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Design of a Fire Extinguishing System in a Warehouse through Image Processing along with Cloud Computing

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Abstract

Every year, thousands of forest warehouse fires 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 warehouse fires have been and still are serious problems for many countries in the world. Currently, there are many different solutions to detect forest warehouse fires. People are using sensors to detect the warehouse fire. But this case is not possible for large acres of forest. In this thesis, we discuss a new approach for warehouse fire detection, in which modern technologies are used. In particular, we propose a platform for Artificial Intelligence using deep learning algorithms such as Convolutional Neural Network. These computer vision methods for recognition and detection of warehouse fire, based on the still images or the video input from the cameras. The accuracy is based on the algorithm which we are going to use and the datasets and splitting them into a train set and test set.

Keywords: Warehouse fire, fire detection, fire extinguishing, Artificial Intelligence, cloud, deep learning, Convolutional Neural Networks.

1.Introduction

Early stage warehouse fire detection is a necessary action which can prevent big problems such as warehouse fire disasters or losing people's lives. A sensor detection system, in general, depends on smoke detecting that means the process will take time until the smoke reaches the sensor and then the system triggers the alarm. It is obvious that every second is necessary when the system deals with a warehouse fire disaster. Vision based warehouse fire detection system is faster than the sensor-based system and it can immediately detect the warehouse fire from cameras. Such systems can save people's lives, properties, national forests, and wild areas. Another aspect that makes this type of systems suitable for early based warehouse fire detection is its ease of installation and cheapness. The LeNet algorithm has been used as a baseline architecture in our work. Several methods have been used in the literature for warehouse fire detection. Mainly the researchers used the motion, color, spatial and temporal features models. Similar methods of warehouse fire detection have been followed by many authors which are: using background subtraction to find moving pixels, then finding the color region by applying the color model. Further analysis (in terms of spatial and temporal) are applied to detect the warehouse fire characteristics[1, 4]. To the best of our knowledge, there is no standard dataset and evaluation protocol in the previous literature which makes it difficult to compare various warehouse fire detection methods. We collected the warehouse fire sequence from some previous literature as well as our own dataset and made patch-wise annotations. With the enlargement of business and the continuous requirements of the food product multiplicity, old style granary/product management prototype will not meet that, due to its heavy capacity and low proficiency. The problem faced by the Central Warehouse Corporation is storage loss of food grains due to environmental changes.

