. Mehmood, S. Rho and S. W. Baik, "Convolutional Neural Networks Based Fire Detection

in Surveillance Videos," in IEEE Access, vol. 6, pages 18174-18183,2018.

In this paper, a photo-based fire alarm is designed, using a laptop and web camera as the main equipment. How to use Convolutional Neural Networks (CNN) to detect fire. However, such methods often require a lot of time for calculation and memory, which hinders its performance on surveillance networks.

B. H Pranamurti ,A Murti and C Setianingsihi, Fire Detection Use CCTV with Image Processing Based Raspberry Pi ,2019 J. Phys.: Conf. Ser. 1201 012015,2019

In this paper H Pranamurti and his team developed a detector device using the Raspberry Pi and Raspberry Pi Camera and used the Image Processing and Internet of Things concept to get real-time detection results. Here the Haar Cascade Classifier Algorithm is used to process images, to get the right image of fire. As long as the device is in active condition, the camera will continue to monitor the conditions in the room. If the fire is detected by the camera, then the fire image will be processed using The process of processing images and the result is a data cable sent to the server and sent to the 5 smartphone user using the concept of Internet Of Things as a warning there is a fire in the room.

C. A. Chauhan, S. Semwal and R. Chawhan, "A network-based fire detection system using a wireless network," 2013 Annual IEEE India Conference (INDICON), Mumbai, 2013.

In this paper, a forest fire problem is considered and a comprehensive plan is proposed using a wireless sensor network to detect fire detection in real time. It can provide more accurate detection of forest fire risk estimates than traditional surveillance systems such as satellite surveillance and monitoring towers. This function mainly describes data collection from a designed data acquisition system and its classification. Also neural network (ANN) communication method, e.g. Vector support (SVM) is used for classification of collected data.

IV. FIRE DETECTION

Fire detection first collects images with fire and without fire to create and train databases by image processing using image processing in MATLAB. We utilized the feed forward back propagation neural network for training and fire detection from the database. First the image will be filtered and converted to gray image using RGB conversion to GRAY. From the altered image elements such as energy, correlation, contrast and homogeneity will be extracted and the total value will be taken for fire detection.

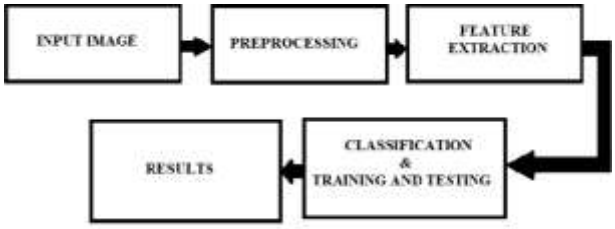


Fig. 1: Block Fire Detection diagram

A. Input image

We collected images with and without fire to create a database. These images will be provided input for fire detection.

B. Image preprocessing and filtering

Image processing defines the first processing of an image to eliminate audio distortion and to correct distorted or reduced data. Firstly the captured image will be very large in size so the system is designed to improve the image without affecting the image quality. The image represents an RGB pixel. Edge acquisition is used for image enhancement. The desired image is obtained after filtering and in which feature extraction is done.

Filtering is the action of transforming or enhancing an image. For example, you can filter an image to highlight some features or to remove certain features. The performance of image processing by filtering includes smoothness, sharpening, and sharpening of the edge.

C. RGB to Gray Conversion

The image generally includes picture elements which includes RGB (Red, Green and Blue) parts. To calculate these features the RGB image is transformed to a gray scale. When an image is converted into an image that measures gray and represents a different degree of intensity. There will be an difference in the amount of solidity of the thing to be separated and the background. The limit value is identified by separating the object behind it. With the help of this border measurement the gray scale image will be converted to a binary image with a value greater than limit 1 and a value less than the limit is 0. With the help of this binary image various features are calculated.

D. Extracting Feature

Image obtained after image preprocessing, filtering and gray conversion can be used for feature extraction. Features that can be extracted from the image are their energy, homogeneity, contrast and correlation. These features help the user to sort photos to find fire.