System solution monitors temperature, humidity and various gasses like LPG, CO, and Methane, but also provides the location coordinates of the warehouse in real time to keep food, vegetables, medicines, and vaccines safe in addition to reducing wastage. This IoT comprises most advanced sensors and Particle cloud software. The sensor data is sent from node to the base station then will proceed and displayed on LCD. The data pushed and stored on particle cloud and can be accessed remotely using a mobile application Blynk [1]. This system is for tracking and alarming for the protection of trees against forest warehouse fires. Nowadays IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, moisture etc. Arduino platform based IOT enabled warehouse fire detector and monitoring system is the solution to this problem. In this project we have built a warehouse fire detector using Arduino UNO which is interfaced with a temperature sensor, a smoke sensor and a buzzer. In order to implement this project, we will be using GSM which is used to provide the final SMS to the user through the given number in the simulation program, Temperature sensor which is used to denote the temperature High and Low that will be displayed in the LCD Display, Flame sensor which is used to denote the flame ranges and if it is high the forest warehouse fire will be detected in the LCD display and if it is low forest warehouse fire won't be detected. Whenever a warehouse fire occurs, the system automatically senses and alerts the user by sending an alert to an app installed on the user's android mobile or web page accessible through the internet [2]. Detection of these disasters should be fast and accurate as they may cause damage and destruction at a large scale. In this paper, comparison of various machine learning techniques such as SVM, regression, decision trees, neural networks etc. has been done for prediction of forest fires. The proposed approach in this paper presents how regression works best for detection of forest warehouse fires with high accuracy by dividing the dataset. Fast detection of forest warehouse fires is done in this paper by taking less time as compared to other machine learning techniques [3]. This system designed a forest environment monitoring solution based on the Raspberry Pi Model 3, analogical and digital sensors and signals analysis algorithms. Parameters such as temperature, gas concentrations, soil humidity etc. are monitored with sensors while background sounds are analyzed with a classification algorithm on the basis of which the generated event can be classified into one of the following categories: Chainsaw, Vehicle, or Forest background noise. The user's accessibility to the collected data is ensured via the Internet and a mobile application that allows the user to receive notifications, whenever warehouse fire, pollution sources, or illegal deforestation are detected. The SeaForest environment monitoring solution is an IoT project, addressed to public and private forest owners as well as to national environmental and disaster response authorities [4]. A semi-supervised rule-based classification model is proposed in this paper to detect whether its zone is a high active, medium active (MA) or low active (LA) cluster in the forest. We train our proposed integrated model in such a way that when only one parameter of sensed data is transmitted by the sensor nodes due to energy constraint to the initiator of that zone, the initiator can be able to predict the state of (HA,MA,LA) zone with 96% accuracy. All the sensor nodes in HA cluster transmit their packet through cluster head to the base station continuously applying greedy forwarding technique. Authors consider energy saving strategies during cluster head selection and data transmission in HA zones. On the other hand, sensors in the MA zone transmit packets periodically and the LA zone avoids transmitting the sensed data. This way proposed technique transmits the sensed data from

HA zone efficiently and quickly to forest office for forest warehouse fire prevention and saves the energy of all sensor nodes in the forest [5]. This system is for tracking and alarming for the protection of trees against forest warehouse fires. Nowadays IOT (Internet of Things) devices and sensors allow the monitoring of different environmental variables, such as temperature, humidity, moisture etc. Arduino platform based IOT enabled warehouse fire detector and monitoring system is the solution to this problem. In this project we have built a warehouse fire detector using Arduino UNO which is interfaced with a temperature sensor, a smoke sensor and a buzzer. In order to implement this project, we will be using GSM which is used to provide the final SMS to the user through the given number in the simulation program, Temperature sensor which is used to denote the temperature High and Low that will be displayed in the LCD Display, Flame sensor which is used to denote the flame ranges and if it is high the forest warehouse fire will be detected in the LCD display and if it is low forest warehouse fire won't be detected. Whenever a warehouse fire occurs, the system automatically senses and alerts the user by sending an alert to an app installed on user's android mobile or web page accessible through the internet [6]. Detection of these disasters should be fast and accurate as they may cause damage and destruction at a large scale. In this paper, comparison of various machine learning techniques such as SVM, regression, decision trees, neural networks etc. has been done for prediction of forest fires. The proposed approach in this paper presents how regression works best for detection of forest warehouse fires with high accuracy by dividing the dataset. Fast detection of forest warehouse fires is done in this paper by taking less time as compared to other machine learning techniques [7]. This system designed a forest environment monitoring solution based on the Raspberry Pi Model 3, analogical and digital sensors and signals analysis algorithms. Parameters such as temperature, gas concentrations, soil humidity etc. are monitored with sensors while background sounds are analyzed with a classification algorithm on the basis of which the generated event can be classified into one of the following categories: Chainsaw, Vehicle, or Forest background noise. The user's accessibility to the collected data is ensured via the Internet and a mobile application that allows the user to receive notifications, whenever warehouse fire, pollution sources, or illegal deforestation are detected. The Sea Forest environment monitoring solution is an IoT project, addressed to public and private forest owners as well as to national environmental and disaster response authorities [8].

2. BLOCK DIAGRAM

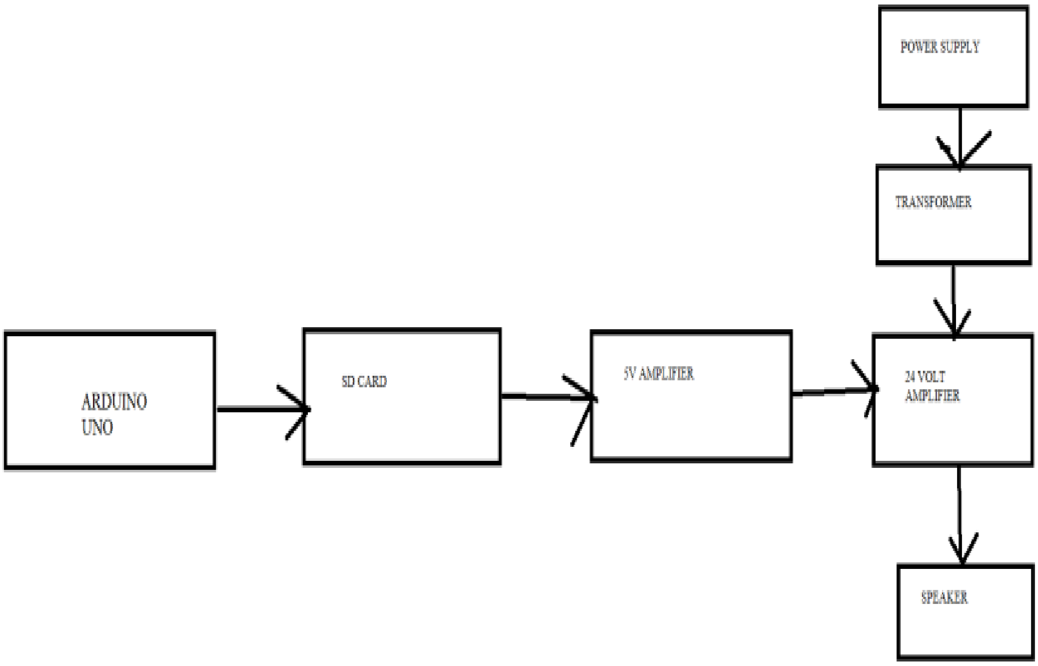

Fig.1 Block Diagram of the Fire Detection System

The arduino UNO sends the data to the SD card which stores the audio. The audio is then sent to the 5 volt amplifier, amplified and then sent to the 24 volt amplifier, re-amplified and sent to the speaker.