E. Gray Level Co-occurrence Matrix (GLCM)

The GLCM is used to test image formation. GLCM is used to represent the relationship between pixels with different levels of gray. For this purpose, a separate matrix will be created for each set of pixel offset and position. Haralick has suggested the second-order number definition descriptions that can be founded by GLCM.

In our study, we used four GLCM parameters namely, power, homogeneity, assembly and contrast. These parameters are obtained using the MATLAB greycomatrix function (R2017a, MathWorks, Natick, Massachusetts, USA). The GLCM contains information about the repetition of the gray matter by a certain offset distance between two pixels and a specific position in relation to it. The default number of gray levels used in the task is 8. GLCM is clearly shown in Figure 3a. Figure 2 contains the figure shown I, which is 4 × 5 size. Since the total number of gray levels in the figure is 8, the GLCM matrix with size 8 × 8 is used to represent the gray-level relationships between pixels.

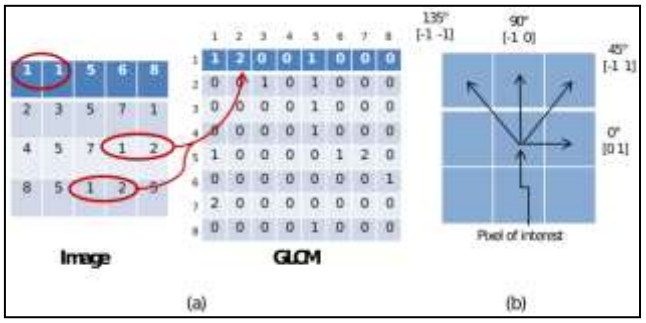


Fig. 2: (a) Gray Level Co-occurrence Matrix (GLCM) showing the number of happenings of gray sets of two adjacent pixels in the image; (b) The GLCM offset directions represented by two pixels lying at 0◦, 45◦, 90◦ and 135◦ The four statistical parameters mentioned above are described below.

1) Contrast

The difference is the median frequency of image area. Differences during GLCM. The difference lies in the highest and lowest values of the combined pixel group. It actually measures the number of local variations in the image:

$$\text{Contrast} = {}^{N-1}\sum_{i,j=0}|i-j|^2 p(I,j) \quad (1)$$

2) Energy

Energy is the addition of the square elements in the GLCM matrix. Also known as Parallel or Second Angular Minute:

$$\text{Energy} = {}^{N}\sum_{i=1}{}^{N}\sum_{j=1} p(i,j)^2 \quad (2)$$

3) Homogeneity

Homogeneity measures how close the scattering of material in GLCM is to play. Also known as the Inverse Difference Moment. If all is the similar, the homogeneity will get a higher value:

$$\text{Homogeneity} = {}^{N-1}\sum_{i,j=0} p(i,j)/1+(i-j)^2 \quad (3)$$

4) Correaltion

Adjustment is a measure of how a picture element is associated with neighboring pixels over the whole image. It is a way of relying on the gray tone line in the image:

$$\text{Correlation} = \frac{[\sum \sum (ij)p(i,j)] - \mu x \mu y}{\sigma x \sigma y} \quad (4)$$

where μx, μy, σx and σy are the most common modes and deviations of px and py. Equations (1)-(4) indicate the four characteristics of GLCM, namely contrast , energy, homogenity and correlation, respectively, where p(i,j) refers to the standard input line i and column j of GLCM; and here I am talking about the strength of one pixel while j is the next pixel of GLCM

F. Artificial Neural Networks

ANN have been used for decagon to resolve real-world problems, specifically in the field of image processing. Here, ANN classifies the images into with and without fire. We used feed forward back propagation neural network. The method used above to edit an image has its functionality divided into two categories. Neural network is made used to separate a picture into two distinct categories. The ANN has three layers: input layer, hidden layer and outputlayer.