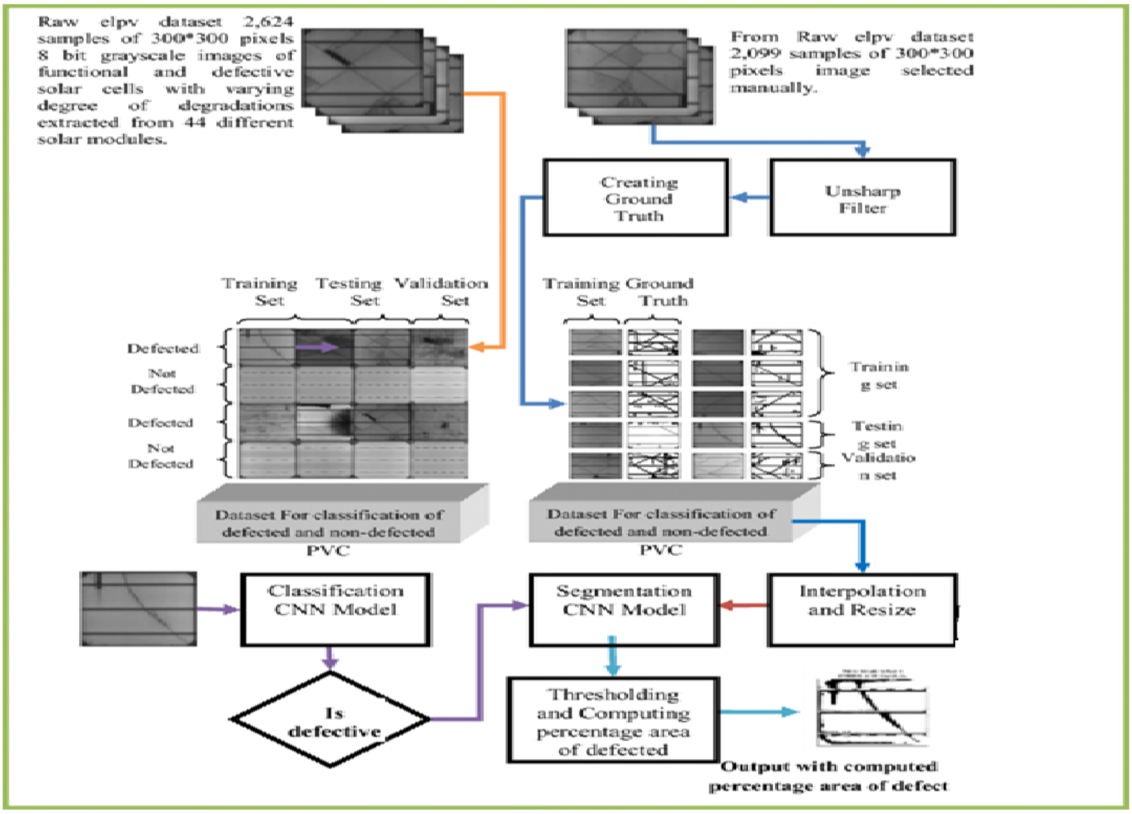

Fig.1 Block Diagram of the Image Processing System

A raw copy of the process image is made which is modified using the unsharp filter and a ground trash of the image is created. The original dataset of the image is tested and trained. The image is classified into the CNN model and is tested for any defects. If the image is defective, it is segmented after the interpolation and resizing model. After this process, the area of defect is thresholded, computed and the output is returned.

3. HARDWARE DESCRIPTION

3.1 SD card module:

Coming to the Arduino SD Card Module Interface, it is interfaced using the SPI (Serial-Peripheral Interface) protocol. I have designed two circuits for this project. In the first circuit, I have simply made the connection between the Arduino and the SD Card Module and extracted the information from the card. This circuit can be considered as an Arduino SD Card Module Hook-up Guide. In the second circuit, the magic of actual data logging happens. It is an extension to the first circuit with sensors connected to the Analog Pins of Arduino and the data from these sensors is captured on an event. The purpose of the SD card is to save the audio.

Fig.2 SD card

3.2 Arduino UNO (ATmega 328) Microcontroller:

Entire functioning of the system depends on the arduino board. Arduino reacts to the 5v supply given by opto-coupler and keeps on counting the supply and then calculates the power consumed and also the cost. The arduino is interfaced with the SD card module using the SPI protocol. The data in the SD card comes either as 1 or as 0. If the data in the SD card file is 0, then there is no fire. If the data in the SD card module is 1, the data is sent to the amplifier section.

Fig.3 Arduino UNO

3.3 Speaker:

The output from the 24 volt amplifier is taken and the corresponding sound wave that is used to extinguish the fire is given out by the speaker. The image of the speaker is shown below.

Fig.4 Speaker

3.4 Amplifier:

The output from the arduino and the SD card is sent to the 5 volt amplifier and after amplification, it is sent to the 24 volt amplifier for the re-amplification purpose. The output is then taken from the 24 volt amplifier to the speaker. The image of the amplifier is shown below.

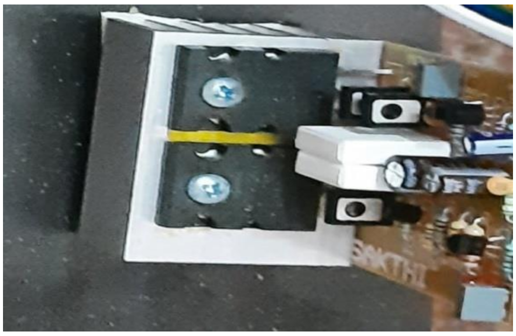

Fig.5 Amplifier

3.5 Webcamera:

A webcam is a hardware camera and input device that connects to a computer and the Internet and captures either still pictures or motion video of a warehouse fire.

4. SOFTWARE DESCRIPTION

4.1 Sketch:

A sketch is the name that Arduino uses for a program. It's the unit of code that is uploaded to and run on an Arduino board.

4.2 Python NumPY:

It is an extension module of Python which is mostly written in C. It provides various functions which are capable of performing the numeric computations with a high speed. NumPy provides various powerful data structures, implementing multi-dimensional arrays and matrices. These data structures are used for the optimal computations regarding arrays and matrices. NumPy provides a convenient and efficient way to handle the vast amount of data. NumPy is also very convenient with Matrix multiplication and data reshaping. NumPy is fast which makes it reasonable to work with a large set of data.There are the following advantages of using NumPy for data analysis.

4.3 OpenCV:

OpenCV is a Python open-source library, which is used for computer vision in Artificial intelligence, Machine Learning, face recognition, etc.

4.4 Convolutional Neural Network (CNN):

The main building blocks of a deep convolutional neural network (CNN) are the convolutional layer, commonly called CONV2D, the pooling layer, the rectified linear unit (ReLU) layer, and a series of fully connected layers. In other words, as shown in Fig.1, a deep CNN basically consists of two subnetworks, a series of 2D convolutional layers and a classical but deep neural network. Convolutional-2D (CONV2D) layers are the main building blocks of CNN. In this operation, a set of 2D filtering kernels (with size n×n) are applied to an image (N×N) to extract certain features or edges. Key parameters of the CONV2D layer operation are: the stride, the kernel size and number of kernels. The kernels can be designed to extract vertical, horizontal, diagonal edges and any other pattern from the input images. Through the convolutional layers, indeed, the feature engineering and feature extraction, from input images, is performed . If the input image is an RGB image, the size of the input image is then (N×N×3), however, the output from this convolution over a volume is 2D rather than a volume again. To accomplish this each edge detector or kernel will be replicated over the volume with size n×n×3. The convolutional layer is usually followed by a Rectified Linear Unit (ReLU) that sets all negative values, produced by the convolution operation, to zeros. Pooling layers; a very popular type of this operation is the max pooling; A max pooling layer, follows the convolutional layer, does two functions: find the maximum of the region and perform down scaling operation. The pool size determines the amount of down-scaling operation. Average pooling is also possible, however, the max pooling is more common. Fully connected layers are similar traditional neural network hidden layers for which the number of outputs is the only parameter to consider during the training of classical CNN algorithms available for application of transfer learning.

4.5 Cloud:

The data from the arduino is sent to the cloud using a link of a cloud website which id then sent to the LabVIEW. Temperature and humidity are separately sent to the cloud. Updated values will be shown in a graphical manner. The history of the previous values will also be shown. The images representing the cloud part in the LabVIEW are attached below.