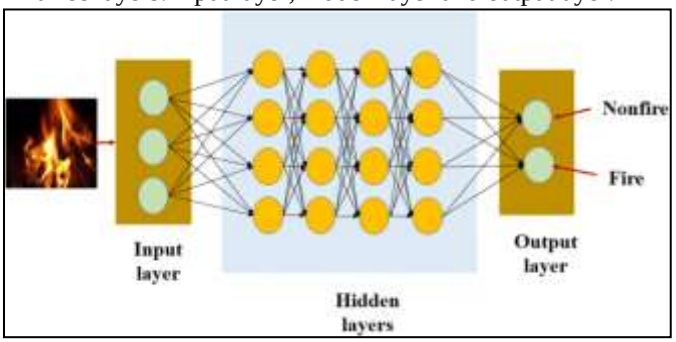


Fig. 3: Standard ANN with installation, hidden and output layers for this project.

The function of the neural network is classified into the training phase and the testing phase. About 100 images with and without fire are used from which some images are made used for training and some images are made used for testing.

- Training phase: Images are made used to train the neural network and get information on each image. During the training the neural network section is trained to detect the fire with features such as energy, contrast, adjustment and homogenity.
- Testing phase: Neural network identifies the image of fire in and out of the fire on the basis of previous information you have received about. The Network analyzes various aspects of an anonymous image and compares it to a database and classified an anonymous image into the desired fire image based upon the information acquired by the neural network while training.

V. AUDIO AND THE VISUAL INDICATION

After the training and testing phase if the image which we have given as input is an image with fire then the output will be given as fire detected. Through the RS232 port the information will be sent to the Peripheral Interface Controller which will then show the status of system as fire detected in the 16*2 Liquid Crystal Display and also turns on the Buzzer to give the alarming sound. If the image which we given as input doesn't have fire then the status will be shown as fire not detected in LCD and the buzzer will not be turned ON.

Fig. 4: Hardware setup

VI. BLOCK DIAGRAM

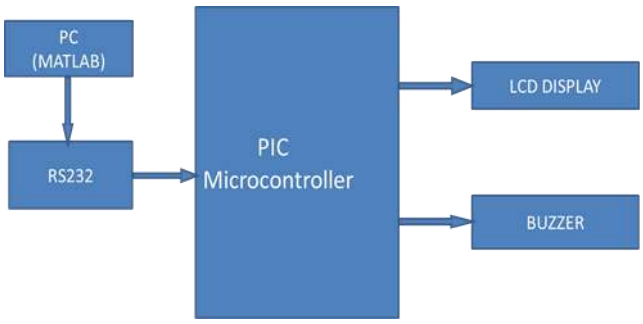
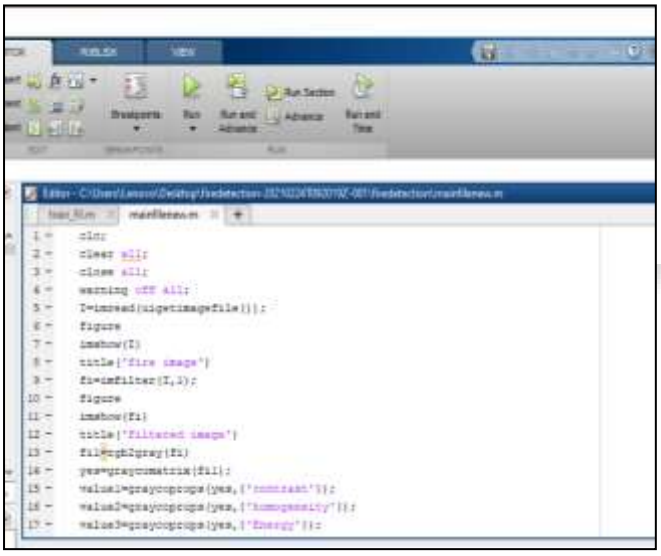


Fig. 5: Block diagram of Fire detection system

The first and the most important part in this system is the image processing & Artificial Neural Network technology. The programs are implemented in MATLAB. The work process is divided into following segments: Collecting image, Pre-processing & image filtering, Feature extraction, training and testing dataset, Compare the result with the stored database and Indicate result. There are various steps in this process and these are implemented in MATLAB. The hardware setup is used for displaying the system status and giving audio indication.