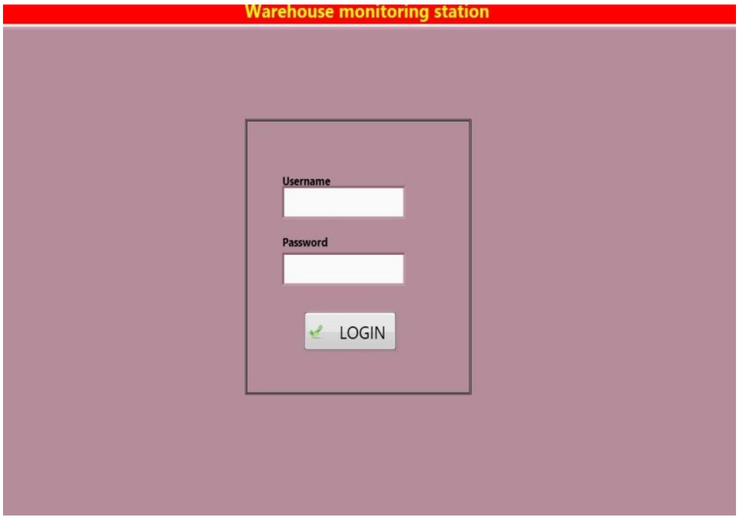

Fig.6 Cloud Part for Entering the LabVIEW Program

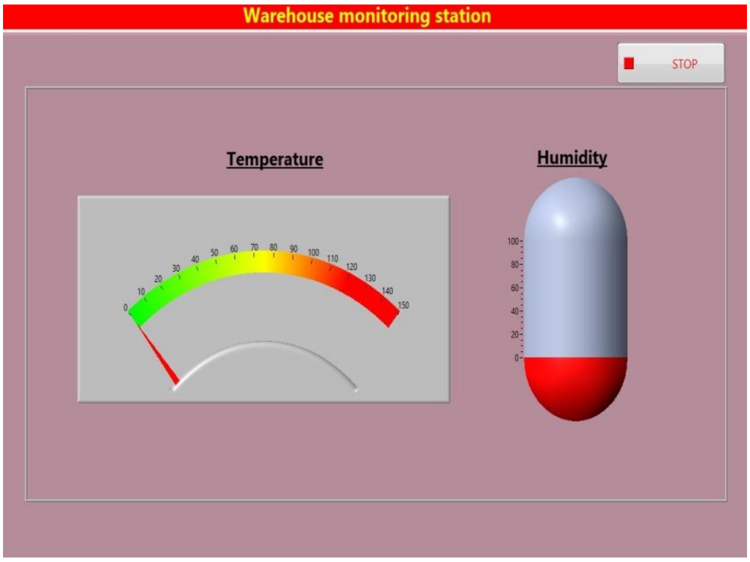

Fig.7 LabVIEW and Cloud Integration

5. EXPERIMENTAL SETUP/ HARDWARE PROTOTYPE

A Sonic Warehouse fire Extinguisher extinguishes the warehouse fire by Sound Waves. Generally, warehouse fire is extinguished with the help of water or carbon dioxide. Extinguishing warehouse fire through sound bass sounds crazy. As compared to the other chemical compound of classic extinguishers, this invention offers the cleanest way to put-off flames. Once we predict the warehouse fire or smoke by deep learning method, we will send a data to the ARDUINO UNO microcontroller from the arduino uno and various sensors. With the microcontroller, a SD card is connected and which is storing the sound files. A speaker and amplifier circuit is connected with microcontroller. Once the micro-controller receives the data for warehouse fire detection from the arduino uno (ATMEGA 328 microcontroller), the controller will read the sound files from SD card and generate the high frequency sound waves to put-off the warehouse fire.

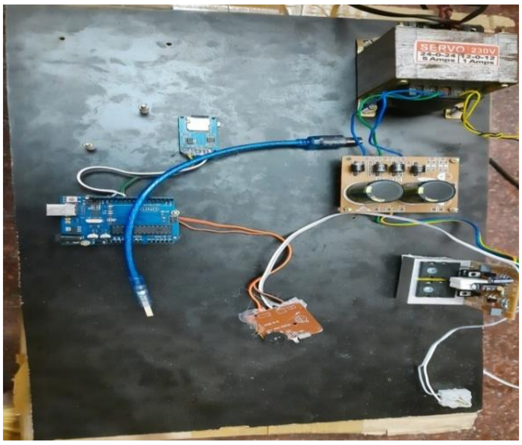

Fig.8 Experimental Setup of Fire detection system

Fig.9 Experimental Setup of Fire Extinguishing System

6. METHODOLOGY

Convolutional deep learning algorithms are proposed for early warehouse fire detection. Our system uses deep CNN which facilitates warehouse fire detecting under different conditions. In this work, a modern method of deep learning is used for warehouse fire region detection depending on feature representations from the data and training discriminative classifiers. Deep convolutional neural networks (CNN) is used as the learning machine. We collected the warehouse fire sequence from some previous literature as well as our own dataset and made patch-wise annotations. We use various sensors to measure the warehouse fire/heat of the Warehouse environment and this system avoids granary/product wastage and also intimated to IOT for further actions. We develop advanced concepts of early warehouse warehouse fire detection and warehouse fire extinguishers. An automatic prediction of warehouse warehouse fire using Deep learning. Extinguishes the warehouse fire using acoustic waves.

After the detection of warehouse fire or smoke, we should put-off the warehouse fire. For that, here a new technology is used which is a Sonic Warehouse Fire Extinguisher that extinguishes the warehouse fire by Sound Waves. Generally, warehouse fire is extinguished with the help of water or carbon dioxide. Here, we are extinguishing the warehouse fire through sound bass sounds crazy. As compared to the other chemical compound of classic extinguishers, this invention offers the cleanest way to put-off flames. Once we predict the warehouse fire or smoke by deep learning method, we will send a data to the Arduino UNO micro-controller from the arduino UNO and various sensors. With the microcontroller, a SD card is connected and which is storing the sound files. A speaker and amplifier circuit is connected with microcontroller. Once the micro-controller receives the data for warehouse fire detection from the arduin UNO (ATMEGA 328 microcontroller), the controller will read the sound files from SD card and generate the high frequency sound waves to put-off the warehouse fire.

7. OUTPUT

The warehouse fire image is captured using the ip camera or the web camera and the fire is detected. This detection is sent to the mail saying “Fire Detected”. After detection, the fire is put out with the help of the sonic sound wave. The output image is attached below.

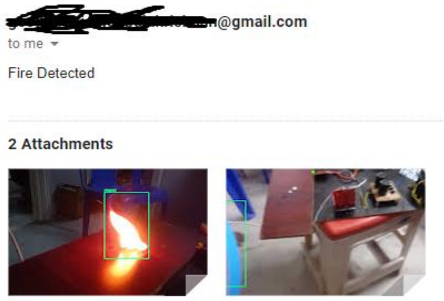

Fig.10 Output Image of the Fire Detection and Extinguishing System

8. RESULT

For the creation of our proposed model, we have used the tensorflow deep learning. The framework provides for the creation of deep networks by choosing appropriate layers and specifying the preceding and succeeding layers in the design. The inputs to the framework can be in the model.ckpt format, which is particularly suitable for the representation of 2D data, such as a kaggle dataset. The steps in preparing the data are explained in the previous section, and are the same for each kaggle dataset image. Hence, we have one model.ckpt model representing all the humans, and each train.csv and test.csv file has the data along with the label. This label is used in both the training and testing phase.

Batch sizes are also variable, and can be set by the user. For large batch sizes, the learning process is significantly slow (requires a few days) and often terminates due to insufficient memory availability. We have used a batch size of 20 for most experiments. The training of the network is run for 120 iterations. After every 100 iterations the network is tested for accuracy. Initial learning rate is set to 0.001 and for every 100 iterations the learning rate drops by a factor gamma=0.1.

9. CONCLUSION

The recent improved processing capabilities of smart devices have shown promising results in surveillance systems for identification of different abnormal events i.e., warehouse fire, accidents, and other emergencies. Warehouse 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 warehouse fire detection systems. Therefore, in this research article, we propose a cost-effective warehouse warehouse 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 warehouse fire. This will enable the video surveillance systems on forest to handle more complex situations in real-world.

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