VII. MATLAB CODE



```
clc;
clear all;
close all;
warning off all;
I=imread(nigetimagefile());
figure
imshow(I)
title('fire image')
fs=imfilter(I,1);
figure
imshow(fi)
title('filtered image')
fil=rgb2gray(fi)
yes=graycomatrix(fil);
value1=graycoprops(yes,'Contrast');
value2=graycoprops(yes,'Homogeneity');
value3=graycoprops(yes,'Energy');
```

Fig. 6: MATLAB Code

VIII. RESUTS AND DISCUSSION

The main aim of the project is to create a fire detection system based on image processing. The simulation process and results are discussed below. By detecting the fire we created the MATLAB code in line with the neural networks for the insertion and processing of images. After completing and compiling the code shown in Figure using MATLAB the system processes the input image after filtering the image and if there is fire, it means detects the fire so that the output will be printed as fire detected ,if the status on LCD display will be shown as fire detectd and the buzzer will be switched ON and if the image is not fire then the output will be printed as fire not detected so that it will we diplayed as fire not detected in LCD.

Fig. 7: Input image with fire

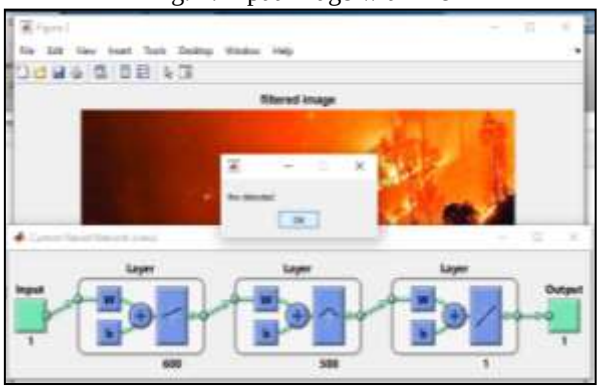


Fig. 8: Output printed as fire detected

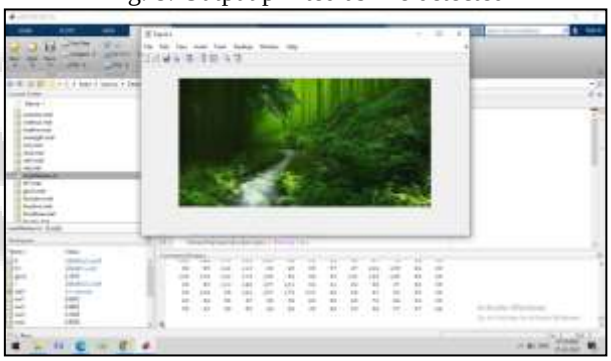


Fig. 9: Input image without fire

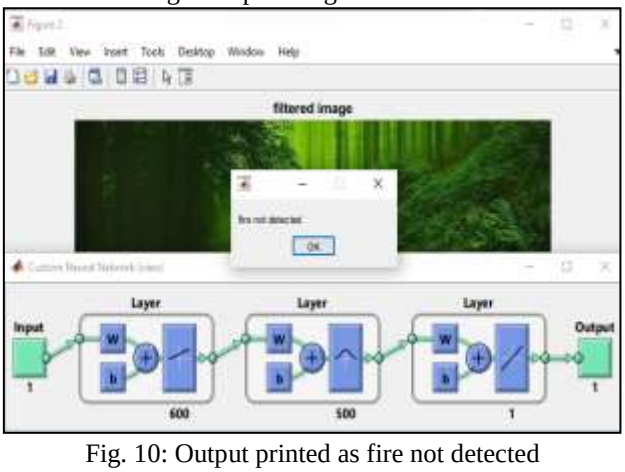


Fig. 10: Output printed as fire not detected

IX. CONCLUSION

We have implemented fire detection from image. Our system successfully detects the fire by isolating features from the image which consists of fire and then character segmentation and recognition. We have applied our algorithm on many images and got the output successfully. The project was

designed mainly for detection of fire system it can be used in emergency situations. Future scopes includes updating the system in real time with evolving new technologies and implementing the project in places where there is high risk of fire accidents by updating the hardware parts which are able to controlling large space .

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